

RESILIENT INDUSTRIES IN JAPAN

Lessons Learned in Japan on
Enhancing Competitive Industries
in the Face of Disasters Caused
by Natural Hazards



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ACRONYMS AND ABBREVIATIONS

BCAO	Business Continuity Advancement Organization
BCM	Business Continuity Management
BCP	Business Continuity Plan
BoJ	Bank of Japan
BOJ-NET	Bank of Japan Financial Network System
DBJ	Development Bank of Japan
DRM	Disaster Risk Management
EOC/EOT	Emergency Operation Center or Team
EP&R	Emergency Preparedness and Response
ESD	Extremely Severe Disaster
ESRI	Economic and Social Research Institute
GDP	Gross Domestic Product
GEJE	Great East Japan Earthquake
GFDRR	Global Facility for Disaster Reduction and Recovery
GHAIE	Great Hanshin and Awaji Earthquake
ICT	Information and Communication Technology
IoT	Internet of Things
JFC	Japan Finance Corporation
JICA	Japan International Cooperation Agency
LEDIX	Local Economic Driver Index
LLP	Limited Liability Partnership
METI	Ministry of Economy, Trade and Industry
MIC	Ministry of Internal Affairs and Communications
MJN	Miyagi Jo-Net
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MOU	Memorandum Of Understanding
NDRRMC	National Disaster Risk Reduction Management Council
NILIM	National Institute for Land and Infrastructure Management
NOAA	National Oceanic and Atmospheric Administration
NPO	NonProfit Organization
OECD	Organisation for Economic Co-operation and Development
PARI	Port and Airport Research Institute
RA	Reconstruction Agency
RESAS	Regional Economy Society Analyzing System
SME	Small and Medium Enterprise
SMEA	Small and Medium Enterprise Agency
TDB	Teikoku DataBank

Prices are converted to US dollars (\$) at the 2018 annual average exchange rate of \$1 = ¥110, based on the yearly average currency exchange rate provided at: <https://www.irs.gov/individuals/international-taxpayers/yearly-average-currency-exchange-rates>.

EXECUTIVE SUMMARY

Industries create jobs, catalyze investments, and bring technological advancement to a country. However, as industries expand across borders and become increasingly complex, so do their risks, including impacts from disasters and climate change. Disasters,¹ including earthquakes and extreme weather events, are disrupting industrial activities and, as a result, undermining sustainable economic development in many countries. Their effects reveal the fundamentally interconnected nature of our global supply chain: even distant disasters can bring local industrial production to a halt. For example, the Great East Japan Earthquake (GEJE) ultimately affected more than 5,000 of the 30,000 parts used in General Motors vehicles, even though Japan was considered only a minor supplier for the Detroit-based company (Sheffi 2018).

No matter where in the world a country is located, fostering resilience is essential to robust and competitive industrial enterprise. **Industry resilience is defined in this report as the ability of industry sectors, firms, and industrial parks to increase competitiveness by maintaining business continuity and growth in the face of disasters and other unprecedented events.**

While the importance of safeguarding industries against increasing disaster and climate risks is being increasingly recognized, many governments and firms still face barriers to undertaking proactive measures to boost resilience. Steps recommended to overcome key barriers include the following:

- Invest in the capacity of **policy and legal systems** to strategically plan and implement multisectoral solutions in support of resilient industry.
- Establish and strengthen **financial tools and measures** that can direct timely support to industries and firms.
- Increase public and **private sector cooperation** in infrastructure planning and prioritization.
- Promote the representation of **women** in leadership and decision-making roles related to industry resilience to help address the disproportionate disaster-related risks faced by women.
- Apply **technological tools** that enhance evidence-based and timely actions to mitigate damage, support businesses, accelerate recovery, and enhance industry competitiveness.

With the number and intensity of climate- and disaster-induced shocks and disruptions on the rise, it is increasingly important to share related knowledge and solutions across countries. Moreover, as industries around the world are severely affected by the novel coronavirus (COVID-19), focusing on industry resilience may also provide guidance and inspiration on ways to rethink business norms, and to build back robust and sustainable industries for the future.

¹ While hazards can be naturally occurring, they only become disasters when they disrupt human settlements, systems, and resources. Therefore, disasters occur at the intersection of hazards (natural or otherwise) and human decisions, and are not natural events (Chmutina and Von Meding 2019). Therefore, in this report, we use the term "disaster" rather than "natural disaster" wherever appropriate.

The objective of this case study on Japan is to share lessons drawing upon Japan's experience of industrial development in the face of diverse disaster risks. The report will focus on the manufacturing sector, given its importance to Japan's economic development, and interconnection with extensive global value chains. The Japanese solutions for resilient industry gathered in this report complement those put forward in the World Bank report "**Resilient Industries: Competitiveness in the Face of Disasters**" (forthcoming 2020), which includes a Resilient Industry Framework. This framework details several ways in which disaster and climate change considerations can be mainstreamed in the various industrial development investment projects the World Bank supports across diverse countries and regions.

CONTEXT OF RESILIENT INDUSTRY IN JAPAN

Japan's capacity to offer lessons for resilient industry stems from a long history of both developing its manufacturing industry and living with natural hazards. The manufacturing sector has been the main catalyst of Japanese economic development since the nation's industrialization in the second half of the 19th century. Although the sector's share of gross domestic product (GDP) has declined slightly over time, it remains important to the nation's economic development and social welfare through the jobs and value it creates. The development of industry in general and the manufacturing sector in particular has been a key national priority, promoted by various policies and institutions.²

Japan is subject to a variety of frequent natural hazards that have the potential to inflict significant economic damage. Major historic disasters have included volcanic eruptions, earthquakes, tsunamis, typhoons, coastal and inland flooding, landslides, and fires. The GEJE and the 1995 Great Hanshin and Awaji Earthquake ranked first and third, respectively, among the costliest natural loss events worldwide between 1980 and 2018 (EM-DAT 2019; Munich RE 2020). The economic damages of the GEJE are estimated between ¥16 trillion and ¥25 trillion (\$145 billion and \$227 billion), and although it struck a relatively rural region it contributed to a 3.5 percent contraction in the Japanese economy in the first quarter of 2011 (Ranghieri and Ishiwatari 2014). In addition to their devastating impacts on society at large, both the direct and indirect effects of disasters have placed a heavy burden on Japan's industry sectors, and in turn its economy. Between 1985 and 2018, 14.3 percent of global economic losses due to disasters occurred in Japan—the second-largest share of disaster-related losses in the world, following the United States (SMEA 2019). Nevertheless, through continuous efforts to learn from experience, Japanese public institutions and private firms have worked toward building back better and more resilient industry each time. Major disasters in Japan have provided catalysts for innovative policies, tools, and programs to this end. Thus, although industries in Japan are highly exposed to natural hazards, they have succeeded in creating resilient structures and practices that reduce the impacts of disasters, including the construction of infrastructure to protect people and businesses from disaster risks as well as the promotion of resilient businesses through business continuity planning.

SOLUTIONS FOR RESILIENT INDUSTRY IN JAPAN

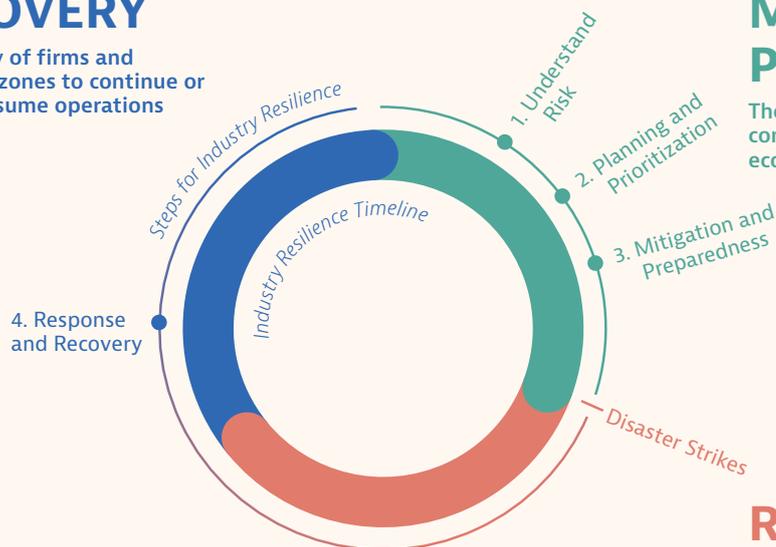
Resilient industry relies on the ability of firms, sectors, and industrial parks to increase their competitiveness by sustaining operations and growth in the face of ever more frequent and intensifying disasters, and other unprecedented events (World Bank 2020). This report identifies the stakeholders and solutions driving resilient industry in Japan, with a focus on the manufacturing sector.

² See table 2.1 in chapter 2 for details on the history of how policies and institutions have supported resilient industry in Japan.

FIGURE ES.1 Resilient Industry: A Timeline of Key Actions

RECOVERY

The ability of firms and economic zones to continue or quickly resume operations



MITIGATION & PREPAREDNESS

The ability to sustain and increase competitiveness of firms and local economies

RESPONSE

The ability of firms and economic zones to minimize direct damages through proper emergency operations and to prevent secondary or cascading damages

Source: Original compilation.

TABLE ES.1 Topics Covered in this Report

Topic	Types covered in report
Solutions	Policy and legislative, financial and economic, infrastructure, gender, and technology and innovation
Natural hazards	Geophysical—earthquakes, tsunamis, and volcanoes Hydrometeorological—floods (caused by heavy rain and typhoons) and storm surges
Stakeholders	Public sector—national and local government, infrastructure operators, etc. Manufacturing—firms, including small and medium enterprises, value chains, etc. Industry—zones operators, associations, etc. Financial sector—banks, insurance companies, etc. Civil society—various organizations, including women’s associations
Sectors	Manufacturing sector and related sectors that enable its operations, such as energy, water and sanitation, transport (roads, rails, ports, etc.), trade, industry, construction, finance, etc.

Source: Original compilation.

Note: The stakeholders listed are only those examined in the report, and do not include all of those important to the manufacturing sector (e.g., retail and logistics).

How Is Industry Resilience Fostered?

In the context of Japan, this report focuses on the ability of governments, firms, and industrial parks³ to identify disaster-related risks to industries; minimize losses and damages (through mitigation and preparedness); continue or quickly resume operations (response); and sustain and increase the competitiveness of firms and local economies following a disaster event (recovery). As outlined in figure ES.1, these actions are critical to building resilient industry, and may be described in more detail as follows:

- **Understanding risk.** In order to enhance their resilience, it is first necessary to understand the risk that firms, industrial areas, key infrastructure assets, and supply chains are exposed to from disasters and climate change. This includes identifying types of hazards as well as estimating their likelihood and potential impacts on industry operations. Risk assessments can focus on one or more hazards and should be tailored to stakeholders' objectives.
- **Planning and prioritization.** Once risks are clear, the next step is for industry stakeholders to develop a plan of action. The planning process should involve prioritizing strategic investments and activities, and establishing institutional frameworks for implementation. Planning can occur at multiple levels, such as via existing national and subnational planning processes, at the level of the industrial park, or within firms.
- **Mitigation and preparedness.** In line with established plans, structural and nonstructural resilience measures can be implemented. Advance actions and investments can reduce damages and help industries to continue or quickly recover critical operations during a disaster. Mitigation and preparedness measures help firms secure the resources needed for such operations. Some measures are structural in nature—such as the construction and strengthening of infrastructure—and their specifics will necessarily vary based on hazard type. Nonstructural measures—such as improving communications, decision-making, and cooperation with outside firms and agencies—are more likely to be applicable across multiple disaster situations.
- **Response and recovery.** When a disaster does strike, response plans created in advance should be activated and followed. Response and recovery measures are triggered based on predetermined criteria. Training and procedures for information management will help stakeholders properly estimate the extent of a crisis. Effective response and recovery measures focus on regaining key functions required for the continuity of critical operations: ensuring the safety of workers and human assets, restoration of facilities and equipment, external communication and coordination, financial management, and logistics. Some firms may also support their surrounding community's response and recovery in the event of a disaster. As industries are a key part of local and national economies, it is important for industry stakeholders to participate in discussions on long-term recovery processes and also help advance opportunities to further enhance resilient industries and economic development. Each disaster is also an opportunity to reflect on the response and recovery process in order to identify improvements for the future.

3 An industrial park—also known as an economic zone, industrial area, industrial zone, industrial investment region, special economic zone, or industrial corridor—is an area planned, developed, and managed for the purpose of industrial and associated commercial, infrastructure, and service activities. Groups of interrelated or non-interrelated businesses (tenant firms) in an industrial park drive wealth creation in a region. For more information, see World Bank (2017).

Who Are the Key Stakeholders and Why Should They Work Toward Industry Resilience?

While the programs, policies, and projects discussed here were developed in Japan's particular economic, social, cultural, and hazard context, the general lessons that the country has learned have relevance for other countries in their efforts to mitigate the impacts of disasters and climate change on their industries. Given the importance of engaging diverse stakeholders and furthering collaboration across sectors, this report identifies the following sector-based lessons for resilient industry. These are general lessons that, in real life, must be carefully adapted to local contexts and capacities.

- **The public sector (national and local government, infrastructure operators, etc.)** can drive resilient industry through policies and institutions that incentivize public and private stakeholders to plan and implement risk reduction investments, contingency and continuity planning, and response mechanisms well in advance of a disaster. Efforts toward industry resilience should include the development of national-level plans as well as land-use planning for industry sites. The public sector also plays a significant role in advancing the resilience of key public infrastructure and the lifeline utilities (e.g., water, energy, and telecommunications) that industry relies on for its continuity and competitiveness. Wherever possible, the public sector should explore strategic partnerships with the private sector in financing, operation, maintenance, and postdisaster response.
- **For the manufacturing sector (firms, value chains, etc.),** planning for emergency preparedness, response, and business continuity is vital to competitiveness. Low-cost, pragmatic preparedness measures may be undertaken in strategic cooperation with national and local governments, firms within the same industry or industrial park, and financial institutions. To ensure industry continuity and competitiveness, it is best to plan measures across the global value chain.
- **Industry stakeholders (industrial park operators, associations, etc.)** would do well to strengthen zonewide capacities for disaster risk preparedness and response. Manufacturing industries are often clustered together in parks, making them key sites for collaborative resilience interventions. Key resilience strategies include promoting mutually beneficial business continuity plans (BCPs) among member firms. Industry stakeholders can also help build strategic partnerships between member firms and governments, critical infrastructure operators, and financial institutions for disaster contingency planning. Industrial parks may be able to gain collective access to financing for resilient infrastructure improvements and postdisaster support.
- **The financial sector (public and private banks, insurance companies, etc.)** can incentivize the manufacturing sector and industry stakeholders to enhance their disaster preparedness, as well as provide financial measures that enable firms and industries to continue operations or quickly recover (and reconstruct) after disasters. Strategies include providing financial incentives, such as preferential loans, insurance premiums, or guarantees to "resilient" firms and industrial parks with BCPs, or to parkwide flood management investment projects. Particularly for small and medium enterprises that may have limited financial reserves to absorb shocks, banks can also create prearranged contingency financing mechanisms for postdisaster low-interest loans, or grace periods for loan repayment. There is also a need for disaster insurance mechanisms to evolve, in order to minimize the processes and time required for payout, for example, through the development of parametric insurance products and the utilization of new technology.

What Actions Can Be Taken to Improve Industry Resilience?

Industry activities can be reduced or halted when the flow of goods, people, financing, and information is disrupted due to a disaster's impacts on infrastructure assets and services. When disasters strike, a combination of tools become necessary to support industries in facilitating the continuity and recovery of the various elements of their activities. By maintaining or recovering the flow of goods, people, financing, and information, industries can minimize damage and disruption, and recover quickly. While diverse solutions exist and continue to evolve and expand, we highlight the following eight approaches to promoting resilient industry in Japan.

1. Mainstreaming resilient industry within policy and institutional frameworks.
2. Promoting business continuity planning and management at various levels.
3. Identifying win-win collaborations for resilient industry through pre-arranged agreements among stakeholders.
4. Minimizing the impacts of infrastructure disruptions through new technology.
5. Fostering public and private sector partnerships⁴ for disaster mitigation infrastructure for industrial parks.
6. Utilizing big data and data visualization technologies for evidence-based resilient industry policy making.
7. Providing safety nets and financial mechanisms for small and medium enterprises to secure their cash flow in the face of disaster shocks.
8. Addressing postdisaster challenges to women's empowerment in industries.

These approaches have been synthesized based on the case study analysis included in the appendix to this report.

KEY LESSONS AND NEXT STEPS

The continuity and quick recovery of industries is critical to the economy, and is best supported by strategic collaboration across sectors. The public sector has a significant role to play in catalyzing discussions to identify opportunities for mutual support.

Disasters in Japan affect an array of stakeholders involved in manufacturing-related industries, including the public sector (national and local government, infrastructure operators, etc.), the manufacturing sector (firms, value chains, etc.), industrial parks (operators, associations, etc.), and the financial sector (banks, insurance companies, etc.). These stakeholders all want to enhance resilient industry, but face limitations in reducing their risks when actions are taken individually. In Japan, disasters have provided opportunities to share risks and responsibilities for mutual gain. One example is the Akemi Industrial Park in Aichi Prefecture, which initiated parkwide business continuity planning in 2008 to address exposure to earthquakes, tsunamis, and other hazards. The planning also involved coordination with local and national governments, including developing communication strategies for times of disaster. National and local governments have

⁴ While in some contexts, public-private partnerships refer to projects where private firms provide public services for a profit with government support or risk-sharing, in this context we use the term in its most general sense, for a project that includes both public and private stakeholders working to achieve mutual aims.

played a significant role in convening and facilitating dialogue between various stakeholders to identify strategic partnerships. Successful collaborations have centered on priorities such as promoting business continuity planning in firms and industrial parks, avoiding human and critical asset losses, strengthening critical infrastructure, and learning from and scaling up good practices innovated by the private sector.

Enhancing access to diverse and comprehensive disaster risk financing mechanisms before, during, and after a disaster event is essential for the continuity, competitiveness, and survival of industries. Ex ante financing mechanisms, such as low-interest loans, guarantees, insurance, or grant schemes, are important to incentivize and enable firms, industrial parks, and governments to invest in risk mitigation and preparedness measures to reduce the impacts of potential shocks. Similarly, ex post measures, such as prearranged no- or low-interest loans, debt relief or extended grace periods, alternative guarantee mechanisms, parametric insurance, as well as diverse grant mechanisms and safety nets—especially for small and medium enterprises and women-owned businesses—could enable quick, effective, and equitable access to financial resources, and relief from financial burdens during and after a disaster event. Disaster risk financing solutions have served as a key resilience measure for Japanese industry by alleviating cash flow constraints that often threaten the survival and competitiveness of firms. Studies of the impacts of the GEJE found that 90 percent of disaster-induced bankruptcy was due to indirect impacts such as the contraction of consumption or disruption of the supply chain, rather than direct impacts to assets, such as building destruction or inundation. In the six years following the GEJE, firms located in Tokyo, away from the epicenter of the disaster, accounted for a greater share of bankruptcy declarations, at 23.4 percent, than did firms in the Tohoku region, at 20.0 percent (TDB 2018). Analysis specific to manufacturing industries found that firms without risk financing measures in place had increased their debt by about 10–20 percent, a much higher level than those with risk financing measures such as earthquake insurance in place (Matsushita and Hideshima 2014).

Minimizing the disruption of lifeline infrastructure services, such as water, energy, transport, and information and communication technology, is critical for industries to remain connected to their supply chains, and to access resources needed for quick response and recovery efforts. While the public sector plays the leading role in ensuring infrastructure's resilience in Japan, innovative public-private agreements have enabled substantial reductions in the length of time that services are disrupted. For example, highways were reopened six days after the GEJE, via the activation of prearranged contracts between local construction companies and the Ministry of Land, Infrastructure, Transport, and Tourism (Ranghieri and Ishiwatari 2014). Private firms in Japan have also leveraged new technologies for lifeline infrastructure services, such as water and energy, maintaining a minimum level of operation through cost-effective, localized backup power and water systems.

Technological advancement and innovation can enhance the policy, finance, and infrastructure solutions supporting resilient industry. Various efforts to develop and apply relevant technologies are emerging in Japan, in areas such as supply chain data analysis and visualization, asset monitoring and management, decentralized water and power backup, remote control systems, and postdisaster damage assessment and reporting tools. The Regional Economy Society Analyzing System (RESAS), developed by the Cabinet Office and the Ministry of Economy, Trade and Industry (METI) in cooperation with several private companies, enables the visualization of public and private big data on industrial structures or population movement and flows. This in turn supports local governments and communities in the creation of evidence-based postdisaster reconstruction plans. Reflecting the lessons learned from the GEJE, Toyota has spearheaded a comprehensive energy management system for one of its industrial parks. This promotes energy efficiency in normal times, and features a backup power supply system during times of disaster.

Disaster and climate change impacts on industries affect men and women differently. Given the diverse and critical roles that women play as industry leaders and workers, as well as in homes and communities, targeted strategies to empower and enable women's participation and access to resources to better prepare and respond to disasters are needed. In the event of a disaster, preexisting challenges and inequities are often exacerbated. For example, after the GEJE, the number of women in disaster-affected prefectures who filed for unemployment support exceeded men, as did the length of time of their support. This is largely due to the fact that women are more likely to be in nonregular employment (such as hourly or contract work) than men. Also, priority jobs during the immediate response and recovery phase were largely in construction, an industry with limited numbers of women (Cabinet Office 2012). Access to finance was also a challenge for the many women aiming to start their own businesses in light of limited employment opportunities. Training programs provided by women's support groups played a critical role in helping women entrepreneurs navigate complex application and review processes. In sum, however, examples of good practices in gender-sensitive resilient industry solutions are still limited in Japan and call for further research and action.

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1

INTRODUCTION

Resilience has become an integral element of Japan's competitive industries. Through its long history of recovering from numerous megadisasters, Japan has developed various strategies for minimizing losses and damages from disaster events. This has allowed the nation to sustain and develop successful industries in the face of ongoing and acute disaster risks. For Japan, disasters are also an opportunity for innovation. Following the Great East Japan Earthquake (GEJE), a *New York Times* headline summarized this process: "From One Tragedy, Tools to Fight the Next" (LaPorte 2012). With innovative tools that range from tsunami escape pods to resilient off-grid infrastructure systems to financial instruments promoting disaster preparedness, Japan's experience shows that being highly exposed to disasters can lay the groundwork for a resilient and innovative manufacturing-fueled economy.

1.1 REPORT OBJECTIVE

This case study draws upon Japan's experience of industrial development in the face of diverse and frequent disaster risks to share lessons learned surrounding resilient industry. The study gathers and reviews examples of how Japanese industries, particularly in the manufacturing sector, have recovered from disasters, highlighting key challenges to sustaining manufacturing operations and industry competitiveness. It further analyzes and showcases some of the lessons learned and effective measures that were developed to enhance resilience to future disasters.

The Japanese solutions gathered in this study inform the World Bank report "Resilient Industries: Competitiveness in the Face of Disasters" (World Bank 2020), which details the ways in which disaster and climate change resilience considerations can be mainstreamed within the various industrial development investment projects the World Bank supports across countries and regions. Together with the concurrently published global report "Resilient Industries: Competitiveness in the Face of Disasters" (World Bank 2020), this Japan-focused report is the first of many efforts toward mainstreaming disaster risk management in the process of sustaining competitive industries. In this initial phase, the study focuses on the manufacturing sector. The intended audience of this report includes government officials and manufacturing industry practitioners who are tasked with safeguarding industry development and competitiveness in the face of growing disaster and climate change risks. Given Japan's particular disaster risk profile, many of the solutions outlined in this study are geared toward earthquakes and tsunamis. However, many such solutions will also be applicable to climatic hazards such as floods and typhoons, and also pandemics. As climate-linked disasters pose a growing risk globally, it is increasingly important to incorporate resilience across all aspects of society, including industry. Moreover, as industries around the world are severely affected by the novel coronavirus (COVID-19), the study may also provide guidance and inspiration on ways to rethink business norms, and to build back resilient industries for the future (see section 4.2).

1.2 IMPORTANCE OF RESILIENT INDUSTRIES

Industrial activity creates jobs, catalyzes investments, and brings technological advancement into a country. Since industry⁵ plays an integral role in a society and economy, the government's support for industry sectors⁶ is often critical to sustainable and equitable development, especially for nations undergoing rapid economic and social transformation.

However, industries are increasingly threatened by risks associated with disasters and climate change. Disasters including earthquakes, extreme weather events, and disease outbreaks are disrupting industrial activities and as a result undermining sustainable economic development in many countries. Due to limited resources for and awareness of preparedness, and poor industrial and public infrastructure, industries in less developed countries are particularly vulnerable to the impacts of disasters and/or climate change as they face limitations in the expertise and resources to identify, mitigate, and respond to the shocks and disruptions caused by disasters. Furthermore, as the supply chains and value chains of industries continue to expand across international borders, the economic and social impacts of industry disruptions due to disasters also grow—affecting not only local livelihoods, but also local (subnational), national, and global economies.

As these risks to industries increase, businesses are increasingly aware that implementing resilience measures is critical for their business continuity, competitiveness, and survival.⁷

Strengthening the resilience of industries through enhanced disaster risk management actions undertaken by various stakeholders can help secure the basic societal infrastructure (electricity, gas, water supply and sanitation, fuel, transportation networks and logistics hubs, etc.) needed for a minimum standard of daily life and economic activity; minimize disruptions to supply chains and value chains; transmit information that can mitigate and reduce human and financial losses; enable prompt emergency rescue and treatment of people and critical assets following a disaster; and as a result avoid or minimize the overall disruption and recovery time of businesses. These resilience measures are also economically strategic to firms, as they may expand their competitiveness, increase their operations, increase confidence and trust among their buyers and consumers, and increase the value of their shares. Resilient industries can also help prevent uncontrollable secondary disasters, such as large-scale fires or infectious diseases, from breaking out in the wake of a primary disaster, fostering regional economic recovery. Furthermore, strengthening preparedness and response capacities is important for meeting the challenges of various types of disasters and shocks, and not only those caused by natural hazards. For example, having a strong business continuity plan and management framework in place is helpful in prioritizing actions needed to maintain essential operations, minimize losses, and recover quickly after a pandemic, social insurgence, or financial crisis.

In light of this context, there is a growing interest in enhancing industries' resilience; however, knowledge and tools are still limited. Policy makers are increasingly aware of the importance of integrating disaster risk considerations into industry development strategies and investments, as well as incorporating strategies for resilient industry in disaster preparedness and response policies and initiatives. However, until today, industry development experts (most often in the private sector) and disaster management and climate change experts (often in the public sector) have

5 In this report, "industry" is used broadly to encompass those companies and activities that create materials, goods, and services for economic purposes, often in a factory, firm, or special area such as an economic zone.

6 In this report, "industry sectors" refer to World Bank Sector Taxonomy Definitions (Revised July 2016) of the Industry, Trade, and Services (YX) Sector that includes: agricultural markets, commercialization and agribusiness, housing construction, trade, services, manufacturing, tourism, public administration (industry, trade, and services), and other industries, trade, and services. For more information, see: <http://pubdocs.worldbank.org/en/>.

7 For example, the proportion of companies in Japan that have adopted BCPs has increased rapidly: 11.3 percent in 2009, 15.0 percent in 2010, 28.9 percent in 2011, 30.5 percent in 2013, and 48.1 percent in 2015 (METI 2019).

had limited experience working together in local, national, and global forums. This case study aims to fill key knowledge gaps in order to support practitioners working to enhance resilient industry.

1.3 DEFINING RESILIENT INDUSTRIES

In this report, we define the resilience of industries as the ability of industry sectors, firms, and industrial parks to increase competitiveness by achieving continuity and growth in the face of ever more frequent and intensifying disasters, and other unprecedented events.

In face of disasters, resilient industries can:

- **Minimize losses and disruptions** of physical and human assets and key business operations, minimizing the shut down time and associated losses for both organizations and individuals. Effective actions taken before, during, and immediately after a disaster event are critical.
- **Continue or quickly resume operations** during and immediately after a disaster event. Business continuity and disaster response plans are best made in advance, and outline the priority operations, actions, and measures that need to take place in the event of a disaster. These may include actions to protect and ensure the safety of workers and critical assets, and to prevent or minimize shutdown of essential business operations through quickly accessing important human, material, financial, and information resources.
- **Sustain and increase industry competitiveness** after disaster events through effective response and recovery actions. After large-scale disasters, industries are often required to sustain business and jump back quickly within a contracted market or a different economic landscape. For firms with sufficient capital, disaster damages can create an opportunity to update outdated technologies and equipment, contributing to long-term growth.⁸ Reducing disaster risks and other resilience actions can also benefit firms in normal times by lowering risk aversion, encouraging firms and investors to take on positive risks and expanding economic potential (GFDRR 2015). Building postdisaster industry competitiveness may require innovation to regain market share and consumer confidence, as well as build back a better business, rather than returning to business as usual. Building such competitiveness may take time; exploring the various postdisaster financial resources and tools in advance is critical to avoid bankruptcies.
- **Provide broader economic, social, and environmental cobenefits** during normal times and disaster events (GFDRR 2015). These cobenefits encourage public and private investments in resilient industries by providing benefits not only during disasters, but also during normal times.

Address both the direct and indirect impacts of disasters on industries, which is critical in strengthening the resilience of industries. A disaster's direct impacts on firms and industrial parks, workers, and related infrastructure include damage to buildings, facilities, equipment, and/or manufactured goods, as well as serious injuries to employees and workers. Direct costs include those required to repair, replace, or treat the physical damages caused by a disaster event.

⁸ Empirical studies, including Skidmore and Toya (2002), have empirically shown that the frequency of natural disasters is positively correlated with human capital accumulation, total factor productivity (TFP) growth, and gross domestic product (GDP) per capita growth, which are deemed to be driven by the absorption of new technologies. Following any major disaster, Japan was able to learn from response and risk reduction challenges, and enhanced future preparedness through postdisaster technology innovation. For more information, see World Bank (2019, chapter 11).

Industrial parks and firms that are not resilient in the face of disasters also have the potential of creating secondary hazards such as fires or chemical spills. Indirect impacts include disaster-induced loss of business or economic activities. Even if firms or industrial parks are not directly affected by a disaster, they can be indirectly affected if suppliers, consumers, or infrastructure that service and connect to their supply chain have been damaged by disaster, and as a result disrupt operations. The indirect impacts of disasters also significantly influence industry competitiveness.

Several key barriers to building up industry sectors' resilience are listed in box 1.1.

BOX 1.1: Barriers to Resilient Industries

Policy and legislative:

- Lack of perceived government responsibility for protecting private firms from disaster impacts
- Lack of understanding and awareness of disaster risks from an industry perspective
- Limited incentives for firms to invest in early actions

Financial and economic:

- There are insufficient data on the economic and financial impacts of disasters at the level of the value chain, nation, region, and individual firm.
- Small and medium enterprises are often hardest hit by disasters (in comparison to larger corporations) but have less means to prepare and/or recover. Such enterprises are likely to have low liquidity, cash flow, and credit scores before, during, and after disasters.
- There is a lack of access to finance to support firms' resilience investments.

Infrastructure:

- While governments are mandated to prioritize the infrastructure needed for the relief and recovery of citizens, there are little to no formal mechanisms to facilitate the infrastructure recovery needed by industries and firms.
- Policies, regulations, and incentives to minimize the disruption of infrastructure-servicing industries need to be enhanced.

Gender:

- Vulnerable groups including women experience undue challenges even during normal times, and these are likely to be amplified by a disaster. These groups are likely to have unique postdisaster needs.
- Very little information is available on the specific challenges faced by women and vulnerable groups during and after a disaster from the perspective of resilient industries.

Technology:

- There is a need for improved research on technological challenges and relevant solutions for resilient industries.
- The report "Resilient Industries: Competitiveness in the Face of Disasters" (World Bank 2020) further describes the details of these barriers.

1.4 CASE STUDY METHODOLOGY

The case studies outlined in this report aim to identify scalable resilient industry solutions informed by experiences and lessons learned in Japan. It analyzes how major disasters in Japan have influenced industries, especially in the manufacturing sector, which is key to the competitive edge of Japan's economy. It also aims to understand why, who, and what types of measures have been implemented to avoid or reduce disaster impacts to industries; explore the challenges and lessons learned from the implementation of these measures; and to recommend ways to further scale and apply these resilient industry solutions outside Japan.

A range of resilient industry solutions have been chosen, showing the variety of required measures. These include setting up new policies and legislation, transforming infrastructure planning and development processes, developing new financial tools and mechanisms, including gender perspectives, and leveraging new tools and technologies. The diverse solutions covered in this study are summarized in table 1.1.

The report was developed from primary and secondary sources and expanded through interviews with stakeholders regarding recent major disasters in Japan. Interviews were conducted with representatives of the public sector (national and local government, infrastructure operators, etc.), the manufacturing sector (firms, value chains, etc.), industry (industrial park operators, associations, etc.), the financial sector (banks, insurance companies, etc.), and civil society groups (including women's associations).

TABLE 1.1 Topics Covered in this Report

Types	Categories
Solution	Policy and legislative, financial and economic, infrastructure, gender, and technology and innovation
Natural hazards	Geophysical—earthquakes, tsunamis, and volcanoes Hydrometeorological—floods (caused by heavy rain and typhoons) and storm surges
Stakeholders	Public sector—national and local government, infrastructure operators, etc. Manufacturing—firms, including small and medium enterprises, value chains, etc. Industry—park operators, associations, etc. Financial sector—banks, insurance companies, etc. Civil society—various organizations, including women's associations
Sectors	Manufacturing sector and related sectors that enable its operations, such as energy, water and sanitation, transport (roads, rails, ports, etc.), trade, industry, construction, finance, etc.
Criteria used to select solutions	Empirical—solutions that have been implemented and tested Evidence based—information is available on how and why the resilience measure was implemented, and the enabling environment that was required Measurable—quantitative and/or qualitative data are available to assess the efficacy of implemented solutions Transferable—potential applicability of solutions and lessons to diverse stakeholders and contexts beyond Japan

Source: Original compilation.

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2

INDUSTRIES AND DISASTERS IN JAPAN

This chapter provides an overview of how Japan has developed its industries over time while experiencing numerous large-scale disasters. Section 2.1 provides an overview of industries in Japan, the important role the manufacturing sector continues to play in the economy, and some of the key opportunities and challenges for future development. Section 2.2 illustrates how Japanese industries have been affected by various disasters. The section reviews recent large-scale disasters and breaks down the complex relationships and impacts of disasters on diverse aspects of industries, including firms (enterprises and establishments⁹), workers, critical infrastructure, financial institutions, industrial parks, and local, regional, national, and global economies and value chains.

2.1 INDUSTRIES IN JAPAN

Overview of Japanese Industries

Japan has a large and mature economy with a significant manufacturing industry. Although physically a relatively small archipelagic nation, Japan has a population of over 126 million¹⁰ and an economy ranked third in the world following the United States and China, with gross domestic product (GDP) of \$4.971 trillion¹¹ in 2018 (Cabinet Office 2020). While the economic share of manufacturing as a percentage of GDP has been declining since the 1980s globally, including in Japan (figure 2.1), manufacturing is the largest sector in terms of value added as a percentage of GDP, accounting for 21 percent of Japanese nominal GDP, followed by wholesale and retail (14 percent), and real estate (11 percent) (figure 2.2).

Within manufacturing, transportation machinery (including a strong auto industry) continues to be one of Japan's leading industries (16 percent) followed by machinery production (15 percent) and food processing (12 percent) (METI 2019a). Japan also has a strong technology manufacturing sector with advanced technology representing 17 percent of exports (Cabinet Office 2020). Figure 2.2 provides an overview of the nominal GDP sector composition in Japan in 2018.

The manufacturing sector continues to play a critical role in the Japanese economy and society due to the number of businesses and jobs it creates. In 2016, over 3.5 million enterprises (both companies and sole proprietors) were reported operational in Japan. Of these, manufacturing accounted for 11 percent of the total, or nearly 380,000 enterprises, the second-largest share after wholesale and retail (SMEA 2019). Even as total sales of manufacturing came second after wholesale and retail in 2015,¹² in terms of value added, manufacturing ranked the highest at 24.7 percent. In 2016, manufacturing was the second-largest employer after wholesale and retail; the sector employed more than 6.2 million people (including full time, part-time, and contract employees), accounting for 22 percent of total industry workers¹³ in Japan.

9 An enterprise is a legal person (excluding foreign companies) or a privately managed establishment operating a business. If two or more privately managed establishments are operated under a single management, these establishments compose one enterprise. An establishment is a unit of location (a demarcated area) with proper equipment and personnel to produce goods or to render services continuously under a single management. Based on the Statistics Bureau of Japan: <http://www.stat.go.jp/english/data/nenkan/1431-07e.html>.

10 Based on World Bank DataBank Country Profile. For more information, see: <https://databank.worldbank.org/views/reports/reportwidget.aspx?ReportName=CountryProfile&Id=b450fd57&tbar=y&dd=y&inf=n&zm=n&country=JPN>.

11 Based on the 2018 annual average exchange rate of \$1 = ¥110.

12 Total sales in all industries across Japan in 2015 were ¥1,603.5 trillion (\$14.58 trillion), while value added was ¥294.8 trillion (\$2.6 trillion). Sales for wholesale and retail amounted to ¥500.8 trillion (\$4.6 trillion) (31.2 percent) and for manufacturing, ¥396.3 trillion (\$3.6 trillion) (24.7 percent). Value added in the manufacturing industry accounted for ¥68.8 trillion (\$625.5 billion) (24.9 percent), and in the wholesale and retail trade industry this was ¥54.2 trillion (\$492.7 billion) (18.2 percent). For more information, see: https://www.meti.go.jp/english/press/2017/0531_005.html; https://www.stat.go.jp/data/e-census/2016/kekka/pdf/k_yoyaku.pdf.

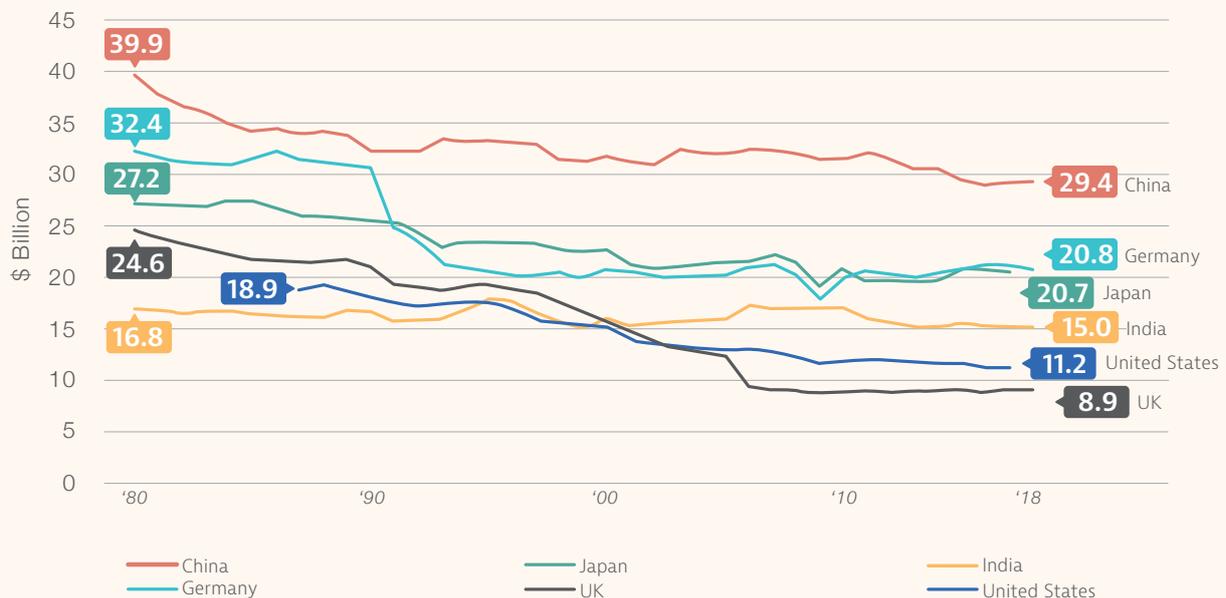
13 Total industry workers were estimated at approximately 46.8 million in 2016. Excludes agriculture. For more information, see: https://www.chusho.meti.go.jp/koukai/chousa/chu_kigyocnt/181130kigyoyou4.pdf.

SMEs drive the Japanese manufacturing industry. More than 99 percent of all enterprises in Japan are SMEs¹⁴ across all sectors, including manufacturing; 61 percent, or approximately 5.5 million of manufacturing workers, are employed by SMEs.

The Japanese workforce is aging and becoming less formalized. While more women are joining the workforce, many are nonregular employees, including part-time and contract employees. In 2019, the number of employed persons across Japan was 67 million, including 30 million women (45 percent); 35 million workers were regular employees, while 22 million were nonregular employees.¹⁵ Employment rates were 70 percent for men and 52 percent for women. The overall unemployment rate in 2019 was 2.4 percent. Compared to the previous year, the rate of full-time employment for women increased while the rate for men decreased. In part-time and contract employment, the shares of both men and women increased, and the women's share remained larger (Statistics Bureau of Japan 2020).

Within manufacturing, transportation machinery (including a strong auto industry) continues to be one of Japan's leading industries (16 percent) followed by machinery production (15 percent) and food processing (12 percent) (METI 2019a). Japan also has a strong technology manufacturing sector with advanced technology representing 17 percent of exports (Cabinet Office 2020). Figure 2.2 provides an overview of the nominal GDP sector composition in Japan in 2018.

FIGURE 2.1 The Global Decline of Manufacturing, 1980–2018



Source: Retrieved from Statista (2019).

Note: Manufacturing value added as a percentage of GDP.

14 SMEs are defined under the Small and Medium-size Enterprise Basic Act as: manufacturing industries with capital up to ¥300 million (\$2.73 million) or up to 300 employees; wholesale industries with capital up to ¥100 million (\$0.91 million) or up to 100 employees; service industry with capital up to ¥50 million (\$0.45 million) or up to 100 employees; retail industry with capital up to ¥50 million (\$0.45 million) or up to 50 employees. For more information, see: https://www.chusho.meti.go.jp/pamflet/hakusyo/2019/PDF/2019hakusyosummary_eng.pdf.

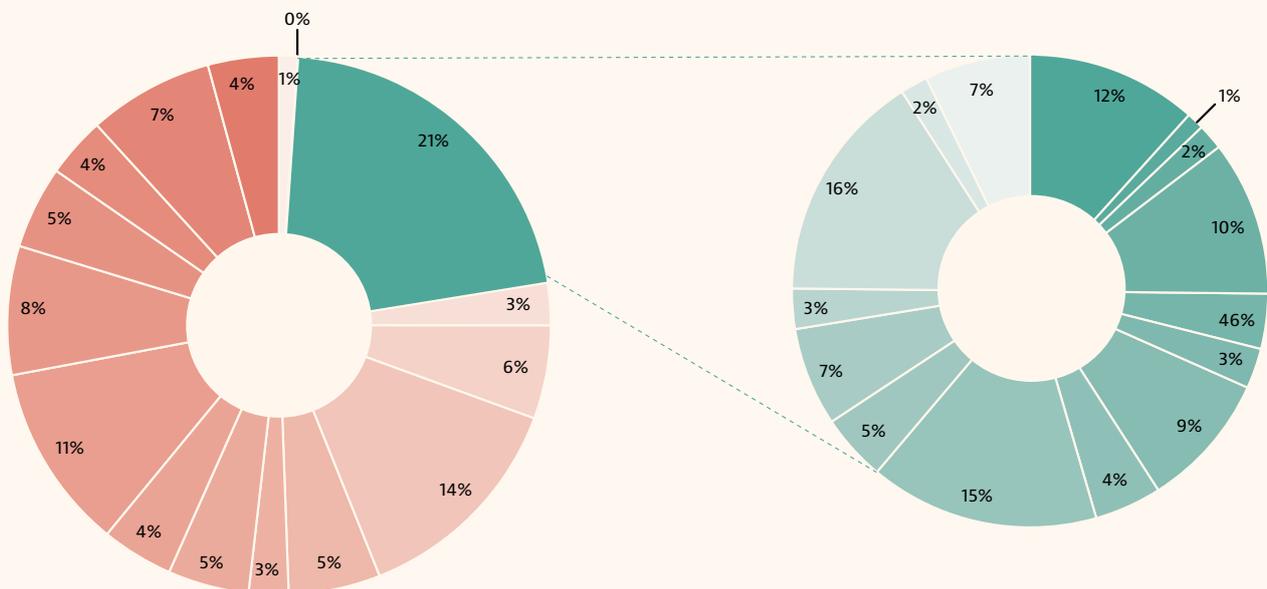
15 Regular workers includes full-time staff and employees. Nonregular workers include part-time workers, employees dispatched from temporary agencies, contract workers, nonregular employees, and other types of non-full-time employments. For more information, see: <https://www.stat.go.jp/data/roudou/sokuhou/nen/ft/pdf/index1.pdf>.

FIGURE 2.2 Nominal GDP Sector Composition in Japan, 2018
(at current prices, national currency)

Share of GDP (Current US\$) in 2018 \$4.971 trillion



Breakdown of Manufacturing Activities



Source: Original compilation based on Cabinet Office (2020).

Note: GDP = gross domestic product; ICT = information and communication technology.

The global competitiveness of Japanese industries is anchored by Japan's automobile-related industries. Japan's global share of electronics materials and equipment is also significant. A study¹⁶ on Japanese firms' global competitiveness relative to the United States, Europe, and China found 26 Japanese products with sales of more than ¥1 trillion (\$9.1 billion) in the global market (as of 2016). With annual sales of ¥63.0 trillion (\$572.7 billion), Japan is highly dependent on automobile manufacturing (METI 2019a). Japanese firms held a 60 percent or more market share in 270 product groups¹⁷ globally (30 percent of all product groups reviewed), or more than the United States, Europe, or China. A majority (60 percent) of these product groups were related to electronics materials and equipment, followed by automobiles (18 percent).

¹⁶ The study surveyed global firms that produced including typical products, intermediate products, and components (for a total of about 1,200 items). Japanese companies were assessed to analyze their global competitiveness.

¹⁷ The products include those related to the electronics, automobile, biomedical, and medical industries.

LOCATIONS OF INDUSTRIES IN JAPAN

Industry is concentrated in a limited area in Japan, with minimal spatial growth.

Approximately 150,000 hectares or 0.4 percent of Japan's total land area is zoned for industrial use, a share that has remained relatively unchanged since the 1970s. One-third of industrial land is in or near the three large metropolises of Tokyo, Nagoya, and Osaka, with the remaining two-thirds spread throughout the country (MLIT 2018). The average individual factory¹⁸ area in Japan is around 1.25 hectares (METI 2020b).

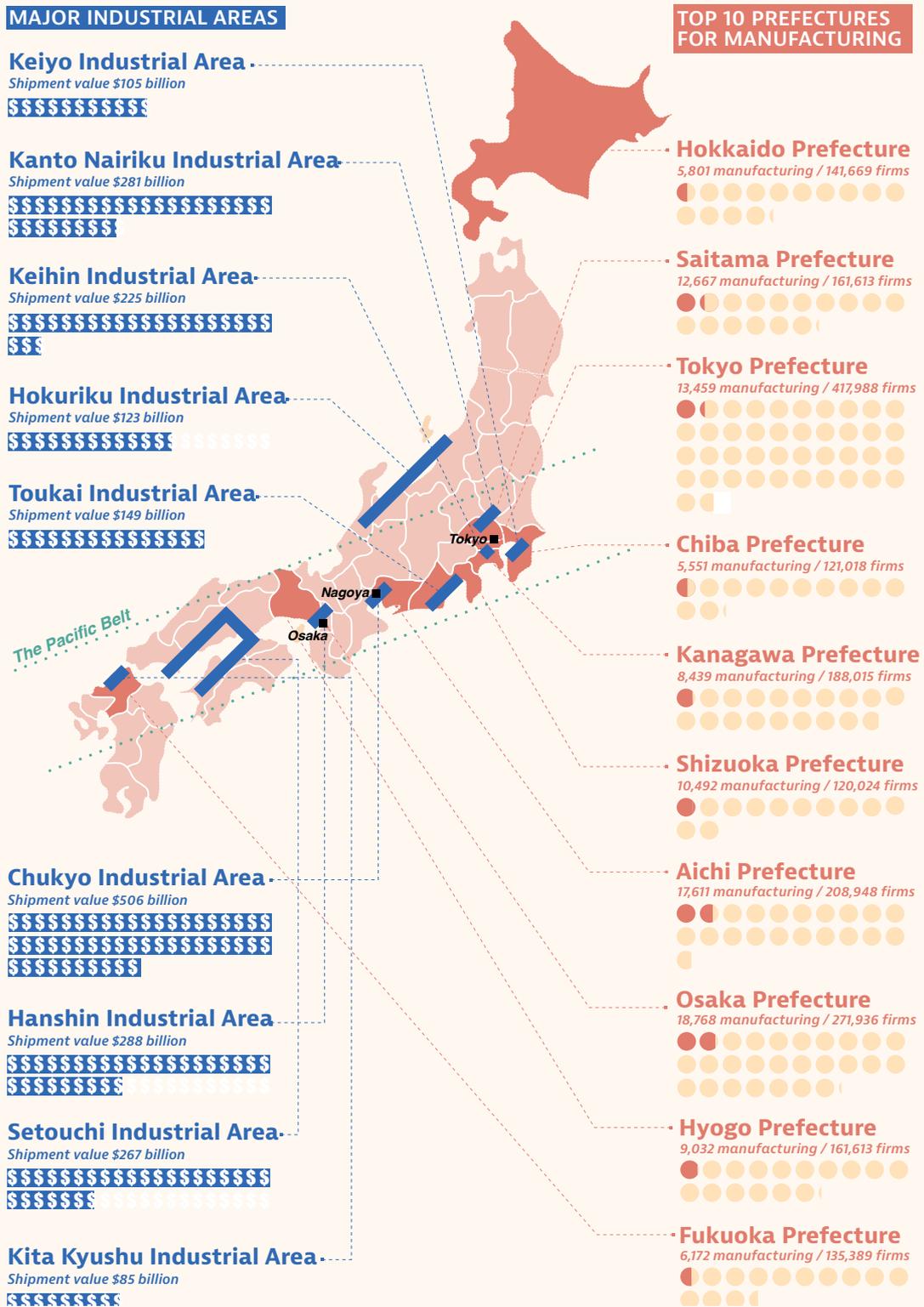
Japan's several industrial areas reflect efforts initiated in the 1960s to promote economic development through industry clusters. The clustering of interrelated firms seeks to increase efficiencies through division of labor and shared access to information and infrastructure services, and promote innovations to enhance productivity.¹⁹ Several large industrial areas continue to serve as key hubs for Japan's industries. The largest are located along the Pacific Belt, shown in figure 2.3, contributing to the growth of Tokyo, Nagoya, and Osaka. The locations and shipment values of these areas are shown in figure 2.3. The top ten prefectures for manufacturing are home to or adjacent to these three metropolises.

Recently, industry development policies in Japan are shifting from centralized, location- and industry-specific approaches, to more decentralized, firm and supply-chain approaches. Promoting regional economic development through "local economic drivers," companies catalyze regional economies by playing a key role within value chains (METI 2018a). From the 1970s through the 1990s, place-based policies led by the Japanese central government promoted an urban to rural redistribution of factories (Industrial Relocation Promotion Act, 1972), the development of high-tech and software industries in rural areas (Technopolis Act, 1983), the revitalization of industrial clusters (Regional Industrial Clustering and Revitalization Act, 1997), and the development of new businesses in select regions (New Business Promotion Act, 1999). Since the 2000s, bottom-up efforts utilizing the strengths and comparative advantages of individual regions have been used to develop new industries and attract new businesses in targeted regions (Industrial Cluster Policy, 2001; Act on the Promotion of Establishment of Enterprises, 2007; and Revisions to the Regional Revitalization Strategy, 2014). Since the 2010s, the Act on Overcoming Population Decline and Vitalizing Local Economy in Japan and Act for Partial Revision of Local Revitalization were formulated in response to the challenges faced by local regions, such as a declining population, super-aging population, and changes in industrial structure (Cabinet Office, 2014). The central government has supported local governments in advancing regional economic development through targeted support to companies that can drive local economic development by operating in global markets, playing integral roles in supply chains, utilizing local resources, generating local employment, or developing new infrastructure services that enhance local quality of life (METI 2020c). A new big data visualization system called the Local Economic Driver Index (LEDIX), developed by Teikoku Data Bank and Takram, helps support these efforts. The LEDIX system brings together complex information on interfirm transactions, company performance, and its regional contribution into a single dynamic visualization system. More information on LEDIX can be found in appendix A14.

18 As defined in METI's Factory Location Trend Survey, "factory" refers to businesses that have acquired 1,000 square meters of land or more for the purpose of constructing a factory or laboratory. Here, "businesses" are defined as manufacturing industries, power supply industries (excluding hydropower plants, geothermal power plants, and solar power plants), gas supply industries, and heat supply industries. For more information, see: <https://www.meti.go.jp/statistics/tii/ritti/result-4.html#menu05>.

19 Based on the Act on Formation and Development of Regional Industrial Clusters through Promotion of Establishment of New Business Facilities, etc. (2007).

FIGURE 2.3 Location of Major Industrial Areas in Japan and Their Shipment Values, and Distribution of Firms of Top 10 Prefectures for Manufacturing



Source: Original compilation based on METI (2020a, 2020b); Statistics Bureau of Japan (2017); and Sugihara (2019).

FIGURE 2.4 LEDIX Visualization Tool of Industrial Maps

Source: Original compilation based on LEDIX (<https://ledix.jp/about>).

Note: Blue lines and red lines show intraregional transactions and transactions with companies outside of the prefecture housing a specific company, respectively. These indices enable users to understand the extent to which selected companies are driving regional economic prosperity, and also evaluate the ripple effects following a shock that stimulates new ideas and discussions.

Minimizing the environmental impacts of industries and industrial areas is a critical concern in Japan, and stringent standards are applied through national laws and local regulations. Manufacturing industries can generate negative impacts on the local environment through pollution of air and water, generation of toxic waste, and greenhouse gas emissions. The Factory Location Act (1959, updated in 2017) aims to ensure that the natural environment surrounding factories is preserved by limiting the risks of pollution and environmental considerations are incorporated in the design phase of factory development and siting. The act also sets national guidelines for local building regulations, including the building coverage ratio (BCR), green space allocations, and environmental amenities (such as green space, sports grounds, and amenities). Depending on the local conditions, the act prescribes that factories should have 30–65 percent BCR, 5–30 percent green space, and 10–35 percent environmental amenities (METI 2015a).

Value Chains

Japanese manufacturing industries have complex and extensive value chains that affect social and economic activities locally, nationally, and globally. Large parent companies and subsidiary SMEs in Japan are interdependent throughout their supply chains. These networks can be examined as “groups of enterprises”: companies connected in a tree-like relationship, consisting of a parent company at the top and its subsidiaries further down. According to 2014 Economic Census data, there were 23,159 groups of enterprises in Japan, composed of 79,653 enterprises (4.5 percent of total enterprises) and 608,232 establishments (21 percent of total establishments), employing over 18 million workers (43 percent) and generating sales of ¥833 trillion (\$757 trillion) (71 percent). The manufacturing sector had the largest share of

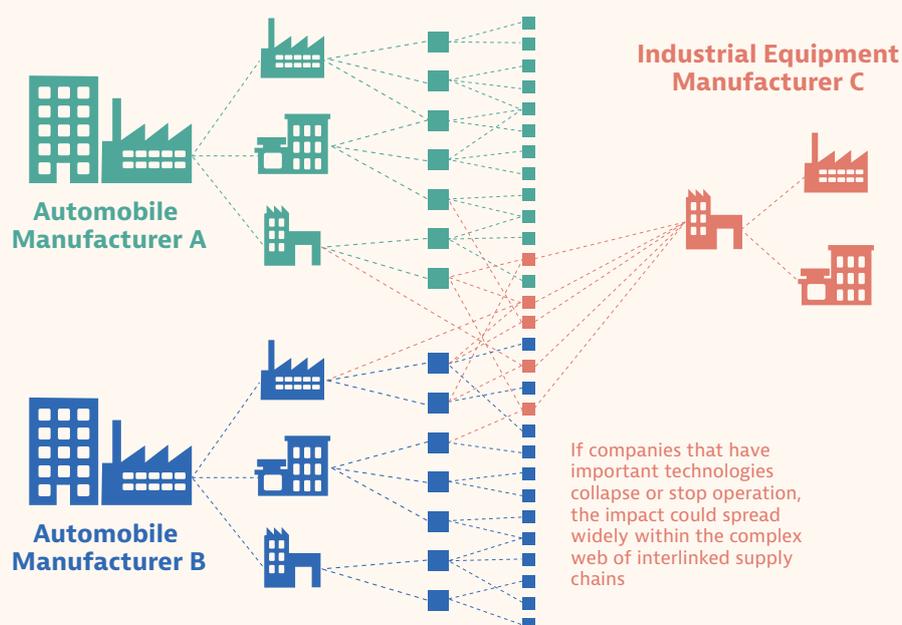
groups (27 percent), followed by wholesale and retail (25 percent), and construction industries (13 percent).²⁰ Around 70 percent of these groups of enterprises consisted of only two enterprises including a parent and subsidiary company; 44 percent of groups were formed by enterprises in the same sector.

The interdependencies between manufacturing firms are also complex, as subsidiary SMEs often supply to more than one parent company, serving as key nodes within a complex web of interlinked supply chains, and “local economic drivers” (figure 2.5).

These firms often possess unique technologies required for manufacturing critical intermediary products and often participate in the supply chains of multiple manufacturers. While these firms can generate significant added value and employment in local industry, studies have shown that disruptions can also generate widespread damage to the local economy (Barrot and Sauvagnat 2016).

Japanese firms have aggressively expanded their investments abroad, extending their supply chains globally by locating subsidiaries and operations overseas. While the number of Japanese firms temporarily decreased during the global financial shock of 2008, it has been steadily increasing since then. In 2016 around 25,000 Japanese companies were operating overseas, 11,000 companies in manufacturing industries and 14,000 companies in nonmanufacturing industries (METI 2019b); 80 percent of overseas manufacturing firms from Japan were in Asia, including China and the Association of Southeast Asian Nations (ASEAN) countries. In 2016 Japan’s overseas production ratio for manufacturing was 23.8 percent; almost one-quarter of all Japanese manufacturing was done overseas. As illustrated in figure 2.6, these overseas Japanese firms create a complex ecosystem of global value chains by supplying and selling intermediate goods and final products for parent companies in Japan, within their host country, and to other countries in the region.

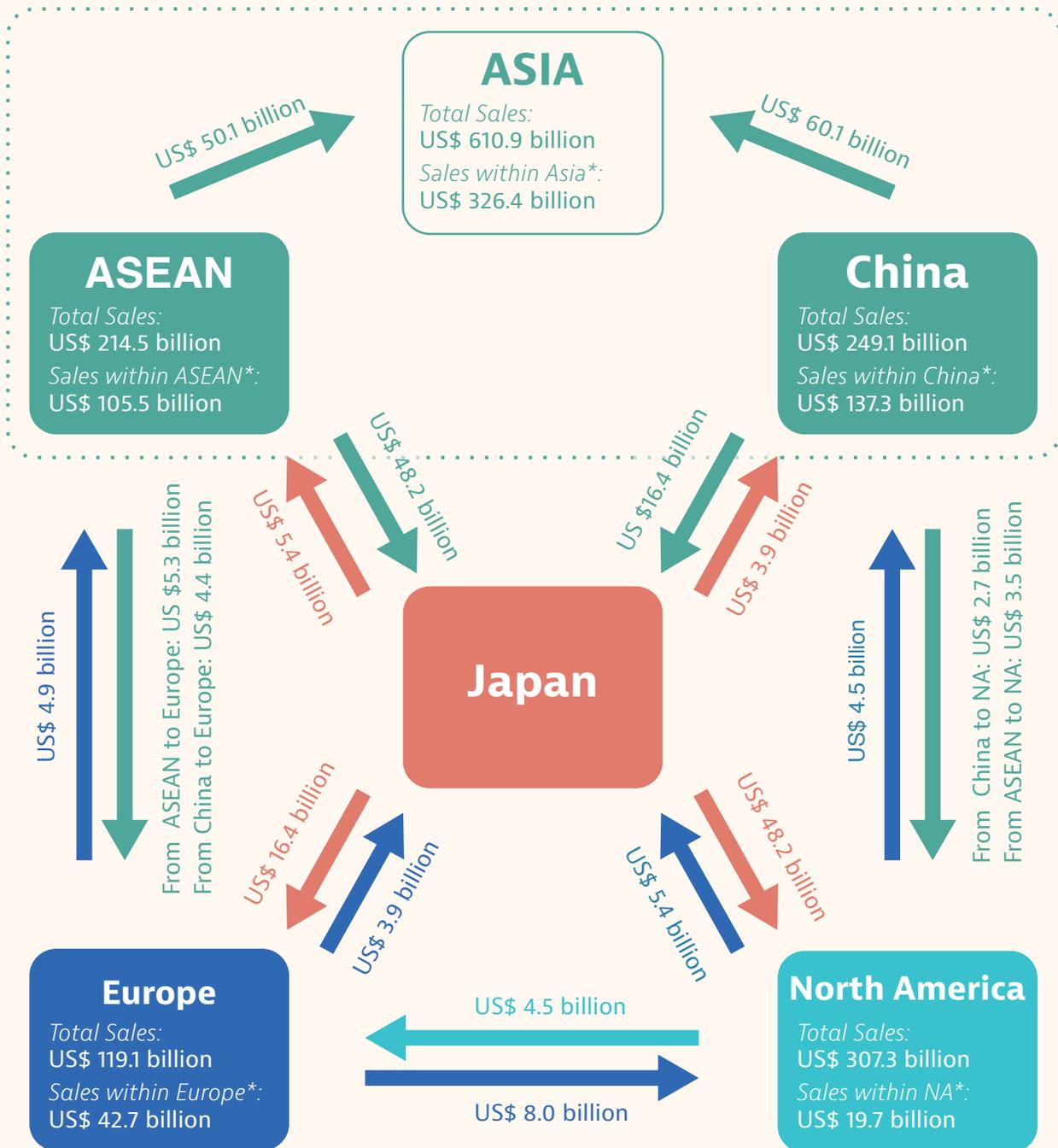
FIGURE 2.5 Supply Chains of the Japanese Manufacturing Industry



Source: Original compilation based on SMEA (2018).

²⁰ A parent company normally refers to a company that directly owns more than 50 percent of the voting rights of a subsidiary company. Similarly, a subsidiary company normally refers to companies where more than 50 percent of the voting rights are owned by a parent company. For more information, see: <https://www.stat.go.jp/training/2kenkyu/pdf/gakkai/toukei/2016/yagishita.pdf>.

FIGURE 2.6 Global Value Chains of Japanese Companies Overseas, by Sales and Procurement, 2016



Source: Original compilation based on METI (2019b).

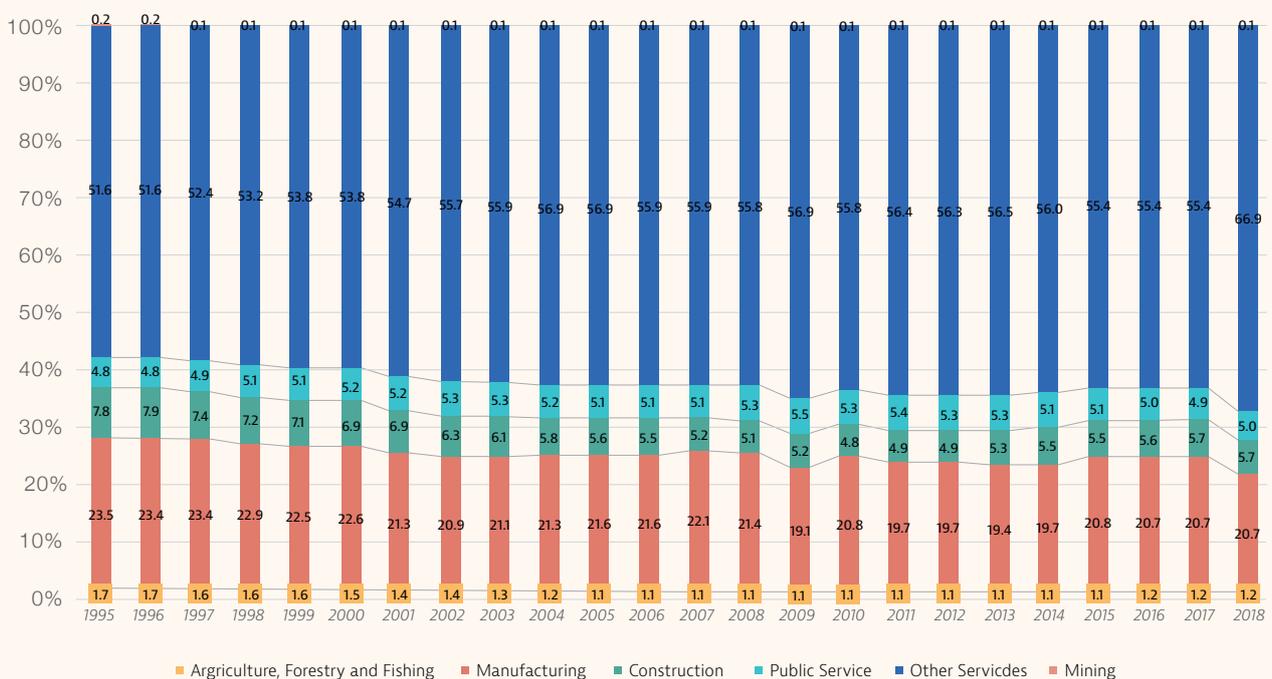
Note: *Sales within Asia, ASEAN, Europe, and North America refer to the total sales of Japanese companies within the countries belonging to that region. ASEAN = Association of Southeast Asian Nations; NA = North America.

CHALLENGES AND NEXT STEPS

While manufacturing industries have been the driving force of post–World War II economic development in Japan, changing national and global contexts pose significant challenges, requiring the transformation and innovation of Japanese industries moving forward. A rapidly shrinking and aging population in Japan is causing a shortage of workers, requiring firms to create enabling and attractive environments for women and foreign workers to join the workforce. The decline of the manufacturing sector globally, especially in the automotive sector, challenges Japanese industries to diversify and innovate in order to drive Japanese global competitiveness. Digitalization and the use of technology for evidence-based decision making and supply chain management could add value by increasing traceability, efficiency, and adaptability. Japanese firms are also gearing up for “Society 5.0”²¹ so that industries can leverage technological innovations including the Internet of Things (IoT), artificial intelligence (AI), and Big Data. Moreover, environmental sustainability and resilience are critical to continuing business and maintaining industry competitiveness, as firms find ways to cope with the increasing frequency and magnitude of disasters and/or climate impacts in Japan and globally. The challenges and solutions to enhance resilience in the face of these risks will be further explored in the following sections.

A brief history of Japanese manufacturing industries is outlined in box 2.1.

FIGURE 2.7 Industry Sector Composition Ratios in Nominal GDP, 1995–2018



Source: Original compilation based on information from the Cabinet Office (2020).

²¹ Society 5.0 is a “human-centered society that balances economic advancement with the resolution of social problems by a system that highly integrates cyberspace and physical space.” This concept was proposed in the 5th Science and Technology Basic Plan as a model for future society that Japan should aspire to. It follows the hunting society (Society 1.0), agricultural society (Society 2.0), industrial society (Society 3.0), and information society (Society 4.0). For more information, see: https://www8.cao.go.jp/cstp/english/society5_0/index.html.

BOX 2.1 History of Japanese Manufacturing Industries

The manufacturing sector, or *monozukuri* in Japanese, has been the main catalyst of Japanese industrial and economic development since the 19th century. During the Meiji period of the mid-19th century, the first industrial revolution in Japan started with the textile industry. After World War II, various heavy manufacturing industries such as shipbuilding, steel, electric machinery, and automobiles contributed to Japan's economic growth. In the 1960s, 36 percent of Japanese GDP came from the manufacturing sector. During this period "trade liberalization" and the removal of de facto import quotas were implemented, leading to increased international competitiveness of Japanese manufacturing industries (Ito and Kiyono 1988; Nakakita 1993). This fueled rapid economic development; in 1960 Japan's GDP ranked fifth in the world and by 1968, it ranked second. The manufacturing of basic metals such as iron and steel, petroleum products, and chemicals led the manufacturing industry at that time.²²

After being hit by the global oil crises of 1973 and 1979,²³ the economic share of Japan's manufacturing industries fell due to severe domestic fuel shortages, while the economic share of the service industry increased. During this time, the manufacturing sector shifted from basic material manufacturing such as textile, petroleum, and other oil products to advanced assembly manufacturing such as machinery and automobile products (METI 2008).

As the Japanese manufacturing sector shifted to more complex assembly manufacturing, value chains also became more complex, extending globally beyond Japan's borders. After the Plaza Accord in 1985, which depreciated the value of the US dollar against the value of the Japanese yen and German deutsche mark, the relative strength of the Japanese yen made exporting manufactured goods more difficult, incentivizing some companies to relocate their factories abroad. Relocation of factories was especially prominent in the automobile sector: by 1995, the overseas production volume of Japanese automobile makers had almost doubled from 1990, reaching 5.7 million vehicles. Meanwhile, the domestic production volume decreased from 13.5 million vehicles in 1990 to 10.2 million vehicles in 1995. Overseas production accounted for more than one-third of total automobile production volume in 1995 (15.8 million vehicles) (ESRI 2011).

In the 1990s and early 2000s, Japan's manufacturing industry was challenged by the burst of Japan's bubble economy, the global financial crisis, the emergence of competitors including China, and the rapid decline of the yen around 1995 and 2008 (METI 2019a). Following the great recession that began in 1990, triggered by a collapse in land and stock prices, sluggish domestic demand further encouraged major manufacturing firms to tap into global markets (Motohashi 2006). As a result, factory relocations and market shifts further advanced, and value chains further expanded on a global scale.

Although the share of the manufacturing sector within Japan's GDP has gradually declined over time, it remains significant to the nation's economic development and social welfare through the jobs and value it creates. The economic share of the manufacturing sector within Japan's nominal GDP decreased from 36 percent in 1970 to 23.5 percent in 1995, and has been decreasing since 1995, while the shares of service sectors increased steadily (figure 2.7). Despite this decrease, the manufacturing sector still accounts for approximately 20 percent of GDP in Japan, whereas in other highly developed countries such as the United States and France, the share is around 10 percent (11.2 percent and 10.1 percent, respectively, as of 2017). The Japanese manufacturing industry has a powerful ripple effect on other industries and continues to hold a large share of GDP (METI 2015b). Analysis of economic growth in the Japanese manufacturing and nonmanufacturing industries since the 1970s shows that manufacturing is also a major driver of technological progress (or total factor productivity, TFP) in Japan,²⁴ and therefore remains a core industry sector.

22 For more information, see p. 20 of <https://www.rieti.go.jp/jp/publications/dp/09j024.pdf>. (in Japanese).

23 The oil crisis in 1973 occurred after the Organization of the Petroleum Exporting Countries (OPEC) decided to quadruple the price of oil in retaliation for Western support of Israel against Egypt and Syria during the Yom Kippur War (1973). The oil crisis in 1979 occurred as a result of the Iranian Revolution. High levels of social unrest severely damaged the Iranian oil industry, leading to a large loss of output and a corresponding rise in prices.

24 For more information, see: https://www.meti.go.jp/report/whitepaper/mono/2015/honbun_html/010102.html.

POLICIES AND INSTITUTIONS

The historical development of Japanese industries, particularly those connected to the manufacturing sector, was enabled by strategic national policies and institutional frameworks coordinated across various sectors and levels. A coordinated effort was led by the national government, and supported by various actors including subnational governments, private sector firms, financial institutions, and academia to reconstruct Japan's economy and the livelihoods of its people after World War II. Advanced industrial policies²⁵ that promote the development of land, infrastructure, workforces, technology and innovation, and financing mechanisms to create a competitive Japanese manufacturing industry were key drivers of these efforts.

The key objectives and roles of industrial policies in Japan have transformed over time, and can be broadly characterized in three phases (Ohashi 2015), outlined as follows.

1940–1960s: Promotion of Trade Protection and Heavy Industry

In the 1950s and 1960s, the Ministry of International Trade and Industry (MITI) initiated an industrial adjustment policy with an **objective to strategically adjust production and investment in targeted industry sectors during a structural recession.** The adjustment policy was first applied to the textile industry, which had suffered from overproduction after the Korean War. The textile industry sought to reduce production and to limit investment in new facilities.

In 1962 the Economic Planning Agency compiled Japan's first comprehensive national development plan, followed in 1969 by the second national development plan. **These national development plans promoted the dispersal of industrial facilities throughout rural Japan, and pursued growth in urban hubs and core cities** through clearly stated output indicators and planned investments for transportation networks, energy and water supplies, waste management improvements, industrial park development, and other land development projects. While manufacturing concentrated in the four major industrial areas alongside the Pacific Belt Zone in the early 1960s, the New Industrial Cities Program was proposed in the 1962 development plan, under which 15 new areas were designated as new industrial cities (most located outside the Pacific Belt Zone) (Yoshioka and Kawasaki 2016). **The national development plans helped reduce regional gaps in manufacturing development and economic growth, and created the basis for the rapid development of industrial areas and industrial parks in Japan.**

1970s–2000s: Transformation of Industrial Structure due to External Pressure

A structural depression following the global oil crisis in 1973 caused a further transition in Japan's industrial economy. In particular, the escalating costs of imported oil harmed material manufacturing industries, which involved high energy usage. As materials became more expensive to produce, production declined and these industries suffered from excess capacity. In response, new industrial adjustment policies helped stabilize affected sectors. Such policies included the Law on Temporary Measures for Stabilization of Specified Depressed Industries (1978), as well as the Designated Industries Structural Revision Extraordinary Measures Law (1983) (Okazaki 2017). As a result of Japan's reliance on increasingly expensive foreign oil, Japanese industry sought to reduce its energy dependence, and began to innovate, shifting toward high-tech electronic and robotic products (Mihut and Daniel 2012).

25 While there are diverse views and definitions of the term that have evolved over time, in this document we interpret industrial policy as "any type of intervention or government policy that attempts to improve the business environment or to alter the structure of economic activity toward sectors, technologies or tasks that are expected to offer better prospects for economic growth or societal welfare than would occur in the absence of such intervention" (OECD 2013). For more information, see: <https://www.oecd-ilibrary.org/docserver/5k4869clw0xp-en.pdf?expires=1584409398&id=id&accname=guest&checksum=8f920f5783716ca9f8f4d13f67843703>.

By the 1980s, the Japanese economy had grown to nearly the scale of the US economy, as measured by both GDP and TFP. However, in 1991 the economic bubble which had grown during that time burst, leading to an economic crash. As the country recovered, MITI focused on the incorporation of new technology for industry in order to reestablish growth (Okazaki 2017). Additionally, in 1991, although the term “BCP” was not used in the document, the Japanese government published an official statement on corporate disaster prevention and business continuity in the White Paper on Disaster Management (The National Land Agency 1991).

In 1999 the Basic Act on the Promotion of Core Manufacturing Technology was implemented to promote innovation. It focuses on research and development, seeks to expand training for engineers, and provides guidance not only on technology but also on patent rights and other industrial property rights. Further components of the measure include **cooperation between manufacturing business operators and universities, promotion of industrial agglomeration, and development of SMEs.**²⁶ The Ministry of Economy, Trade and Industry’s (METI’s) 2001 Industrial Cluster Policy is an additional example of efforts **promoting innovation and energizing local economies by creating networks of industrial firms.** METI helped to establish 20 industrial clusters that included a variety of SMEs as well as universities (Okazaki 2017).

2000s to the Present: Disaster Response and Resilience Building after the Global Economic Crisis and the Great East Japan Earthquake

In recent decades Japan has increasingly focused on industrial policy to improve disaster response and resilience capabilities. This trajectory has been informed by recent crises, including the global financial crisis of 2007–08 and the 2011 GEJE. In 2010, an economic growth strategy called the “Rebirth Strategy for Japan” was approved by the government (revised in July 2012). This strategy set economic goals for 2020, **targeting the development of \$1.3 trillion in new industries and 4.7 million jobs by 2020, taking advantage of Japan’s strengths in manufacturing and technology.**

The Industrial Competitiveness Enhancement Act, enacted in 2013, is another key policy for industry development in Japan. Under this law, programs including the System to Remove Gray Zone Areas and the System of Special Arrangements for Corporate Field Tests were established in order to encourage companies to venture into new frontiers of business. It is often unclear to companies how existing laws and regulations will be applied to their new businesses. Through utilizing the System to Remove Gray Zone Areas, companies can get clarification regarding their concerns about laws and regulations from relevant government ministries. If a new business venture is regulated under existing laws and regulations, companies can utilize the System of Special Arrangements for Corporate Field Tests, in which companies can submit a proposal for special arrangements related to existing regulations, allowing them to initiate a business with special provisions.

In Japan, policies and legislative frameworks related to industries, including those connected to the manufacturing sector, have been developed in close partnerships between the public and private sectors. Private sector industry associations play a critical role, ensuring that policy frameworks for industries and businesses consider the voices and realities of the firms on the ground. The Japan Automobile Manufacturing Association, Inc. (JAMA) is a good example of how business associations can take part in industrial policy making. JAMA consists of Japan’s 14 manufacturers of cars, trucks, buses, and

26 For more information on the Basic Act on the Promotion of Core Manufacturing Technology, see: http://www.japaneselawtranslation.go.jp/law/detail_main?id=98&re=02&vm=02

motorcycles. It conducts studies and surveys related to the production, distribution, trade, and use of automobiles, assisting in the rationalization of automobile production, helping establish policies for innovative production technologies, and offering recommendations on government policies. The Japan Chamber of Commerce and Industry (JCCI) is a network of comprehensive local economic organizations representing 1.25 million member-businesses nationwide. The JCCI represents its local chambers by presenting suggestions to the government and other bodies. The JCCI also plays an important role in the dissemination of information concerning government policies and programs, and the promotion of nationwide projects. Keidanren (Japan Business Federation), an economic organization with a membership representing 1,376 companies, 109 nationwide industrial associations, and 47 regional economic organizations, also plays an important role in policy formulation. The federation establishes consensus and provides support to the business community on a variety of important domestic and international issues. At the same time, Keidanren communicates with a wide range of stakeholders including political leaders, administrators, labor unions, and citizens.

Table 2.1 presents a detailed timeline of manufacturing-related legislation and policies in Japan.

TABLE 2.1 Historical Development of Policies and Institutions Related to the Manufacturing Industry in Japan

Development of Policies and Institutions to Manufacturing Industry in Japan	Year	Related Global and Japanese Events
Establishment of the Ministry of International Trade and Industry (MITI)	1949	Adoption of the single exchange rate of ¥360 to the dollar
Launch of the People's Finance Corporation and the Council for Industrial Rationalization		
Industrial Standardization Law		
Foreign Exchange and Foreign Trade Control Act	1950	Tokyo, Nagoya, and Osaka Stock Exchanges were founded
Operation of Export Credit Insurance begins		
Chamber of Commerce and Industry Law, Small and Medium Enterprise Credit Insurance Law		
Establishment of the Bank of Japan	1951	Signature of the Treaty of Peace with Japan and the Japan-US Security Treaty
Commodity Exchange Law		
First Rationalization Plan for the Iron and Steel Industry		
Establishment of the Japan Development Bank	1952	Japan joins the International Monetary Fund (IMF)
Enterprise Rationalization Promotion Law		
Inauguration of Japan Finance Corporation for Small and Medium Enterprise, Credit Guarantee Association Law	1953	
Ordnance Manufacturing Act	1955	Japan formally joins the General Agreement on Tariffs and Trade (GATT)
National Car Concept		
Second Rationalization Plan for the Iron and Steel Industry	1956	"The postwar period is over" (as expressed in an economic white paper) becomes a catchphrase
Act on Temporary Measures for the Promotion of Machine Industry		
Law on Temporary Measures for Textile Industry Equipment and Related Equipment		
Law on Temporary Measures for the Promotion of Electronics Industry	1957	

TABLE 2.1 continued.

Development of Policies and Institutions to Manufacturing Industry in Japan	Year	Related Global and Japanese Events
Patent Law, Utility Model Law, Design Law, Trademark Law	1959	
Liberalization Plan for Trade and Foreign Exchange	1960	
Commerce and Industry Association Law		
Installment Sales Law, Electrical Appliance and Material Control (Safety) Law	1961	
Basic Act on Disaster Management		
Household Goods Quality Labeling Act, Shopping District Promotion Association Law	1962	
Law for the Development of New Residential Areas		
Small and Medium Enterprise Basic Law	1963	
Industry Structure Council Launched		
	1964	Japan joins the Organisation for Economic Co-operation and Development (OECD) Japan becomes an IMF Article 8 nation
Law on the Promotion of the Development of Special Regions for Industrial Development		
Liberalization of import of finished vehicles	1965	
Basic Law for Environmental Pollution Control (abolished in 1993)	1967	The Association of Southeast Asian Nations (ASEAN) was founded The European Community (EC) is inaugurated
The first stage of capital liberalization (liberalization of foreign direct investment to Japan)		
Basic Law on Consumer Protection, Air Pollution Control Law	1968	
Japan-US textile negotiations started		The Japan World Exposition is held
Waste Disposal and Public Cleansing Law	1970	Establishment of the Nippon Steel Corporation
Water Pollution Control Law, Law on the Promotion of Subcontracting Small and Medium Enterprises		
Interim Report of the Industrial Structure Council's "Creation of 1970s Vision"	1971	Dollar (Nixon) shock
Law on Temporary Measures for the Promotion of Specified Electronics Industries and Specified Machinery Industries		
Industrial Relocation Promotion Law	1972	Return of Okinawa, normalization of diplomatic relations between Japan and China
Consumer Product Safety Law	1973	First oil shock, floating exchange rate system
Law on the Promotion of Small and Medium Retail Business		
Law on Temporary Measures for the Promotion of Specified Machinery and Information Industries	1978	
Law on Temporary Measures for Stabilization of Specified Depressed Industries		
	1979	Second oil shock
Industrial Structure Council's "Formulation of 1980s Vision"	1980	Japan becomes the world's top automobile producer
Voluntary regulation of auto exports to the United States begins	1981	
Law on Temporary Measures for the Structural Improvement of Specified Industries	1983	
Law for the Facilitation of Research in Key Technologies	1985	Plaza Accord
"Challenges and Prospects for Economic and Industrial Policy in the 21st Century"	1986	

TABLE 2.1 continued.

Development of Policies and Institutions to Manufacturing Industry in Japan	Year	Related Global and Japanese Events
Basic Act on the Promotion of Core Manufacturing Technology	1999	European single currency "euro" is born
Top Runner Program		
Basic Act for Establishing a Sound Material-Cycle Society	2000	
MITI was reorganized to the Ministry of Economy, Trade and Industry (METI)	2001	Reorganization of government ministries into 1 cabinet and 12 ministries
Establishment of the Research Institute of Economy, Trade and Industry (RIETI)		
The first Economic Partnership Agreement (EPA) with Singapore goes into effect	2002	Nippon Keidanren is inaugurated
Establishment of the Industrial Revitalization Corporation of Japan	2003	Japan filed the second-largest number of international patent applications
New Industry Promotion Strategy	2004	
Kyoto Protocol Target Achievement Plan	2005	The Kyoto Protocol comes into effect
The Monodzukuri Nippon Grand Award begins		The first East Asia Summit (EAS) is held
Companies Act		Japan holds the Exposition of Global Harmony
New Economic Growth Strategy, Outline of Economic Growth Strategy	2006	
Act on Formation and Development of Regional Industrial Clusters through Promotion of Establishment of New Business Facilities, etc.	2007	
Revision of New Economic Growth Strategy	2008	Price of gasoline reaches a record high amid skyrocketing oil prices
Act on Promotion of Collaboration between Agriculture, Commerce, and Industry		Subprime crisis
Development of Japan's New Growth Strategy (Basic Policies)	2009	
Establishment of the Innovation Network Corporation of Japan (INCJ)		
Industrial Structure Vision 2010	2010	Asia-Pacific Economic Cooperation (APEC) Summit Meeting (Yokohama)
Japan's New Growth Strategy, Three-Step Economic Measures for the Realization of the New Growth Strategy		
Response to the shortage of electric power supply; dispatch of METI staff to disaster areas; responses to the accident at the Tokyo Electric Power Company Holdings' (TEPCO's) Fukushima Daiichi Nuclear Power Station (NPS); establishment of the Nuclear Damage Compensation Facilitation Corporation (NDF)	2011	Great East Japan Earthquake
Launch of negotiations for the Regional Comprehensive Economic Partnership (RCEP)	2012	
Establishment of the Cool Japan Fund Inc.	2013	Participation in the Trans-Pacific Partnership (TPP) Negotiations
Industrial Competitiveness Enhancement Act		Adoption of the World Trade Organization (WTO) Bali Package

Source: Modified based on information provided by METI: <https://www.meti.go.jp/english/aboutmeti/data/ahistory.html>.

2.2 IMPACTS OF DISASTERS ON INDUSTRIES

Japan faces frequent and diverse risks of disasters. This context has had a significant and multifaceted impact on industries. Between 1995 and 2018, 185 major disaster events were reported in Japan, ranging from geophysical events including earthquakes, tsunamis, and volcanic eruptions to hydrometeorological events that may be amplified by climate change such as floods caused by typhoons, torrential rains, and/or storm surges (Cabinet Office 2018a). Total damage costs from these disasters are estimated at \$481 billion.²⁷

Drawing upon examples of recent large-scale disasters in Japan, this section describes how disasters have affected industries in Japan, influencing their business continuity, competitiveness, and, in the worst cases, survival. While impacts vary depending on the type and magnitude of disasters, experiences of Japanese industries highlight how both direct damages to physical assets, as well as indirect disaster effects, can endanger business operations. Indirect effects of disasters can include disruption to flows of information, goods, and finance, such as through damage to communication and logistical infrastructure. They can also include negative impacts on stock prices, consumer confidence, and client reputation, for example, if buyers do not believe producers in disaster-impacted areas will be able to follow through on orders. Disasters in Japan affect individual firms, and the industrial parks and infrastructure assets that support them, and can disrupt supply chains and cause significant economic shocks to local, national, and global economies.

Past disaster events in Japan have highlighted barriers—related to policies, finance, infrastructure, gender, and technology—that have limited the capacities of industries to manage, respond, and recover from the impacts of disasters on industries in Japan. However, after each major disaster, government and industry stakeholders have made efforts to better understand and address these barriers. This process has enabled incremental improvements in enhancing the capacities of Japanese industries to better safeguard their businesses against disaster risks.

DISASTERS IN JAPAN

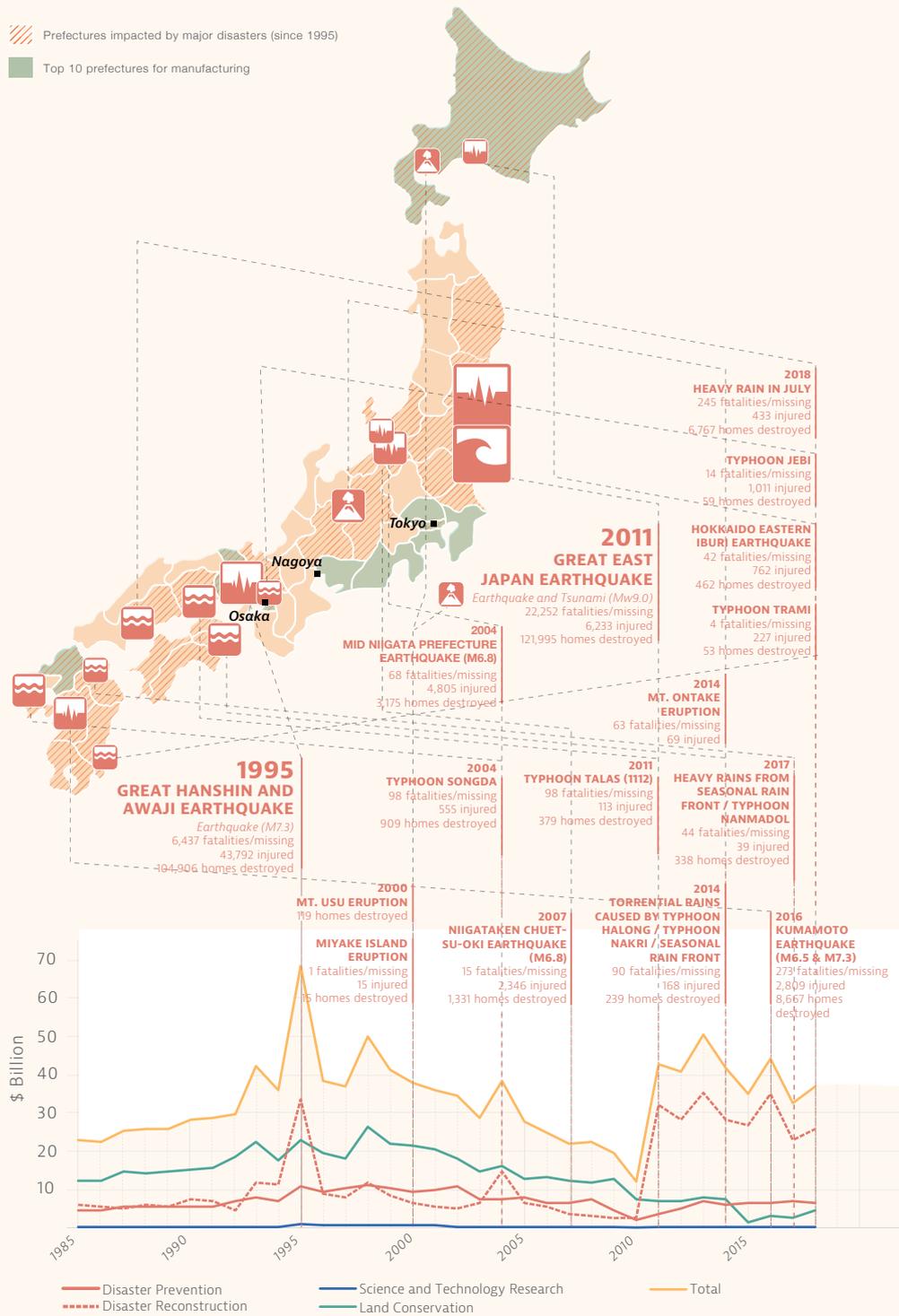
Japan's exposure to disaster risks is one of the highest in the world. Numerous devastating disasters over time have caused significant social and economic impacts. The Great East Japan Earthquake that devastated the Tohoku region in Japan on March 11, 2011, was one of the largest disasters in Japan and in the world, taking the lives of more than 15,000 people, completely destroying more than 121,000 houses, and causing overall losses of approximately \$210 billion, making it the costliest natural disaster of all time.²⁸ Impacts of floods and typhoons are also significant in Japan, and are recently increasing in frequency and intensity: in 2018 and 2019, multiple floods and typhoons²⁹ hit Japan. These events were ranked within the Top 10 Global Economic Loss Events for both years, with over \$23 billion and \$25 billion in economic losses reported in 2018 and 2019, respectively (AON 2018, 2019). Frequent large-scale disasters also require significant government financing for disaster risk management in Japan. An overview of recent major disasters and disaster risk management (DRM) budgets (in comparison to other annual budgets) in Japan is provided in figure 2.8, which shows that the additional budget for disaster reconstruction in years with major disasters (1995, 2011) has a large impact on the overall national budget. In the case of the 2011 GEJE, these additional expenditures have endured for many years.

27 Based on the EM-DAT database: <http://www.emdat.be>.

28 For more information, see: <https://www.munichre.com/en/risks/natural-disasters-losses-are-trending-upwards.html>.

29 Typhoons refer to storms that occur in the Northwest Pacific Ocean, while in the North Atlantic Ocean and Northeast Pacific they are called **hurricanes**, and in the South Pacific and Indian Ocean they are called **cyclones**.

FIGURE 2.8 Overview of Major Disasters and Disaster Risk Management Budgets in Japan between 1995 and 2018



Source: Original compilation based on Cabinet Office (2019a, 2020).

Note: Major disasters selected include disasters in Japan that occurred between 1995 and 2018 where the Disaster Relief Act was applied, where Extreme or Major Disaster Management Headquarters were established, that were designated as extremely severe disasters, and/or that were listed as major natural disasters in Japan since 1945 in the "White Paper on Disaster Management 2019" (Cabinet Office 2019a). It is difficult to isolate the budget for disaster reduction measures, and the budget presented in this figure is based on the "White Paper on Disaster Management 2019" (Cabinet Office 2019a), which has been calculated based on a number of assumptions.

Japan is exposed to various types of natural hazards throughout the country, requiring a multihazard approach to DRM. Japan experiences various geophysical disasters such as earthquakes, tsunamis, volcanic eruptions, and landslides (caused by both heavy rain and earthquakes) as well as diverse hydrometeorological disasters such as floods (caused by heavy rain and storms or typhoons), storm surges, and heavy snow (table 2.2). While geophysical disasters occur less frequently in Japan than hydrometeorological events, one large-scale earthquake and tsunami can have large-scale economic and human losses.

The lead time and duration of different disaster types affect the availability of technologies and measures to detect, warn, mitigate, and avoid risks. Generally, the lead time for predictions of hydrometeorological disasters is much longer than for geophysical disasters. For floods, the duration of inundation can be much longer than that of tremors. While earthquake early warning systems are in place in Japan, the lead time from hazard detection to warning and to shaking is only a matter of seconds. Therefore, measures to mitigate and reduce earthquakes' impacts on industries need to be implemented well in advance of a disaster; actions that can be taken during or after a disaster are quite limited, and primarily focused saving lives. On the other hand, warnings for heavy rains, typhoons, and storm-surge-induced flood events are issued normally days or weeks in advance. Therefore, measures to avoid or reduce flood damages are available before, during, and after the disaster. These measures are further elaborated in chapter 3, section 3.2.

Japan will face even more extreme and frequent hazards in the future and will need to enhance preparedness. Urban and industrial centers in the Tokyo and Nankai regions (which include Wakayama, Osaka, and Kochi prefectures) face a 70–80 percent chance of large-scale earthquakes within the next 30 years, including the Nankai Trough Earthquake (M8 or more) and the Tokyo Inland Earthquake (M7 or more).³⁰ These anticipated seismic events are expected to cause significant economic, asset, and financial damages, requiring up to 20 years for recovery and reconstruction. Additionally, future massive storm surges and large-scale river floods are expected to cause devastating impacts to the large metropolises of Tokyo, Osaka, and Nagoya, which are also key manufacturing hubs. Although the expected recovery and reconstruction time is less than 14 months, the overall impacts of these hydrometeorological events, including to industries, are extremely significant. Table 2.3 illustrates projected impacts from the various megadisasters Japan is preparing for in the near future.

30 For more information, see: http://www.bousai.go.jp/kaigirep/hakusho/h24/bousai2012/html/honbun/1b_2h_2s_00_06.htm.

TABLE 2.2 The Costs of Disaster: Frequency of Disaster Types and Total Costs between 1995 and 2018

Category	Disaster Type	Number of Occurrences	Reported Damage Costs (\$ million*)	Reported Death Toll, People
Geophysical	Earthquake	29	169,406	25,690
	Tsunami	3	210,758	
	Volcanic eruption	8	10	107
	Landslide**	11	248	295
Hydrometeorological	Flood	27	24,280	736
	Typhoon	106	79,333	1,480
	Heavy snow	—	—	1,190
Total		184	484,035	28,018

Source: Original compilation based on EM-DAT (2019). Reported death tolls from earthquakes, tsunamis, and heavy snow are based on the latest report by Cabinet Office (2018a).

Note: *Reported damage costs encompass all economic losses directly or indirectly related to the disaster.

**While landslides can occur due to both earthquakes and heavy rain, they are included in the geophysical category.

TABLE 2.3 Mega Disasters Expected to Occur in Japan

	Predicted Scale of Disaster	Economic Damage (\$ billion)	Asset Damage (\$ billion)	Financial Damage (\$ billion)	Affected Population (no. of deaths)
Earthquake and Tsunami (cumulative damage over 20 years)					
Nankai Trough Earthquake	M8 or more	11,273	1,545	1,191	323,000
Tokyo Inland Earthquakes	M7 or more	6,645	427	700	23,000
Storm surge (cumulative damage over 14 months)					
Tokyo Bay	911.6 hPa (1934 Muroto typhoon levels)	418	582	45	8,000
Osaka Bay	929 hPa (1961 Typhoon Nancy levels)	591	509	64	1,300
Ise Bay	930 hPa (1959 Isewan Typhoon levels)	82	91	9	1,000
River Flood (cumulative damage over 14 months)					
Tokyo Arakawa River	Large-scale flood caused by possible maximum rainfall (1,000-year return period)	236	327	25	2,100
Osaka Yodo River	Large-scale flood caused by possible maximum rainfall (1,000-year return period)	64	55	6	670
Nagoya Shonai River, etc.	Large-scale flood caused by possible maximum rainfall (1,000-year return period)	109	118	12	200

Source: Original compilation based on Japan Society of Civil Engineering (2018).

IMPACTS OF DISASTERS ON INDUSTRIES

More than half of Japan's economic production is centered on coastal municipalities, which are likely to be exposed to hazards such as tsunamis and storm surges.³¹ In the event of large-scale disasters, the flows of people, goods, finance, and information that enable industrial activities are often disrupted due to both direct (physical) and indirect (nonphysical) impacts. Direct impacts of large-scale disasters such as earthquakes or floods to firms may include physical damage to facilities, buildings, and equipment, or injuries and death of employees. These impacts, combined with physical disruptions of multiscalar infrastructure and services such as transportation networks, water, electricity, and information and communication technology (ICT) systems can also make it difficult for workers to safely commute and work, and for businesses to maintain their production and sales functions. As a result, business operations may be halted or reduced for an extended period of time, until physical damages are repaired. Additionally, indirect impacts, which are nonphysical damages such as to the reputation and perceived reliability of firms, and changes in consumer behaviors (such as client companies switching to alternative suppliers or reduction in consumer spending and changes in consumer preferences) may further cause business contraction and sales losses. If firms do not have the financial means to persevere under these financial constraints, they may need to significantly downscale their operation, or ultimately close. This has a significant negative ripple effect on the local and national economy, due to the loss of capital that drives economic activity, increasing unemployment and the number of people struggling to make ends meet. More than half of female workers in Japan are employed as nonregular workers, and are at a high risk of loss or reduction of income (Cabinet Office 2018b). For increasingly expanding manufacturing supply chains, disruption of one firm can cause detrimental impacts to partner firms along the value chain. An overview of how disasters affect industries is provided in figure 2.9.

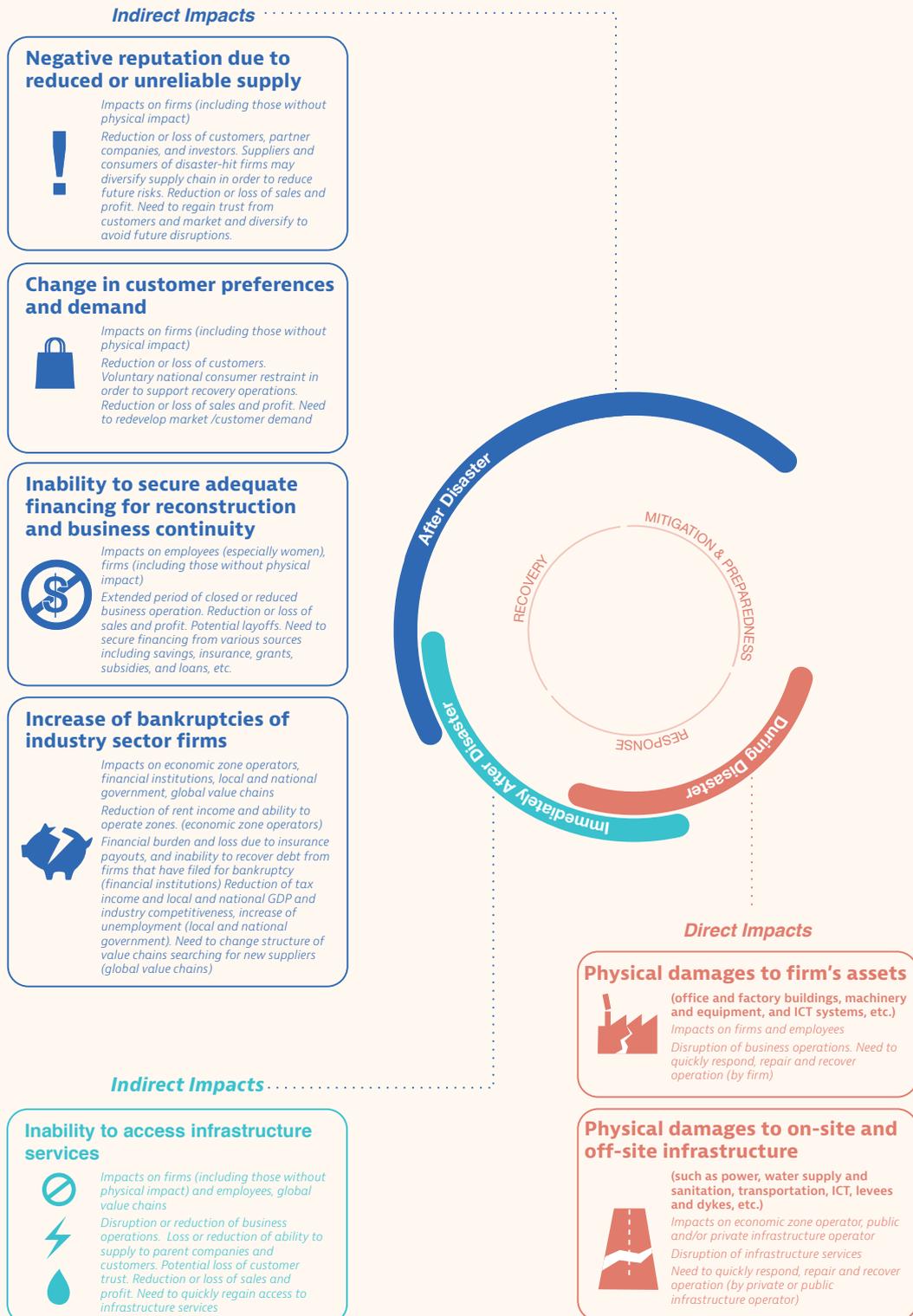
KEY LESSONS FROM DISASTER IMPACTS ON JAPANESE INDUSTRIES

Despite significant impacts, each disaster experience has helped Japan to better understand the complex ways in which disasters may affect industries and their diverse stakeholders. A 2018 survey³² targeting 30,000 SMEs in Japan (15 percent response rate) found that the top four recent disaster events that affected SMEs were the: (i) Great East Japan Earthquake (2011), (ii) heavy rains in July 2018, (iii) Kumamoto Earthquake (2016), and (iv) Hokkaido Eastern Iburi Earthquake (2018). The majority of firms directly affected by the GEJE were SMEs (SMEA 2012). Furthermore, SMEs highlighted a range of physical and nonphysical impacts from these disasters on their business operations, including the inability of employees to come to work; decreased sales due to disaster-related damages to customers and partner companies; loss of business due to disruption of infrastructure services (water supply and sanitation, power, gas, ICT, etc.); physical damages to or inundation of offices and stores, factories, and equipment, final products and warehouses, and transportation vehicles; disruption of raw material supply due to disaster-related damages to suppliers; and inability to secure financing needed for business continuity (SMEA 2019). An overview of industry impacts from these four disasters is given in table 2.4.

31 According to METI (2019d), the gross value added for coastal municipalities in 2019 was 60.67 trillion yen, and for inland municipalities the gross value added was 51.21 trillion yen. Over 60 percent of firms regularly revise BCPs, motivated by "preparedness for natural disasters" rather than "actual disaster experience" (Cabinet Office 2018a).

32 Survey was conducted by Mitsubishi UFJ Research and Consulting. In December 2018, 30,000 SMEs were surveyed (15.1 percent response rate), including 20,006 SMEs (15.3 percent response rate) in the areas affected by major disasters, and 9,994 SMEs (14.6 percent response rate) in other areas. SMEs were defined as firms with 21 or more permanent employees. For more information, see: https://www.chusho.meti.go.jp/pamflet/hakusyo/2019/PDF/chusho/05Hakusyo_part3_chap2_web.pdf.

FIGURE 2.9 Overview of How Disasters Negatively Affect Industries



Source: Original compilation.

Note: GDP = gross domestic product; ICT = information and communication technology.

TABLE 2.4 Overview of Impacts on Industries from Four Recent Major Disasters in Japan

	Great East Japan Earthquake	Kumamoto Earthquake	Heavy Rains in July 2018	Hokkaido Iburi Earthquake
Year	March 11, 2011	April 14 and 16, 2016	June 28–July 8, 2018	September 6, 2018
Disaster type	Earthquake and tsunami (nuclear power plant accident)	Earthquake	Flood/storm	Earthquake
Affected areas	Tohoku and other areas (especially Iwate, Miyagi, and Fukushima)	Kyushu Area (especially in Kumamoto)	Nationwide (especially in Hiroshima, Okayama, Ehime)	Hokkaido
Economic impacts: physical (stock) ³³	Approximately ¥16.9 trillion ³⁴ (\$153.6 billion)	Approximately ¥2.4–¥4.6 trillion ³⁵ (\$21.8–\$41.8 billion)	Approximately ¥0.9–¥1.7 trillion ³⁶ (\$8.1–\$15.5 billion)	Approximately ¥232 billion ³⁷ (\$2,109.1 billion)
Economic impacts: nonphysical (flow) ³⁸	Estimated annual reduction of gross domestic product (GDP) 3 years after earthquake as follows: first half of 2011, ¥0.5–¥2.25 trillion (\$4.5–\$20.5 billion) second half of 2011: ¥2–¥4.25 trillion (\$18.2–\$38.6 billion) 2012: ¥3.75–¥8.25 trillion (\$34.1–\$75.0 billion) 2013: ¥2.75–¥6.5 trillion ³⁹ (\$25.0–\$59.1 billion)	Approximately ¥90–¥127 billion ⁴⁰ (\$0.82–\$1.15 billion)	Approximately ¥150–¥190 billion (\$1.36–\$1.73 billion) across 10 affected areas ⁴¹	Estimated impact on industry and commerce: Approx. ¥131.8 billion (\$1.2 billion) Estimated impact on tourism: Approx. ¥35.6 billion ⁴² (\$0.32 billion)
Key disaster impacts on critical infrastructure and services	Severe impacts to airports, roads, power supply, water supply and sanitation, information and communication technology (ICT) systems, etc. Power was 95% recovered within a week and fully recovered within 3 months. Gas was fully recovered in 2 months. ⁴³	Impacts on power, gas, water supply, and ICT systems. Approximately 476,000 households lost power, but most houses regained power by April 20th. Water supply was fully recovered in 3.5 months' time.	Impacts on gas, power, and transportation. Gas was stopped but recovered by July 8. Power outages were resolved by July 13.	Impacts on transportation and power. Closure of airport for 2 days. Closure of rail. Partial recovery in 1 day, and full recovery in 20 days.

33 The physical economic impacts include physical damages to buildings and facilities and products due to earthquakes and power outage.

34 Based on Cabinet Office (2016).

35 Based on Cabinet Office (2016).

36 Based on Cabinet Office (2018c).

37 Based on METI (2018b).

38 The nonphysical economic impacts include decrease of production (sales) due to business operation disruptions and reduction and supply chain disruptions.

39 Based on Ranghieri and Ishiwatari (2014).

40 Damage from decrease of production (sales) due to business operation disruptions and reduction within 34 days of earthquake. Based on Cabinet Office (2016).

41 Based on Cabinet Office (2018c).

42 Based on METI (2018b).

43 Based on MIC (2017).

TABLE 2.4 continued.

	Great East Japan Earthquake	Kumamoto Earthquake	Heavy Rains in July 2018	Hokkaido Iburi Earthquake
		Communication and broadcasting systems were disrupted due to power outages; however, fixed-line and mobile communication as well as broadcasting systems were mainly recovered by April 18 and fully recovered by April 27.	Rails were devastated. High-speed rail was fully recovered by July 7, but local lines were expected to take at least 1 year for full recovery. Highway roads were disrupted on 13 routes over 900 kilometers (km). Main routes were reopened by September 27.	2.95 million households experienced power cuts: 75% recovered in 1 day; 99% recovered in 2 days. 20% power reduction requested on September 10, which was eased on September 13.
Share of manufacturing in GDP of disaster-affected area	Approximately 18%. Largest share of Tohoku area's GDP. ⁴⁴	Approximately 19%. Largest share in Kumamoto Prefecture. ⁴⁵	Approximately 23–30% and largest share of GDP in Hiroshima, Okayama, and Ehime. Approximately 10% of affected enterprises were in the manufacturing sector (the fourth-largest share) by services, construction, retail, and manufacturing. Agriculture and tourism were the key sectors affected.	Approximately 12% following wholesale and retail (22%) and medical and social welfare (13%) sectors. Tourism and steel industries were the key sectors affected.
Key manufacturing industries affected by disasters	Electronic parts and devices; food products; transportation machineries and equipment; ICT machineries and equipment, etc.	Electronic parts and devices; food products; transportation machineries and equipment; ICT machineries and equipment, etc.	Transportation machineries and equipment and electronic parts and devices. ⁴⁶	Food products and transportation machineries and equipment. ⁴⁷
Disaster-related bankruptcies	1,946 (between March 2011 and February 2020)	12 (as of April 2017 ⁴⁸)	1 (as of August 2018 ⁴⁹)	2 (as of November 2018 ⁵⁰)
Insurance payouts ⁵¹	¥1,279.5 billion (\$11.63 billion)	¥382.4 billion (\$3.48 billion)	¥190 billion (\$1.73 billion)	¥33.8 billion (\$0.31 billion)

44 Based on METI (2019c). Manufacturing located outside of Tohoku was also directly and indirectly affected.

45 Based on METI's analysis. For more information, see: https://www.meti.go.jp/policy/local_economy/bunbunseki/47bunseki/43kumamoto.pdf.

46 Based on DBJ (2018).

47 Based on Cabinet Office (2019b).

48 Based on TDB (2017). Twenty-eight as of April 2018, reported by the Nihon Keizai Shimbun: <https://www.nikkei.com/article/DGKKZO29013990U8A400C1LXC000/>.

49 Reported by Tokyo Shoko Research. For more information, see: https://www.tsr-net.co.jp/news/tsr/20180831_01.html.

50 Reported by Tokyo Shoko Research. For more information, see: https://www.tsr-net.co.jp/news/tsr/20181107_04.html.

51 As reported by the General Insurance Association of Japan (2018): https://www.sonpo.or.jp/news/release/2018/1812_06.html.

Some of the key lessons learned from these recent disasters in Japan are as follows:

- **When disasters strike, business operations are disrupted not only by damages to firms' physical assets, but also due to impacts they may cause to employees and their families, on-site and off-site infrastructure, supply chains, partner companies such as suppliers and parent companies, and customers.** A study of approximately 1,300 manufacturing firms directly affected by the GEJE found that disruption or reduction of business operations was mainly caused by the physical damages to factories and office buildings due to the earthquake and tsunami, followed by power outages and supply chain disruptions (Chujyo, Fujii, and Ishikawa 2013). While information is limited, estimates from megadisasters in Japan such as the GEJE show that the indirect costs of disasters could be as large as the direct cost of disasters (Minakawa 2014). Customers and suppliers outside the disaster area experienced substantial impacts (Kashiwagi, Todo, and Matous 2018). Some studies also suggest that the GEJE not only resulted in a decline in the growth rates of the disaster-affected firms' immediate downstream customers and upstream suppliers, but also that effects extended to firms that were only indirectly linked to disrupted firms (Carvalho et al. 2016; Kashiwagi, Todo, and Matous 2018).
- **The cost of disasters to manufacturing firms is significant. Response, recovery, and reconstruction from disasters, in order to continue or quickly resume business operations, require significant financing.** Renesas Electronic Corp, the world's largest manufacturer of custom-made microchips, stopped production for about three months after the GEJE because its major factories were directly affected by the earthquake (METI 2011). With significant efforts by employees and support from partner companies to repair and recover factory buildings, assembly lines, and lifeline infrastructure supply, business operations were able to resume one month ahead of schedule. Nevertheless, the response and recovery process generated a significant financial burden for Renesas, as well as major losses for the automobile industry supply chain in Japan and internationally. The type and cost of items that were required for disaster response and recovery, as listed in the 2011 Renesas annual report, are included in table 2.5.

TABLE 2.5 Cost of Disasters to a Manufacturing Firm: The Renesas Electronic Corporation after the GEJE

	Amount (\$ million ⁵²)
Cost of repairs to property, plant, and equipment	732.2
Loss from disposal of damaged stock	123.9
Loss from disposal of damaged fixed assets (i.e., equipment, office materials, etc.)	105.4
Payment of fixed expenses (rent, salaries, etc.) during suspension of operations	100.1
Loss on cancellation of lease contracts and others	51
Total loss on the disaster	1,112.5
Insurance payments received	(281.8)
Net GEJE-related losses	830.7
Annual sales in 2011	10,344.5

Source: Renesas Electronics 2011.

Note: GEJE = Great East Japan Earthquake.

52 Converted using the 2018 annual average exchange rate of \$1 = ¥110, based on the yearly average currency exchange rate provided at: <https://www.irs.gov/individuals/international-taxpayers/yearly-average-currency-exchange-rates>.

- **Disasters caused by natural hazards also have widespread impacts on manufacturing industries, as manufacturing firms face the risks of business disruptions.** Four months after the GEJE, in July 2011, a study found that more than half (52.9 percent) of surveyed manufacturing firms in disaster-affected areas were not operating. Additionally, 80 percent of manufacturing firms surveyed nationwide, including those not physically affected by the disaster, responded that they were affected by the disasters, due to constraints in demand and supply. More than half of the impacted manufacturing firms across Japan were affected by a decrease in demand due to the disaster's impacts on their customers and partner companies. Firms also struggled to operate due to constraints in accessing raw materials and parts due to impacts on their suppliers, as well as their supplier's suppliers, and disruption to the distribution and power networks required to connect firms to their suppliers. Through the GEJE experience, many manufacturing firms also realized that they did not have a full overview of their supply chain, which made it difficult for them to effectively plan for the quick recovery of their operations. Most firms had limited information beyond their direct suppliers and customers, requiring weeks or months to understand the bottlenecks within their supply chain that was causing the disruption (METI 2011).
- **The loss of critical lifeline infrastructure services can extend the impacts of a disaster, expanding economic damages beyond the areas physically damaged.** For example, while the physical impacts of the Hokkaido Iburi Earthquake were relatively contained, the major blackout and power shortages that occurred across Hokkaido Prefecture had a significant impact on its people and industries. In particular, for the agriculture sector approximately 20,000 tons of milk could not be shipped out due to the blackout, which was equivalent to about ¥2.4 billion (\$21.8 million) of losses. The power cut disrupted the sterilization treatment and bulk coolers, which forced many farmers to dispose of their harvested milk. Additionally, due to disruption to the automatic milking equipment, many cows suffered mastitis, further affecting the dairy industry (Cabinet Office 2019b).
- **Disaster-related bankruptcies expand across space and time.** While the numbers gradually decreased, 44 bankruptcies associated with the GEJE were observed in 2019, nine years after the disaster. Out of the 1,946 GEJE-related bankruptcies, more than 90 percent were of firms indirectly affected, with no physical damages from the earthquake and tsunami. The cumulative bankruptcies affected over 29,000 people who were employed as full-time staff in these firms, and many other part-time employees. One-third of the full-time employees who lost their jobs were working in firms located in Tokyo. The manufacturing sector accounted for 23.2 percent of the GEJE-related bankruptcies, following 26.6 percent in the service sector (Tokyo Shoko Research 2020).
- **Women face a disproportionately higher risk of disaster-related unemployment.** After the Great Hanshin and Awaji Earthquake of 1995 (GHAE), a mass dismissal of female workers (around 100,000) occurred (Gender Focal Point Network 2008). And past disasters have also shown that women face greater hurdles to reemployment: the number of unemployment insurance receivers increased 1.7 times for male workers, and 2.3 times for female workers after the GEJE (Cabinet Office 2012).

- **SMEs may struggle more to recover from disasters than large-scale firms.** After the GEJE, total sales of SMEs started to fall. They hit bottom around the beginning of 2013 with quarterly sales of ¥123 trillion (\$1.1 trillion), and this remained largely unchanged till the second quarter of 2016. Large companies' total sales also hit bottom around the beginning of 2013, with quarterly sales of ¥136 trillion (\$1.2 trillion), but recovered to over ¥140 trillion (\$1.3 trillion) by the end of 2013. A study by Todo, Nakajima, and Matous (2015) shows that having a diverse network of suppliers and customers outside a disaster-stricken area facilitates the quick restart of business operations: a supply chain consisting of a conglomeration of businesses linked together by cross-shareholdings was found to recover relatively quickly from the GEJE in 2011 (Todo, Nakajima, and Matous 2015).
- **Recovering business and economic competitiveness even after large-scale disasters is possible, with advanced preparedness in place.** Immediately after the GEJE, the automobile sector in Japan experienced the greatest fall in production among all industries, with a 47.6 percent decrease in its industrial production index from the previous month.⁵³ However, the automobile sector showed rapid recovery and regained predisaster production levels by the end of August 2011,⁵⁴ as facilities reopened and vital transport networks were repaired, owing to the dedicated service of well-trained and experienced government staff, prior agreements with the private sector, and advance financial arrangements. Looking at individual firms, Toyota's domestic assembly lines across Japan were shut down immediately after the GEJE to ensure the safety of employees and their families, and to allow investigation of the damages to production lines and supply chains. Thirty-eight days after GEJE, domestic assembly lines had returned to about 50 percent of normal operation capacity, and reached 70 percent in approximately three months (Ono et al. 2016).

DISASTERS BEYOND BORDERS

Given the global nature of modern value chains, especially within the manufacturing sector, disasters have impacts on firms and economies across borders. As Japan's experiences with past disasters show, disasters within a country can affect not only industries domestically, but also connected industries internationally. Similarly, international disaster events can affect connected industries domestically.

For example, after the GEJE in 2011, the Japanese automobile manufacturing sector and electrical component manufacturing sector experienced a production decline of 47.7 percent and 8.2 percent, respectively.⁵⁵ The impact spilled over to other countries in the region: automobile production volume decreased by 19.7 percent in Thailand, 24 percent in the Philippines, and 6.1 percent in Indonesia. Electrical component production volumes also decreased by 17.5 percent in the Philippines and 8.4 percent in Malaysia.⁵⁶

53 For more information, see the report, *The Impact of the Great East Japan Earthquake on Corporate Activities* (Cabinet Office 2011).

54 Based on METI's Indices of Industrial Production: <https://www.meti.go.jp/statistics/tyo/iip/index.html>.

55 Based on the CEIC database: <https://www.ceicdata.com/en>.

56 Based on the CEIC database: <https://www.ceicdata.com/en>.

BOX 2.2 Supply Chain Impacts in Japan and Beyond Borders: The Case of Automobile Manufacturing in Thailand

In 2011, Thailand was hit by the most damaging floods in its history. Seven industrial parks along the Chao Phraya river were submerged and the economic loss was estimated to be over \$40 billion (Ye and Abe 2012). The flood was caused by high monsoonal rainfall between May and October and rainfall from four tropical storms that hit the north of Thailand (Gale and Saunders 2013). Poor urban planning, deforestation, lack of floodwater management systems, and the failure of previous master plans to address flood mitigation were considered the primary contributors to flood damages. In the manufacturing industry, 23 percent of Japanese firms located in Thailand were directly affected and 78 percent were indirectly affected. The effects were especially felt in the automobile and electronics sectors (Ye and Abe 2012). All nine of the Japanese car manufacturers that were operating in Thailand were forced to suspend production.

Although its facilities were not inundated, Toyota Motor Thailand (TMT) suspended production at the Samrong, Gateway, and Ban Pho plants from early October to late November 2011 due to supply shortages caused by the disruption of its supply chain. The effect of production suspension rippled out to factories in Indonesia, the Philippines, Japan, North America, and South Africa, where factories were forced to cut production rates and cancel overtime shifts. In January 2012, the plants of TMT returned to normal operations, but by then Toyota's global production had fallen behind targets by 260,000 cars.⁵⁷ Honda's Ayutthaya factory was the only Japanese automobile factory that was inundated and required 174 days to resume operations. Honda had to stop its production in a factory near Bangkok as well. As a result, the flood reduced Honda's global production by 150,000 cars during the suspension of production (Haraguchi and Lall 2015). In addition, a shortage of electronic parts caused by the floods in Thailand forced Honda to reduce its production even in North America. Nissan halted production in factories in Thailand after 120 suppliers were inundated, which caused an output loss of 33,000⁵⁸ vehicles globally. Out of the three aforementioned Japanese car manufacturers, Nissan was able to recover the quickest because of its supplier diversity and the size of its inventory, which was larger than that of either Honda or Toyota (Haraguchi and Lall 2015). Toyota lost almost the same amount of operating profit as Honda even though its three assembly plants in Thailand were not inundated while Honda's Ayutthaya plant was inundated.

Toyota's relatively large loss was due to low inventory and limited supply sources. Toyota's global value chain had achieved cost reduction by reducing inventory, shortening transportation timelines, and streamlining production systems. However, the entire chain could suffer disruption and breakdown in the event of a disaster at any of its global links (Haraguchi and Lall 2015). Manufacturers in Thailand serve as low-cost assembly lines; assembled products are exported to markets such as the European Union (EU), Japan, and the United States. In November 2011, due to the flood, Thailand's export growth declined by 32 percent for EU markets, 21.4 percent for the United States, and 14.1 percent for Japan. In the automotive industry, the closure of Japanese automotive parts assembly lines in Thailand in December 2011 resulted in a 24.1 percent decrease in unassembled vehicle exports from Japan.

In response to the flood in Thailand, the Japanese government decided to dispatch a disaster relief team to inundated industrial parks including the Rojana Industrial Park and Bangkadi Industrial Park.⁵⁹ It is estimated that the team pumped out approximately 8,100,000 cubic meters of water (equivalent to about 3,200 Olympic swimming pools) in 32 days (Fujiyama 2012). In addition, the Ministry of Economy, Trade and Industry (METI) and the Japanese Small and Medium Enterprise Agency (SMEA) helped the Thai employees who worked in damaged factories to be dispatched to alternate production facilities in Japan; more than 5,300 visas were issued under the special regulation from the Japanese government. The intention of the policy was to support, preserve, and promote the prompt recovery of supply chains (Sukegawa 2013). After the disaster, industrial zone operators in Thailand invested in strengthening physical assets to mitigate damage from future disasters. Most companies did not leave the industrial zone following the flood.

57 For more information, see: https://www.toyota.co.jp/jpn/company/history/75years/text/leaping_forward_as_a_global_corporation/chapter5/section5/item2.html.

58 For more information, see: <http://www.gccapitalideas.com/2011/11/03/floods-in-thailand-2/>.

59 The Japan Disaster Relief Team was composed of the Japanese government and private sector. The pumping vehicles and operators were provided by MLIT and the private sector. See: <http://www.skr.mlit.go.jp/yongi/menu/summary/24-1gihou/img/04.pdf>.

The 2011 Thai floods showed that disasters in other countries can significantly affect Japanese manufacturing industries through direct impacts to offices and partner companies integral to their supply chains. Thailand is one of the largest overseas hubs for Japanese firms and subsidiaries. As of 2018, there were 1,764 JCCB registered companies, out of which 44 percent were in the manufacturing sector.⁶⁰ After the floods occurred in Thailand, analysis showed that overall manufacturing production in Japan fell by 2.4 percent due to supply chain disruptions and production suspensions.⁶¹ Box 2.2 showcases how disruptions of auto industries' global supply chain were induced by the 2011 Thailand floods, and how this affected Japanese manufacturing industries.

Despite the detrimental economic impacts of disasters, as shown in these examples, it is often difficult for individual firms to prioritize trade-offs between everyday supply chain efficiency and disaster risk preparation. By limiting the number of suppliers used, firms can cut costs, but a limited supply chain is more vulnerable to disaster. On the contrary, when firms use multiple suppliers, production costs usually increase but the supply substitutions available in the event of a disaster enhance disaster resilience. Other ways to enhance supply chain resilience include selecting suppliers based on risk criteria rather than cost minimization, shortening the supply chain and/or increasing supply chain visibility, utilizing different distribution channels and supplies, and enhancing relationships with other supply chain partners (Ye and Abe 2012). The balance between supply chain efficiency and disaster resilience is especially important in complex, globally connected value chains.

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60 For more information, see: <https://www.jcc.or.th/about/index3>.

61 Based on the CEIC database: <https://www.ceicdata.com/en>.

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3

ENHANCING RESILIENT INDUSTRY IN JAPAN

Learning from each experience, Japanese industries have incrementally developed various approaches to enhance their resilience against disaster risks. As highlighted in chapter 2, Japanese industries have experienced various shocks and disruptions to economic development throughout their history due to exposure to various natural hazards. Approaches to promoting industry resilience are also diverse, reflecting the types of hazards and risks they aim to manage, as well as who takes action and why, and what types of tools and mechanisms are utilized.

In this chapter, we showcase the diverse resilient industry approaches trialed in Japan, and the early lessons learned. Solutions that may have global relevance are highlighted. For the purpose of this analysis, the resilience of industries is defined as **the ability of industry sectors, firms, and industrial parks⁶² to increase competitiveness by achieving continuity and growth in the face of ever more frequent and intensifying disasters and other unprecedented events. This can be achieved through preparedness, minimizing losses and damages; response, continuing or quickly resuming business operations; and recovery, sustaining and increasing the competitiveness of industry sectors, firms, and industrial parks following a disaster.**

This chapter identifies the stakeholders and solutions driving resilient industry in Japan. The analysis focuses on the manufacturing sector, given its significance to the economy of Japan and many other developing countries.

Section 3.1 provides an overview of the process of enhancing resilience. Section 3.2 highlights the various industry stakeholders, and why they may all be critical to implementing solutions. Section 3.3 summarizes the key solutions that have been trialed in Japan and highlights preliminary findings of lessons learned and challenges. Section 3.4 summarizes several examples and areas for further investigation.

3.1 HOW: RESILIENCE PROCESS AND STEPS

How countries can strengthen resilience against disasters is outlined in the Sendai Framework for Disaster Risk Reduction 2015–30⁶³ (the Sendai Framework). Its four priority areas of action are to (i) understand disaster risk; (ii) strengthen disaster risk governance; (iii) invest in efforts to mitigate disaster risk; and (iv) enhance disaster preparedness for effective response and to “build back better” through recovery, rehabilitation, and reconstruction. The Sendai Framework stresses that “in order to enhance resilience, measures need to address the three dimensions of disaster risk (exposure to hazards, vulnerability and capacity, and hazards’ characteristics) in order to prevent the creation of new risk, reduce existing risk, and increase resilience.”⁶⁴

Building on the Sendai Framework, key steps toward promoting resilience include: (i) **understanding the range of disaster and climate risks** that can affect and threaten business continuity and competitiveness; (ii) **planning and prioritizing evidence-based investments and actions** to address key bottlenecks and strategically avoid or minimize negative impacts; (iii) implementing key actions and investments in advance for **disaster mitigation and preparedness**; and (iv) taking good **response decisions and actions during and after disaster events** to minimize disruptions and losses, and as a result, maintain and enhance industry competitiveness.

62 Economic zones (EZs) are also known as industrial parks, industrial areas, industrial zones, industrial investment regions, special economic zones, and industrial corridors, among other terms. They are areas planned, developed, and managed for the purpose of industrial and associated commercial, infrastructure, and service activities. Groups of interrelated or noninterrelated businesses (tenant firms) in an EZ drive wealth creation in a region. For more information, see World Bank (2017).

63 For more information, see: https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf

64 For more information on the Sendai Framework, see: <https://www.undrr.org/implementing-sendai-framework/what-sf>

Solutions that enhance resilient industry could involve one or more of these four steps for enhancing disaster risk reduction. Each step is described in more detail in figure 3.1.

UNDERSTAND RISK

The first step toward enhancing the resilience of industries is to better understand the risks of disasters and climate change to firms, industrial areas, key infrastructure assets, and supply chains. This is done through analyzing the types of hazards industries are exposed to, the likelihood of their occurrence, and their potential impacts, taking into consideration local contexts and industry characteristics. Risks to industries could be analyzed at various levels, including at the national, regional, industrial park, and firm levels, depending on the intended purpose and use of the analysis. Furthermore, the relevant types of risks to assess also depend on the characteristics and location of industries (such as water and energy needs and infrastructure, supply chain structure and complexity, location of critical infrastructure and assets, etc.). Understanding infrastructural interdependencies can be essential in risk assessments as the ability of industries to mitigate and recover from disasters is highly dependent on infrastructure networks. Thus, it is also important to understand local infrastructure failure interdependencies (electricity needs to be recovered for water supply to recover, etc.). These risks could be analyzed individually or in combination through a multi-hazard approach. It is important to ensure that the risk assessment is tailored to the intended objectives and users.

FIGURE 3.1 Steps toward Resilient Industry



Source: Original compilation based on UNDRR (2015).

Note: This diagram is based on the disaster timeline, also reflected in figure ES.1. Note that the distribution of the steps around the cycle does not reflect their weight or importance, and each action will contribute to industry resilience.

In Japan, diverse and frequent disasters have led national and local governments to conduct various disaster risk assessments, especially for earthquake, flood, and volcanic hazards. These assessments are disseminated and utilized widely through multiple channels and mediums such as hazard maps that are accessible online. Many local governments now have an online platform where various layers of hazard risk levels are made publicly accessible.⁶⁵ Nevertheless, efforts to examine the risks and impacts of disasters that affect firms, industrial areas, industries, and supply chains are still limited, but some initial efforts are emerging. Three examples of risk assessments by industry stakeholders are included below.

Risk Assessment for Firms

- Business continuity plans (BCPs) and business continuity management (BCM) in firms and institutions first gained attention in Japan after the September 11 attacks in 2001 in the United States, when the operations of some multinational firms and financial institutions in Japan were affected. This led to some firms implementing contingency mechanisms so that essential business operations could be maintained in disaster situations. After the devastating experience of the Great East Japan Earthquake in 2011 and its significant impact on firms and supply chains, BCPs were further mainstreamed and promoted in Japan by the national government as a key approach to promoting industry resilience and competitiveness (Hiruma 2011). In particular, the Cabinet Office of Japan has been providing guidance to firms and institutions on how to go about assessing and evaluating risks for their BCPs and BCM within its Business Continuity Guidelines, last updated in 2013 (Cabinet Office 2013). While the target incident for the guideline is defined as a disaster that disrupts firms and institutions' operations, especially in relation to product and service delivery, it stresses applicability to other incidents such as pandemics, large-scale accidents, and terrorism attacks that can halt supply chains and business operations. Local ordinances in Japan may provide further context-specific or more stringent BCP guidelines. (Note that this section focuses on risk assessment aspects of BCPs; these processes are expanded on in the following section on planning and prioritization.)
- The **Cabinet Offices' Business Continuity Guidelines** highlight priorities of the risk assessment and evaluation process:
 - **It is important that risks are assessed separately by hazard and incident type when developing an all- or multihazard BCP/BCM.** The aim of BCP/BCM is to maintain priority operations under any type of emergency. Therefore, it is important to remember that implementation should be consistent and effective across all types of disasters and incidents. However, during the assessment process, evaluating each hazard's risks and estimating its potential impacts separately is important in identifying the appropriate management targets and triggers (i.e., seismic levels in case of earthquakes), and in determining and prioritizing the appropriate measures to be included in the BCP.
 - **Steps for risk assessment in the BCP creation include: (i) identification of incidents, (ii) risk mapping, and (iii) detailed risk analysis of critical impacts.** First, all types of incidents that could potentially disrupt business operations are listed, including events that are likely to be beyond the management capacity of the firm or institution. It is also advisable to consider the possibility of multiple incidents occurring consecutively, such as large floods or earthquakes happening within a short time frame. Second, the risks of all incidents identified are evaluated quantitatively and qualitatively based on the possibility

65 Aichi Prefecture provides their Disaster Learning System to the public. The tool is also referenced for parkwide BCP development. Available at: <https://www.pref.aichi.jp/soshiki/kinyu/180322.html>.

of occurrence and the degree of impact. Based on this, incidents are ranked by risk level and prioritized for action. Third, business risks are estimated for the prioritized incidents, based on their impacts on management resources, suppliers, lifeline infrastructure, customers, etc. of affected firms and institutions. Generally, the business risk assessment evaluates impacts against priority factors of operations (i.e., power, port functions, etc.), by estimating the disruption and recovery time needed for the key factors of operation (recovery time under existing conditions), and what business level could be continued and/or recovered (recovery level under existing conditions).

Further details on the Cabinet Offices' Business Continuity Guidelines are included in appendix A2.

Risk Assessment for Industrial Parks

- Japanese efforts to assess risks of natural hazards in industrial parks have evolved together with growing interest in promoting parkwide BCPs (METI 2012). Similar to firm BCPs, industrial park BCPs have gained attention as a result of the devastating experience of the GEJE in 2011, where firms and institutions faced significant limitations in what they could do alone in continuing and recovering businesses when faced with a megadisaster. As a result, interest and awareness emerged among firms to foster coordination and collaboration with other firms and institutions in the same region, sector, and supply chain to enhance resilient industry.
- Aichi Prefecture, with the largest share of manufacturing in Japan, developed a **manual and template for industrial park BCPs**. Its guidelines elaborate several key steps and considerations for risk assessments in industrial parks, as below:
 - **Utilize available risk information such as hazard maps provided by the local government.** In the Aichi Industrial Park BCM, risk information released by the prefecture is preinserted for use relative to key hazards including earthquakes, liquefaction, and floods. Based on the risk maps, industrial parks, often based on their location, are to determine the level of disaster risks they need to plan for.
 - **Consider the possibility of extreme events.** While most of the hazard risk assessments in Aichi Prefecture have been estimated based on historical maximum or projected worst-case scenario events, the guidelines alert industrial parks of the possibility of extreme events that could exceed the level of risks presented in the hazard maps or other documentation. Therefore, risk above the assessed level should also be considered in the planning and prioritization of resilience measures and solutions.
 - **Most park-level risk assessments could also be used at the firm level. However, assessments of risks to buildings and infrastructure assets at the firm level require further, separate examination.** As the types, location, and resilience measures implemented for buildings, equipment, and infrastructure facilities may vary between individual firms located in the same industrial park, additional assessment in these areas would be required for firms to conduct further analysis at the asset level. For seismic risks, in addition to the building and infrastructure resilience against seismic motion, it is also important to consider potential additional hazards such as tsunamis, coastal floods, and/or liquefaction.

Detailed information on the case study of an areawide BCP development in Aichi Prefecture is included in appendix A17.

Integrating Industry Impacts in Economic Analysis of Flood Protection Infrastructure

- The development of public flood protection infrastructure such as river embankments and dams in Japan involves an economic assessment of benefits and cost-effectiveness. While recognizing the limitations of the valuation of intangible assets, the assessment aims to estimate the benefits of flood protection infrastructure investments through analyzing the potential avoided damage from floods, including direct and indirect impacts to businesses (MLIT 2005). Other factors of economic analysis include an increase of disposable income derived through mitigation of direct/indirect damages to human lives and properties; economic benefits created by improved productivity of land use together with decreased flood disasters; and enhanced sense of security among citizens due to improved flood safety.
- The ***Manual for Economic Evaluation of Flood Control Investment (draft)***, developed by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT 2005), outlines the methodology for estimating the economic impact of flooding to businesses. Key considerations are highlighted below:
 - **Both direct and indirect damages by floods to businesses should be considered.** Direct damages to businesses estimated in the economic evaluation of flood infrastructure include damages to buildings and assets, and depreciation in the value of land, buildings, and inventory due to inundation. Indirect damages include reduced production levels because of interruption or termination of manufacturing activities due to flooding; expenses required for disaster response activities such as cleaning up disaster waste and procurement of emergency supplies such as drinking water, etc.; the ripple effect of business disruption in the area due to reduced production levels from limited access to supply or lifeline utility services; and the psychological damage to people due to loss of business properties and assets.
 - **For the calculation of direct damages to business assets, a range of damage rates are estimated based on inundation levels and the type of business assets.** Damage rates for below-floor-level inundation are estimated to be much lower than above-floor-level inundation rates, reflecting the cost required for recovery. Furthermore, damage rates for depreciable assets are set higher than inventory assets. The bases of these damage rate estimations are derived from the "Fact-Finding Survey of Flood Damage"⁶⁶ that was based on flood events occurring from 1993 to 1996.
 - **For the calculation of indirect damages to businesses, damages from business disruptions and emergency response costs are calculated.** Damages from business disruptions are calculated based on the estimated number of days where businesses operations are closed or reduced in capacity. These values will vary based depending on the expected flood level, the number of workers per industry type, and their per capita added value. Estimated business disruption days are included in the guideline based on a "Questionnaire Survey on Flood Damage" undertaken in the aftermath of flood disasters in 1995 and 1996. For example, the business disruption days for below-floor-level floods (smaller floods) are 3 days of business closure and 6 days of reduced operations, and for severe floods with inundation of 300 cm above floor level, it is 22.6 days of business closure and 45.2 days of reduced operations. Per capita added value per industry categories are also estimated in the guidelines based on various industry and labor census data. Based on 2004 data, per capita added value for manufacturing industry workers was estimated at ¥28,917 (\$262.9).

66 MLIT has been conducting the survey every year since 1961. For more information on the survey, see: <https://www.e-stat.go.jp/stat-search/files?page=1&toukei=00600590>.

To calculate the emergency response costs, the guideline provides an estimate of expense burdens for alternative activities (or emergency response activities due to flood) per business establishment. This metric was developed based on the “Questionnaire Survey on Flood Damage” undertaken in the aftermath of flood disasters in 1995 and 1996. The estimated expense burden for alternative activities for a business establishment affected by below-floor-level flood is ¥470,000 (\$4,272.7), and for severe floods with inundation of 300 cm above floor level, the estimated expense burden is ¥6,619,000 (\$60,172.7) (Ministry of Health, Labor and Welfare 2013).

- **As with any disaster risk management initiatives, having good data is key to assessing the resilient industry benefits of flood infrastructure investments, as well as possible risks with or without the investments.** The overall methodology for assessing flood impacts to businesses and industries proposed in the Manual for Economic Evaluation of Flood Control Investment requires good hydrometeorological data to estimate flood inundation levels, as well as good industry and labor statistics and postflood industry impact surveys to develop estimates on business disruption days, per capita added value per industry type, and the financial burden, per business, of implementing alternative emergency response activities in response to floods.

PLANNING AND PRIORITIZATION

Once the potential risks to industries are identified and shared among stakeholders, the next step is to develop a plan of action where strategic actions and investment for resilience are prioritized, and to put in place institutional frameworks for the implementation of the plan. This could be included in existing national and subnational planning processes such as through integrating disaster and/or climate risk considerations within the development of national industry development strategies, industrial park master plans, or development guidelines, as well as through integrating industry perspectives within national and subnational disaster risk reduction and management frameworks. At the industrial park and firm levels, the Government of Japan encourages actions for resilience to be planned and prioritized through the development of BCPs and emergency preparedness and response (EP&R) plans. New or existing institutional structures, such as multisectoral or multidepartmental emergency preparedness and response teams, will be designated to lead the planning and prioritization process.

As described in section 2.1, disaster and climate resilience considerations in Japan are integrated within national economic and industrial development strategies as well as mandates of key institutions, and resilient industry is also increasingly prioritized as a key element of disaster preparedness, response, and recovery strategies at the national and subnational levels. As of 2019, 100 percent of prefectural governments and 89.7 percent of municipal governments had developed subnational level BCPs (MIC 2019). The resilience of industrial sectors, firms, and supply chains is prioritized under recent policies including the **Basic Act for National Resilience Contributing to Preventing and Mitigating Disasters for Developing Resilience in the Lives of the Citizenry (Basic Act for National Resilience) 2013**, the **Fundamental Plan for National Resilience** (2014, updated in 2018), and the annual **Action Plan for National Resilience** (since 2014). At the subnational level, key industrial areas such as Aichi Prefecture and Kawasaki City have integrated resilient industry as one of the key pillars of their **Fundamental Plans for Regional Resilience**.⁶⁷ In Aichi Prefecture, the key objectives of the Resilience Plan are to protect and quickly recover lives and local industries and socioeconomic activities in the face of megadisasters; to promote sustainable growth and competitiveness of

⁶⁷ For more information, see: https://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/tiiki.html#guideline.

industries within global markets; and to contribute to strengthening national and international resilience (Aichi Prefecture 2020). With the aim of maintaining key economic functions, the plan outlines several measures to avoid potential risks to industries. Scenarios include the decrease of firm production capacity and global competitiveness due to supply chain disruptions; disruption of energy supply and impacts to supply chains; damages, fires, and explosions at industry complexes and other critical facilities; logistical disruptions due to a damaged arterial transport network that can halt the flow of goods and people; disruption of financial services that can affect livelihoods and commerce; and disruption to food and water security.

Under these national-level policies, the Japanese government has designed a group of initiatives across multiple ministries to encourage the private sector to promote resilience.

The Basic Act for National Resilience provides an overall goal for resilience to be shared among all types of stakeholders. The Fundamental Plan for National Resilience specifies 4 basic principles, 8 goals for disaster preparedness, and 45 “worst events that should never happen,” including events that may severely disrupt supply chains and economic activities.⁶⁸ In accordance with these policies, a number of ministries have developed various private sector incentives, such as subsidies, tax incentives, regulation exemption, and certification systems. Examples of subsidies from the national government to companies include subsidies for area developers that develop central business districts. Subsidies have been provided when developers invest in energy systems to maintain the business continuity of business districts (e.g., near the Tokyo Station) where multiple large corporations’ offices are located. Tax incentives are also provided as a part of taxation policy that are reviewed, continued, and/or revised every financial year in accordance with the annual Action Plan for National Resilience. For example, METI and MOE support companies that introduce cogeneration facilities. Cogeneration can generate electricity as distributed independent energy systems so that users can rely on it when large energy systems were to shut down during disasters. Cogeneration can also significantly reduce energy consumption and CO₂ emissions. When companies invest in cogeneration, they will receive a fixed property tax reduction for the first three years of capital investment.

As an example of a regulation exemption, MLIT has set up an exemption for floor area ratio (FAR) regulations in buildings. FAR regulations require a company to limit the ratio of a building’s total floor area to the size of the land upon which it is built. However, when companies take resilience actions, they can exclude the floor area of spaces designed to support resilience from their FAR calculations. For example, suppose a company located near transportation hub stations secures a space for stockpiles for citizen’s evacuation and backup emergency generators. In that case, these spaces are not counted toward the total floor area for this regulation. In addition, the Cabinet Office launched a Resilience Certification System in 2018. The system certifies companies that agree with the mission of the Action Plan for National Resilience and proactively undertakes measures for business continuity. If companies are certified by the system, they can publicly announce this to consumers. Furthermore, certified firms can get financial support from DBJ and other commercial banks with preferential interest rates.

EP&R plans, BCPs, and combined EP&R+BCP plans⁶⁹ are also widely developed in Japan, including by industry stakeholders. Private firms, together with national and subnational governments and lifeline utility companies and financial institutions, are requested to develop EP&R plans and BCPs to continue their operations under the **Basic Act on Disaster Management** and **Basic Disaster Management Plan, respectively**. While this program is voluntary, the government conducts regular surveys to assess progress in EP&R/BCP plan development, and develops incentives and programs to help improve participation. Additionally,

68 For more information see: https://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/en/fundamental_plan.pdf

69 For an example, see <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0584pdf/ks058404.pdf>.

under the Action Plan for National Resilience (2014), the Government of Japan has put forth a target for 100 percent of large firms and 50 percent of midsize firms⁷⁰ to establish BCPs by 2021 (Cabinet Office 2018a).

EP&R plans and BCPs each play a unique and important role in enhancing resilience. To minimize burdens and streamline planning processes, plans that feature both EP&R and BCM are increasingly encouraged, especially for firms and SMEs. The main objective of EP&R plans is to save lives; account for staff safety; and gather, report, and disseminate disaster information. BCPs often build on EP&R plans and focus on defining and continuing priority business operations and functions, target recovery time, and alternative modes of operations (Cabinet Office 2007). By expecting possible worse-case-scenarios and defining not only what to do, but also what not to do in the event of an emergency, BCPs are a practical planning and prioritization tool for private sector firms to maintain essential services and operations to quickly respond and recover after a disaster event. The key differences and relationship between EP&R plans and BCPs are further elaborated in box 3.1.

BOX 3.1 Business Continuity Plans vs. Emergency Preparedness and Response Plans—What Is the Difference?

While both business continuity plans (BCPs) and emergency preparedness and response (EP&R) plans aim to enhance the resilience of institutions (e.g., firms and governments), in Japan, there is a significant difference in their basic planning assumptions due to the country's unique policy context described above.⁷¹

EP&R plans in Japan focus on saving lives and minimizing damages. They are generally composed of action plans for: (i) preparedness, (ii) response, and (iii) recovery and reconstruction. Under the three phases, all actions that need to be undertaken by the institution or firm are outlined. In many cases, EP&R plans may not consider impacts such as the potential reduction of capacity and resources of institutions due to disaster impacts (Haraguchi 2020). However, EP&R plays a critical role in strengthening the awareness and capacity of all stakeholders to know how to best prepare and respond to disasters. Before the introduction of BCPs, EP&R plans were the primary planning tool for disaster risk reduction.

On the other hand, **BCPs** in Japan focus on how to maintain or restore business operations when an institution must operate with limited human, material, information, and financial resources (Haraguchi 2020). Therefore, BCPs aim to identify and prioritize resources needed postdisaster to maintain minimum levels of operation for business continuity. Therefore, BCPs outline the institutional setup, management procedures, contingencies and backup plans, and the resources needed in advance, so that businesses can continue under disaster situations (Newton Consulting Ltd. 2018). BCPs may include strategies such as storing food, conducting disaster risk reduction drills, forming an emergency rescue system, and/or promoting alliances among employees. They serve as critical business risk management tools benefiting business owners, managers, and employees.

Given the differences and unique role of EP&R plans and BCPs, both planning processes are essential to strengthening the resilience of institutions, including a wide range of industry stakeholders. These two elements could also be combined in a single plan.

70 In the case of the manufacturing industry, midsize firms are defined as firms with capital worth more than ¥300 million (\$2.7 million) but less than ¥1,000 million (\$9.1 million), and with more than 301 full-time employees (Cabinet Office 2018a).

71 As elaborated in section 3.1, in Japan, EP&R plans and BCPs are planning tools promoted under different policies. EP&R plans are planning instruments under the Basic Act on Disaster Management, while BCPs are under the Basic Act for National Resilience Contributing to Preventing and Mitigating Disasters for Developing Resilience in the Lives of the Citizenry (Basic Act for National Resilience) 2013.

Planning and prioritizing resilience actions and investments for SMEs can be challenging, and specialized support is needed. In the event of large-scale disasters, SMEs especially face significant challenges to continuing or rebuilding their businesses and competitiveness. However, due to competing priorities, climate and disaster risk preparedness and response are not yet widely recognized as a key priority within SMEs' business strategies and management plans. Despite these policy frameworks at the national level, BCP establishment can be challenging, especially for SMEs. A survey conducted in 2019 found that while 81.4 percent of surveyed large firms had established or were developing BCPs, this was the case for only 46.5 percent of medium-sized firms (Cabinet Office 2020). In 2019, the Act on Strengthening of SMEs was established to better support SMEs in enhancing their resilience against various challenges, including disasters from natural hazards and an aging workforce. In light of this context, the law institutes measures that enable SMEs to strengthen business continuity, disaster management capacities, and business succession. The law introduces basic policies that outline actions SMEs can take before disasters to reduce disaster impacts, as well as actions financial institutions, local governments, business associations and parent companies of supply chains can take to collaborate with one another to collectively strengthen resilience. Furthermore, under the law, METI has established a system to certify BCPs formulated by individual companies, provide financial incentives such as low-interest loans and tax incentives for disaster resilient investments, and prioritize BCP companies within grant selection processes. Through these incentives, the establishment of BCPs at the firm level, as well as among groups of firms, are encouraged (METI, 2019).

Key barriers to the resilience of SMEs include lack of awareness, resources, and incentives. Studies have found that demand and support from parent companies, clients, and financial institutions are key factors that drive SMEs to advance their BCP efforts. This role of industry networks needs to be considered when designing programs to advance resilience in SMEs. A survey of top management issues faced by Japanese firms (Japan Management Association 2017) highlighted that, given competing priorities, managing disaster risks and planning for continuity is far less of a concern for business management, compared to other urgent issues such as increasing sales, profits, and shares, and enhancing human resource quality and capacities.⁷² Another survey (Mizuho Research Institute 2016) found the top three barriers for SMEs in developing BCPs were lack of skills and knowledge (49 percent), perceived lack of importance (34 percent), and limited human resources (32 percent). Similarly, the top three barriers for SMEs to enroll in insurance for natural disasters were a lack of belief that they would experience disaster (39 percent), high insurance premiums (30 percent), and a lack of awareness of disaster insurance (24 percent).⁷³ In terms of motivations and incentives for BCP establishment, another survey, conducted by the Small and Medium Enterprise Agency (SMEA 2016), found that the top three motivations for SMEs to establish BCPs were due to decisions made by management (50 percent), to fulfill supply responsibilities to customers (36 percent), and by request from the parent company (29 percent). Firms that had not yet established BCPs indicated that they may be encouraged to establish BCPs if preferential interest rates on loans were provided (25 percent), if insurance premiums were discounted (25 percent), or if requested from the parent company (24 percent). While continuous efforts are required to advance SMEs' individual, firm-level BCP efforts, the next step is to consider developing areawide BCPs to enhance inter-organizational cooperation after disasters so that issues that cannot be tackled by a single company can be addressed through mutual support.

72 The questionnaire was sent to 3,460 major companies across Japan (samples extracted by the Japan Management Association) with a 9.7 percent response rate.

73 The questionnaire was sent to 20,000 firms (2,600 among them had more than 300 employees) with an 18.1 percent response rate.

BCPs are emerging in industrial areas in Japan as a way to collectively address residual disaster risks that single firms alone would find difficult to address (METI 2012). In Aichi Prefecture, efforts to promote industrial park BCPs highlight their potential benefits and synergies with firm-level BCPs. Benefits include making BCM in general more effective, efficient, and easy to develop and implement. Through a collective approach, the overall costs to individual firms for BCP development, management, and implementation can be reduced. Elements of BCPs that have been identified as particularly beneficial if approached collectively rather than individually include disaster risk assessment, identification of risk reduction and preparedness measures, staff training and drills, evacuation route and shelter planning, prepositioning and procurement of emergency supplies and equipment, strategies to support local community in case of disasters, and the development of key contact lists. Strengthening business continuity in local communities and industries through cooperation between industry and government from normal times will lead to disaster-resilient communities and industries. As part of the parkwide BCP at Akemi Industrial Park, the timeline of “what” will be implemented in response to a disaster, by “who,” and exactly “when” a disaster occurs was developed and shared with the local government to align their response and recovery actions (MLIT 2018). A detailed analysis of the parkwide BCP developed by the Akemi Industrial Park in Aichi Prefecture can be found in appendix A17.

Mitigation and Preparedness

In accordance with the planning and prioritization process, structural and nonstructural measures for enhancing the resilience of firms, industrial parks, and supply chains will be implemented. Mitigation and preparedness measures for industries include actions and investments made in advance to avoid or reduce damages and continue or quickly recover critical operations postdisaster. These measures enable securing the resources needed to continue critical operations, as well as reduce damages and losses to these operations by safeguarding them against resource constraints (SMEA 2012).

The types of structural mitigation and preparedness measures available for industry stakeholders differ based on hazard type. For example, in Japan where earthquakes are a significant risk throughout the country, mitigation measures include seismic proofing of buildings and facilities as well as critical infrastructure that supplies power, water, ICT, and transportation services to industries. On the other hand, for floods, investments in large-scale flood mitigation infrastructure such as river levees and coastal dikes are normally developed by the public sector, while some of the smaller-scale and site-specific infrastructure could be developed by individual industrial parks. Firm-level interventions are normally building- or site-level investments (such as raising the first floor of critical facilities, etc.). Structural measures to enhance industry preparedness include investments in backup power generation, water supply and treatment, and access to data and communication channels in case critical infrastructure services are disrupted.

Nonstructural measures can enable key preparedness actions highlighted in BCPs, and therefore can be applicable across various types of disasters. These measures include efforts to develop and enhance BCPs; ensure safety of workers; improve information gathering, communication, and decision-making processes; establish prearranged collaboration agreements with neighboring firms, critical infrastructure operators, public sector agencies, or remote firms that could enable backup operations and services for the continuity of supply chain; implement training and evacuation and response drills; establish manuals, guidelines, and protocols; and put in place various risk financing and insurance solutions that can help ensure cash flow and cover costs needed for repair and response. Since a BCP does not specify the type of disaster being planned for, nonstructural measures applicable to many disaster types are particularly relevant.

Table 3.1 provides an overview of the various types of structural and nonstructural measures implemented by Japanese industries based on a study of existing BCPs conducted by Japan’s Cabinet Office (2018) and SMEA (2018).

TABLE 3.1 Examples of Structural and Nonstructural Measures for Mitigation and Preparedness

Measure Type	Hazard Type	Stakeholder	Measure Description
Structural	Flood	Firm	<p>Mitigation: Raising floor level of critical facilities and storage buildings. Installation of watertight doors. Procurement of sandbags.</p> <p>Preparedness: Positioning key equipment or high-value products on higher floors or shelving. Procurement of pumps and boats for evacuation.</p>
		Industrial park / area	<p>Mitigation: Developing flood protection levees to prevent coastal/river floods. Developing stormwater management reservoirs or green spaces. Procurement of sandbags.</p> <p>Preparedness: Procurement of pumps and boats for evacuation. Installation of river and/or rain gauges, flood early warning systems (i.e., sirens), etc.</p>
		Local or national government	<p>Mitigation: Developing flood protection levees to prevent coastal/river floods. Developing stormwater management reservoirs or green spaces. Procurement of sandbags.</p> <p>Preparedness: Installation of river and/or rain gauges, flood early warning systems (i.e., sirens), etc.</p>
Earthquake	Earthquake	Firm	<p>Mitigation: Seismic proofing buildings and facilities. Decentralizing warehouses. Installation of emergency shutdown systems in factories.</p> <p>Preparedness: Procuring and prepositioning of spare parts and repair equipment.</p> <p>Preparedness: Installation of seismometer, earthquake early warning systems (i.e., sirens), or automatic shutdown systems for assembly lines, etc.</p>
		Industrial park/ area	<p>Mitigation: Seismic proofing of critical infrastructure facilities on site.</p> <p>Preparedness: Procurement and prepositioning of spare parts and repair equipment for critical public infrastructure servicing firms and industrial parks.</p> <p>Preparedness: Installation of seismometer, earthquake early warning systems (i.e., sirens), etc.</p>
		Local or national government	<p>Mitigation: Seismic proofing of critical infrastructure facilities off site.</p> <p>Preparedness: Procurement and prepositioning of spare parts and repair equipment for critical public infrastructure servicing firms and industrial parks.</p> <p>Preparedness: Development of earthquake early warning systems (i.e., sirens), etc.</p>
Multihazard		Firm and/ or zone wide	<p>Preparedness: Installation of backup power and water supply. Procurement of postdisaster road and site clearing machinery. Procurement of backup transport vehicles. Citing off-site data and information and communication technology backup systems. Development and upgrade of disaster-proof and inclusive evacuation centers.</p>

TABLE 3.1 continued.

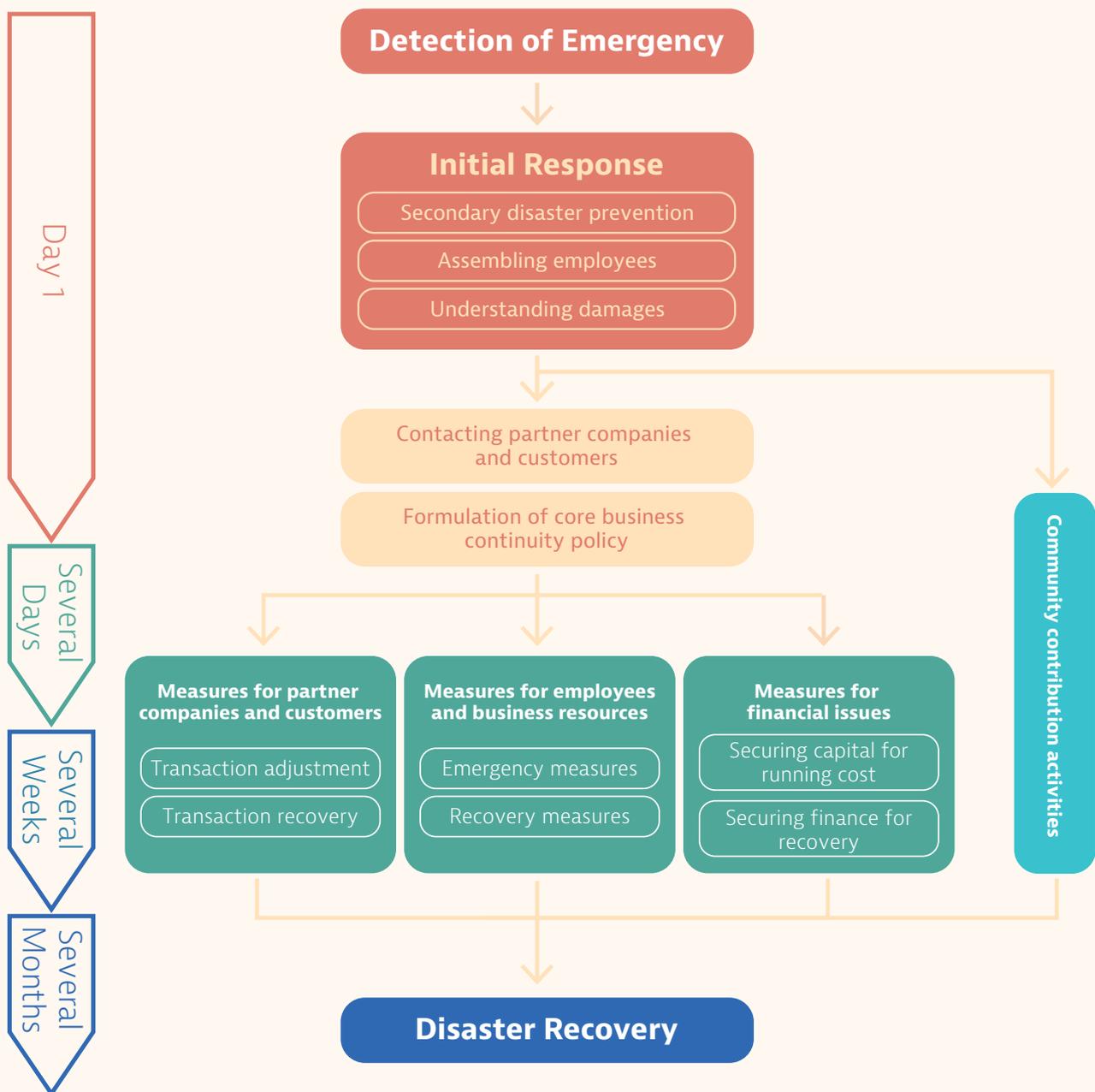
Measure Type	Hazard Type	Stakeholder	Measure Description
Nonstructural	Multihazard	Firm and/or zone wide	Preparedness: Development and updating of hazard maps and evacuation plans and protocols. Definition of emergency operation center, members, and communication and decision-making protocols, including backup plans. Definition of evacuation routes and centers and backup plans. Maintenance of staff member and key contact lists. Education and capacity development of works and employees on emergency preparedness and response plans and protocols including periodic evacuation and response drills. Prearranged agreements with other firms and stakeholders for alternative production and/or service delivery mechanisms. Restoration procedures for critical on-site infrastructure (i.e., postdisaster checklists, external communication protocols, etc.).
		Firm level	Preparedness: Restoration procedures for factories and facilities (i.e., postdisaster checklists, external communication protocols, etc.). Prearranged agreements with clients, suppliers, group companies, etc. for postdisaster coordination and response mechanisms including information collection, sharing, and decision-making protocols. Analysis of the potential financial losses from business disruptions (one week, one month, six months, etc.) and various disaster risk finance solutions (such as insurance, prearranged postdisaster low-interest loans, low-interest loans, prearranged loan repayment grace period arrangements, subsidies, grants available for resilience investments and actions).

Source: Original compilation based on Cabinet Office (2018) and SMEA (2012, 2018).

RESPONSE AND RECOVERY

The final step toward resilient industry is to effectively respond during and immediately after a disaster in accordance with the procedures outlined in the BCP. Response and recovery measures are triggered based on predetermined criteria. Their implementation is led by teams responsible for key business continuity functions. In Japan, SMEA guidelines (SMEA 2012) provide an overall framework for response and recovery efforts from the day of disaster through a few months of early recovery (figure 3.2). After each disaster response and recovery experience, it is also important to reflect on what worked well and what requires improvement, and update and adjust the resilient industry plans and actions to reflect lessons learned.

FIGURE 3.2 Flowchart of BCP Actions Triggered in the Event of a Disaster



Source: Original compilation based on SMEA (2012).

Setting clear criteria for triggering the BCP, at the level of the individual firm, infrastructure operator, industrial park, and government is very important. These criteria should be developed based on critical operations that need to be maintained. Unless the criteria are clearly defined, often by type of hazard (such as flood, cyclone, earthquake, fire, or pandemic), and are widely shared among key stakeholders, effective and timely response and recovery measures cannot be implemented. As a result, core business operations may not be restored within the target recovery time. The criteria for triggering the BCP should be informed by the essential functions needed to maintain priority business operations defined in the BCP, as well as the target recovery time. Criteria can vary from hazard-specific disaster levels, to a description of a condition when operational functions face risks that can hinder business continuity. For example, an “earthquake with magnitude 6 or higher occurring in the prefecture where the firm operates” could be one BCP trigger criterion for a firm with most of its key business operation functions housed within a building proofed for an earthquake of magnitude 6. Other firms or institutions may define the criteria for triggering and dissolving BCPs more broadly, such as “when the Head of the Emergency Operation Center (i.e., CEO) has deemed significant risks to maintaining the critical business operations.” For floods, possible criteria to trigger a BCP can include those that local governments use for setting up emergency management offices (e.g., river discharge levels and rainfall amounts) (NILIM 2012). Possible factors to consider when designing activation criteria include a disasters’ effects on: workers’ safety and ability to safely commute to work; conditions and operational capacities of company buildings and facilities; disruptions to critical infrastructure such as electricity, water, sewage, gas, and communications networks; and conditions of business partners.

Effective response and recovery measures are focused on regaining four key functions required for the continuity of critical operations: restoration of facilities and equipment, external communication and coordination, financial management, and logistics. Setting up clear institutional structures and teams responsible for these functions is critical for the smooth execution of BCPs. Restoration functions include checking damage levels and repair needs of mainly on-site facilities and equipment to minimize disruption of critical operations. External communication and coordination functions are important during and after disasters to gather key information on damage, as well as liaise with business partners, cooperating companies, associations and trade associations, and the public (Haraguchi, Lall, and Watanabe 2016). Sharing information can facilitate necessary decision-making. Many firms in Japan also provide support services to surrounding communities after large-scale disasters through close coordination with local governments and community groups. For example, the firm Fukuyama Transport Co., Ltd. has established an agreement to provide both predisaster services like hazard mapping and community preparedness drills, as well as postdisaster emergency supply logistics, office facilities, and company housing as shelters (Hiroshima Prefecture 2017). Financial management is another critical tool for securing the financial resources needed to keep businesses running, by covering additional costs that may be incurred to implement the response and recovery efforts, providing support to workers’ safety, as well as securing cash flow to cover fixed costs (i.e., rent, loan repayments, salaries, utilities, taxes, etc.) under possible sales losses. Logistics management is also crucial for an effective response and recovery operation, which may include anything from human resource management and support, to arranging and delivering emergency food, water, and supplies.

Initial response during and/or immediately after the disaster event includes confirming the safety of employees, families, clients, and facilities; preventing secondary disasters; and establishing an emergency operation center or team (EOC/EOT) with predetermined essential staff members. In accordance with communications channels (i.e., phone tree, etc.) outlined in the EP&R plan or BCP, the safety of staff and family are checked and confirmed. If necessary, the safety of clients and business partners is also checked. Staff on site will also take actions to prevent any secondary disasters, such as facilitating a move to safe ground and evacuation centers, providing first aid, and calling ambulances and fire departments. Once an EOC/EOT is set up, conditions and damage levels of buildings, facilities, equipment, ICT systems, critical lifeline infrastructure, and neighboring firms and communities will be surveyed.

After the initial response efforts are completed, under the leadership of the EOC/EOT leader (CEO, etc.), measures to maintain business continuity functions are initiated. Whenever possible, it is helpful to set up a physical location for the EOC that can serve as a central hub for response and recovery efforts. Based on damage assessment, response and recovery goals—such as the time frame and location of critical business operations—will be determined. The need to activate prearranged cooperation agreements or seek partnerships with external firms and institutions will also be assessed. Recovery costs and cash flow risks will also be assessed, which will serve as the bases for financial management strategy for the recovery process. If there are human resource constraints, support from retirees, industry associations, and/or partner firms may be sought or provided to other firms and organizations in need.

Response and recovery measures involving customers and business partners, employees, and financial institutions will be discussed and implemented. Firms will reach out to customers and supplier networks and, depending on the level of impacts to their production and operations, may need to discuss temporary adjustments to the volume of business transactions. Timelines and conditions for shifting back to predisaster levels of business transactions need to be clearly discussed and agreed upon. The EOC team will continue to share timely information on response and recovery status with employees as well as provide necessary support to assure their safety and security. Facilities, equipment, ICT, and other infrastructure are to be repaired according to clear timelines and phasing plans while making necessary adjustments to what was planned in the BCP. For financial management, also based on the BCP, a business operation budget for at least one month will be secured, utilizing savings and or any financial support that may be made available by the local or national government as emergency grants and loans. Close coordination with banks and financial institutions is critical to ensure that issued bills do not become dishonored; an additional grace period may be provided for loan repayment. To cover any additional reconstruction costs, in accordance with the BCP, financial managers may activate the various disaster risk finance and insurance mechanisms such as receiving payment from insurance programs, applying for Employment Adjustment Subsidies,⁷⁴ selling securities and other assets, receiving prearranged disaster recovery loans from government-affiliated financial institutions, or applying for new low/no-interest postdisaster loan programs.

If capacities allow, firms in Japan often provide support to their surrounding community in conjunction with business continuity measures. The nature of support to the surrounding community depends on the location, size, and nature of each business and industrial park. Firm support to communities can include providing food or supplies and making them available at an emergency evacuation center, channeling lifeline utility services such as power or water to the surrounding community when central systems are down, or volunteering for road clearing or emergency shelter operations. These supports are often set up in conjunction with local government, social welfare councils, local neighborhood associations, and nonprofit organizations (NPOs).

As industries and businesses are a key part of local and national economies, it is important for industry stakeholders to participate in discussions for medium- to long-term recovery processes and in turn help advance opportunities to further enhance resilient industries and economic development. After large-scale disaster events in Japan, such as the Great East Japan Earthquake in 2011, reconstruction plans are developed, where the recovery of industries and businesses often serves as a central pillar to build back the life and livelihood of disaster-affected communities. As part of these efforts, various new initiatives, such

74 The Japanese government implements Employment Adjustment Subsidies. Employers forced to scale back operations temporarily and who place employees on furlough without terminating them receive financial support in proportion to those employees' wages. For information on the Employment Adjustment Subsidies implemented during the COVID-19 pandemic in 2020, see: https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/koyou_roudou/koyou/kyufukin/page107.html.

as investments in green technology and energy systems, are implemented through partnership between the public and private sectors. For example, in Ohira Industrial Park, which was reconstructed after the GEJE in Miyagi Prefecture, Toyota Motors Company together with 11 union member firms established an F-Grid system that optimizes power supply to the industrial area by combining the electricity generated from the on-site electric power company, cogeneration, and solar power generation. More information is available in appendix A18.

3.2 WHO AND WHY: STAKEHOLDERS AND INCENTIVES

Enhancing industry competitiveness is a key concern for many stakeholders, including government, industries and firms, financial institutions, and citizens. Therefore, with appropriate support, many stakeholders would have the incentive to drive actions that can enhance resilient industry. Interest is growing, alongside awareness of resilience as an essential element of competitiveness. The key actors incentivized to drive resilient industry in Japan include: **the public sector** (national and local government, infrastructure operators, etc.), **the manufacturing sector** (firms, value chains, etc.), **industry stakeholders** (industrial park operators, associations, etc.), the **financial sector** (banks, insurance companies, etc.), and **civil society groups** (including women's associations).

The resilience of the manufacturing industry is everybody's business in Japan; increasingly frequent and extensive damages and disruptions due to disasters affect many stakeholders' operations and competitiveness across sectors. Consequently, these diverse stakeholders are becoming more aware and motivated to drive efforts toward enhancing resilience—and thus sustaining the viability of their businesses, services, and livelihoods. In this section, we highlight the motivations and barriers for resilient industry across four key types of stakeholders: the public sector (national and local government, infrastructure operators, etc.), the manufacturing sector (firms, value chains, etc.), industry stakeholders (industrial park operators, associations, etc.), and the financial sector (banks, insurance companies, etc.). The public sector includes policy makers and national and local government officials tasked with strengthening and maintaining the Japanese economy. The manufacturing sector includes the owners and employees of manufacturing firms, an essential component of Japan's economy. Industry stakeholders, including industrial zone managers and employees, provide Japan's industries with a collaborative environment for accessing business critical infrastructure and resources. The financial sector, including public and private financial institutions and investors, provides financial products and support for Japan's industries. These stakeholders are each key drivers of resilient industry through their own unique motivations and methods. Key stakeholders such as women and SMEs, which are critical to any consideration of industry resilience, have been targeted by few measures to date, making detailed analysis difficult. These challenges and areas of further work are also highlighted.

PUBLIC SECTOR

Motivations Driving Resilience

Resilience is increasingly recognized as an essential strategy for sustaining and enhancing economic competitiveness. Public policy makers and officials are responsible for ensuring that the economy is strong so that it supports the livelihoods of their constituents. As described in chapter 2, the manufacturing sector is vital to the Japanese economy. Disaster risks to industries negatively affect both macro- and microeconomic development at the national and local level.

The Kumamoto earthquake of April 2016⁷⁵ is a recent example. Although the earthquake occurred five years after the GEJE, sufficient local mitigation and preparedness measures were not in place. The Cabinet Office estimated that the total damages from the Kumamoto earthquake were up to \$42 billion, or 46 percent of regional GDP. The impact of the earthquake on the local economy was enormous. As the region has many automobile industry factories, the earthquake also caused a large-scale disturbance across the automobile supply chain network and national economy.

Disasters also have a negative social impact—reducing employment opportunities and working conditions, especially for women, the elderly, and other vulnerable groups.

Many women are part-time workers, a group that has faced mass dismissals after past disasters (Statistics Bureau of Japan 2020; Gender Focal Point Network 2008). After the GEJE, the rate of female workers receiving unemployment insurance increased sharply, compared to male workers in Iwate, Miyagi, and Fukushima. A contributing factor was a misalignment between the types of jobs women were looking for and the actual jobs available. While job openings remained low in the food manufacturing sector and had a comparatively high number of female applications, there were more job openings than applicants in the construction and civil engineering sectors, which had only a small number of female applications (Cabinet Office 2012b). This shows that women may have a harder time rejoining the workforce after a disaster. Managing the increasing risks and impacts from climate and natural hazards is therefore a key concern to public sector stakeholders as they pose major threats, not only to the safety and security of the population, but also to national and local economies.

Approaches to Enhance Resilience

The Japanese public sector works to enable resilient industry by setting up supportive policies. Although the government's primary concern is saving lives and protecting the well-being of citizens, it also plays a role in supporting the resilience of private firms. This includes the establishment and implementation of policies such as the Basic Act for National Resilience Contributing to Preventing and Mitigating Disasters for Developing Resilience in the Lives of the Citizenry (Basic Act for National Resilience) 2013, promoting the disaster preparedness of the private sector through awareness raising, capacity building, and the development of guidelines and tools for private sector business continuity planning (figure 3.3; approaches 1, 2). Policy makers and public officials help to establish safety nets for postdisaster business recovery finance, especially for SMEs and women-owned businesses (figure 3.3; approaches 7, 8). Government officials are also responsible for gathering, analyzing, and distributing data on disaster risks for use in public policy making and private sector/community awareness raising (figure 3.3; approach 6). **The public sector plays a key role in strengthening the resilience of critical infrastructure with the goal of avoiding or reducing the disruption of transportation, power, water, and telecommunication networks** (figure 3.3; approaches 3, 4, 5). Public sector policies and programs for medium- and long-term recovery after a disaster can support innovative and resilient postdisaster industry development investments to stimulate the economy by creating jobs and enable the building back of more competitive industries. These approaches create an enabling environment for resilient industry, minimizing or avoiding postdisaster business disruptions.

75 The magnitude was 6.5.

Remaining Challenges

The amount of financial and technical support demanded from the government after a disaster is immense, as the public sector is responsible for protecting the lives and needs of citizens, and the recovery of critical infrastructure services. Thus, the public sector's capacity to support the private sector immediately and adequately after disasters may be limited. In Japan, the government's primary concern immediately after disasters has been addressing the damages to critical infrastructure like schools, hospitals, transportation, water, and energy services, followed by recovering the quality of life of people in the affected region. The government's strong emphasis on recovering social infrastructure influences budget allocation for disaster recovery. For example, the total government budget relating to disaster recovery between FY1994 and FY1999 was \$47.7 billion, of which \$40.5 billion (85 percent) was used for the recovery of physical infrastructure and residential housing in line with contingent liabilities, while 15 percent of the total budget was used for supporting SMEs and individuals. Since the GEJE, new public and private sector collaborations have been developed that help address the disaster-related needs of SMEs and individuals. For example, the Reconstruction Agency, an agent of the Japanese government, has created initiatives that help create venues for local SMEs in damaged areas to gather information for exchange, and has provided subsidies for them to hire outside disaster recovery experts.

Immediately after a disaster, the government's primary responsibility is to protect citizens' lives. As support for the private sector is a secondary concern, firms need to plan for self-sufficiency immediately postdisaster. For example, the Cabinet Office developed "Guidance for Continuing Business of Local Governments in the Event of a Large-Scale Disaster" in 2010 (updated in 2016). This recommends operational standards for information gathering, lifesaving, and supporting temporary housing and relief of affected populations within the first three days after a disaster event. Efforts to support industry recovery are recommended to begin within two weeks after a disaster event (Cabinet Office 2016). Japanese policy makers and public officials have focused on preemptive policies and initiatives for resilient industry, such as the promotion of BCP and resilient infrastructure investments that allow damages to be minimized and empower firms to ensure their own postdisaster business continuity while the government attends to rescue and relief efforts. For example, as a new policy to strengthen the effectiveness of BCP, the Japanese government formulated the Resilience Certification System in 2018 (Cabinet Secretariat 2018). This allows firms to be more self-sufficient following disasters and allows public sector resources to concentrate on critical lifesaving and social infrastructure. However, in the longer term, the government in Japan plays an important role in aiding private sector recovery: for example, since the GEJE, it has introduced programs to aid in SME recovery and restore facilities damaged by disaster.

Decisions to upgrade or invest in new public infrastructure often do not consider the potential costs and benefits to resilient industry. The MLIT provides manuals for cost-benefit analysis of public initiatives, such as road, rail, housing and urban development, water supply and sanitation, ports, and flood management infrastructure for rivers and dams. While MLIT's *Flood Control Economic Research Manual* (2005 draft) advises considering losses from business disruptions in the calculation of indirect damage estimates, examples of how these methods can be applied to inform infrastructure investment for enhancing resilient industry are still limited.

MANUFACTURING SECTOR

Motivations to Drive Resilience

Given the severe economic losses incurred due to frequent and extreme disaster events, there is a growing business case for disaster risk management in the manufacturing sector. The owners and employees of manufacturing firms have an interest in protecting their

livelihoods and continuing business operations postdisaster. **The impact of disasters on firms' financial soundness can be primarily attributed to decreases in financial asset holdings, decreases in payment capacity** due to postdisaster recovery/repair costs, and decline in sales and profits, leading to a **deterioration in cash flow**. Disasters also impact firms' financial soundness indirectly by **increasing background risks** and subsequently discouraging positive risk taking, entrepreneurial activities, and business investments (GFDRR 2015).

These financial issues can be caused not only by damages to a firm's physical assets, but also by damages to its suppliers and supply chain. **Damages to a firm's physical assets** necessitate the procurement of replacements or repairs, entailing large expenditures and decreases in financial asset holdings. Production stoppages due to physical damages also reduce cash flow. **Damages to suppliers** can be caused by delays in payments to suppliers, as a result of decreases in payment capacity caused by the disaster damages. This reduces the financial asset holdings of the suppliers and can trigger bankruptcy and a subsequent shortage of parts for manufacturers. Suppliers may also take on additional loans to offset decreasing deposits even as they struggle with reduced loan repayment capacity due to difficulties in collecting receivables. In the long term, damage to suppliers leads to decreases in new capital investments and research and development (R&D) and results in a decrease in the competitiveness of the supplier and has a negative impact on medium- and long-term sales and profits. Finally, **damages to a firm's supply chain** are caused by delays due to disruptions of critical infrastructure. This can result in a lack of access to both raw materials and markets, impeding production and subsequent sales activities. Given the nationally and globally interconnected nature of today's supply chains, disaster damages to both upstream and downstream supply chains can disrupt the operations of manufacturing firms (Carvalho et al. 2016; Tokui et al. 2017; Kashiwagi, Todo, and Matous 2018). The indirect effects caused by the **increased background risks** of disasters are felt throughout supply chains, forcing manufacturers to diversify their suppliers and incur higher costs in an effort to mitigate the risks presented by disasters.

Approaches to Enhance Resilience

By developing BCPs/BCM, Japanese companies identify and implement measures that can minimize losses and damages, and enhance postdisaster response and recovery capacity by outlining what needs to be done after a disaster event (figure 3.3; approach 2).

Based on a 2018 survey conducted by the Japanese Cabinet Office, by 2017, 64 percent of large companies had developed BCPs, and 17 percent responded that they were in preparation. Among SMEs, 32 percent had developed BCPs, and 15 percent were developing BCPs. These figures show substantial growth in BCP development both for large companies and SMEs: in 2007 only 19 percent of large companies and 12 percent of SMEs had developed BCPs. **A 2014 study of listed companies in Japan showed that manufacturing companies that had introduced BCPs experienced less damage to sales following the GEJE (Matsushita and Hideshima 2014)**. This study analyzed the influence of the GEJE on the financial soundness of manufacturing companies. Companies that did not prepare for risk financing through BCPs were forced to increase their debts by 10–20 percent, and ordinary profits after the GEJE decreased by up to 30 percent. Firms with BCPs experienced significantly less reduction in their financial soundness following the disaster. This case shows how preparation for disasters can pay off in the long run. To further enhance business continuity, manufacturing firms can employ supply chain risk management systems, such as Fujitsu's SCRKeeper, to visualize and manage risks throughout their supply chains. This SCRKeeper system was developed for Toyota and has also been implemented at Nissan and Honda, proving a valuable tool for risk management in the complex, globally connected automotive supply chains (Suzuki and Usami, 2019).

As part of a comprehensive disaster risk finance strategy, insurance can also be used to improve the resilience of industry. Japanese SMEs are increasingly purchasing insurance. Sompo Riskcare Management Inc. (2017) studied how SMEs damaged by past disasters had prepared for and recovered from disasters; 66 percent of surveyed SMEs had insurance, and

insurance coverage rates increased after disaster events. Key reasons for purchasing insurance included securing capital for recovery and daily postdisaster operations. A majority (53 percent) of those surveyed found insurance effective in disaster recovery; 57 percent of SMEs that needed additional postdisaster financing leveraged a combination of loans, insurance, subsidies, and existing capital.⁷⁶ Subsidies were reported to be a particularly effective recovery tool. Other research has found that Japan's group subsidy program, a major subsidy that helps SMEs recover or rebuild facilities postdisaster, was effective in helping SMEs recover after GEJE (Kashiwagi 2020).⁷⁷ The survey of SMEs affected by disasters including the Niigata Chuetsu Earthquake, Noto Peninsula Earthquake, and Kumamoto Earthquake showed that, postdisaster, the share of SMEs with BCPs increased from 15 percent to 24 percent, and respondents highlighted discounted insurance premiums and lowered interest rates as effective incentives for BCP adoption (Sompo Riskcare Management Inc. 2017). In sum, the survey found insurance, public financing, and BCP incentive schemes to be key drivers of disaster preparedness for SMEs.

Collaboration between firms through prearranged cooperation agreements also contributes to resilient industry in Japan (figure 3.3; approach 3). There are many collaboration schemes between firms in providing alternative production facilities to reduce postdisaster recovery costs and predisaster BCP investments. Another scheme is collaborative investment in disaster-resilient structural design improvements, infrastructure, and equipment (figure 3.3; approach 5). This can include technological solutions like backup power systems and communication channels (figure 3.3; approach 4), or infrastructural solutions like coastal defenses, flood protection infrastructure/equipment (i.e., sandbags, etc.), and earthquake-resilient building retrofits. Firms are incentivized to collaborate with one another to share both the costs and benefits of these facilities. Another collaboration strategy is improving supply chain monitoring and management in order to detect disruptions and implement solutions quickly. The top company in a supply chain has a particular incentive to develop these systems because it can significantly reduce recovery costs from disasters, consequently benefitting all the firms lower in the supply chain as well. In some cases, mutual collaboration agreements between companies in different regions can help secure alternative production facilities in the case of damage to either party. This in turn minimizes production disruptions and ripple effects throughout the supply chain. **By planning to work together predisaster, collaboration agreements can improve resilience and recovery postdisaster, maintaining the livelihoods of business owners and employees.**

Remaining Challenges

SMEs often lack the financial and technical means to implement DRM measures. The 2017 survey described above reveals that a lack of DRM measures such as insurance and BCPs often reflects the financial costs of implementing these measures and a lack of human resources to implement them. **The Japanese government has focused on implementing a variety of measures, particularly in raising awareness of DRM and reducing its implementation costs.**

The trade-off between profit and risk management is of great concern to many cost-sensitive SMEs. Many SMEs are not purchasing insurance because they recognize it as expensive. Many are not preparing BCPs because they do not envision that disasters in the future will affect them. These misconceptions lead to poor decision-making. The Japanese government has made efforts to disseminate information to bridge these gaps.

⁷⁶ The first figure (53 percent) is about the effectiveness of insurance, and the second figure (57 percent) is about how they dealt with postdisaster financing needs.

⁷⁷ The study found that the group subsidy was particularly effective in the recovery of firms with limited networks outside the disaster-impacted area (Kashiwagi 2020).

INDUSTRY STAKEHOLDERS

Motivations to Drive Resilience

Industrial park managers and resident firms/employees have a common interest in increasing the resilience of manufacturing industries to help secure the long-term financial stability of local industries and economies. If the member firms of an industry association, zone, or parks are affected by disaster, they may go bankrupt or be forced to relocate, lowering the overall competitiveness of local industries and industrial zones. Damage or disruptions to industrial park infrastructure can force member firms to halt or reduce business, and as a result relocate or file bankruptcy.

Approaches to Enhance Resilience

Industry associations, zones, and parks can play an important role in driving resilient industry by promoting mutually beneficial collaboration between member firms. This can be achieved through the establishment of planning activities such as areawide BCPs for disaster preparedness. Akemi Industrial Park, located in Japan's central hub for automobile manufacturing, began developing an areawide BCP in 2008, in addition to promoting firm-level BCPs (figure 3.3; approach 2). Industrial associations, zones, and parks help to catalyze a collective approach to improving the continuity and resilience of infrastructure for defense against disasters (flood protection, coastal defenses, etc.) and securing lifeline services (backup power systems, roads, ports, water supplies, sanitation) (figure 3.3; approach 2). They also enable a collective approach to accessing financing for investment in these defense and lifeline services that will mutually benefit member firms. For example, the Rojana Ayutthaya industrial park, located near Bangkok, Thailand, was able to leverage the collective power of its many resident firms, including Japanese automobile manufacturers Honda and Toyota, to obtain large subsidies and low-interest loans from the Thai and Japanese governments for major disaster resilience improvements after the devastating 2011 Thai floods (see box 2.2). Associations can also conduct awareness raising and technical support initiatives to improve disaster preparedness through identifying and enabling strategic partnerships for support in advance of disasters, often in the form of prearranged contracts and cooperation agreements (figure 3.3; approach 2). Industry associations also play an essential role in addressing the challenges faced by women and other vulnerable groups before, during, and after disasters (figure 3.3; approach 2).

Remaining Challenges

Solutions differ from one manufacturing industry and area to another and may not be applicable across all industrial associations, zones, and parks. Some solutions may not work for all types of manufacturing industries or areas, as there are significant differences between industry types and firms and their interrelations.

FINANCIAL SECTOR

Motivations to Drive Resilience

The Japanese financial sector, including public and private financial institutions and investors, has an interest in the long-term strength and competitiveness of Japanese industries and firms of all sizes. Financial institutions provide products and programs for firms of various scales to increase resilient industry and maintain long-term financial stability. Insurance has also been an important measure for firms to prepare for damages induced by disasters. However, massive payouts for increasingly frequent and severe disasters are affecting insurance agencies through a potential decrease in creditworthiness. Total payouts by Japanese insurance companies are increasing as disasters increase in frequency and severity of damages. Among the

top ten insurance payouts for typhoons between 1990 and 2018, four were from after 2015, with the largest payout occurring in 2018.⁷⁸ The same trend is exhibited in earthquake insurance: of the top five largest payouts for earthquakes, four occurred after 2011. **As insurance premiums increase in response to increasing disasters in Japan, measures to alleviate and prepare for disasters will be more important than ever before.**

Bankruptcy due to disasters can lead to losses in the financial sector. According to analysis conducted by Teikoku Data Bank, a large number of GEJE-related bankruptcies occurred in the years following the disaster. The service sector experienced the most bankruptcies, followed closely by the wholesale and manufacturing sectors. Bankruptcies attributed to the direct impacts⁷⁹ of the earthquake were significantly fewer than bankruptcies attributed to the indirect impacts of the earthquake, due to the large number of firms indirectly impacted. Among these bankruptcies, most companies reported indirect damages as a result of lowered consumer spending, while less than 10 percent reported logistics turmoil or cancellations/changes to production plans. From this analysis, reduction in consumer demand is the most devastating indirect impact of disasters on local businesses.

Approaches to Enhance Resilience

Public finance institutions can incentivize firms to undertake DRM investments and actions to minimize losses and damages. The Japan Finance Corporation (JFC) and Development Bank of Japan (DBJ) have loan programs for large companies and SMEs that have implemented BCP and/or BCM, and provide preferential loans for investment in BCP-related projects or investments in strengthening competitiveness (figure 3.3; approaches 2,). Shizuoka Prefecture provides precontracted guarantees from the prefectural guarantee corporation to local SMEs that have implemented BCPs, to ease the burden of financing in the event of disasters (figure 3.3; approach 2). The **high implementation rate of BCPs among SMEs is attributed to these financial incentive programs.** Many private regional banks provide special loans to businesses that take proactive disaster preparedness and business continuity actions. For example, Shiga Bank and Kyoto Bank offer special loans to promote and incentivize corporate disaster prevention and BCM. Saikyo Shikin Bank, based in Shinjuku Ward, Tokyo, has developed a special loan program called Sonae (which means “prepare” in Japanese) in collaboration with the Tokyo Metropolitan Government. Under the program, businesses can not only apply for low-interest loans to finance disaster preparedness investments, such as seismic retrofitting of buildings, but also access technical advice and support from technical institutions and local governments, such as institutions that can conduct seismic risk assessments.⁸⁰

Public finance institutions have developed specialized financial products and support mechanisms for SMEs, who are often more vulnerable to external shocks, including those from disasters. These products and services may include access to low-interest loans to finance postdisaster recovery work, or extended grace periods for debt repayment after major disaster events. This support reduces the bankruptcy of SMEs due to cashflow challenges postdisaster, and as a result reduces the total number of businesses lost in the disaster-affected region. Soon after the GEJE, JFC, a government-owned finance corporation, created a special preferential loan program for SMEs in damaged areas. This program has provided 24,800 loans, totaling \$14.7 billion, contributing to reliable financing for local SMEs after the GEJE.

78 For more information, see: https://www.sonpo.or.jp/news/release/2018/1812_06.html.

79 Firms damaged, with capital losses, due to earthquakes and tsunamis.

80 <http://www.shinkin.co.jp/saikyo/pdf/bousaiyuushi.pdf>.

Remaining Challenges

Equity finance can be a solution for supporting a company that is severely damaged but indispensable to the local economy. After the GEJE, relatively large core companies in affected regions and smaller, lightly damaged companies located in inner areas were able to obtain financing easily. However, severely damaged companies, especially SMEs, faced difficulty obtaining additional financing because banks were hesitant to provide loans to companies that seemed unlikely to repay them on time, even if these companies were indispensable to the local economy (Organization for Small & Medium Enterprises and Regional Innovation 2013). **Equity funds created by the DBJ and other financial institutions helped to successfully recover severely damaged companies, although these initiatives are nascent, even in Japan.**

Financial support should be developed locally. In Japan, a wide variety of financial support programs, from subsidies to preferential loans, are available. However, these programs are constructed on the scale of companies and structured uniformly. Recovery needs may differ from region to region based on local industry structures and disaster risks. Therefore, it is important for financial support programs to take regional specifics into consideration. For example, the Shizuoka Prefecture has implemented its own financial support program, a precontracted guarantee program based on the implementation of BCP.

3.3 WHAT: TOOLS AND APPROACHES

When disasters strike, a combination of tools become necessary to support the continuity and recovery of various industry activities. Industry activities can be reduced or halted when flows of goods, people, finance, and information are disrupted due to disaster impacts on infrastructure assets and services. Diverse tools including **policy and legislation, finance, infrastructure, gender-focused, and technology** measures have been shown to minimize damage and disruption.

Driven by the many stakeholders and their motivations, described in section 3.1, this section identifies approaches shown to strengthen the resilience of industries against disasters in Japan. While these solutions continue to evolve and expand, we highlight eight notable approaches to strengthening resilient industry in Japan (figure 3.3).

FIGURE 3.3 Overview of Eight Resilient Industry Approaches

	Type of Solution	Key Drivers / Stakeholders	Hazard Type	Industry Resilience Approach	Appendix Cases
1	Mainstreaming industry resilience within various policies and institutional frameworks Policy and Legislative	Public sector (national)	Earthquake, Volcano	Strengthening disaster risk governance to manage disaster risk	A1, A18
2	Promoting business continuity planning and management at various levels Policy and Legislative, Financial	Public sector (national and local), The manufacturing sector (firms, value chains, etc.), Industry stakeholders (zones operators, associations, etc.), The financial sector (banks, insurance companies, etc.)	Earthquake, Volcano	Strengthening disaster risk governance to manage disaster risk	A2, A3, A4, A15, A16, A17
3	Identifying Win-Win Collaborations for Resilient Industry through Pre-Arranged Agreements among Stakeholders Policy and Legislative, Infrastructure	Public sector (national and local), The manufacturing sector (firms, value chains, etc.)	Earthquake, Volcano	Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation, and reconstruction	A5, A6, A7
4	Minimizing impacts of infrastructure disruptions with new technology Infrastructure, Technology and Innovation	Public sector (national and local), The manufacturing sector (firms, value chains, etc.), The financial sector (banks, insurance companies, etc.)	Earthquake, Volcano, Tsunami	Investing in disaster risk reduction for resilience, Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation, and reconstruction	A8, A18
5	Fostering Public and Private Sector Partnerships for Disaster Mitigation Infrastructure for Industrial Parks Policy and Legislative, Infrastructure, Financial	Public sector (national and local), The manufacturing sector (firms, value chains, etc.), The financial sector (banks, insurance companies, etc.)	Earthquake, Volcano, Tsunami	Investing in disaster risk reduction for resilience, Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation, and reconstruction	A9, A10, A11, A12, A13
6	Utilizing Big Data and Data Visualization Technologies for Evidence-Based Resilient Industry Policy Making Policy and Legislative, Technology and Innovation	Public sector (national and local), Other civil society groups (including women's association)	Earthquake	Understanding disaster risk, Strengthening disaster risk governance to manage disaster risk	A14
7	Providing safety nets and financial mechanisms for SMEs to secure cash flow in the face of disaster shocks Policy and Legislative, Financial	Public sector (national and local), Industry stakeholders (zones operators, associations, etc.)	Earthquake	Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation, and reconstruction	A15, A16, A19, A20, A21
8	Addressing postdisaster challenges to women's empowerment in industries Policy and Legislative, Gender	The manufacturing sector (firms, value chains, etc.), Industry stakeholders (zones operators, associations, etc.), Other civil society groups (including women's association)	Earthquake	Understanding disaster risk, Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation, and reconstruction	A22, A23

Source: Original compilation.

Note: SME = small and medium enterprise

1) MAINSTREAMING RESILIENT INDUSTRY WITHIN POLICY AND INSTITUTIONAL FRAMEWORKS

Overview

Policies and regulations related to industrial development, industry competitiveness, industrial land use planning, and DRM collectively provide an enabling environment for key resilient industry solutions. The Cabinet Office, responsible for mainstreaming DRM in sectoral policies and institutions; and the Ministry of Economy, Trade, and Industry (METI), responsible for policies and institutions for promoting industry competitiveness including SMEs, are key players in creating an enabling environment for resilient industry in Japan (appendix A1).

Though there is no single law for resilient industry in Japan, resilient industry considerations are integrated within various legislative frameworks and institutional mandates. These policies and legal frameworks create an enabling environment to strengthen resilient industry in Japan by defining the legal responsibilities of the public sector in supporting resilient industry. They create resources for information gathering and awareness raising, provide guidelines and technical support that helps foster capacity building, and provide training that advance resilient industry actions. The policies and frameworks also establish financial mechanisms to ensure efficient postdisaster access to disaster recovery finance and insurance.

Key Drivers and Examples

From its historic experience with large-scale disasters, Japan has shown that the participation and engagement of both the public and private sectors is key for quick and effective postdisaster recovery as well as preparedness and risk mitigation. Several pieces of legislation have been key to establishing an institutional framework for resilient industry. In response to the devastating Ise Bay Typhoon of 1959, Basic Act on Disaster Management (1961), requiring national and local governments to assume the primary responsibility for ensuring the availability of services that affect human life, citizens livelihood, and infrastructure. **Act on Special Financial Support to Deal with the Designated Disaster of Extreme Severity** was also created in 1962 to provide special assistance programs for SMEs in the event of disasters. The National Basic Disaster Management Plan was established in 1963 based on the **Basic Act on Disaster Management (1961)**, requiring private companies to fully recognize the role they are expected to play when disaster strikes, preserving human life, preventing secondary disasters, continuing business, and contributing to the community, while understanding their own risks from disasters and implementing disaster risk management. Development of BCPs to minimize damages and disruptions are also required within this plan.

Japan promotes disaster resilience through policies and institutions that target industry competitiveness. For example, **Act on Special Measures Concerning Revitalization of Industry and Innovation in Industrial Activities** was aimed at revitalizing industrial vitality and innovation in industrial activities. Companies that prepared a business restructuring plan and were certified by the government received taxation and finance benefits. **Special loans were offered to certified business operators that suffered from megadisasters.** The Japanese government recognizes that the large-scale companies that are the backbone of its economy depend on many smaller firms within their supply chains. **The Industrial Competitiveness Enhancement Act (2013)** targeted the strengthening of SMEs that supply materials, parts, software, and design to large-scale assembly companies. **Continuous strengthening of the base technologies of the manufacturing industry is a key driver of industrial competitiveness.** The strength of SMEs is essential to the overall strength and resilience of the economy as a whole. Further strengthening of SMEs was incentivized through the **Act for Facilitating New Business Activities of Small and Medium-sized Enterprises (1999)**, which provides easy-to-understand guidance for improving the productivity of SMEs. The government offers tax reductions and financial support to SMEs that formulate management improvement

plans to improve productivity and management skills. Competitive firms and sectors will be more likely to survive and even thrive in the event of a disaster.

Existing policy measures helped boost local communities after the GEJE. In 2013 the development of “F-Grid,” a regional emergency power supply system, was supported by METI’s Subsidy for Projects Promoting the Introduction of Smart Communities Program (appendix A18). **The 2013 Subsidy for Projects Promoting the Introduction of Smart Communities** provided an enabling environment and incentives for manufacturing firms and local governments to collectively develop resilient industry solutions in conjunction with low-carbon Smart City/Community development, creating climate cobenefits and boosting local economies in the affected regions concomitantly.

Policies around the protection and development of land also promote industry resilience. Japan has strengthened infrastructure resilience and ensured business continuity and competitiveness by implementing plans and regulations for national land protection such as the Flood Protection Law (1949 rv. 2015), the Sewerage Service Act (1958 rv. 2015), and the Sediment Disaster Prevention Law (2001). These measures targeted the improvement of flood control, sediment disaster mitigation, coastal protection, etc. to mitigate the risks from flooding. **During the period of rapid economic growth in Japan starting in 1955, at least 5 percent of GDP was invested in national land protection. Since 1962, the Japanese government has made extensive use of comprehensive National Land Development Plans (NLDPs) to support resilient industry.** The Multi-Polar Patterns National Land Formation Promotion Act (1988) promoted the decentralization and agglomeration of industrial facilities in rural areas, and guided planned investment for transportation network improvements and industrial park development. **Through the use of land development planning, an industry sector concentrated in one region can be supported by suppliers concentrated in another region and minimize disruptions/losses after a disaster event.** As a result, many Japanese automotive manufacturers and parts suppliers are still operating in the same cities, clusters, and industrial parks as they were before numerous disasters.

The frequency and magnitude of disasters is increasing in Japan. This has magnified the impacts on the people and economy of Japan. MLIT, together with other agencies in Japan, is establishing priorities for soft and hard investments, and increasing investments in DRM (Cabinet Secretariat 2018). **Through these efforts, government ministries aim to strengthen the resilience of their responsible sectors. As a result of the accumulation of various efforts, the resilience of private sector industries, which are vital to the lives and livelihoods of the public, is strengthened.**

Lessons Learned and Recommendations

- **There is no single law for resilient industry in Japan;** resilient industry is integrated into policies for industrial development, industry competitiveness, industrial land use planning, and DRM, creating an enabling environment for resilient industry solutions.
- **Resilient industry is an interdisciplinary issue** that requires cross-sectoral collaboration and interpolicy coordination across ministries and departments.
- **Resilient industry policies should be improved based on postdisaster lessons.** While resilient industry policies should be established before a disaster strikes, disasters should also be seen as learning opportunities. Policies and institutions that support resilient industry in Japan are routinely enhanced after disasters.

2) PROMOTING BUSINESS CONTINUITY PLANNING AND MANAGEMENT AT VARIOUS LEVELS

Overview

Business continuity plans (BCPs) and business continuity management (BCM) identify the potential effects of disruptions to an organization's critical operations if a disaster were to occur, and specify effective response actions and quick recovery measures for postdisaster business continuity (Ono and Ishiwatari 2011). They are different from and complement disaster and emergency management and response plans.

In Japan, BCP measures are developed at many scales—at the national, sectoral, subnational, industrial park, and large to small business levels. **The BCP measures developed and utilized across various levels have served as a critical resilient industry tool for the manufacturing sector in Japan, enabling the continuity of businesses and supply chains and as a result, minimizing disruptions and recovery time.** BCPs can be effective through a cascade approach, implementing and coordinating BCPs and BCM across various scales. The public sector promotes the development of BCPs in the private sector through various financial incentives. The methods used are tailored to the size of the enterprise, providing a differentiated approach to BCP development for SMEs and large-scale firms.

Key Drivers and Examples

After experiencing the GHAE, the importance of BCP started to gain attention (Asanuma 2012). Many companies in the United States and Europe started developing BCPs after the September 11 terrorist attacks in the United States (2001), which inspired the Government of Japan and Japanese companies to promote BCP development (DBJ 2005). Additionally, after the GEJE (2011) many private sector enterprises experienced significant losses and damages, further reinforcing the importance of BCPs. The Government of Japan has placed a high priority on resilient industry within policies and official guidelines. **The Basic Disaster Management Plan (rv. 1995)** encouraged firms to develop and operate BCPs to continue critical functions after a disaster, including operations with suppliers and supply chains. **The Business Continuity Guidelines (2005, rv. 2009, 2013/14)** were established and periodically updated by the Cabinet Office to aid Japanese firms in implementing BCPs. **The SME BCP Establishment and Operation Guidelines (2006, rv. 2012)** were established and updated by SME-METI to provide targeted advice for SMEs. **The Japan Revitalization Strategy (2012)** set BCP establishment targets at 100 percent of large firms and 50 percent of SMEs by 2020. **The Basic Act for National Resilience Contributing to Preventing and Mitigating Disasters for Developing Resilience in the Lives of the Citizenry (Basic Act for National Resilience) 2013** committed to promoting firms' BCP development through the development of manuals and awareness raising campaigns.

The GEJE (2011) illustrated that the development of BCPs by firms and organizations in isolation is insufficient to effectively negotiate the impacts of disasters on industries. Disasters highlight how shared infrastructure and networked supply chains require a collaborative approach to planning for resilient industry. A collaborative approach could also allow organizations to learn from one another; a study found that one reason BCPs failed to work well during the GEJE is that firms had limited disaster experience, resulting in poorly designed disaster plans (Sakaguchi and Makino 2011). Kyoto Prefecture utilized its convening power to identify and enable private sector collaboration in the BCP development process, **integrating an areawide approach to resilient industry through the engagement of private companies and industrial parks in the prefectural BCP development process (appendix A3).** This can be achieved through the appointment of a private sector focal point in local disaster response headquarters. Kyoto Prefecture has also made efforts in connecting firms in the same industries to develop collective BCPs and partnership agreements for disaster response.

The importance of BCM and DRM for private sector resilience and competitiveness has been reinforced through the experiences of past megadisasters. **In 2006 the DBJ developed a system for rating a firm's BCP and uses this rating to grant access to preferential loans and postdisaster guarantee programs.** DBJ ranks companies based on a 100-part questionnaire that evaluates the client's disaster risk reduction and business continuity efforts. Preferential loans are offered to firms with a high BCM rating (appendix A15). This system has been promoting the development of BCPs in recent years, especially since the 2011 GEJE. A total of 378 BCM ratings have been provided as of March 2020. **In 2017 the Shizuoka Prefecture Credit Guarantee Association developed a postdisaster guarantee program for SMEs** (appendix A16). Through the program, SMEs with BCPs can submit preapplications for postdisaster credit guarantees, whereby the guarantee fee is waived as an incentive for BCP development. These guarantee programs provide efficient access to postdisaster finance for well-prepared SMEs.

Akemi Industrial Park is the largest Industrial park in the Mikawa Port area, which is Japan's central hub for automobile manufacturing; more than 120 companies are located on 659 hectares of reclaimed land, outside the protection of sea walls. Given that the area is zoned as nonresidential, it is given low priority for postdisaster response and recovery of lifeline infrastructure and social services under local government disaster response mandates. Therefore, **Akemi Industrial Park took the initiative to develop a parkwide BCP, whereby strategic areas of collaboration and collective solutions were identified and mechanisms set up to enable areawide solutions,** particularly establishing shared evacuation sites and pooling resources for medical staff, search and rescue efforts, fuel, and disaster response activities (appendix A17). The Akemi Industrial Park BCP was driven from the experiences of significant supply chain disruptions and associated losses from the Niigata Chuetsu-Oki Earthquake in 2007, a large typhoon in 2009, as well as the significant future risk of the Nankai Trough Earthquake.

Furthermore, a private company can support other firms' BCPs. Mitsubishi Estate Co., Ltd., one of the largest real estate developers in Japan, has numerous properties around Tokyo Station, which is one of the leading business central districts in Japan. Mitsubishi Estate has formulated a district continuity plan to support the BCPs of other companies in the business district (Nakajima 2016). During disasters, as a district management company, Mitsubishi Estate will collaborate with governments and provide fundamental lifeline services (e.g., backup generators, evacuation spaces, emergency medical support, food, and water) to support business continuity of other companies (Nakajima 2016). The plan aims to maintain competitiveness by securing business continuity in the business district.

As the awareness and demand for BCPs increase, there is a growing need for a pool of experts that can develop, manage, update, and implement BCP and BCM measures.

Private institutions have been established for technical support in developing and implementing BCPs. The Business Continuity Advancement Organization (BCAO) is a network of academics, consultants, and industry representatives. It was established as a NPO in 2006 and provides technical training, expert development, BCP certification, standard and guideline development, information dissemination, and awareness-raising events to support private sector companies in developing BCP and BCM measures (appendix A4).

Lessons Learned and Recommendations

- **National governments have a significant role to play in establishing policies and guidelines to advance the preparedness of industries** against disasters through the promotion and incentivization of business continuity planning and management. In Japan, resilient industry is prioritized within key policies of both the Cabinet Office, responsible for DRM, and METI, responsible for industrial development and SMEs. Both institutions develop targeted BCP guidelines for large firms and SMEs.

- **At the subnational level, local governments can play an integral role in catalyzing the development of areawide BCPs to complement firm-level BCPs**, identifying strategic areas where a coordinated and collaborative approach can be implemented for maintaining business continuity after a disaster event.
- **Financial institutions play an important role in promoting BCP development by offering financial incentives for investments in resilient industry.** In Japan, various financial institutions provide a range of financial products that provide incentives for firms to invest in BCPs. These incentives provide mutual benefits to the financial institutions and firms, as well-prepared firms are more resilient to disaster and provide less risk of bankruptcy or loan default.
- **Industrial associations/parks can empower their members in creating collective solutions to resilient industry.** The establishment of industrial parkwide BCPs allows for the establishment and sharing of essential resources such as evacuation zones, medical facilities, search and rescue, and lifeline services. This may especially benefit SMEs, who may not have the capacity for developing these resources on their own.
- **NPOs can provide a pool of experts for the development and implementation of BCPs.** In Japan, the Business Continuity Advancement Organization (BCAO) provides technical training, expert development, BCP certification, standard and guideline development, information dissemination, and awareness-raising events to promote the development and implementation of BCP.

3) IDENTIFYING WIN-WIN COLLABORATIONS FOR RESILIENT INDUSTRY THROUGH PRE-ARRANGED AGREEMENTS AMONG STAKEHOLDERS

Overview

Identifying and establishing strategic cooperation agreements in advance of disasters is a practical solution for firms and industries to continue operations and minimize disruptions in the event of disasters. Prearranged agreements are a critical element of BCP and BCM measures. Based on numerous disaster experiences, an array of prearranged agreements have been established in Japan.

Strategic cooperation agreements can be established between individual firms, within industrial parks, between utility companies, or between infrastructure operators and firms. **The objective of the agreements can include provision of goods and services postdisaster; sharing of information; loans for equipment, land, facilities, or personnel; special financing or procurement arrangements; and rationing of lifeline utilities and shared resources.** The modality of the prearranged agreements can be a legally binding contractual agreement or a more general memorandum of understanding for partnership and collaboration. Agreements between national and local governments and construction companies provide for efficient postdisaster infrastructure reconstruction. Agreements between utility companies allow for load sharing and personnel support in the event of disaster-related disruptions. Agreements between private firms in the same sector for use of personnel, equipment, and facilities help to maintain business continuity and minimize disruptions throughout the supply chain.

Key Drivers and Examples

In Sendai City a preagreement was formulated in 1991 between Miyagi Prefecture and the local contractors' association. The agreement was in response to damage from heavy rains at the end of the 1980s. This catalyzed other cities within Miyagi Prefecture to enhance their postdisaster risk management strategies, identifying strategic prearranged agreements between various firms and industry associations. **Agreements for facilitating the cleanup and reconstruction of**

damaged roads are important to supply chain logistics following a disaster event. Since 2010, Sendai City and the Sendai General Construction Association have maintained a Post Disaster Emergency Response Partnership Agreement, whereby member firms (approximately 80) of the construction association provide postdisaster operations for debris cleanup and the reconstruction of roads (Miyagi Prefectural Government 2018). The agreement specifies how Sendai City can request support after a disaster event (in writing or by phone) and the expected nature of the request (i.e., requested number of personnel, equipment, location, and type of work). While the agreement indicates that firms work under the direction of city government officials, it also allows them flexibility to make their own decisions in the absence of public officials. Payments for goods and services provided are reimbursed ex-post based on the city's unit price, which is based on a prearranged special pricing list for postdisaster reconstruction and recovery work. Similar agreements between Sendai City and a demolition company and waste management company associations were established to respond quickly to the postdisaster cleanup needs and minimize the disruption of critical infrastructure. **During the 2011 GEJE, this partnership agreement was activated, and by March 19, only eight days after the devastating earthquake and tsunami, all critical roads in Sendai City were accessible** (appendix A5). Based on the agreements and regular drills implemented by association members and the city, only a few hours after the disaster event, city officials were able to request support from the Sendai General Construction Association for road clearing and recovery.

In 2007, the Chuetsu Earthquake caused major damage to Riken Corporation's automotive component factory in Kashiwazaki and eventually the suspension of its operations. This caused a disruption of the car production lines of automakers nationwide. As a result of these disruptions, **many firms initiated the development of BCPs, which included the identification and establishment of prearranged agreements between firms within the same supply chain and firms within the same sector.** In 2008 Suzuki Kogyo Corporation, a small waste management company located in Sendai City, initiated its BCP development process. One of the key measures to ensure business continuity was the establishment of prearranged agreements with a manufacturer of incinerator parts, an external waste collection truck rental firm, and with a separate waste management company located in the neighboring Yamagata Prefecture. During the 2011 GEJE, Suzuki Kogyo's incinerator was damaged due to a five-meter tsunami that hit the waste management facility. Less than one hour after the earthquake and tsunami, the BCP was activated. **Within six days of the earthquake and tsunami, Suzuki Kogyo was able to collect and treat waste, utilizing the facilities of its partner company in Yamagata Prefecture** (appendix A7). Similarly, a prearranged partnership between newspaper agencies in Kobe and Kyoto enabled the Kobe newspaper agency to continue publishing newspapers during and after the 1995 GHAE using the Kyoto newspaper agency's printing facilities.

Lessons Learned and Recommendations

- **National and local governments can benefit from establishing cooperation with private firms to develop prearranged agreements for recovery work,** significantly reducing the time needed to recover major logistics routes.
- **Private firms and industry associations have an incentive to cooperate in the quick recovery of the critical infrastructure** essential to business continuity, loss minimization, and industry competitiveness.
- **Parent firms with large supplies should catalyze collaboration between firms in their supply chain** as the impacts of supply chain disruptions can cause significant losses to the entire supply chain.
- Given the limited capacity and resources of SMEs, **collaboration between large firms and SMEs is equally as important as prearranged agreements that provide support through finance and human resources.**

- Firms in Japan have found **establishing reciprocal cooperation agreements between competitors in different regions** to be beneficial and effective in strengthening overall business and resilient industry.
- **Prearranged agreements between different firms, as well as between local governments and firms, can enable continued operation of firms and businesses** even if their key production facilities and services are affected by disasters. This can significantly reduce the loss of revenue of the directly affected firms and the firms connected throughout the supply chain, enhancing the overall resilience of the manufacturing sector and regions.

4) MINIMIZING THE IMPACTS OF INFRASTRUCTURE DISRUPTIONS THROUGH NEW TECHNOLOGY

Overview

Industrial firms and parks can play a significant role in minimizing the impacts of infrastructure disruptions by utilizing new technologies that allow redundant access to critical infrastructure such as water and power. Redundancy is a key component of resilience, ensuring continued access to lifeline services even if some infrastructure is damaged. New technology such as sensors can also help to automate dangerous tasks, such as automating the closure of flood gates. In Japan, technological development for infrastructure disaster mitigation is implemented through collaboration between national and local governments, industrial firms, and technology developers.

Key Drivers and Examples

During the development phase of the F-Grid Ohira, a regional emergency power supply system in the Second North Sendai Central Industrial Area, METI provided subsidies, as part of its Smart Community initiatives, that helped system investors/operators to implement the project and recover their investments faster due to reduced initial investment costs (appendix A18).

The F-Grid system is useful for maintaining access to power in the event of a disaster; however, the system would not be economical if it were used only during emergencies. During normal times, the F-Grid system can be used to optimize industrial electricity consumption, providing economic and environmental benefits. The benefits during normal times are a significant incentive for implementing this system. During times of power grid disruption, the system provides self-standing power to industrial facilities and transmits power to emergency centers in the region.

Access to a backup water supply is also important for business continuity, not only for production requirements but also for the health and hygiene of industrial workers.

Thus, both the availability and quality of the backup water supply is important. Hino Motors implemented the Mitsubishi Chemical Aqua Solutions Co., Ltd. groundwater purification system in its Hamura Plant for backup manufacturing and drinking water needs. The system is compact and decentralized, making it an ideal alternative for postdisaster water supply for industries.

The groundwater purification system enables the Hamura Plant to utilize an alternative source of clean, stable, and cost-efficient water during disasters as well as normal times.

Hino Motors has reported a 16 percent reduction in annual water supply costs after installation of the system (appendix A8).

Innovation with new technology can also help mitigate problems identified during past disasters. This is illustrated through innovation around floodgates, which play a critical role in protecting lives and assets in the face of storm surges and tsunamis. During GEJE, 48 firefighters who tried to close floodgates in seawalls or other flood barriers lost their lives to the tsunami. This tragedy instigated the development and utilization of an automatic floodgate closing and locking system triggered by tsunami early warning systems using satellite communication systems and the Internet of Things (IoT⁸¹) (appendix A13).

Automatic floodgate systems can have significant benefits to industrial parks that are often located by coastlines and may be protected by coastal barriers. Many prefectural governments and cities are considering the adoption of automatic water gate closing and locking systems, whereby the process to close gates is automatically triggered by the national disaster alert system (J-Alert) through satellite communication systems. Adoption of this system for up to 220 water gates throughout Japan is currently planned.

Lessons Learned and Recommendations

- **Backup systems for infrastructure using new technology are most effective when used during normal times as well as in postdisaster situations.** This develops the capacity of operators to manage the system, as well as ensures maintenance needs are met. Use during normal times also avoids malfunctioning and ensures effective operations in postdisaster times, while also providing environmental and economic benefits during normal business operations.
- **New technologies can respond to the lessons of past disasters.** During the GEJE, manual flood gate closures cost lives. Connecting automatic floodgates to existing disaster alert systems means this infrastructure need not be operated manually during a disaster.
- **The development and implementation of new technologies for minimizing infrastructure disruptions can benefit from strategic collaboration with existing programs outside the areas of DRM and industry development.** The Smart Community Program that supported the F-Grid project was an existing subsidy program for eco-conscious smart power distribution systems. Automatic floodgates can integrate into existing disaster alert systems, such as the connection of automatic flood gates to Japan's J-Alert system.
- **Government agencies play a critical role in helping create successful partnerships** between utility companies and industrial parks/firms for new resilient industry technology initiatives.
- **Government subsidies are vital to help initiate the implementation of new technological solutions** for minimizing the impacts of infrastructure disruptions. Investments toward resilient and innovative industry infrastructure as part of governments' postdisaster reconstruction programs and stimulus packages can enable rebuilding of more competitive industries that are future proof.

81 The Internet of Things is a network of smart devices able to collect, share, and act on information from their environments.

5) FOSTERING PUBLIC AND PRIVATE SECTOR PARTNERSHIPS FOR DISASTER MITIGATION INFRASTRUCTURE FOR INDUSTRIAL PARKS

Overview

In Japan, the national government plays a significant role in the design, development, and upgrade of disaster defense infrastructure. A strategy to attract private investments in disaster defense infrastructure is also important. **Partnerships between local governments and the private sector are being explored to ensure the resilience of manufacturing firms, industrial parks, and industrial zones**, which are often located in disaster-prone areas.

Key Drivers and Examples

In Japan, the public sector is not mandated to protect areas outside of seawalls in the event of disasters. However, many manufacturing industries that play an important role in the economy exist in coastal and port areas outside the protection of sea walls. Given the importance of the manufacturing sector, there was a need for the national government to provide guidance on preventing and minimizing the impacts of disasters to port areas.

The “Guidelines for Measures to Lower Storm Surge Risk in Harbors Not Protected by Levees” (2018) provided guidance for protecting coastal areas outside of sea walls (appendix A10). Under the guidelines, a port administrator, often overseen by the national or local government port authority, coordinates the development of a “Response Plan for Storm Surges” and “Plan for Disaster Risk Reduction.” These plans are developed through the participation of the public and private sector stakeholders responsible for port management, disaster risk reduction, industrial parks, and private sector firms. MLIT, in collaboration with port administrators, developed Response Plans and Disaster Risk Reduction plans for the ports of Tokyo and Nagoya based on these guidelines.

Hirosaki City developed the Fujishiro Industrial Park based on the city’s policies promoting the establishment of a new industrial complex. National and local government investment in flood protection infrastructure enabled the establishment of Fujishiro Industrial Park in 1996 (appendix A11). MLIT developed levees in the area where the Fujishiro Industrial Park was to be located as a part of the comprehensive Iwaki River Improvement Project. **Before the installation of the flood protection infrastructure, the land was zoned as an area prohibited for development. With the levees, the municipal government was able to rezone the land for industrial use.**

As the supply chain for the manufacturing industry expands globally, so must public and private sector partnerships for disaster defense infrastructure in industrial parks. After the 2011 floods in Thailand, Thai insurance companies started to demand larger flood insurance premiums with lower coverage rates. Therefore, private firms had to bear a greater share of the burden of flood risks. This created an incentive for firms to locate only in areas with low flood risks.

The operator of the Rojana Industrial Park in Ayutthaya, Thailand, catalyzed financing for the development of flood protection levees to build back better after heavy damages from the 2011 floods (appendix A12). As a key strategy to attract firms back to the industrial park, the industrial park operator worked with the Thai national government and the international community to enhance disaster risk management capacity through the construction of levees. Subsidies and low-interest loans to support the improvements were provided through Thailand’s Ministry of Finance with support from the Government of Japan.

Lessons Learned and Recommendations

- National governments responsible for the development and operation of large-scale disaster defense measures, such as coastal seawalls and flood protection levees, play a critical role in enabling infrastructure investment that benefit resilient industry. **By collaborating with local governments, public infrastructure investments can enable new lands to meet disaster (i.e., flood) protection standards for industrial development.**
- **Public and private sector partnerships for increasing resilient industry should expand globally as manufacturing supply chains expand globally.** Global partnerships are needed to minimize losses and disruptions within globally expanding supply chains.
- **Industrial park operators can coordinate with their tenants to enhance disaster risk management and business continuity planning, while working with the public sector to make a case for disaster defense infrastructure investments.** The role of industrial park operators to attract public investments for disaster defense infrastructure may be particularly important during the postdisaster reconstruction process to build back industrial parks better.

6) UTILIZING BIG DATA AND DATA VISUALIZATION TECHNOLOGIES FOR EVIDENCE-BASED RESILIENT INDUSTRY POLICY MAKING

Overview

Big data technology has a significant role to play in enhancing the resilience of industries against disasters. In Japan, the visualization and analysis of big data are being utilized to help policy makers and business owners understand the risks of disasters to complex supply chains. "Big data" refer to exceptionally large datasets that cannot be analyzed or utilized through traditional data processing tools. **By illustrating complex information, these new tools and technologies can also help protect industries and business assets in the face of disasters without undermining the safety of workers.**

Key Drivers and Examples

Big data are increasingly leveraged in Japan to better understand and prepare for disaster impacts. In 2012, NHK, the national broadcasting network in Japan, ran a special program called Earthquake Big Data II, demonstrating a model and software that analyzed and visualized the impact of GEJE on people, businesses, and infrastructure through big data. Based on the visualizations and analysis of Earthquake Big Data II, in 2014 the Cabinet Office and METI commissioned a project to develop evidence-based planning tools and programs for local governments. This project was a key pillar of the Cabinet's Regional Revitalization Strategy (Chihou Sousei).

Big data visualization can also aid in policy making that supports resilient industry. In 2015, the Cabinet Office and METI developed the Regional Economy Society Analyzing System (RESAS) database with data and system design partners including Teikoku Databank, Takram, and teamLab. The system synthesizes and visualizes public and private big data such as industrial structures, population movement, and flows. It supports local governments, aid organizations, and educational institutions and is used for evidence-based policy making. The tool has been widely used, particularly for enabling local governments and communities to have better-informed planning tools for postdisaster reconstruction planning; 58 percent of municipalities used RESAS to help develop their five-year Regional Comprehensive Strategy (Cabinet Office 2019). These five-year regional strategies have been required by the Cabinet Office since 2015, and represent strategies and policies developed by the individual regions to support regional economic development while aligning with the Fundamental Plans for Regional Resilience. The

system continues to be updated and expanded, as illustrated by the recent launch of V-RESAS, which visualizes near-real-time consumer behavior data. This information is being used to inform planning and decision-making for COVID-19 business recovery at the firm and government levels.⁸²

Technologies surrounding big-data collection and analysis are expanding globally, including low- and no-cost platforms. The development costs for RESAS (figure 3.4) were around ¥1.34 billion (around \$12 million).⁸³ However, as an early high-cost and high-tech platform, this exact technology may not make sense for other countries. Yet, there is potential for other governments as well as individual firms to consider low-cost big data visualization platforms for industry, which, like RESAS, can be used to aid evidence-based disaster related decision-making at the national, local, and firm levels.

Big data can support supply chain resilience. A new big data visualization system was further developed called the Local Economic Driver Index (LEDIX). A collaboration between the Teikoku Data Bank and Takram, LEDIX visualizes the flow of goods and services between firms and regions, thus identifying key leading companies from various levels and sectors. The partnership is currently working to incorporate external shocks including disasters. This project shows how big data and visualization technology can be utilized to map out supply chains in order to understand the impacts of supply chain disruptions and opportunities for economic development, including postdisaster recovery. Another example of leveraging big data for supply chain resilience is Toyota's "RESCUE," which was developed with Fujitsu. It enables Toyota to reduce disruption risk and to capture its supply chain situation quickly once a disaster happens. With RESCUE, supply chain status can be visualized in less than a day, whereas before the project's 2011 installation, this process would have taken weeks.⁸⁴

FIGURE 3.4 Image of RESAS Web Platform



Source: <https://resas.go.jp/#/13/13101>.

82 V-RESAS is a new tool provided by the Office for Promotion of Regional Revitalization and developed in partnership with Teikoku Databank and Takram. It brings together high-frequency big data to help local governments, financial institutions, commercial and industrial groups, and businesses better understand the impact of COVID-19 on their regional economies and help them better plan for the future. Having more data and being able to separate fact from fiction becomes all the more important during these uncertain times and V-RESAS aims to provide greater clarity in decision making. For more information, please see <https://v-resas.go.jp/>.

83 For more information, see: https://www.cao.go.jp/yosan/pdf/h28/27002400_naikakufu.pdf.

84 For more information on Toyota's RESCUE project, see: <https://www.sankeibiz.jp/business/news/190703/bsc1907030500004-n1.htm>; http://merc.e.u-tokyo.ac.jp/mmrc/dp/pdf/MMRC487_2016.pdf.

Lessons Learned and Recommendations

- **Big data visualization technology can help enhance the resilience of industries with complex, diverse, and vast supply chains.** Supply chain mapping and visualization using big data and the IoT could be a valuable tool for understanding supply chain vulnerability as well as informing decisions and actions on risk mitigation, quick recovery, and enhancing industry competitiveness.
- **Technology tools such as RESAS and LEDIX can provide beneficial information for disaster-preparedness policy making.** By helping users to understand disaster risk in the context of interconnected business activities, technology tools can aid in the design of policies that engage various stakeholders to collaborate in designing and implementing solutions for resilient industry.

7) PROVIDING SAFETY NETS AND FINANCIAL MECHANISMS FOR SMES TO SECURE CASH FLOW IN THE FACE OF DISASTER SHOCKS

Overview

Given the vulnerability of SMEs to external shocks, increasing their resilience to disasters is essential for overall resilient industry. However, SMEs often have limited resources and capacity to invest in costly disaster preparedness investments. For example, while BCP establishment in Japan is common for large firms (approximately 60 percent), only about 30 percent of SMEs have established BCPs (2018 Cabinet Office Survey).

One of the key challenges SMEs face postdisaster is a lack of liquidity, creating a cash flow problem that makes it difficult to finance repairs or other postdisaster measures. SMEs can also face challenges borrowing money quickly after a disaster due to lack of prearranged guarantees or options to take out loans. This inhibits SMEs from managing and quickly recovering from disruptions, damages, and losses. In the worst cases, this can lead to bankruptcies.

In response to these risks to SMEs, Japan has established a wide variety of financial support programs that are available to SMEs for disaster preparedness, recovery, and resilience measures.⁸⁵

Key Drivers and Examples

Financial institution regulations in Japan help minimize economic disruptions postdisaster. The Bank of Japan Act (1997) obligates the Bank of Japan (BoJ) to maintain the liquidity and stability of the financial system in case of a disaster. This regulation was proven effective in the context of the GEJE (appendix A19). Through the establishment of strategies and guidelines to keep the liquidity of local banks in a disaster region, the BoJ and local banks cooperated and remained open in the first weekend after the GEJE to respond to needs for cash. The BoJ also provided cash to local banks totaling \$200 billion the following Monday, three days after the GEJE, in order to retain liquidity in the market. This was the biggest single-day provision in Japanese history.

⁸⁵ A wide variety of financial support programs are available to large companies, such as postdisaster long-term, low-interest loans provided by the JFC and DBJ. For more information, see: https://www.mof.go.jp/financial_system/fiscal_finance/kiki/jisseki/joukyou_20181109.html.

SMEs often face difficulties borrowing money from banks after a disaster even if their financial records are good. A prearranged guarantee program contributes to effective financing postdisaster. Since 2008, prefectural credit guarantee corporations have offered prearranged guarantee programs to help SMEs cope with sudden and unexpected financial needs, including after disasters (appendix A20). The guarantee programs are available for SMEs that have high enough credit scores with individual credit guarantee corporations. For SMEs that have developed BCPs, no fee is charged before a disaster event occurs.

The Japan Finance Corporation (JFC) is a public policy bank owned by the government, and the Japan Finance Corporation Act (2007) stipulates its obligation to provide necessary financing to SMEs in the case of an emergency (appendix A21). This includes offering SMEs long-term, low-interest loans for both investment and financing after disasters. Following the GEJE, the JFC created and implemented the GEJE special loan program, which supported SMEs damaged both directly and indirectly by the disaster. This program has provided 24,800 loans, totaling \$14.7 billion. **By providing SMEs with access to funds postdisaster, policies like the Japan Finance Corporation Act and Bank of Japan Act enable these businesses to spring back quickly after a disaster strikes.**

Predisaster financial support can also reduce impacts when a disaster strikes. In Japan, the 2019 **Act on Strengthening of SMEs** incentivizes businesses to implement disaster reduction efforts through mechanisms including tax benefits, financial support, and/or subsidies to SMEs that have an approved Cooperative Business Continuity Enhancement Plan. In addition to supporting resilience-building actions within SMEs, this legislation also encourages large enterprises and financial institutions to support SME mitigation and preparedness efforts (appendix A1).

Lessons Learned and Recommendations

- In Japan, **addressing the liquidity challenges SMEs face postdisaster has been effective in ensuring business continuity, minimizing disruptions, and ensuring competitiveness to avoid bankruptcy after a disaster event.** National and local governments and financial institutions can support the resilience of SMEs in industry sectors by offering various financial products for SMEs.
- **Arrangements between central and local banks for postdisaster liquidity to support SMEs can aid in the recovery process.** Establishing a protocol for communication and collaboration between central and local banks may help financial institutions to effectively support SME business continuity, quick recovery, and competitiveness postdisaster.
- **Postdisaster financial safety nets for SMEs should be complemented with efforts to incentivize and support SMEs' preparedness activities,** such as the DBJ's preferential loan programs for firms with a high BCM rating (see appendix A15 for more information).
- **Providing SMEs access to finance in normal times can help them improve resilience to future disasters.** Smaller firms are less likely to have easy access to preparedness and mitigation funds, so programs and policies that support investment in the strengthening of SMEs can reduce disaster impacts.

8) ADDRESSING POSTDISASTER CHALLENGES TO WOMEN'S EMPOWERMENT IN INDUSTRIES

Overview

Gender equality is still nascent in Japan. In 2018 Japan placed 110th out of 148 countries in global gender equity in a survey conducted by the World Economic Forum, with significant gaps observed between men and women in labor participation, rates of full-time employment, and salaries. While significant policy efforts are now being implemented in Japan to enhance the overall workforce participation and working conditions of Japanese women, there are currently no formal institutional and legal frameworks in Japan that put forth a gender-based approach to resilient industry.

As a result, NPOs are the main actors in providing targeted support for women to play a significant role in enhancing preparedness and enabling quick recovery of industries, as well as mitigating the disproportionate burdens women face postdisaster (see table 3.2). In light of this context, examples of gender-sensitive resilient industry solutions from Japan are scarce. However, **Japan's past disaster recovery efforts offer some examples of how financial programs targeting women, as well as the establishment of childcare or remote working arrangements, can encourage mothers to return to work.**

TABLE 3.2 Gender Challenges Related to Disasters in Japan

Physical Aspect	Social Aspect
<ul style="list-style-type: none"> The number of female disaster victims tends to be larger than that of male victims. 1.37 times as many women as men died in the Great Hanshin and Awaji Earthquake (GHAE), 114 times in the Great East Japan Earthquake (GEJE) (2011). 	<ul style="list-style-type: none"> Postdisaster environments may not be effective in maintaining women's dignity and privacy; for example, in the GEJE, only 26 percent of all evacuation centers were considered conducive to women's needs. Increase of gender-based violence. For example, domestic violence increased by 3.5 times after the GHAE, by 64 percent in Fukushima and 33 percent in Miyagi after the GEJE.
Cultural Aspect	Economic Aspect
<ul style="list-style-type: none"> Main caregiving responsibilities are borne by women (family and work place a twofold burden on women). Women have insufficient opportunity to participate in decision-making related to disaster management across all phases. 	<ul style="list-style-type: none"> Women face higher risks of dismissal and/or unemployment. The mass dismissal of female workers after the GHAE is an example. Women face greater hurdles to reemployment. For example, the number of people receiving unemployment insurance after the GEJE increased by 1.7 times for male workers, and 2.3 times for female workers. A large number of single-mother households are forced into poverty or relocation from disaster-affected areas.

Source: Original compilation based on Cabinet Office (2012a, 2012b); Endo (2012); Gender Focal Point Network (2008); Human Rights Now (2011); Jiji Press (2013); Takenobu (2012).

Key Drivers and Examples

Aomori Prefecture suffered from a lack of human resources to revitalize its local economy after the GEJE in 2011. In response, women's participation in the local economy was prioritized within local public policy. This catalyzed the establishment of postdisaster guarantee programs for female entrepreneurs. In 2014, Aomori's prefectural government initiated the Farming and Fishing Village Women Entrepreneurship Challenge Support Project, providing guarantees to female entrepreneurs starting businesses (appendix A22). Female entrepreneurs can receive subsidies from the prefectural government to cover expenses relating to starting a new business using agricultural and fishery resources, such as purchasing facilities, R&D, advertising, hiring advisors, and hiring clerical workers. The subsidy is up to \$4,587 (¥500,000) per business.

Although significant gender equity/equality issues exist postdisaster (see table 3.2), there are few formal institutions or legal frameworks in Japan to address gender issues while fostering resilient industry. A number of NPOs were created after the GEJE and other disasters to fill this policy gap. These groups provide training and consultation services to empower women and provide support postdisaster.

NPOs in Miyagi, including Miyagi Jo-Net (MJN), provided support, technical and financial resources, and training to address gender-specific issues after the GEJE (appendix A23).

From the chaotic period right after the earthquake, MJN provided postdisaster job training tailored to women, advocated for women's rights in the relief process, and created support structures for gender equity in postdisaster decision-making. By helping reduce the gender-specific burdens women face postdisaster, they helped women rapidly rejoin the workforce and supported local recovery.

Lessons Learned and Recommendations

- **There is more work to do in promoting women's needs postdisaster.** In Japan, while the Cabinet Office has actively promoted gender issues, women's participation is not yet a strong consideration in Japanese companies' BCP, regardless of its size.
- Due to a lack of public sector support in Japan, **NPOs have provided the primary support system for women seeking to recover their businesses from disasters.**
- **Ensuring that female entrepreneurs and business owners have access to credit after disaster events advances a gender-based approach to resilient industry.** Providing loan guarantees to female entrepreneurs, such as those provided by Aomori Prefecture, can alleviate the hardship of borrowing money from banks. Targeted financial products, tools, training, and support services to enhance women's access to credit and financial products before and after disasters increase the resilience of women within industry and society as a whole.
- **A gender-based approach to resilient industry needs to be promoted within an overall framework for fostering gender equity.** Women's equity should be treated as part of a long-term initiative, involving a holistic approach to increasing women's participation in the workforce, as well as improving women's rights and working conditions. In this way, industries can enhance competitiveness.

3.4 AREAS OF FURTHER WORK TO PROMOTE RESILIENT INDUSTRY IN JAPAN

- The disruptions to local industry caused by disasters have a strong negative impact on local economies. Given the diversity of industry types and hazard profiles across Japan, appropriate measures will differ by region. **Therefore, there is a need to clearly define the role of local governments in strengthening resilient industry.**
- It is well understood that infrastructure resilience is beneficial to the overall resilience of societies and populations. However, there is more work to be done in **understanding the specific ways in which infrastructure investments affect resilient industry.** Understanding the impact of infrastructure disruption on industries explicitly can help both the public and private sector make decisions on how to better invest in preparation for disasters.
- Compared to larger firms, **SMEs have less technical and financial resources to prepare for and respond to disasters.** Strengthening the resilience of SMEs and creating incentives for implementing BCP and DRM measures can help this portion of the economy better prepare for disaster risks.
- Although women face unique risks and vulnerabilities postdisaster, there has been little work done on **understanding and addressing the role of women in industries and their unique vulnerabilities to disaster risks.** In order to form equitable plans for resilient industry, there is a need to ensure that the needs of women and other vulnerable populations are met effectively.
- Although there is extensive research on the direct impacts of disasters and how to mitigate them, less is known about how **the risk of potential disasters indirectly limits economic potential through reduced positive risk-taking activities and what measures are effective in reducing this risk aversion.**

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4

KEY LESSONS AND NEXT STEPS

As the exposure of industries to disasters increases as a result of climate change, urbanization, and industrial growth, firms and governments around the world are increasingly faced with the need to plan for resilience in order to remain competitive.

Intensifying and more frequent natural hazards can have severely negative impacts on the growth of national economies, industries, and firms, and on global value chains and the well-being of people. For example, Thailand's 2011 floods led to estimated economic losses of approximately \$46.5 billion due to lost production and turnover, increased production costs, and job and salary losses (GFDRR 2011; World Bank 2012). In 2015, floods in south India led to estimated losses of \$2.2 billion, stemming mostly from lost production capacity in the automobile manufacturing sector, a key driver of India's economy (Swiss Re 2016). **Manufacturing industries and firms bear a large proportion of these economic losses.** Thailand's manufacturing sector, which accounted for 38.5 percent of the country's annual GDP at the time, bore roughly 70 percent of these damages and losses (approximately \$32.5 billion) with estimated export losses of \$7.9 billion in 2011 alone (World Bank 2012). Much of this loss was borne by the automotive, electronics, and machinery manufacturing sectors through damage to industrial park infrastructure and the assembly plants of tenant companies (see the report "Resilient Industries: Competitiveness in the Face of Disasters" [World Bank 2020]).

A country with a strong manufacturing history as well as a high exposure to natural hazards, Japan has been working on developing resilient industries for many years.⁸⁶

Although the country has been highly exposed to natural hazards, effective tools and approaches have shaped the ways in which the Japanese public sector, manufacturing sector, industry stakeholders, and financial sector work toward making industry more resilient to disaster events before, during, and after disasters. While the policies and investment programs discussed here were developed in Japan's particular socioeconomic, cultural, and hazard context, general lessons that the country has learned have relevance for other contexts. By describing not only what Japan has done to strengthen its industry's resilience against disasters, but also providing details on who, how, and why, practitioners and decision makers from diverse countries and sectors can adapt the lessons and solutions from Japan to efforts within their own contexts to strengthen industry competitiveness through resilience.

This chapter summarizes the key high-level lessons that can be drawn from Japan's experience to inspire and support developing countries embarking on efforts toward resilient industry. It also highlights critical next steps.

4.1 KEY LESSONS

Resilience makes industries competitive

- **Investing in resilient industry not only reduces risks of disruption and losses when a disaster strikes, but it also enables long-term industry competitiveness.** Experience from Japan has shown that firms, industrial parks, global value chains, and economies that incorporate predisaster planning, preparedness and mitigation, and effective postdisaster responses will have a competitive edge over those who do not. For example, at the national level, many policies and programs promote BCP and BCM, including the *Cabinet Office of Japan's Business Continuity Guideline*, which mainstreams BCPs as a key resilient industry and industry competitiveness strategy. Firms with BCPs in place will be more resilient when disasters strike, and are less likely to face disruptions, allowing the overall economy to recover quickly. After the GEJE, firms with BCPs experienced significantly less reduction in their

86 Japan's efforts toward developing industries in the face of disasters are described in Section 2.2 of this report.

financial soundness; benefits included reductions in extraordinary losses, increased borrowing, and greater ordinary income (Matsushita and Hideshima 2014). Advance plans and programs have allowed Japan to respond rapidly during a crisis: based on the Bank of Japan Disaster Prevention Action Plan, the BoJ successfully opened its disaster countermeasures office within 15 minutes after the GEJE occurred. By rapidly providing liquidity to disaster-impacted firms, the private sector could also respond quickly to the disaster. Planning for resilience reduces disaster disruptions and speeds up the response and recovery process, meaning an industry sector can remain competitive even in the face of growing disaster risks.

- **Promoting the representation of women and minorities in industry can create a stronger, more resilient sector.** A strategy for improving resilient industry that emerged in the wake of Japan's GEJE is empowering female businessowners and entrepreneurs, through programs such as Aomori Prefecture's subsidies to women-owned businesses in agriculture and fishery industries (3.3; approach 8). Although gender disparities remain high in Japan, empowering women in industry as part of a larger framework for gender equity not only addresses ongoing inequities, but also helps build local (and in this case rural) economies. In developing countries where women's rights or the rights of other minority groups remain uneven, incorporating equity into resilient industry can help promote a more competitive and just economy.

Resilient industries benefit a range of stakeholders

- **Resilient industry is important not only because of the direct beneficiaries of resilience projects, but also because of the broader social and economic benefits of maintaining an industry sector that can thrive even in the face of growing disaster risks.** For the public sector, including national and local governments, creating an enabling environment for resilient industry is beneficial to the economy overall. In Japan, METI used the Smart Communities program after the GEJE to both help firms recover and rebuild a more resilient and robust economy (3.3; approach 1). National policies in Japan promote the implementation of BCPs, and the importance of BCM and DRM for private sector resilience and competitiveness has been reinforced through the experiences of past megadisasters. Industries that can survive and thrive after disasters maintain jobs and livelihoods, and promote local and national economic vitality. Therefore, countries and regions that promote resilient industries will be able to bounce back quickly after a disaster occurs.
- For **industry stakeholders and manufacturing firms**, advance planning and action, such as business continuity planning and investment in structural measures, diminish the risks of industry disruptions. If the member firms of industry associations, zones, and parks are affected by disasters, they may go bankrupt or be forced to relocate, lowering the overall competitiveness of local industries and industrial parks. When disasters strike, business operations are disrupted not only by damages to firms' physical assets, but also due to impacts to employees and their families, on-site and off-site infrastructure, partner companies such as suppliers and parent companies, and customers. Smart resilience investments can benefit implementors not only after a disaster strikes, but can also provide everyday benefits. For example, Hino Motors implemented the Mitsubishi Chemical Aqua Solutions Co., Ltd.'s groundwater purification system for backup manufacturing and drinking water needs. The groundwater purification system enables the Hamura Plant to utilize an alternative source of clean, stable, and cost-efficient water that limits disruptions and safety issues during disasters while reducing annual water costs during normal times (3.3; approach 4). Industry stakeholders and manufacturing firms that put resilient industry plans and actions in place before a disaster will face less disruptions to operations and supply chains, and remain competitive even in the aftermath of a disaster.

- The **financial sector**, including public and private financial institutions and investors, has an interest in the long-term strength and competitiveness of industries and firms of all sizes. Japan has seen insurance premiums go up in response to increasing disasters; as a result, measures to alleviate and prepare for disasters will be more important than ever before (3.2). Actors in the financial sector that support resilient industries through programs such as preferential loans and prearranged guarantees can help minimize the risk of losses and bankruptcies. In Japan, the GEJE caused significant impacts to firms directly and indirectly, resulting in more than 1,300 earthquake-related bankruptcies between 2011 and 2013.⁸⁷ Such bankruptcies weaken industry resilience in affected regions and slow recovery. Following the GEJE, the JFC created and implemented the GEJE special loan program, which supported SMEs damaged both directly and indirectly by the disaster. Financial agencies in Japan also provide incentives for firms to develop BCPs, decreasing the likelihood that a disaster will cause unrecoverable harm to businesses (3.3; approach 7). Through programs that promote resilient industry, actors in the financial sector can help maintain an overall resilient and competitive economy.

Collaboration can strengthen industries' resilience

- **Japan's experience in developing competitive industries in the face of acute disaster risks highlights that resilient industry must be a multisectoral effort; neither the public nor private sector can achieve resilient industry on its own.** For example, a resilient and competitive manufacturing sector was enhanced by collaborations among actors in the Akemi Industrial Park, which took the initiative to develop a parkwide BCP. In response to a history of typhoons and earthquakes and the potential of a future Nankai Trough mega-earthquake and tsunami, strategic areas of collaboration and collective solutions were identified and mechanisms set up to enable areawide solutions. Strategies included establishing shared evacuation sites and pooling resources for medical staff, search and rescue, fuel, and disaster response activities (3.3; approach 2). The project involved collaboration between the park and more than 120 firms, as well as coordination with local and national governments. Japan has also established multisectoral agreements for facilitating the cleanup and reconstruction of damaged roads that are important to supply chain logistics following a disaster event, as well as the recovery of society overall (3.3; approach 3). Strategic collaborations for efforts such as industry-park-wide BCPs and shared responsibilities for infrastructure, which may include multiple firms and actors across sectors, can be win-win actions for resilience and competitiveness.
- Collaboration for resilient industry can occur not only across sectors, but also between firms through prearranged cooperation agreements. **Identifying strategic areas where neighboring firms or firms along the supply chain can collaborate to plan for contingencies, and prearrange partnerships for support, can help establish collective resilience.** Firms in Japan have implemented collaborative investment in disaster resilient structural design improvements, infrastructure, and equipment. They have also worked together to improve supply chain monitoring and management in order to detect disruptions and implement solutions quickly. After the 2007 Chuetsu Earthquake, the Suzuki Kogyo Corporation, a small waste management company located in Sendai City, established a BCP that included prearranged agreements with a manufacturer of incinerator parts, an external waste collection truck rental firm, and a separate waste management company located in neighboring Yamagata Prefecture. When the GEJE struck in 2011, Suzuki Kogyo was able to leverage these partnerships to collect and treat waste within six days (3.3; approach 3). By planning to work together predisaster, collaboration agreements can improve resilience and recovery postdisaster, maintaining the livelihoods of business owners and employees.

87 For more information, see: https://www.tsr-net.co.jp/news/analysis/20190308_03.html.

Resilient industry is an ongoing process

- Resilient industry is not a one-off action. Rather, **effective approaches to resilient industry should be seen as ongoing efforts in a cycle** of understanding risk, planning for disaster events, implementing preparedness and mitigation measures, and taking planned response and recovery actions if and when a disaster does strike. In Japan, programs encourage firms to regularly update and revise their BCP measures. For example, the Business Continuity Advancement Organization (BCAO) is a nonprofit network of academics, consultants, and industry representatives that can help private sector organizations continue to improve these plans (3.3; approach 2). Shizuoka Prefecture's Disaster-Triggered Credit Guarantee Program incentivizes regular BCP updates through an annual review and renewal process (appendix A16). At the national level, policies are often updated in response to disaster impacts as part of an ongoing cycle of resilience building. This cyclical nature of resilient industry means that resilient plans and actions can be implemented regardless of what stage a firm or sector is in its development. For developing countries, where the manufacturing sector is still nascent, there is particular potential for mainstreaming resilient industry from the ground up.
- **Mainstreaming resilient industry strategies into public policy and business management helps enable this ongoing process.** In Japan, for example, there is no single law for resilient industry; rather, resilient industry is integrated into policies for industrial development, industry competitiveness, industrial land use planning, and DRM, creating a broader enabling environment for resilient industry solutions (3.3; approach 1). A mainstreaming approach acknowledges that resilient industry is an interdisciplinary issue that requires cross-sectoral collaboration and interpolicy coordination across ministries and departments. Countries working to improve the resilience of their industry sector should look for opportunities to integrate resilient industry efforts in the creation of new legislation and programs.

Create competitive and future-proof industry by building back better

- **Disasters are an opportunity to learn, improve, and adapt—building back better.** While mitigation and preparedness are best addressed in advance of a disaster, disasters are by nature unpredictable. Each disaster event provides new lessons on how preparedness, mitigation, response, and recovery can be improved across sectors and stakeholders. This might be achieved by enacting new resilience legislation, constructing and improving infrastructure, or updating and adapting BCPs and EP&R plans. Building back better can be considered not just within the industry sector, but also in the larger community: firms in Japan often provide support to the surrounding community postdisaster in conjunction with business continuity measures.
- **Public and private actors in Japan have a long history of learning from and improving upon resilience postdisaster.** Many key national resilience legislations in Japan have been enacted and updated following major disasters, and these policies in turn have proven effective in improving outcomes during subsequent disasters. For private sector actors such as manufacturing firms and industry stakeholders, building back better may also include innovation that meets emergent postdisaster needs. For example, Toyota Motors Company, together with 11 union member firms, established the F-Grid emergency power system in the Ohira Industrial Park in Miyagi Prefecture, which was reconstructed after the GEJE. The system optimizes the power supply of the industrial area by managing electricity from the national grid along with electricity and heat from on-site electric cogeneration and solar power generation facilities (3.3; approach 4).

- **Postdisaster government subsidies and stimulus programs are vital to help initiate the implementation of new technological solutions for minimizing the impacts of infrastructure disruptions.** Investments toward resilient and innovative industry infrastructure as part of governments' postdisaster reconstruction programs and/or disaster stimulus packages can enable building back more competitive, future-proof industries. The F-grid project also leveraged METI's Subsidy for Projects Promoting the Introduction of Smart Communities Program (3.3; approach 1) in order to finance the creation of a resilient postdisaster infrastructure system. Postdisaster subsidies and stimulus programs create an opportunity to invest in technologies and infrastructure that promote long-term resilience, reducing the impacts of future disasters.
- As building back better and stronger following a disaster may require significant investments, the financial sector also has a key role to play. **In addition to postdisaster government subsidies, financial institutions can provide access to low-interest loans to finance postdisaster recovery work, or extended grace periods for debt repayment after major disaster events.** After the 2011 GEJE, JFC, a government-owned finance corporation, provided 24,800 loans through a preferential loan program for SMEs in affected areas, helping these businesses recover with strength (3.3; approach 7). Creating postdisaster financial instruments that support building back better can help businesses and economies adapt and grow even in the face of growing disaster risks.

In developing countries, considerations of resilient industry may lag behind other economic and political priorities. However, preparing industries for disasters can help protect jobs, livelihoods, economies, and resource availability. Even in countries where exposure to natural hazards is comparatively low, given the growing risks of climate change and the interconnected nature of global value chains, no country has the luxury of completely disregarding disaster preparedness. For developing countries that are working toward establishing resilient industry, it is important to take a multisectoral approach across the disaster timeline. Countries planning for resilient industry can consider the capacity of government, firms, industrial park and infrastructure operators, firm associations, and the national financial sector when making decisions about how to make industry more resilient in any particular country. Developing countries should also consider the rights and well-being of women and other disenfranchised groups when they plan for resilient industry. While any disaster preparedness strategy needs to be adjusted to the nuances of local context, tools like BCP, insurance, infrastructural resilience, and postdisaster financing provide a productive starting point for establishing a suite of resilient industry strategies.

4.2 NEXT STEPS: THE FUTURE OF RESILIENT INDUSTRY

Opportunities for Improvement

Although Japan is a global forerunner in the development of DRM and resilient industry, there is still work that can be done to improve resilient industry in Japan. A key area for improvement is promoting the rights and well-being of women postdisaster within industry preparedness, response, and recovery. Government support targeting the specific needs of women workers, business owners, and entrepreneurs postdisaster are emerging but limited, and as a result, these needs have been addressed mainly by NPOs instead. Other countries can keep this in mind, and integrate the rights and well-being of women and other vulnerable populations as they establish resilient industry policies and programs.

Areas for Further Investigation

This report has used a historical narrative and collection of case studies (aggregated in the appendix) to help demonstrate why and how Japan has established a trajectory of resilient industry, and describe specific strategies that Japan has found effective in preparing industry for disasters. However, there are some future areas of research that could expand this body of knowledge of resilient industry in Japan. For example, there is a need for a better understanding of coordination mechanisms among the central government ministries and departments that drive resilient industry in Japan. As this report has shown, establishing a policy and institutional framework is key for resilient industry (see section 3.2), and a study of this nature would identify the particular roles of various levels of government. Given the severe impacts of disasters on local economies, clarifying the roles of local government can help ensure that resilient industry policies meet the particular industry and hazard contexts across the country (see section 3.1).

The growing realm of ESG (environmental, social, and governance) investment offers a potential connection between sustainable finance and industry resilience. Tokyo, Nagano, and Kanagawa prefectures, among others, have issued green bonds to attract ESG investment from institutional investors and individuals, and have used them to fund disaster prevention measures. Tokyo, in particular, has issued bonds in the amount of ¥20 billion (\$18 million) per year to be used for projects that contribute to regional resilience through the development of seawalls and rivers.⁸⁸ ESG investment can be investigated for additional applications toward resilient industry in both the public and private sector.

An area for research and improvement in BCPs and EP&R plans is making plans more dynamic and including multiple disaster scenarios. Firms in Japan often support surrounding communities during disasters in conjunction with business continuity measures. However, companies' and governments' EP&R plans have limited focus regarding possible disaster scenarios. Notably, current planning efforts often do not distinguish between time of day, weekdays vs. weekends, seasons, or locations (e.g., indoor, outdoor, or underground). In this sense, future studies must propose how BCPs and ER&R plans can capture diverse disaster scenarios using big data and data visualization.

Infrastructure resilience is shown to benefit society overall, but there is more work to be done in understanding the specific ways in which infrastructure investments shape resilient industry in Japan. Understanding the impact of infrastructure disruption on industries explicitly can help both the public and private sector make decisions on how to better invest in preparing for disasters. Similarly, it would be useful to investigate entry points for integrating resilient industry priorities within various sectoral policies such as smart communities, energy efficiency, environmental sustainability, etc.

Hazard types offer an additional area for further investigation. Although earthquakes remain a significant risk, recent trends suggest that the vulnerability of modern society to wind and flood damage should be emphasized. Research suggests that vulnerability to flood and wind damage is increasing due to the characteristics of modern society (e.g., the development of industrial zones and the concentration of population in alluvial lowland areas) (Science Council of Japan 2020).

88 See: https://www.zaimu.metro.tokyo.lg.jp/bond/tosai_ir/gb/greenbond20191220.pdf

Lastly, future studies must propose how industries and industry stakeholders can manage interconnected risks and weigh the costs and benefits of mitigation actions. Risks propagate through interconnected supply chains during disasters (Inoue and Todo 2019; Shughrue, Werner, and Seto 2020) and pandemics (Guan et al. 2020). Damages to a second or third-tier supplier might become a source of disruption to the entire supply chain. Furthermore, infrastructure systems are interconnected networks. The resilience of individual infrastructure assets is not sufficient for the resilience provided at the network level (Hallegatte, Rentschler, and Rozenberg 2019; Haraguchi and Kim 2016). For example, a blackout due to damages to a power transmission facility may cause malfunctions of water systems in industrial parks. However, manufacturing firms and industry stakeholders have to weigh trade-offs between actions to mitigate supply chain disruption such as supply chain redundancy, and the cost efficiencies of these actions during normal times. Harnessing big data with data visualization can be one way to help practitioners manage interconnected risks. Managing interconnected risks and building networked resilience is required to sustain resilient industry holistically. Expanding the body of research and institutional knowledge on these topics can offer further insight on how Japan and other nations can improve their approaches to resilient industry.

Resilient Industry and Public Health Emergencies

This report has focused on disasters that Japan experiences at a high rate: specifically, those triggered by natural hazards such as earthquakes, typhoons, and floods. Different hazard types can vary widely in impacts, duration, and geographical distribution. However, many of the strategies highlighted here have relevance for diverse types of crises, including public health emergencies. The completion of this report has coincided with the COVID-19 pandemic. The impacts of the 2019–20 novel coronavirus on global economies has been extreme, including upon industrial production, supply and distribution chains, and markets. Industry stakeholders have struggled with customs clearance, retaining workers, and the import of raw materials. Based on the survey conducted by Nikkei Monozukuri in the beginning of March, 68.9 percent of the respondents (476 manufacturing firms) answered they are being affected by the disease outbreak, mostly by supply chain disruptions. Sixty percent of the respondents answered they are expecting further negative impacts through the disruption of supply chains, halted factory operations, and decreased domestic and global sales (Nikkei XTECH 2020).

Although health emergencies are not the focus of this report, many of the strategies put forth have relevance for pandemics and similar crises. **Nonstructural measures in particular, which are more likely to be applicable across a large range of disaster types, may help industries in the event of a public health emergency even if planning has not emphasized this type of hazard.** For example, BCPs that considers eventualities of disruption to production or supply chains can be activated in order to ensure supply chain continuity (3.3; approach 2). As this report has highlighted, the global supply chain is deeply interconnected, and disaster impacts elsewhere can also disrupt operations. As this report has highlighted, global supply chains can be deeply interconnected, and disaster impacts elsewhere can also disrupt operations at home. Health emergencies disrupt supply chains in ways distinct from other disaster types. Unlike floods or earthquakes, pandemics such as COVID-19 may cause limited physical damages to infrastructure assets. However, they can impact businesses and supply chains significantly through disruption of the flow of people, finance, and infrastructure services. Therefore, similar to disasters caused by natural hazards, the advance contingency planning of prioritizing key operations, cooperation agreements with financial institutions and expanded supply networks, and information sharing can help firms implement nimble responses to unforeseen problems (3.3; approach 3). Big data and visualization tools, such as V-RESAS, can help local governments, financial institutions, industry associations, and manufacturing firms to better understand the impacts of pandemics on their regional economies and assist in planning for the future. In the context of COVID-19, the V-RESAS tool is being used to visualize near-real-time consumer behavior data, providing greater

clarity for decision making during uncertain times.⁸⁹ COVID-19 has been particularly disruptive to the cash flow of many SMEs, and so the provision of safety nets by financial institutions can help firms maintain liquidity (3.3; approach 7). There are already some examples of companies that have formulated BCPs for infectious diseases as of 2017 (Cabinet Office 2018). Governments also support the development of BCPs based on the assumption of a new type of influenza through the “Guidelines for SME BCP Formulation for Countermeasures against Pandemic Influenza” (SMEA 2009).

COVID-19 has been particularly harmful to already disenfranchised communities. This report’s consideration of improving the empowerment of women in industry (3.3; approach.8) might also be translated to helping ensure the safety, well-being, and empowerment of those who might be made more vulnerable or have special needs during a health emergency such as the elderly, disabled, and poor and/or minority communities.

Preparedness for and mitigation of public health emergencies could be further improved by explicitly including these risks in the planning process. For example, pandemics can be included in risk analyses and BCP measures, with an emphasis on supply chain continuity. COVID-19 has shown that structural actions may also help to mitigate the spread of contagious viruses, and firms and industrial parks might also consider physical modifications such as improved ventilation systems, handwashing stations, or contingency plans for modifying production in ways that accommodate social distancing.

While advance planning and preparation is essential, the full scope of future disasters will never be entirely known. Evaluating and planning for multiple disaster scenarios, however, can put industry stakeholders in the best position to act quickly and effectively even when the unknown strikes. **Unforeseen emergencies like the COVID-19 crisis can also be an opportunity to build back better: as public and private sectors work to adapt to the changing global health context, there is an opportunity to rethink how industries are managed with a renewed focus on resilience.**

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APPENDIX A

CASE STUDIES OF RESILIENT
INDUSTRY SOLUTIONS FROM
JAPAN

I. DEVELOPING A NATIONAL FRAMEWORK FOR RESILIENT INDUSTRIES

A1: TAKING A MULTISECTORAL APPROACH TO ADVANCE RESILIENT INDUSTRIES AT THE NATIONAL LEVEL

Cabinet Office; the Ministry of Land, Infrastructure, Transport and Tourism (MLIT); and the Ministry of Economy, Trade, and Industry (METI)

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Policy and legal	<ul style="list-style-type: none"> Public sector—national, prefecture, city 	 Earthquake  Tsunami  Flood  Storm Surge  Volcanic Eruption  Other - such as pandemics	<ul style="list-style-type: none"> Strengthening disaster risk governance to manage disaster risk 	<ul style="list-style-type: none"> Continue business Minimize disruptions and recover quickly Sustain and improve competitiveness

Context

Enhancing the resilience and competitiveness of firms, industrial parks, and industry sectors requires a multisectoral policy and legal approach. Disaster risk management (DRM) principles need to be integrated within economic development policies and infrastructure investment frameworks. Through Japan's experiences with various large-scale disasters and their significant impacts on firms, the Japanese government has worked to integrate measures for enhancing resilient industry within various sectoral policies and institutional mandates, simultaneously developing coordination mechanisms to avoid duplication and enhance collaboration. Japan's approach to developing an integrated policy and institutional framework for enhancing resilient industry is outlined below.

Solution Design and Key Features

Solution Design

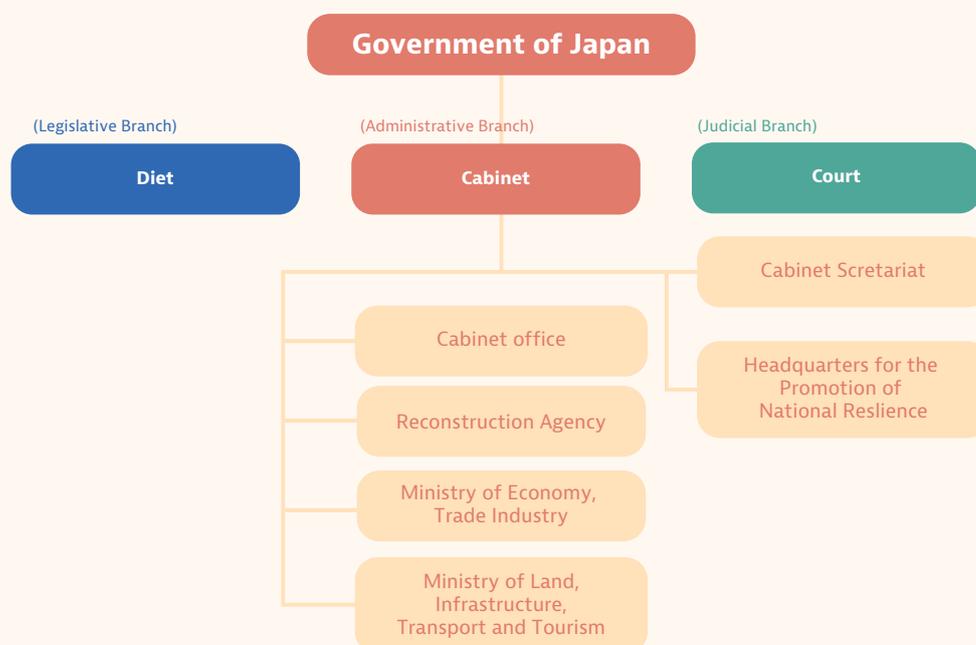
Engaging multiple government sectors to promote resilient industry: Three central Japanese government ministries—the **Cabinet Office**; the Ministry of Land, Infrastructure, Transport and Tourism (**MLIT**); and the Ministry of Economy, Trade, and Industry (**METI**)—coordinate at the national level to implement legal frameworks and policies that promote the resilience and competitiveness of industries and firms in Japan (figure A1.1). **Specialized coordination agencies, such as the Reconstruction Agency (RA) and the National Resilience Promotion Headquarters, have also been established in Japan with targeted efforts to accelerate resilient industry.**

Key Features

Coordination across government sectors

- **The Cabinet Office plays a critical role in enhancing resilient industry through outlining the roles that firms play in disaster preparedness and response, as well as ensuring that financial resources are made available to small and medium enterprises (SMEs) to support recovery after disaster events.** As the coordinating institution for DRM in Japan, the Cabinet Office governs the Basic Act on Disaster Management. First enacted in 1961, the Basic Act on Disaster Management defines the role of national and local governments in times of disaster, as well as stressing the importance of collaboration between all stakeholders for disaster preparedness, response, and recovery. In the event of a large-scale disaster, **the Cabinet Office is also responsible for the designation of an “extremely severe disaster” (ESD) as per the Act on Special Financial Support to Deal with the Designated Disaster of Extreme Severity. Article 12 of this law enables SMEs to access various financial assistance from the national government in the event of a designated ESD.** For example, the floods that occurred in Fukuoka Prefecture in June and July of 2018 were designated as an ESD under this law. As a result, affected SMEs were able to access special guarantees and low-interest loans to recover and reconstruct their businesses in the disaster-affected areas.⁹⁰ Under this law, from 2015 to 2019, financial support for SMEs was implemented for nine designated ESD events including earthquakes, typhoons, and heavy rains.⁹¹
- **MLIT governs the development, operation, and quick recovery of infrastructure that supports business activities in the face of disaster events, such as roads and coastal and river flood prevention measures.** The public infrastructure managed by MLIT serves

FIGURE A1.1 Institutional Structure for Resilient Industries in Japan



Source: Edited based on Cabinet Secretariat (2017).

90 For more information, see: <https://www.chusho.meti.go.jp/keiei/antei/2017/170808saigai.htm>.

91 For information on the list of designated ESDs and the measures taken, see: <http://www.bousai.go.jp/taisaku/gekijinhukko/list.html>.

an integral role in enhancing the resilience of industries, avoiding or reducing the impacts of disasters on industries and firms. MLIT is also mandated with national-level policy making regarding land utilization, and may have influence over where industries are located in accordance with the level of disaster risks these industrial zones may face. MLIT also oversees and updates various laws related to DRM infrastructure such as the **Flood Protection Law** and the **Sediment Disaster Prevention Law**. Furthermore, MLIT is responsible for the safety of areas within the protection of MLIT-owned coastal levees and river embankments. In 2015, facing increasing extreme weather events and climate change, MLIT established a working group to study how the impacts of storm surges and coastal floods in industrial areas outside of levees can be avoided or minimized through the development of areawide business continuity plans (BCPs) (MLIT 2016).

- **METI is responsible for the development of Japan's economy and industries through promoting the economic vitality of private companies and advancing external economic relationships.** It also oversees power and water utilities through the **Agency for Natural Resources and Energy (NRE)**, and SMEs through the Small and Medium Enterprise Agency (SMEA). METI's mandates for competitiveness and industrial zone development are outlined in the **Industrial Competitiveness Enhancement Act** (2013) and the **Multi-Polar Patterns National Land Formation Promotion Act** (1988); however, neither law currently indicates how disaster risks are considered. In 2019, the **Act on Strengthening of SMEs** (or Act Revising Part of the Small- and Medium-Sized Enterprises Business Enhancement Act to Contribute to the Continuity of Business Activities of SMEs) was enacted (SMEA 2019). This act strengthens disaster prevention and reduction measures for SMEs (revision of the Small- and Medium-Sized Enterprises Business Enhancement Act) and the support systems of chambers and associations of commerce and industry (revision of the Act for Facilitating New Business Activities of Small and Medium-sized Enterprises). This is done through providing tax benefits, financial support, and/or subsidies to SMEs that have an approved Cooperative Business Continuity Enhancement Plan. The act incentivizes SMEs to take preparedness measures, and also encourages related parties such as large enterprises and financial institutions to support SMEs in enhancing their resilience (SMEA 2019).

Specialized Coordination Agencies Supporting Targeted Efforts to Accelerate Resilient Industry

- The **Reconstruction Agency (RA)** was established in 2012 after the devastating Great East Japan Earthquake (GEJE) in 2011 to accelerate structural reconstruction and revitalization of affected areas. The GEJE caused significant impacts to firms directly and indirectly, resulting in more than 1,300 earthquake-related bankruptcies between 2011 and 2013.⁹² In light of the large-scale and widespread devastation caused after the GEJE, the RA was established directly under the Cabinet as a temporary government agency until March 2021.⁹³ The RA serves as a one-stop shop where representatives from various national- and municipal-level institutions can join forces to collectively advance reconstruction work. In close coordination with central ministries and local municipalities, the RA has played a critical role in the response and recovery of firms and industries in disaster-affected areas through various financial programs, workforce development efforts, regional business investment promotion, industrial zone development projects, and the encouragement of public and private partnerships.⁹⁴

92 For more information, see: https://www.tsr-net.co.jp/news/analysis/20190308_03.html

93 The possibility of extending the Reconstruction Agency for another 10 years is being discussed. For more information, see: <https://www.asahi.com/articles/ASMC744YFM7UJZU005.html>

94 For more information, see: <https://www.reconstruction.go.jp/topics/main-cat1/sub-cat1-19/>

- **The National Resilience Promotion Headquarters** was established under the **Cabinet Secretariat** in line with the **Basic Act for National Resilience Contributing to Preventing and Mitigating Disasters for Developing Resilience in the Lives of the Citizenry**, or **Basic Act for National Resilience** (Act No. 95, December 11, 2013).⁹⁵ The headquarters promotes the implementation of the **Basic Act on Disaster Management** (1961) through the 2014 **Fundamental Plan for National Resilience**⁹⁶ (see table A1.1) and annual **Action Plan for National Resilience** (Cabinet Secretariat 2018a). The headquarters promotes securing the continuity and competitiveness of social and economic systems as key principles for national resilience. The Fundamental Plan includes various resilience measures that are essential in advancing resilient industry.⁹⁷

Lessons Learned

- **Industrial resilience is an interdisciplinary issue that requires cross-sectoral collaboration and strong coordination of institutions and policies at the national level.** Numerous disaster recovery experiences in Japan have led to incremental enhancements of the institutional framework and mandates for resilient industry, supporting collaboration across government sectors and institutions.
- **Specialized coordination agencies have been proven necessary and effective to advance resilient industry actions**—especially when disaster risk preparedness of firms needs to be strengthened quickly and widely (i.e., the National Resilience Promotion Headquarters) or when firms and industries in disaster-affected areas need to be rebuilt and revitalized quickly (i.e., the Reconstruction Agency).
- **National government ministries across sectors have significant roles to play in creating an enabling environment for enhancing disaster preparedness and response capacities of industries**—through establishing policies and legal frameworks that induce: (i) firms, supply chains, and supporting critical infrastructure services to enhance their preparedness against disasters, as well as (ii) firms, particularly SMEs, to enhance their disaster response capacities.

Results

Though there is no single law for resilient industry in Japan; resilient industry considerations are integrated within various legislative frameworks and institutional mandates. These policies and legal frameworks create an enabling environment to strengthen resilient industry in Japan by defining the legal responsibilities of the public sector in supporting resilient industry. They also create resources for information gathering and awareness raising, provide guidelines and technical support that help foster capacity building, and provide training that advances resilient industry actions. The policies and frameworks also establish financial mechanisms to ensure efficient postdisaster access to disaster recovery finance and insurance. Specialized coordination agencies enable collective solutions across many public and private organizations.

⁹⁵ For more information, see: <http://www.japaneselawtranslation.go.jp/law/detail/?id=2879&vm=04&re=02>.

⁹⁶ For more information, see: https://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/index_en.html.

⁹⁷ The plan entails 12 individual sectors of measures and 5 cross-cutting sectors including industries such as healthcare and welfare, energy, finance, information and communications, industrial structures, transportation and logistics, land use, and human resources development.

TABLE A1.1 Resilience Measures for Industries Outlined within the Fundamental Plan for National Resilience

Goal	Measures	Responsible Ministries
Investment toward resilient infrastructure, equipment, and structures	Relevant ministries will enhance the disaster resistance of industrial equipment, including internal equipment such as a production line, etc. Energy supply systems, industrial water works, and logistics infrastructure that support industries and supply chains will also be made more disaster resistant. To support the business continuity of private companies, relevant government ministries and agencies will discuss measures to ensure redundancy, such as creating multiple supply chains, increasing substitutability of critical components, and dispersing and/or relocating factories and business establishments based on disaster risks.	Cabinet Office (Disaster Management); Ministry of Education, Culture, Sports, Science and Technology; Ministry of Economy, Trade and Industry (METI); Ministry of Land, Infrastructure, Transport and Tourism (MLIT)
Resilient energy supply at firm levels	Relevant ministries and agencies will encourage companies to make efforts to ensure emergency energy supply systems necessary for continuing industrial activities. The government also promotes cooperation between large companies and small and medium enterprises (SMEs) for building nonutility power generation facilities, procuring and stockpiling fuel, etc. In developing such systems, attention should be paid to business types and processes that require uninterrupted energy for achieving swift recovery and reconstruction.	METI
Establishment of business continuity plans (BCPs) and business continuity management (BCM) at the firm, group, and supply chain level	In response to the increasingly globalized nature of supply chains, relevant ministries and agencies will promote the establishment of group BCP and BCM structures and industrial BCP and BCM structures through collaboration between private companies and economic organizations, in addition to the establishment of independent BCP and BCM structures by individual companies and supply chains.	Cabinet Office (Disaster Management); METI; and other relevant ministries and agencies
Establishment of BCP and BCM measures for SMEs	The establishment of BCP and BCM structures at every company, large and small, will be encouraged by the government. Awareness of disaster management and disaster mitigation measures for SMEs will be raised, with emphasis on core companies in regional economies and leaders in regional supply chains.	Cabinet Office (Disaster Management); METI; and other relevant ministries and agencies
Awareness raising and management for BCP development and implementation	In tandem with structural measures, efforts will be made to create a framework to properly evaluate BCP systems and capabilities. Relevant ministries and agencies will also work on initiatives for securing and developing human resources and creating an enabling environment for resilient industry taking into consideration challenges such as shortages of skilled labor in the construction industry for recovery work. These initiatives help maintain business continuity by securing and developing in-house human resources through continuing education and training, familiarizing and enlightening management on BCP concepts, and implementing the plan-do-study-act (PDCA) cycle to support continuous improvements in resilience.	METI; MLIT; and other relevant ministries and agencies
Promoting areawide BCPs and regional collaboration	Cooperation among relevant government ministries and agencies, their regional branches, local governments, and economic organizations will be advanced in each regional block in order to further enhance the effectiveness of individual companies' BCP and BCM structures by integrating them into larger-scale BCP approaches.	Cabinet Office (Disaster Management); Financial Services Agency; Ministry of Agriculture, Forestry and Fisheries; METI; MLIT; and other relevant ministries and agencies
Support for relocation and expansion of headquarter functions	Regional relocations and expansions of the headquarter functions of companies based on disaster risks will be actively supported. The development of an enabling business environment will also be comprehensively promoted to ensure that relocations and expansions proceed smoothly.	Cabinet Office; Ministry of Economy, Trade and Industry; Ministry of Land, Infrastructure, Transport and Tourism

Source: Created based on Cabinet Secretariat (2018b).

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II. ENHANCING BUSINESS CONTINUITY PLANNING AND MANAGEMENT

A2. DEVELOPING BUSINESS CONTINUITY GUIDELINES AND MANUALS FOR PRIVATE COMPANIES: CABINET OFFICE AND METI

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Policy and legal	<ul style="list-style-type: none"> Public sector—national, prefecture, city Manufacturing industry—large firms, small-medium enterprises, women-owned businesses Financial sector—large banks, local banks, insurance companies, other Industry associations—associations, parks, zones Other—civil society, etc. 	 Earthquake  Floods	<ul style="list-style-type: none"> Strengthening disaster risk governance to manage disaster risk 	<ul style="list-style-type: none"> Continue business Minimize disruptions and recover quickly

Context

Following the 9/11 terrorist attack in the United States, many companies in the United States and Europe started developing their own BCPs to prepare for potential future disasters. This inspired the Government of Japan and private companies in Japan to promote BCP development. The importance of BCPs was more fully recognized after Japan experienced the GEJE in 2011. This event inflicted severe financial damages on many industries and firms, through both property damages and economic losses due to the interruption of their operations.

There have been discrepancies between large companies and SMEs in the progress of disaster prevention measures, mainly because of financial resources. SMEs are mainly interested in day-to-day business operations and often have comparatively low levels of financial strength and creditworthiness, thus they are financially more vulnerable than large companies. The reality is that SMEs often put off advance preparations for sudden disasters. Therefore, the major challenge has been to promote the development of BCPs not only for large companies but for SMEs as well.

Solution Design and Key Features

Solution Design

In order to promote the development of BCPs for private companies in Japan, the Government of Japan, through the Cabinet Office and METI, has published several manuals to guide companies in developing their BCPs. The “Guidelines on Formulating and Implementing BCPs for Small and Medium Enterprises: 1st Edition” (METI 2006) was published in 2006. Similarly, in 2007, the Cabinet Office compiled the *Business Continuity Guidelines Manual: First Edition*. These guidelines are very comprehensive, ranging from the definition of a BCP up to how to calculate and fund possible recovery expenses.

Key Features

- **Guideline development followed by consultation services:** Documents written based on a manual are often prone to direct copying, making the BCPs too general for effective use by a wide range of firms. BCPs that are too formulaic and generic are often not effective. Ideally, alongside publishing guidelines, government agencies should conduct seminars and provide access to professional consultation services.
- **Understanding the importance of business continuity planning for enterprises of all sizes:** For business continuity planning to be effective across an economy, the government should acknowledge the economic importance of BCPs for enterprises of all sizes. Large firms are often dependent on a large number of smaller firms for business-critical supplies and services. The government should allocate adequate financial resources to fund various programs relating to business continuity planning for firms of all sizes to ensure business continuity throughout industries.

Results

The Japanese government has set a long-term goal of comprehensive BCP coverage for companies all over Japan. The Japan Revitalization Strategy of 2012 aims for 100 percent of large companies and 50 percent of SMEs to have their own BCPs by the end of 2020. As of 2017, about 60 percent of large companies and over 30 percent of mid-sized companies had formulated BCPs. Including companies in the process of developing BCPs, the proportion of large enterprises is over 80 percent, and that of midsize enterprises is almost 50 percent.

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http://www.chusho.meti.go.jp/keiei/antei/download/110728JapanBCP_SME_Eng.pdf.

A3. DEVELOPING AREAWIDE BUSINESS CONTINUITY PLANS AT THE PREFECTURAL LEVEL: KYOTO PREFECTURE

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Policy and legal	<ul style="list-style-type: none"> Public sector—national, prefecture, city Manufacturing industry—large firms, small-medium enterprises, women-owned businesses Financial sector—large banks, local banks, insurance companies, other Industry associations—associations, parks, zones Other—civil society, etc. 	 Earthquake  Tsunami  Flood	<ul style="list-style-type: none"> Understanding disaster risk Strengthening disaster risk governance to manage disaster risk 	<ul style="list-style-type: none"> Continue business Minimize disruptions and recover quickly

Context

Kyoto Prefecture has a long history of manufacturing, and is currently home to many global leaders in electronics manufacturing, including Kyocera, Murata, Nidec, and Omron. Manufacturing accounts for 20 percent of Kyoto Prefecture's gross domestic product (GDP) (METI 2014) and is an essential component of regional and local employment. The resilience of the manufacturing industry in Kyoto Prefecture is not only important locally, but it is also a key component of the global electronics industry.

A series of disaster events has reinforced the importance of resilient industry in Kyoto Prefecture. The GEJE in 2011 caused extensive damage to Kyoto Prefecture and across the nation. The Cabinet Office estimated national production losses from direct damages to be ¥0.5 trillion–¥1.25 trillion (\$0.45 trillion–\$1.14 trillion) in the first half of the 2011 fiscal year, and total production losses to supply chains of ¥0.25 trillion (\$2.3 billion) (GFDRR 2012). Many industries were also indirectly affected by the disaster due to production interruptions and supply shortages of essential parts and raw materials. Although many firms had formulated their own BCPs, there was a lack of collaboration between the various stakeholders, including industrial entities, infrastructure companies, financial institutions, and the prefectural government. In response, the Kyoto Association of Corporate Executives appealed to the prefectural government to launch measures encouraging collaboration on larger-scale BCPs (Kyoto Association of Corporate Executives 2012). Kyoto Prefecture realized that industry plays a vital role in the local economy and job sustainability, including after a large-scale disaster such as the GEJE. The prefecture expands the context of BCP, which is typically a single organization's emergency action plans, to the entire prefecture. The effort aims to protect the entire prefecture's performance and to build resilience against disaster (Kyoto Prefecture 2017).

Solution Design and Key Features

Solution Design

While BCPs may be effective for individual firms and organizations, Kyoto Prefecture has emphasized the value of coordination between various stakeholders for BCP development and review. In 2012, the prefectural government established the Kyoto BCP Review Conference to assist firms in mitigating the direct and indirect effects of disaster events. The conference was reorganized as the Kyoto BCP Promotion Council in 2014 with the goal of improving the prefecture's overall disaster management capacity, increasing disaster preparedness and recovery rates throughout the region. In the same year, the prefectural government developed the "Kyoto BCP Action Guidelines," promoting collaborative efforts to protect livelihoods and industrial activities indispensable to regional recovery and reconstruction. The guidelines were crafted to apply to all industry stakeholders throughout the Kyoto Prefecture, describing the actions to be taken by different stakeholders (i.e., industrial zones/associations/parks, infrastructure companies, financial institutions, and government institutions) for disaster mitigation and recovery (METI 2015). The prefectural government coordinates the entire regional plan to ensure cooperation across the region in order to establish an enabling environment for disaster mitigation and recovery.

Key Features

- **A memorandum of understanding (MOU) between the prefectural government and private firms:** As part of the regionwide BCP, in 2016 an MOU was signed between the Kyoto prefectural government and economic organizations and major banks in the region.⁹⁸ The MOU facilitates the sharing of information on emergency stockpiles, as well as efficient lending of equipment, supplies, and facilities in the event of a disaster.
- **Establishment of a corporate liaison office:** A contact point office for corporate information was created within the Disaster Response Headquarters of the Kyoto prefectural government, facilitating the sharing of information between corporate stakeholders and the government during disasters (Kyoto Prefecture 2017). The office helps to identify requirements for restoring lifeline services in industrial parks, requests the dispatch of repair teams, identifies needs for recovery funds, offers information on low-interest loans, identifies issues in supply chains, and disseminates pertinent information to relevant organizations and firms.
- **Active participation of financial institutions and establishment of mutual support agreements:** Tokio Marine, Nichido Fire Insurance, and Mitsui Sumitomo Insurance have formulated BCPs independently. However, to facilitate more efficient funding after disasters, a collaborative plan has been prepared by these financial institutions and the government. The collaborative plan is based on a comprehensive partnership agreement between the government and the financial institutions, and is a part of Kyoto's regional BCP under the prefectural government's coordination. Agreements of mutual support have also been reached with local financial institutions that have been conducting annual training sessions. This establishes a communication system and a mechanism for sharing damage information.

98 For more information, see: <https://www.pref.kyoto.jp/kikikanri/kyotobcp/kekka2016.html>.

Results

Kyoto Prefecture promotes the preparation of a BCP for every company, to support collaboration in the face of disasters. At the same time, areawide BCP initiatives from the government enable companies, local financial institutions, and lifeline operators to cross-collaborate. The prefectural government acts as a point of contact for industrial associations that coordinate with various stakeholders. The Kyoto BCP Guidelines outline modes of cooperation between companies as well as local government and other stakeholders. The guidelines also detail actions to be undertaken by individual stakeholders. These actions have greatly promoted disaster preparedness and relief and recovery efforts to ensure that life in general, and businesses in particular, can go back to normal as soon as possible following a disaster. Since the GEJE, Japanese companies, including those in Kyoto, have deepened their understanding of the importance of preparation for disasters. According to the latest survey by Teikoku Databank (TDB 2019), 13.7 percent of the private companies in Kyoto Prefecture have established BCPs, which is above the average in the Kinki region (12.7 percent). Additionally, around 30 percent of companies are preparing BCPs or planning to develop BCPs. Thanks in part to the initiative of the prefectural government, private firms are voluntarily participating in the areawide BCPs to enhance their own competitiveness in the face of disasters (Kyoto Prefecture 2015).

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A4. NONPROFIT ORGANIZATIONS' ROLE IN PROMOTING RESILIENT INDUSTRY: THE BUSINESS CONTINUITY ADVANCEMENT ORGANIZATION

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Policy and legal	<ul style="list-style-type: none"> • Manufacturing industry—large firms, small-medium enterprises, women-owned businesses • Other—civil society, etc. 	 Earthquake  Tsunami  Flood  Storm Surge  Volcanic Eruption  Other - such as pandemics	<ul style="list-style-type: none"> • Understanding disaster risk • Strengthening disaster risk governance to manage disaster risk 	<ul style="list-style-type: none"> • Continue business • Minimize disruptions and recover quickly

Context

Business continuity planning experts are needed because BCP guidelines and standards must be general in nature, applying to a wide range of industries and firms. These guidelines may not be applicable or specific enough for all stakeholders and disaster risk profiles. In order for BCPs to be most effective they must be tailored to a firm's individual needs and disaster concerns, ensuring access to business-critical resources and services in times of disaster. Experts can also facilitate the integration of collaboration in BCPs, expanding the effectiveness of planning beyond the scale of individual firms. As described in appendices A2 and A3, many government organizations and financial institutions offer various incentive programs for firms that have implemented BCPs, and there is a need for systems to evaluate and certify BCPs for access to these programs. Nonprofit organizations (NPOs), such as the Business Continuity Advancement Organization (BCAO), can provide valuable, impartial expertise in the area of business continuity.

Solution Design and Key Features

Solution Design

In order to meet the growing need for experts in the field of business continuity, the BCAO was established as a NPO in 2006 to support the public and private sectors in the development of BCPs pertaining to all potential risks (natural, corporate, and accidental) and mitigating socioeconomic damages. Since its establishment, the BCAO has been active in promoting business continuity through technical training, expert development, standard and guideline development, information dissemination, and awareness-raising events (BCAO 2015).

Key Features

- **Guideline development followed by seminars and training courses:** To promote BCPs and the overall management of disaster preparedness, the BCAO has published public documents and guidelines, including: *Disaster Countermeasures to Protect Companies—Advance Business Continuity Brochure*, which introduces the importance of business continuity and measures to ensure it, as well as the *Small-to-Medium Enterprises (SMEs) BCP Step-up Guide*, which provides guidelines specific to SMEs for the formulation of BCPs. However, the development of a company's BCP should not be based solely on guidelines but should also be personalized to a company's unique experiences and needs. To help firms personalize their BCPs, the BCAO regularly conducts business continuity promotion seminars and training courses providing guidance to business continuity officials for the development and enhancement of their BCPs.
- **A qualification system for human capacity development:** The BCAO operates a three-level qualification system of "Certified Business Continuity Specialists" as part of its business continuity promotion strategy, aiming to develop the human resources that can promote and manage corporate (including public sector) business continuity based on practical knowledge. In order to enhance the capability of certified business continuity specialists, the BCAO provides training courses for different levels of specialists.
- **Providing awards to encourage improving BCPs:** The BCAO also presents the BCAO Awards, recognizing outstanding work in DRM and business continuity. Special awards related to the 2016 Kumamoto Earthquake were granted in 2016 and 2017. The organization aims to encourage continuous improvement of BCPs through the award system.⁹⁹

Results

The establishment of the BCAO in 2006 as an NPO demonstrated the potential role NPOs play in supplementing and buttressing government-provided incentives for promoting BCPs and overall management efforts related to preventing, preparing for, and recovering from the impact of disasters. As of March 2019, 910 individuals have been trained as certified business continuity specialists,¹⁰⁰ and BCP support courses and seminars have been continually provided by the organization for the development and enhancement of participating companies' BCPs. The BCAO can serve as a role model for the establishment of other such organizations outside of Japan.

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A5. ESTABLISHING A PREARRANGED AGREEMENT FOR QUICK REHABILITATION OF CRITICAL INFRASTRUCTURE: SENDAI CITY GOVERNMENT AND SENDAI GENERAL CONSTRUCTION ASSOCIATION

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Policy and legal  Infrastructure  Finance	<ul style="list-style-type: none"> Public sector—national, prefecture, city Manufacturing industry—large firms, small-medium enterprises, women-owned businesses Financial sector—large banks, local banks, insurance companies, other Industry associations—associations, parks, zones 	 Earthquake  Tsunami  Flood	<ul style="list-style-type: none"> Strengthening disaster risk governance to manage disaster risk 	<ul style="list-style-type: none"> Continue business Minimize disruptions and recover quickly

Context

Sendai City, located along the coast in northeastern Japan, has historically experienced severe earthquakes approximately every 40 years. The city has also been hit by several severe flood events throughout its history. Severe disasters pose a significant threat to infrastructure and services critical to industrial activities and supply chains in the region, affecting the stability of the local economy and the lives and livelihoods of its residents. During disaster events, the government prioritizes lifesaving and emergency response activities and may have less resources to conduct the standard contracting and procurement procedures for restoration activities. However, efficient and timely restoration of critical infrastructure and services is key for maintaining the continuity of industrial activities and supply chains. Prearranged agreements between governments and construction associations can enable quick restoration of critical infrastructure and services.

Solution Design and Key Features

Solution Design

Heavy rainfall events in the 1980s caused significant damage within Miyagi Prefecture. In response to these flooding events, in 1991, the Sendai City government established a prearranged agreement with the Sendai General Construction Association (composed of 80 construction companies headquartered in Sendai City). This Post-Disaster Emergency Response Partnership Agreement helps the local government to provide the necessary services to ensure prompt recovery efforts during disasters as well as contributes to the continuity of the industry supply chain.

Key Features

- **Quick initial reconstruction response:** This prearranged agreement enables the rehabilitation of infrastructure without going through time-consuming contracts and procurement procedures. Under the prearranged agreement, rehabilitation work can be initiated smoothly after a notice from the city government to the association. The Sendai General Construction Association will coordinate the mobilization of its member companies.
- **Avoidance of individual contract requirements for speedy action during emergencies:** The prearranged agreement makes individual contracts between the city government and individual construction companies unnecessary; the standing prearranged agreement between the association and the city government is sufficient for initiating simultaneous work from any of its member firms. Payment for the work will be made to each company upon completion of the work based on prearranged pricing agreements. Bypassing the need for individual contracts with many companies saves a significant amount of time during emergencies.
- **Local governments need to identify suitable collaborators for rehabilitation work:** In the case of Sendai City, collaboration with the construction companies was critical to prepare for diverse reconstruction needs based on local industry needs and disaster risks. Local governments can enable, and benefit from cooperation between firms in the form of prearranged agreements for recovery work, significantly speeding up logistical procedures and securing the continuity of industry supply chains. Prearranged agreements should be regularly renewed and revised for the protection of all parties involved. Local governments should also closely monitor the financial and technical capabilities of engaged providers to ensure that firms have the capacity to perform the required tasks in the event of a disaster.

Results

The Post-Disaster Emergency Response Partnership Agreement, between the Sendai City government and the Sendai General Construction Association, serves as a prearranged agreement to enable quick response to disasters and restoration of vital transportation infrastructure. It was invoked during the GEJE in 2011. The Sendai City government immediately asked the association for the mobilization of firms for road clearance and rehabilitation works. Under the prearranged agreement, 563 units of equipment and 813 personnel were mobilized during the eight-day clearing operation. The Sendai City government also asked for the mobilization of the Demolition Company Association and Waste Management Company Association, on an emergency basis without any advance agreement, to remove and treat debris on the roads. Eight days after the devastating event, all critical roads within Sendai were made accessible. This collaboration between the construction industry, demolition industry, and industrial waste disposal industry for prompt road clearance helped accelerate the recovery of industrial activities in the Sendai port area, including the Kirin brewery (200 employees when the GEJE occurred¹⁰¹). Based on this experience, in April 2018, Sendai City entered into a prearranged agreement with three industry associations for road clearance to minimize disruption of critical transport at times of disaster. As of March 2018, the Sendai City government had six disaster response prearranged agreements with various industry associations (Miyagi Prefectural Government 2018).

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A6. ESTABLISHING A PREARRANGED AGREEMENT FOR QUICK REHABILITATION OF THE EXPRESSWAY: EAST NIPPON EXPRESSWAY CO. LTD AND JAPAN FEDERATION OF CONSTRUCTION CONTRACTORS

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Policy and legal  Infrastructure	<ul style="list-style-type: none"> Public sector—national, prefecture, city Industry associations—associations, parks, zones 	 Earthquake  Tsunami	<ul style="list-style-type: none"> Strengthening disaster risk governance to manage disaster risk 	<ul style="list-style-type: none"> Continue business Minimize disruptions and recover quickly Sustain and improve competitiveness

Context

The 2011 GEJE damaged expressways over a wide range of eastern Japan. Cracks in pavement and embankment collapses occurred at approximately 4,200 locations. Many bridges were damaged at the bearings and joints. Approximately 2,300 kilometers (km) of expressways were closed, representing 65 percent of expressways managed by East Nippon Expressway Co. Ltd. (NEXCO East Japan), resulting in major supply chain disruptions. Quick restoration of damaged roadways is critical for minimizing disruptions to the supply chain.

Under normal circumstances, road construction starts with the procurement process, including public announcement, bidding, and contract finalizations. During normal times it usually takes several months to complete this procedure. After the 2011 GEJE, restoration work needed to be implemented urgently, therefore this work was carried out as additions to ongoing contracts between various companies and NEXCO East Japan. For example, when the GEJE occurred, restoration work was immediately amended to a service area renovation contract that had already been in progress. The amendment was immediately acknowledged by both parties. Doing so eliminated the time it would have taken to create a new contract. The company that worked on the restoration work was paid after completion of the restoration work based on the actual quantity of work implemented (Kishida 2012). Restoration of expressways was completed first, which made the restoration of local roads much easier. Since such immediate action is impossible with the usual contract process, it led to the development of additional prearranged agreements to ensure quick restoration without going through time-consuming contract procedures.

Solution Design and Key Features

Solution Design

Learning from the experiences of the 2011 GEJE, NEXCO East Japan and the Japan Federation of Construction Contractors' Kanto Branches formed the Agreement on Disaster Emergency Response Work in April 2013. This is a prearranged agreement on the emergency restoration of expressways after the occurrence of large-scale disasters.

Its main contents include:

- NEXCO East Japan cooperates with the federation for surveys of affected facilities, emergency restoration, and technical support.
- Both parties will establish emergency contact systems.
- In the event of a disaster, NEXCO East Japan requests the federation to provide information on the capabilities, interconnections, and mobilization times of its members.
- NEXCO East Japan can request the mobilization of the federation's members for the quick restoration of damaged facilities of the expressway.
- NEXCO East Japan promptly approves construction contracts with companies that respond to mobilization (mobilization is implemented first and contracts are finalized afterward).

Key Features

- **Establishment of the Japan Federation of Construction Contractors:** In 2011 the Japan Construction Industry Association, Japan Civil Engineering Contractors Association, and Japan Building Industry Association merged to form the more comprehensive Japan Federation of Construction Contractors (JFCC).¹⁰² JFCC was established with 140 member companies, including all of Japan's major general construction contractors, such as Kajima Corporation, Obayashi Corporation, Shimizu Corporation, and Taisei Corporation. The federation is capable of coordinating its member companies for urgent mobilization in case of large disasters.
- **Urgent mobilization possible:** The prearranged agreement was designed in a way that efficiently facilitates the urgent mobilization of construction companies without going through time-consuming contract and procurement procedures.
- **Reduction of recovery time from disasters:** Infrastructure companies benefit from establishing cooperation between construction contractors for prearrangements for recovery work. This helps in significantly reducing the time to recover major logistic routes by avoiding formal contracting processes.
- **Enabling environment:** The Act on Expressway Companies (2004) places a responsibility on the Expressway Company to be strongly committed to preparedness for disasters, an important factor that contributes to creating an enabling environment for resilient industry. An association of construction contractors is also indispensable to integrate and coordinate recovery/restoration work during times of disaster.

Results

Based on the lessons learned from the 2011 GEJE, the Agreement on Disaster Emergency Response Work was created between NEXCO East and JFCC. The agreement eliminates the need for the type of stopgap measures taken in 2011 after the GEJE. JFCC helps the coordination and cooperation of its member firms for restoration work in the case of disasters, allowing for speedy recovery of vital transport infrastructure.

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A7. ESTABLISHING PREARRANGED AGREEMENTS BETWEEN COMPANIES WITHIN THE SAME INDUSTRY SECTOR: SUZUKI KOGYO (WASTE DISPOSAL)

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 <p>Policy and legal</p>  <p>Infrastructure</p>	<ul style="list-style-type: none"> Manufacturing industry—large firms, small-medium enterprises, women-owned businesses 	 <p>Tsunami</p>	<ul style="list-style-type: none"> Strengthening disaster risk governance to manage disaster risk Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation, and reconstruction 	<ul style="list-style-type: none"> Continue business Minimize disruptions and recover quickly

Context

Suzuki Kogyo, established in 1966, is a small-scale enterprise specializing in waste disposal. Suzuki Kogyo is located in Sendai, which experienced the devastating 1978 Miyagi Offshore Earthquake (magnitude 7.4). The earthquake destroyed many homes and buildings, producing an enormous amount of rubble.

In 2000, “Long-Term Evaluation of the Miyagi Offshore Earthquake” was published by the National Earthquake Research Promotion Headquarters, which estimated that Sendai had a 70 percent probability of a magnitude 7.6 earthquake and a 2–3 meter tsunami within 10 years, and a 99 percent probability of such an event within 30 years (Headquarters for Earthquake Research Promotion 2000). Suzuki Kogyo became keenly aware of its high-risk exposure to a major disaster and the company realized the urgent need to formulate DRM measures to ensure business continuity and the ability to respond to large disasters. The business continuity of a waste disposal company is not just important for its owners and employees, but also to the public for disaster restoration efforts.

The rubble produced by disasters needs to be treated quickly and properly so that the affected areas can be reconstructed and made clean and safe. However, disasters can affect the operation of local waste disposal companies, and often it is difficult for a single company to handle the large amounts of rubble generated by disasters. In order to solve these problems, cooperation across a wide area is required.

Solution Design and Key Features

Solution Design

In order to enhance their capacity to manage disaster risks, Suzuki Kogyo established a committee in 2008 to formulate a BCP. Suzuki Kogyo's plan incorporated a prearranged agreement for outsourcing operations to another company in the same sector in the neighboring Yamagata Prefecture in the event that either company became inoperable or overloaded due to a disaster. Under the prearranged agreement, Suzuki Kogyo and the partner company agree on bilateral cooperation in times of disasters. The partner company selected is located more than 50 km from Sendai, which makes it unlikely that both companies will be affected by a single disaster event (Research Center of Niigata 2017).

Key Features

- **Noncompetitive relationship:** The current system for solid waste management regulates the import of waste across boundaries in many prefectures, including Yamagata and Miyagi Prefectures. Suzuki Kogyo and its partner company were already in a noncompetitive relationship due to this regulation of solid waste management in Yamagata and Miyagi prefectures, which was one of the key factors in the success of the collaboration.
- **Loaning of resources in the aftermath of disasters:** Companies from the same sector tend to have similar resources: not only equipment, but also technical knowledge and human resources. A bilateral agreement is mutually beneficial in times of disaster, since it allows one company to continue its operations during a disaster, while the partner company generates income through loaning its resources.
- **Selection of a partner company:** A partner company must be selected considering its geographic proximity, available resources and capabilities, and its vulnerability to disasters.
- **Established communication channels and procedures:** Disasters often cause large-scale disorder and confusion, leading to difficulties in the communication necessary for the activation of prearranged agreements. Communication channels and procedures should be established during normal times to minimize difficulties during disasters. In the case of Suzuki Kogyo, good communication and an established relationship with the partner company made smooth collaboration possible during the emergency.
- **Win-win collaboration:** Agreements among peer companies are a win-win collaboration since companies in the same sector can share resources if either party is damaged by a disaster. Resource sharing allows income generation for both parties during a disaster, since the affected company can continue its operations while the partner firm gets extra revenue from loaning its resources.

Results

On March 11, 2011, the GEJE caused a massive tsunami that generated a large volume of waste and damaged Suzuki Kogyo's incinerator. The agreement with its partner company was activated within an hour of the earthquake, and by March 15, the partner company in Yamagata Prefecture was entrusted with waste disposal activities in accordance with the agreement. Until the damaged facilities were fully restored on April 18, Suzuki Kogyo was able to continue its operations through effective collaboration with the partner company, quickly processing the large volume of waste generated by the disaster (World Bank 2012). The disruption of operations was kept to a minimum, owing to the prearranged agreement, which was a central part of Suzuki Kogyo's contingency plans for not only surviving disasters but also for contributing to the public welfare by ensuring that the waste could be disposed of effectively.

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A8. SECURING COST-EFFICIENT BACKUP WATER SUPPLY USING A DECENTRALIZED GROUNDWATER TREATMENT SYSTEM: MITSUBISHI CHEMICAL AQUA SOLUTIONS CO., LTD.'S SYSTEM IN HINO MOTORS' HAMURA PLANT

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 <p>Infrastructure</p>  <p>Technology</p>	<ul style="list-style-type: none"> Manufacturing industry—large firms, small-medium enterprises, women-owned businesses 	 <p>Earthquake</p>  <p>Tsunami</p>  <p>Storm Surge</p>  <p>Volcanic Eruption</p>  <p>Other - such as pandemics</p>	<ul style="list-style-type: none"> Investing in disaster risk reduction for resilience Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation, and reconstruction 	<ul style="list-style-type: none"> Continue business Minimize disruptions and recover quickly Sustain and improve competitiveness

Context

Hino Motors Ltd., a subsidiary of Toyota Motor Corporation, manufactures heavy and light automobiles and engines.¹⁰³ The operation of its Hamura plant in Tokyo—with 4,800 employees (Hino Motors 2019)—was affected by the 2011 GEJE. Although the Hamura plant was able to access its water supply at that time, the GEJE triggered a discussion about installing a backup water supply system in anticipation of a future disaster, such as a Tokyo mega-earthquake or the anticipated Nankai Trough earthquake. Utilities such as water are vital resources for the operation of companies like Hino Motors. Disruption of utilities could lead to a significant interruption of business activities, resulting in economic losses. Therefore, securing a backup source of clean, stable, and cost-efficient water during disasters became a priority for Hino Motors.

Solution Design and Key Features

Solution Design

The need to install a groundwater treatment system was driven by a number of factors, including maintaining business continuity in the aftermath of an earthquake as well as decreasing water costs during normal times. Hino Motors decided to install Mitsubishi Chemical Aqua Solutions Co., Ltd.'s water treatment system at its Hamura plant. Formerly known as Wellthy Corporation, it was established as a group company under the Mitsubishi Chemical Corporation in November 1985. The corporation specializes in decentralized water treatment and supply systems.

103 For more details of Hino Motors Ltd.'s corporate profile, see Hino Motors (2018). https://www.hino.co.jp/corp/about_us/pdf/2018_corporate_profile_english.pdf.

Key Features

- **Compact and decentralized backup water supply system:** Mitsubishi Chemical Aqua Solutions Co., Ltd. has developed a groundwater treatment system that is compact and decentralized, making it an ideal alternative postdisaster water supply for industries. The decentralized and stand-alone nature of the groundwater treatment system makes it very suitable as a backup water supply source, greatly contributing to business continuity during a time of disaster.
- **The backup water system supports the local community:** Hino Motors has pledged to supply water to the community through taps installed on the boundary of its property. Based on an agreement between the company and Hamura City, Hino Motors has also pledged to lend heavy machinery and fuel, and provide a temporary evacuation site in times of disaster.
- **Reduction of water costs and operation interruptions:** Mitsubishi Chemical Aqua Solutions Co., Ltd.'s system has been shown to successfully reduce costs as well as operation interruptions during disasters. During the recent Osaka Hokubu Earthquake in 2018, the system effectively functioned as a postdisaster water source for a manufacturing company in Osaka.
- **Water quality and environmental concerns:** Having a backup water supply system is important for business continuity, not only for production requirements, but also for the sustenance and hygiene of industrial workers. Hence, both availability and quality of the backup water supply are important. However, overextraction of groundwater may cause significant environmental issues such as land subsidence and saltwater intrusion. Continuous overextraction of groundwater may be more harmful than beneficial in some places. Therefore, thorough and site-specific assessments are necessary to reduce negative impacts.

Results

The installation of the Mitsubishi Chemical Aqua Solutions Co., Ltd. water treatment system has provided Hino Motors with a backup water supply system that increases its capacity to continue operations in the event of disasters such as earthquakes. Additionally, water costs for the plant during normal times have also been reduced. As a regular water alternative, Hino Motors has reported an annual reduction of water supply cost of 16 percent (at the time of installation) after installation of the system. The system has shown its international applicability through several overseas projects in Vietnam, Myanmar, China, and Kenya.

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A9. ESTABLISHING TECHNICAL STANDARDS FOR RESILIENT PORT INFRASTRUCTURE: MINISTRY OF LAND, INFRASTRUCTURE, TRANSPORT AND TOURISM

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Infrastructure	<ul style="list-style-type: none"> Public sector—national, prefecture, city 	 Earthquake  Tsunami  Storm Surge	<ul style="list-style-type: none"> Strengthening disaster risk governance to manage disaster risk Investing in disaster risk reduction for resilience Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation, and reconstruction 	<ul style="list-style-type: none"> Minimize disruptions and recover quickly

Context

In Japan, port infrastructure must be constructed, improved, and maintained in accordance with the technical standards set by MLIT as stipulated in the Port and Harbor Act (1950). The technical standards include design methods for structures that are resistant to external forces generated by disasters such as earthquakes, storm surges and tsunamis, and floods. The Technical Standards for Port Facilities have been revised almost every 10 years since their first publication in 1974, reflecting the latest recommendations of port engineers and researchers. The robust ports that connect Japan to other nations are critical to its industrial and economic development.

Japan is surrounded by the sea on all sides, and many ports have been built along its coast. There are 993 ports in Japan as of 2019 (MLIT 2019). Of the 993 total ports, 986 are operated by local governments (prefectures, cities, towns, or villages), six by unions, and one by a public port authority. These ports are the basis of the industrial supply chain and a critical hub for logistics, transporting goods and products both domestically and internationally. This highlights the need for robust port infrastructure that can protect industries against disasters.

When the GEJE occurred on March 11, 2011, 31 ports (14 international or major ports¹⁰⁴ and 17 local ports) in the northeast region of Japan were affected. In particular, the damage to the breakwaters was severe due to the magnitude of the tsunami. The breakwaters were either completely or partially destroyed at Hachinohe Port, Kamaishi Port, Ofunato Port, and Soma Port. In addition, in areas where the earthquake’s impact was more severe, there was damage such as deformation of quays, collapse of wharves, collapse of cargo-handling machines, and ground subsidence. Consequently, port operations were suspended. Facilities built in the area adjacent to the harbor, such as loading areas, warehouses, roads, and bridges, were also damaged. According to MLIT (2012), the damage to port infrastructure was estimated at about ¥412.6 billion (\$3.75 billion).

¹⁰⁴ Defined under the Port and Harbor Act (1950), international ports include “strategic international ports” and “central international ports,” which serve as hubs of the international ocean freight transportation network; a major port is neither of these but is otherwise of great importance to the national interest.

On March 14, technical teams were dispatched to the damaged ports from MLIT, the National Institute for Land and Infrastructure Management (NILIM), and the Port and Airport Research Institute (PARI) for inspections and technical support (Koizumi 2014). By March 24, some of the quays were reopened at 14 major ports with help from the port managers. By March 1, 2012, 275 of the 373 berths in the 21 ports from Hachinohe to Kashima ports were operational. Given the industrial activities in the region, the port facilities that had been restored were used to carry in raw materials and carry out products, contributing to the continuity of industry and the economy (MLIT 2012).

The total volume of cargo handled at ports in the affected area dropped to 22 percent year-on-year (YoY) for April immediately after the GEJE. However, as port facilities recovered significantly and the container route service resumed, cargo volumes for October 2011 recovered to 101 percent YoY. The value of industrial production in the Aomori and Ibaraki prefectures, where the ports affected by the GEJE are located, fell to around 50–70% YoY immediately after the GEJE, but recovered to around 60–90% YoY by October. The amount of trade recovery showed a trend in line with the progress of port restoration (MLIT 2012).

Table A9.1 shows examples of the industrial activities resumed following the restoration of port facilities. This illustrates that, for industry, the restoration of port facilities is a critical factor in resuming business operations.

The ports damaged by the GEJE were designed based on either the 2007 version of the Technical Standards for Port Facilities or earlier standards. Given that the latest Technical Standards for Port Facilities was the 2007 version, many seawalls were damaged by the force of the tsunami and the loss of structural stability. In the latest standard developed in 2018, the methodology to define a design tsunami scale was clearly stated, although the specific values of the design scale were not defined in the original or latest standards. The 2018 standard, however, emphasized that seawall design should be determined based on the importance of the facility to be protected, in the context of DRR-related plans for the area.

TABLE A9.1 Resumed Industry Activities Following Restoration of Port Facilities after the GEJE

Name of Port	Restoration of Port Facilities	Industry Restoration
Hachinohe	Domestic berth opened on April 23; international berth opened on May 19–December 16.	Mitsubishi Paper Mills Ltd.'s Hachinohe factory resumed partially on May 24, and fully on November 15.
Onahama	International berth opened on June 7; domestic berth opened on July 12.	Onahama Smelting Ltd. resumed partially on July 1 and fully on September 1.
Ibaraki (Hitachi district)	Berths opened March 20–May 25.	Import of Mercedes-Benz resumed in late May; export of Nissan for North America resumed on July 25.
Ibaraki (Hitachinaka district)	Apron of North berth rehabilitated and C berth opened on March 22, and B berth on April 1.	Komatsu resumed shipping of heavy equipment on April 25.

Source: MLIT 2012.

On April 14 and April 16, 2016, two earthquakes of magnitude 6.4 and 7.3 occurred in the Kumamoto Prefecture, located in the south of Japan. As a result, Kumamoto Port suffered from subsidence of the foundation for its gantry cranes, deformation and breakage of bridge abutment foundations, and subsidence of area roads (PARI 2018). At Yatsushiro Port, cracks occurred behind the quay, and liquefaction and depression occurred in several places on the roads (MLIT 2016). Lessons from this experience with earthquakes were also incorporated into the 2018 revised technical standards.

Solution Design and Key Features

Solution Design

The 2007 Technical Standards for Port Facilities were revised in 2018 to incorporate lessons learned from the GEJE and the Kumamoto Earthquake, and to further prepare for extremely severe disasters, such as the anticipated Nankai Trough Earthquake.

Key Features

- **Breakwaters with resilient structure:** Based on the results of the analysis and examination of the GEJE, a description of a resilient tsunami-resistant breakwater design has been added to the technical standards. With a resilient breakwater, the inflow of a tsunami behind the breakwater can be suppressed, and the time taken by the tsunami to advance can be increased. This leads to less damage and casualties in the area behind the breakwater. After the GEJE, research by MLIT found that the breakwater at the Kamaishi Port reduced the height of the tsunami by 40 percent and slowed it down. The same effect was seen at the other ports. Based on the results of the analysis, this technology was proven feasible and effective (MLIT 2018).
- **Measures concerning emergency withdrawal of oil-, LPG-, and LNG-handling equipment:** At the time of the GEJE, loading arms for oil, liquefied petroleum gas (LPG), and liquefied natural gas (LNG) were damaged because ships could not easily detach the arms. Measures have been introduced to enable the emergency withdrawal of cargo-handling machinery, ensuring safe cargo handling during a disaster (MLIT 2018).
- **Review of design conditions (waves, earthquakes):** Based on the experience of the GEJE and the Kumamoto Earthquake, design conditions including the seismic intensity formula have been revised to enhance resilience toward tsunamis and earthquakes (MLIT 2018).

Results

This case demonstrates that technical standards can be an effective solution for the construction, maintenance, and improvement of port facilities. Based on the standards, port infrastructure that is resistant to disasters can be efficiently constructed and maintained, allowing the impact of disasters on industry to be attenuated. The standards have been created with the latest technical and scientific findings currently available; consistent revision of the standards is key to incorporate new technologies and lessons learned from previous disasters. Standardization of port construction technology is key to establishing robust port infrastructure nationally, significantly contributing to the business continuity of industry.

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A10. DEVELOPING GUIDELINES FOR STORM SURGE RISK REDUCTION MEASURES TO LOWER STORM SURGE RISK IN HARBOR LAND NOT PROTECTED BY LEVEES

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Policy and legal	<ul style="list-style-type: none"> Public sector—national, prefecture, city Manufacturing industry—large firms, small-medium enterprises, women-owned businesses Industry associations—associations, parks, zones 	 Storm Surge	<ul style="list-style-type: none"> Understanding disaster risk Strengthening disaster risk governance to manage disaster risk 	<ul style="list-style-type: none"> Continue business Minimize disruptions and recover quickly

Context

Ports around the globe have suffered significant economic damage due to storm surges. According to the estimate made by the National Oceanic and Atmospheric Administration (NOAA), Hurricane Sandy (2012) was one of the costliest tropical cyclones to have hit the mainland United States since 1990, with estimated damages of \$70.2 billion (NOAA 2018). Hurricane Sandy caused a seven-day closure of the ports of New York and New Jersey, which resulted in supply chain disruptions throughout the United States (University Transportation Research Center 2013). In the Philippines, the National Disaster Risk Reduction Management Council (NDRRMC) reported that Typhoon Yolanda caused a total of ₱93 billion (around \$1.94 billion¹⁰⁵) in damages (NDRRMC 2013), with 77 ports damaged during the typhoon (JICA 2015). Japan suffered a similar storm surge event in the Seto Inland Sea region in 2004, and more recently in Osaka Bay during Typhoon Jebi in September 2018. Typhoon Jebi caused a storm surge in Osaka Bay, and many of the local port facilities and Kansai International Airport were inundated and damaged (Japan Society of Civil Engineers 2018). Insurance payments for Typhoon Jebi damages amounted to the highest ever for a typhoon on record at ¥747.8 billion (\$6.86 billion) (General Insurance Association of Japan 2018).

In Japan, 99.7 percent of foreign trade passes through ports and harbors and 38.7 percent of domestic trade is distributed through marine transport, making ports and harbors of critical importance for Japanese economic activity. There are three major bays in Japan: Tokyo Bay (six harbors including Tokyo), Osaka Bay (five harbors), and Ise Bay (five harbors including Nagoya). These three major bays handle 35 percent of all port cargo in Japan, and yield a total export value of ¥78 trillion (\$715.5 billion). Approximately 80 percent of the port districts of these three major bays are located outside of areas protected by coastal defense infrastructure (for example, levees and seawalls), placing a significant number of firms and employees at risk from storm surges. Furthermore, the majority of these companies are manufacturing firms and companies that provide critical logistical functions for port operations. Therefore, damage from storm surge

¹⁰⁵ Converted into US dollars (\$) at the 2019 annual average exchange rate of \$1 = 48, based on the yearly average currency exchange rate provided at: <https://www.irs.gov/individuals/international-taxpayers/yearly-average-currency-exchange-rates>.

events could significantly disrupt economic activities and whole supply chains in these areas. Given the importance of strengthening the resilience of industries in these areas, it was critical for the national government to provide guidance to mitigate the impact of disasters in unprotected areas.

Solution Design and Key Features

Solution Design

In response to the need for guidance regarding the mitigation of storm surge hazards, MLIT formed a working group to develop the “Guidelines for Measures to Lower Storm Surge Risk in Harbors Not Protected by Levees” in January 2017, and completed the guidelines in March 2018 (MLIT 2018).

Key Features

- **Port managers responsible for coordination:** The guidelines require port managers to coordinate the development of a “Plan for Storm Surge Risk Reduction.” The plan shall be developed based on an areawide response of both public and private sector stakeholders responsible for port management and DRM. MLIT facilitates the formulation of the plans by providing accurate information and technical support to the port managers. For example, in the case of Ise Bay, stakeholders—including the national government, port managers, and private companies in the area—organized a workshop to discuss coordination in developing plans for storm surge risk reduction.
- **Vital government support:** The guidelines help facilitate the development of storm surge risk reduction plans. The provision of accurate information and technical support from the government is of vital importance for creating efficient and effective storm surge reduction plans.
- **Multi-stakeholder coordination:** Areawide and multi-stakeholder coordination is critical for the plan to be effective because the national government, port managers, and private companies all play key roles in the port districts’ DRM. Both the public and private sectors must be aware of storm surge hazards and their potential consequences, and must have technical capacity in hydrodynamic modelling and mitigation infrastructure.

Results

Along with extensive support provided by MLIT, the 2018 “Guidelines for Measures to Lower Storm Surge Risk in Harbor Land Not Protected by Levees” contributed to the development of storm surge risk reduction plans for Japan’s three major bays (Tokyo Bay, Osaka Bay, and Ise Bay). The guidelines have shown their effectiveness in facilitating the formulation of appropriate soft storm surge countermeasures or action plans, which can greatly reduce storm surge risks in a low-cost manner, based on the conditions of hard countermeasures.

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A11. ESTABLISHING INDUSTRIAL PARKS IN FLOOD-VULNERABLE LOCATIONS: FUJISHIRO INDUSTRIAL PARK

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Infrastructure	<ul style="list-style-type: none"> Public sector—national, prefecture, city Industry associations—associations, parks, zones 	 Flood	<ul style="list-style-type: none"> Investing in disaster risk reduction for resilience 	<ul style="list-style-type: none"> Continue business Minimize disruptions and recover quickly Sustain and improve competitiveness

Context

The Fujishiro Industrial Park is one of two major industrial parks in Hirosaki City. The park has a total land area of 153,086 square meters (m²) and is located along the inner bend of the Iwaki River. It has an industrial shipment value of ¥8.2 billion (\$75.2 million), which is equivalent to around 4 percent of Hirosaki's industrial shipment value. Around 18 percent of the manufacturing companies in Hirosaki (total: 177) are located in the Fujishiro Industrial Park, making the park one of the core manufacturing bases of the city (Hirosaki City 2017).

Historically, the Iwaki River has experienced several major flooding events, with land damage extending to more than 40 square kilometers (km²) during the flooding events of August 1975 and August 1977 (MLIT 2011). Most relevantly, the flooding event in August 1975 inundated the area where the current Fujishiro Industrial Park is located. In order to cope with the increasing possibility of disasters in the area adjacent to the Iwaki River, river improvement works began in 1917 and are still ongoing. Under the current River Improvement Master Plan for the Iwaki River, 94.2 percent of the planned dike has already been constructed (Aomori Prefectural Government 2018).

Hirosaki City completed the development of the Kitawatoku Industrial Park, a predecessor of the Fujishiro Industrial Park, in October 1975, and was successful in attracting several industrial companies from outside the prefecture. The lack of land appropriate for industrial developments hindered further advancement of the industry sector in Hirosaki. For this reason, when the city decided to establish the Fujishiro Industrial Park it struggled to find a suitable plot of land for industrial development.

Solution Design and Key Features

Solution Design

The Hirosaki City government took advantage of the river improvement works implemented along the Iwaki River to create a new area suitable for industrial development. The flood control projects that were implemented greatly attenuated the flooding along the river's flood plain. Due to these improvements, areas that were previously inundated during floods are now suitable for industrial development. As such, the Fujishiro Industrial Park, which was historically in an inundation area, was subsequently developed in December 2005 (Hirosaki City 2017).

Key Features

- **Creating new industrial land while implementing flood protection measures:** Construction of flood protection infrastructure, primarily implemented for the protection of citizens, can also create developable land that may help in revitalizing the economy of a city or a prefecture.
- **Land use policy changes:** Before dike construction, the area where the Fujishiro Industrial Park is located was agricultural land. Under a policy promoting industry in traditionally agricultural areas, the land was designated as an "area where industry was to be introduced" in 1994. The river dike development was a catalyst for the change in the land use designation of the area.

Results

The national government, through MLIT, led the construction of a dike in the area where the Fujishiro Industrial Park is currently located. This was completed in 1994 as part of the comprehensive Iwaki River Improvement Project. The development of the dike improved the flood mitigation capacity of the area, making it possible to build the industrial park in the previously unsuitable location. The Hirosaki City government was responsible for the establishment and development of the industrial parks. When combined with appropriate land use policy, the design and construction of dikes not only contributed to a reduction of disaster risks, but also created developable land that helped in revitalizing the local economy. The benefits of the synergy between the national and local governments is evident in the increased number of employees in the area (from 6,771 in 1995 to 8,088 in 2009), as well as the improvement of the city's product shipment value.¹⁰⁶

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¹⁰⁶ Based on MLIT: http://www.mlit.go.jp/river/stock_kouka/jirei/jirei02.html.

A12. DEVELOPING FLOOD PROTECTION LEVELS TO BUILD BACK BETTER: ROJANA AYUTTHAYA INDUSTRIAL PARK

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Policy and legal  Infrastructure  Finance	<ul style="list-style-type: none"> Public sector—national, prefecture, city Manufacturing industry—large firms, small-medium enterprises, women-owned businesses Financial sector—large banks, local banks, insurance companies, other Industry associations—associations, parks, zones 	 Flood	<ul style="list-style-type: none"> Investing in disaster risk reduction for resilience Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation, and reconstruction 	<ul style="list-style-type: none"> Continue business Minimize disruptions and recover quickly Sustain and improve competitiveness

Context

Rojana Ayutthaya is the largest industrial park of four operated by the Rojana Industrial Park Public Co. Ltd. The company was established in 1988 by a joint venture between Japanese (Nippon Steel and Sumikin Bussan Corporation) and Thai (Vinichbutr Group) companies. In total, the Rojana Ayutthaya Industrial Park covers an area of 24 km², making it one of the largest industrial parks in Thailand.¹⁰⁷

From October to November 2011, many companies, including Rojana Ayutthaya, suffered from severe flooding of the Chao Phraya River. The Rojana Ayutthaya Industrial Park was inundated for 51 days before being completely drained (Haraguchi and Lall 2015). According to its 2011 annual report, the Rojana company suffered a net loss of B 838 million (\$27 million¹⁰⁸) due to flood damages and a further B 966 million (\$31.2 million) due to disruptions of machinery and equipment resulting from the flood disaster (Rojana Industrial Park Public Co. Ltd. 2011). A total of 218 companies (including 147 Japanese companies) within the park were affected. The floods damaged factories of a supplier that produced electronic components for Japanese automobile manufacturers. Collaboration within the global value chain enabled Japanese automotive firms to recover faster by manufacturing the necessary components at an alternative supplier in Japan while the supplier in Thailand recovered (METI 2012). This collaboration among suppliers minimized the damages to the Japanese automotive industry caused by disruptions in the global value chain (Haraguchi and Lall 2015). In addition to direct flood damages, the Rojana Ayutthaya Industrial Park suffered indirect damages due to the perception that it is significantly exposed to flood hazards (Rojana Industrial Park Public Co. Ltd. 2011).

Based on the severe flood damages experienced by the industries within the park, insurance companies began demanding larger flood insurance premiums with lower coverage rates from the park’s occupants, making insurance an increasingly untenable solution for disaster mitigation.

¹⁰⁷ For more information on the Rojana Ayutthaya Industrial Park, see: <http://www.rojana.com/>.

¹⁰⁸ Converted into US dollars (\$) at the 2019 annual average exchange rate of \$1 = B 31, based on the yearly average currency exchange rate provided at: <https://www.irs.gov/individuals/international-taxpayers/yearly-average-currency-exchange-rates>.

Additionally, 29 (14 percent) of the 218 affected companies closed or stopped operation at the park entirely. Only 69 of the affected firms were fully operational seven months after the flooding event, with an additional 85 having partially recovered (Haraguchi and Lall 2015). The Rojana company suffered a net loss for the year 2011 driven by the significant losses due to the impairment of investment (weakening of assets).

Therefore, there was an immediate need to install flood protection infrastructure to provide security to current park occupants and their assets, as well as to attract new industrial firms to the park. However, the park operators were financially incapable of shouldering the cost of the necessary flood protection infrastructure on their own.

Solution Design and Key Features

Solution Design

Realizing the need to install extensive flood protection infrastructure, the Rojana Industrial Park worked together with the national government to enhance the park's disaster risk management capacity. Considering the significance of the park to Thailand's industry sectors and economy, the Thai government subsidized two-thirds of the cost of the flood protection infrastructure, and also provided low-interest loans through Thailand's Ministry of Finance, with added support from the Japanese government. In total, construction of flood protection infrastructure for the Rojana Ayutthaya Industrial Park cost around ¥7 billion (\$63.6 million). This includes a 73 km levee with a crest 6.05 m above mean sea level surrounding the park area. The construction of the levee wall started in February 2012 and was completed within the year.

Key Features

- **Private and public sector cooperation:** High-value assets justify the high costs of providing flood protection. Significant financial capital and technical expertise are needed to optimize the design of flood protection infrastructure. For large-scale construction of disaster-mitigating infrastructure to be feasible, cooperation between private and public sector entities is often required.
- **Benefits of disaster-mitigation infrastructure for industrial parks:** The provision of disaster-mitigation infrastructure for industrial parks lowers economic risks and can help in improving a country's economy by attracting direct foreign investment, as well as providing employment for its citizens.
- **Shifting flood risk to adjacent areas:** Construction of flood walls that regulate the river flow will often pose an increased flood risk in adjacent unprotected areas. This must always be considered and included in the economic and feasibility studies of proposed projects.

Results

The extensive flood protection infrastructure significantly enhanced the Rojana Ayutthaya Industrial Park's disaster risk management capacity. The high capital costs of the flood protection infrastructure was justifiable considering that manufacturers based in Rojana Ayutthaya lost a lot more than the cost of the improvements due to the flood damage. The damage from the floods was ¥23 billion (\$209 million) in the case of Honda, and Toyota recorded ¥110 billion (\$1 billion) in indirect damages due to supply chain disruption even though their factory was not inundated (Bangkok Post 2012). The effects of the project were immediately demonstrated by the rebound in the number of firms occupying the park to around 210 (Ito and Takahashi 2014).

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A13. DEVELOPMENT AND UTILIZATION OF THE AUTOMATIC RIVER FLOOD GATE AND LAND LOCK CLOSING SYSTEM

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 <p>Infrastructure</p>  <p>Technology</p>	<ul style="list-style-type: none"> Manufacturing industry—large firms, small-medium enterprises, women-owned businesses 	 <p>Tsunami</p>	<ul style="list-style-type: none"> Investing in disaster risk reduction for resilience Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation, and reconstruction 	<ul style="list-style-type: none"> Continue business Minimize disruptions and recover quickly Sustain and improve competitiveness

Context

Flood gates and land locks (floodwall gates on roads) are important infrastructure to prevent the encroachment of water into residential and industrial areas. Gates and locks can play a pivotal role in preventing potential disasters caused by tsunamis and high tides. Out of approximately 27,000 gates and locks in Japan, 5,000 are always closed and 1,600 have been automated. The remaining 20,000 gates and locks remain manually operated and are subject to failures and accidents in their closing mode. When the GEJE occurred, 48 firefighters who tried to operate gates and locks were killed by the tsunami (MLIT 2016). Failures of gates and locks aggravated damages to industry from the disaster. In regions at risk of tsunamis, ensuring safe and quick action is required for the effective operation of gates.

Solution Design and Key Features

Solution Design

An automatic closing system for flood gates and land locks was implemented in the coastal area of Iwate Prefecture in July 2017 (Toshiba 2018). The system is interlinked to the nationwide instantaneous alert system, J-Alert, through satellite communication. The system automatically closes flood gates when a tsunami alert is issued. The robustness of this system is ensured by multiple redundant systems, including a duplex satellite system, a repetition system for the closing orders, a backup control system at the operation center, and backup power systems. Closed-circuit television (CCTV) monitoring systems also help to avoid failures and accidents during closing operations.

With 49 systems installed at the end of 2019 (Iwate Prefectural Assembly 2019), Iwate Prefecture has planned to expand the automatic system to 220 gates and locks in total in the next few years, with ¥6.8 billion (\$61.8 million) toward capital expenditure and ¥120 million (\$1.1 million) toward operating expenditures.¹⁰⁹ Most infrastructure projects in Japan are expected to have sound cost-benefit analysis results. Although implementation of the gate-closing system calls for a significant financial burden, the Nankai Trough Earthquake Disaster Prevention Basic Plan released by the Central Disaster Management Council (2019) prioritizes saving lives over cost efficiency and promotes the installation of the system. Budgets for the implementation were allocated based on the risk priority level of the structures to be automated. Larger facilities are more critical as their failures have greater implications, including the possibility of greater damage and loss of life. Miyagi Prefecture also started installing an automatic system in 2019.¹¹⁰ They will expand the system first to the 243 extensively used gates and locks out of the total 865 (Miyagi Prefecture 2018). Kobe City also launched the system in 2019 and will implement it at 74 gates and locks in total by 2024.¹¹¹

Key Features

- **Increase in safety for gate operators:** With the help of a dedicated satellite connection, gate closing can be operated remotely, quickly, and safely. There is no risk to the life of the gate operators as there are no personnel involved at the physical location of the gate.
- **Coordination with national and regional governments:** For this system to work, the satellite communication system and J-alert system must be reliably in operation. Simplification of the system might be necessary to adapt to more rudimentary information exchange systems that may be available in other countries. A real-time monitoring system using CCTV and a gate status (open/closing/closed) information system is also indispensable to verify successful operation and alert neighbors and affected institutions. Financial and administrative support from national and regional governments is necessary for this system to work effectively at a regional scale. Information exchange with relevant local governmental agencies is also necessary.

Results

The automatic floodgate closing system is effective and applicable to all tsunami-prone areas. The system has proven to provide a quick response to alarms and is highly reliable. While it usually takes a few hours to fully close the manual gate system that has been installed in most of the flood gates in Japan, the automatic system has shown to significantly shorten the closing time to around 10 minutes.¹¹² The system is beneficial for saving human life as well as cutting floodgate operation costs. MLIT and the Ministry of Agriculture, Forestry and Fisheries have also suggested that technological solutions that work without using electrical power for the operation of gates should be developed and utilized.

109 Based on Iwanichi Online (2017): <https://www.iwanichi.co.jp/2017/08/01/26573/>.

110 For more information, see: <https://www.pref.miyagi.jp/soshiki/kasen/suimonrikko-system.html>.

111 Based on Nikkei Business Publications Online (2019): <https://project.nikkeibp.co.jp/atclppp/PPP/news/122701005/2ST=ppp-print>.

112 For more information, see: <http://www.marsima.co.jp/special/index.html>.

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A14. BIG DATA ANALYSIS AND VISUALIZATION TOOLS FOR EVIDENCE-BASED REGIONAL ECONOMIC ASSESSMENT AND POLICY MAKING: REGIONAL ECONOMY SOCIETY ANALYZING SYSTEM (RESAS)

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Policy and legal  Technology	<ul style="list-style-type: none"> Public sector—national, prefecture, city Manufacturing industry—large firms, small-medium enterprises, women-owned businesses 	 Other - such as pandemics	<ul style="list-style-type: none"> Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation, and reconstruction 	<ul style="list-style-type: none"> Sustain and improve competitiveness

Context

Regional economies in Japan are comprised of a complicated web of interdependent relationships. Visualizing structural views of regional economies can enable regional policy makers to develop better-informed plans for postdisaster reconstruction. Understanding the overall performance and capability of groups of firms in regional economies is important for building resilient industries as well as revitalizing regional economies (Oka, Sasaki, and Sakata 2017). In 2012, NHK, the national broadcasting network in Japan, ran a special television program called Earthquake Big Data II, in which they showcased a model and software for analyzing and visualizing big data in order to illustrate the impact of the GEJE on people, businesses, and infrastructure. In 2014, the Cabinet Office issued a 5-year Regional Revitalization Strategy including a Cabinet Secretariat and METI-commissioned project to develop evidence-based planning tools and programs for use by local governments (Cabinet Office 2014).

Solution Design and Key Features

Solution Design

The Regional Economy Society Analyzing System (RESAS), launched in 2015 (figure A14.1), was developed by the Cabinet Office and METI in cooperation with data and system design partners including Teikoku Databank (TDB), Takram, and teamLab. The system synthesizes and visualizes public and private big data for categories such as industrial structures or population movement and flows. It supports local governments, aid organizations, and educational institutions and is used for evidence-based policy making. The tool has been in wide use among local governments and communities in the creation of better-informed planning tools used in postdisaster reconstruction plans, especially among rural communities facing significant challenges stemming from declining populations.

FIGURE A14.1 Map of Manufacturing Industry from RESAS Visualization Tool



Source: Created using RESAS visualization tool: <https://resas.go.jp/#/13/13101>.

Note: The map shows the industrial productivity of manufacturing industries by prefecture.

In 2018, a new big data visualization system called the Local Economic Driver Index (LEDIX) was developed through a collaboration between TDB and Takram. LEDIX is a powerful visualization system that brings together complex information on inter-firm transactions, company performance, and its regional contribution into a single dynamic visualization (figure A14.2). In turn, it helps identify key companies in various regions and industry sectors. LEDIX provides visualized information based on data collected from companies awarded as “the driving company for the regional future” by METI in 2017¹¹³. Companies are selected from all over Japan. The partnership is currently working on incorporating external shocks, including disasters, into the LEDIX system.

FIGURE A14.2 LEDIX Visualization Tool



Source: Created using the LEDIX visualization tool: <https://ledix.jp/about>.

Note: Blue lines and red lines show intraregional transactions and transactions with companies outside the prefectures for specific companies.

113 As of April 2020, LEDIX covers 343 companies out of the 2,148 companies awarded by METI. For more information, see: <https://ledix.jp/about>.

Key Features

- **Big data for evidence-based policy making (EBPM):** Utilizing these big data visualization systems (RESAS and LEDIX), various economic and societal relationships and their relative importances (weight) can be visualized, enabling the discovery and understanding of the challenges, needs, and gaps in local economies. The visualization systems facilitate the utilization of industry big data for EBPM and planning for regional economic development and resilience, such as diversifying the support for SMEs from subsidies and financial assistance to proactive engagement with connector hub companies.
- **Availability of private sector finance data:** In Japan, TDB Ltd. has a long history of collecting and analyzing firm-level data. TDB was established in Japan in 1900 and has been collecting business intelligence data through corporate credit checks. It currently provides a range of financial research and support services, including, but not limited to, corporate credit research, market research, database support, and electronic commerce support. The availability of reliable private sector data was indispensable for building big data visualization systems like RESAS and LEDIX.

Results

According to a survey conducted by METI in 2017, RESAS has been implemented in 97 percent of municipalities across Japan. These municipalities have utilized the visualization system for discussing policy planning and demonstrating the effectiveness of various measures. In addition, the system is being employed in a wide variety of fields, including financial institutions, commerce and industry associations, chambers of commerce and industry, and educational institutions.¹¹⁴ By utilizing RESAS, Kasugai City identified that the manufacturing industry has the highest added value and greatest intraregional ripple effect among industries in the region. Kasugai City also used RESAS in matching buyer and supplier manufacturing companies with local banks to further strengthen the manufacturing industry in the region (METI 2017).

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114 For more information, see: http://www.meti.go.jp/english/press/2017/0602_004.html.

A15. PROMOTING DISASTER PREPAREDNESS THROUGH PROVIDING PREFERENTIAL LOANS TO FIRMS WITH HIGH BUSINESS CONTINUITY MANAGEMENT RATINGS: DEVELOPMENT BANK OF JAPAN

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Finance	<ul style="list-style-type: none"> Financial sector—large banks, local banks, insurance companies, other 	 Earthquake  Tsunami  Flood  Storm Surge	<ul style="list-style-type: none"> Investing in disaster risk reduction for resilience Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation, and reconstruction 	<ul style="list-style-type: none"> Continue or quickly resume operation Sustain and increase competitiveness

Context

In the aftermath of the 2011 GEJE, the Japanese government started encouraging companies to implement contingency plans to ensure the continuity of their businesses after disaster events, which has led to growing adoption of business continuity plans (BCPs) and business continuity management (BCM) in private firms in Japan.

However, the dissemination of BCPs has been limited, especially among small and medium enterprises (SMEs) as they may require significant time, technical expertise, and financial resources, with limited immediate gains. Financially, development of BCPs may be perceived as a financial burden rather than an incentive: financial institutions’ evaluations of a company’s business performance are mainly based on financial information rather than their risk management, business continuity, and/or sustainability capacities. Disaster preparedness and prevention measures are rarely taken into consideration when assessing the firms’ reliability and value, especially by financial institutions. A lack of measures for the assessment of BCP activities, lack of incentives to implement BCP-related activities, and lack of investments in resilient industry have been major challenges to BCP adoption.

Solution Design and Key Features

Solution Design

In 2006, to incentivize BCM with the understanding that resilient firms are more financially reliable and competitive, the Development Bank of Japan (DBJ), a government-owned policy finance corporation, introduced the **BCM Rated Loan Program** that provides preferential loans based on companies’ BCM ratings. As part of this loan program, DBJ has developed rating criteria for companies to assess their business continuity management performance. The rating is composed of 15 criteria (as of 2020) relevant to firms’ disaster risk reduction and business continuity management practices (DBJ, 2020). DBJ’s BCM-rating-based loan program provides firms with preferential loan conditions as an incentive for disaster preparedness, based on the result of the BCM assessment. Additionally, DBJ provides BCM monitoring services, from the perspective of a financial institution, to companies that have signed an MOU pledging to maintain and improve their BCM activities.

For example, in 2012, TOTO Ltd., the largest domestic company that manufactures and sells home appliances such as sanitary ware and toilets, received the highest BCM rating for “excellent disaster prevention efforts,” and as a result DBJ provided ¥2.5 billion (\$22.7 million) in loans at the program’s lowest preferential interest rate. TOTO Ltd. received the highest rating due to its incorporation of: (i) seismic resistance and seismic isolation measures at major domestic and overseas offices and balanced geographical distribution of production bases in and outside Japan, (ii) an effective BCP in place for eliminating bottlenecks in business continuity and building a robust supply chain, and (iii) occasional practical risk simulation focusing on core business processes. Since the GHAE in 1995, 70 percent of the domestic production sites for TOTO Ltd. have undergone seismic diagnosis and reinforcement, and received loans through the BCM rating system. TOTO Ltd. completed seismic diagnosis and reinforcement for all of its domestic production bases in 2013, four years ahead of their original plan.¹¹⁵

Alps Electric, Co., Ltd. an electronic manufacturing company in Tokyo, initiated its BCP efforts in 2006, receiving BCM-preferential loans from DBJ in 2011 and 2016 with the highest BCM rankings. Their high BCM rankings were attributed to DRR efforts which included not only conducting lifesaving disaster drills for their own staff, but also providing postdisaster supplies and evacuation centers for the local community. Alps Electric also implemented BCM to enhance their stock monitoring and management to improve disaster recovery lead time, minimizing disruptions to manufacturing and logistics. After the March 11, 2011 Great East Japan Earthquake, Alps Electric was able to activate their BCP and restore operations quickly, with all of their factories resuming operations by March 28th, less than one month after the disaster¹¹⁶.

Key Features

- **Detailed BCM rating system:** The BCM rating system is composed of 15 categories: 6 categories for disaster preparedness and 9 categories for improvements in resilience (table A15.1). DBJ assesses companies based on these criteria, evaluating performance in three stages and providing loans with lower interest rates to companies with high ratings.

TABLE A15.1 Criteria for DBJ’s BCM Ratings

Category	Evaluation Criteria
Disaster risk reduction (DRR) & prevention	A. Corporate disaster prevention system B. Employee safety protections C. Participation in district and regional disaster prevention D. Disaster prevention drills and training (emergency response, first response) E. Good practice of DRR initiatives F. Compliance
Business Continuity Management	G. Crisis management system H. Business impact analysis (BIA) I. Strategy on business continuity J. Good practice of BCP initiatives K. Risk management for supply chain and value chain L. Business continuity education, training and review M. Active risk communication and crisis management publicity N. Contribution to sustainable development O. Good practice of BCM initiatives

Source: DBJ (2020).

Note: BCM = business continuity management; BCP = business continuity plan

115 For more information, see: <https://www.dbj-sustainability-rating.jp/bcm/case/case01.html>.

116 For more information, see: <https://www.dbj-sustainability-rating.jp/bcm/case/case02.html>.

Results

Between 2006, when the BCM rating system was launched, and 2019, 261 companies¹¹⁷ received preferential loans under DBJ's BCM Rated Loan Program. Preferential loans based on BCM ratings provide incentives for companies to incorporate BCP and BCM into their business strategy without substantial fiscal support from the government.¹¹⁸ DBJ has expanded their BCM Loan Program into a more comprehensive risk management service. This includes programs that promote disaster risk reduction and preparedness through consultations and BCM-rated loans. It also incorporates postdisaster risk finance solutions by providing property insurance and postdisaster repair service products¹¹⁹ where discounts are available (up to 20%) based on a company's BCM ratings. DBJ has partnered with Sompo Japan Nipponkoa (formerly Sompo Japan) to provide the insurance products. DBJ publishes online the names and key features of the resilience measures taken by firms that have received support from the BCM Loan Program.¹²⁰ Companies that have received BCM loans from DBJ also form a BCM Rating Club, a platform for peer to peer knowledge sharing and information exchange. These active efforts to connect and share knowledge continuously have also helped other companies to succeed in strengthening and scaling resilience efforts through the BCM Loan Program.

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117 Based on the DBJ's list of companies who received preferential loans. For more information, see: <https://www.dbj-sustainability-rating.jp/bcm/list.html#list>.

118 See LNews (2017) and Maruha Nichiro Corporation (2017) for the case of Maruha Nichiro Corporation.

119 For more information, see: <http://www.dbj-sustainability-rating.jp/en/bcm/rmservice.html>.

120 DBJ list of certified companies: <http://www.dbj-sustainability-rating.jp/en/bcm/list.html>.

A16. PROMOTING DISASTER PREPAREDNESS THROUGH ESTABLISHMENT OF A DISASTER-TRIGGERED CREDIT GUARANTEE PROGRAM: SHIZUOKA PREFECTURE

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Finance	<ul style="list-style-type: none"> Financial sector—large banks, local banks, insurance companies, other 	 Earthquake  Tsunami  Flood  Storm Surge	<ul style="list-style-type: none"> Investing in disaster risk reduction for resilience Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation, and reconstruction 	<ul style="list-style-type: none"> Continue or quickly resume operation Minimize disruptions and recover quickly

Context

Shizuoka Prefecture, located between Tokyo and Nagoya, has a long coastline facing the Pacific. Due to its favorable location as a node between the megacity Tokyo and the manufacturing center Nagoya, many companies have constructed factories along the Pacific coast in Shizuoka. This formed an indispensable and critically important industrial belt for the Japanese industry. However, the coast of Shizuoka Prefecture directly faces the Nankai Trough, a seismically active zone where a massive-scale earthquake with a magnitude 8 to 9 (equivalent to the GEJE or stronger) is expected within the next 100 years. Shizuoka has been identified as one of the prefectures that would suffer the most damage from the predicted Tokai and Nankai Trough earthquakes (Cabinet Office 2019). Given this background, the Shizuoka government is one of the most motivated prefectural governments in Japan in terms of enhancing preparedness against potential earthquakes.

SMEs often face difficulties in acquiring necessary loans after disasters even if they have sound creditworthiness. Some SMEs have been forced to go bankrupt due to a lack of liquidity. Such bankruptcies weaken the industrial resilience in affected regions and slow recovery.

In order to alleviate the anticipated massive damages from these earthquakes, the Shizuoka prefectural government has introduced substantial policies requiring local companies to prepare for these predicted disasters in an efficient manner. The introduction of business continuity planning among SMEs has been one of the policies prioritized by Shizuoka Prefecture in order to prepare for the predicted earthquakes. However, implementation can be costly for SMEs and the adoption has been slower than anticipated. A lack of incentives to implement BCP-related activities was identified as one of the major challenges in increasing industrial resilience.

Solution Design and Key Features

Solution

The Shizuoka government has launched a few novel support programs for local SMEs to enhance resilient industry in the prefecture. One of these programs is the Disaster-Triggered Credit Guarantee Program. This program aims to smoothly provide financing to local SMEs after a disaster occurs, utilizing prearranged guarantee agreements with SMEs that have created and

introduced their own BCPs. This allows SMEs to borrow money smoothly from banks, even if they suffer severe damages, by enhancing their creditworthiness through the prearranged guarantees received from the prefectural guarantee corporation (Cabinet Secretariat 2018).

Key Features

- **Creating incentives for disaster contingency plans:** SMEs that have introduced BCPs are eligible for the Disaster-Triggered Credit Guarantee Program. Participating SMEs benefit as no-guarantee fees are charged until a disaster event happens (as shown in table A16.1). The Shizuoka prefectural government provides a template BCP so that local SMEs can create their BCP easily and qualify for the guarantee program.
- **Annual monitoring:** Credit guarantee contracts from the program continue for one year. The prefectural guarantee corporation renews contracts by annually checking the financial condition and BCP implementation status of signed corporations, which is also a good incentive for companies to regularly revise and update their BCPs.
- **Guarantee free of charge:** Under the program there are no fees for obtaining a prearranged guarantee, which is a significant incentive for SMEs to consider this measure. Although it is costly to implement BCPs for SMEs, the no-fee system of the prearranged credit guarantee program acts as a good incentive for SMEs to create their BCPs. The incentive needs to be coupled with a template or guideline for creating BCPs, as in the case of Shizuoka Prefecture.

TABLE A16.1 Overview of the Disaster Triggered Credit Guarantee Program

Eligibility	Local small and medium enterprises that have introduced business continuity plans
Limit of guarantee	Up to ¥280 million (\$2.55 million); up to ¥480 million (\$4.4 million) for cooperatives
Effectiveness	For one year from the date of the approval notice of the contract
Guarantee fee	No guarantee fee before the event happens

Source: Based on Shizuoka Guarantee Corporation.

Note: For more information, see: <https://www.cgc-shizuoka.or.jp/hosyo/bcp.html>.

Results

The Disaster-Triggered Credit Guarantee Program has already been utilized by 148 SMEs in Shizuoka Prefecture (as of February 2018), and the number is increasing each year. The program has shown its effectiveness as a significant incentive for implementing BCPs among SMEs in Shizuoka Prefecture (Cabinet Secretariat 2018).

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A17. PROMOTING AREAWIDE BUSINESS CONTINUITY PLANNING IN INDUSTRIAL PARKS: AKEMI INDUSTRIAL PARK, AICHI

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Policy and legal	<ul style="list-style-type: none"> Industry associations—associations, parks, zones 	 Earthquake  Tsunami  Flood  Storm Surge	<ul style="list-style-type: none"> Strengthening disaster risk governance to manage disaster risk 	<ul style="list-style-type: none"> Continue or quickly resume operation

Context

Due to a lack of available land and high land values, industrial parks in Japan are often located outside of the urban areas that are protected by public coastal and river embankments. Access to public disaster risk management services—such as warning alarms, evacuation centers, fire stations, search and rescue, or hospitals—may be limited in outlying industrial parks. Without access to public resilience measures, finding solutions for individual firms and industrial parks to continue business operations and minimize losses in face of large-scale disasters may be challenging and/or costly.

This is the case for the Akemi Industrial Park, a large, 659 hectare (ha) industrial park in the Mikawa Port area, Japan's central hub for automobile manufacturing.¹²¹ More than 120 companies are located in the park, facing significant risks from disasters due to its location on reclaimed coastal land.

In 2009, the storm surge in Mikawa Port from category 5 Typhoon Melor (No. 18) caused significant damages to firms in the Akemi Industrial Park.¹²² Additionally, in 2014, the Cabinet Office's Central Disaster Management Committee released damage estimates for the predicted Nankai Trough Earthquake revealing significant risks from a potential M9.1 earthquake and an associated 5–10 m tsunami. Based on these estimates, a tsunami of up to 5.1 m, and inundation of approximately 0.2 to 0.6 m were projected for the Akemi Industrial Zone (Chubu Regional Development Bureau 2011), which could bring devastating impacts to the Akemi Industrial Park's infrastructure, assets, services, and business operations.

As firms in Akemi Industrial Park attempted to develop plans to protect their workers and assets, and continue operations in the face of the projected impacts from the Nankai Trough Earthquake, many firms found that they shared similar challenges and bottlenecks, such as ensuring access to lifeline utilities and critical infrastructure. Further, depending on the size and location of the

121 For more information on Akemi Industrial Park, see: <http://www.port-mikawa.jp/area/akemi.php>.

122 For more detailed information, see: https://researchmap.jp/?action=cv_download_main&upload_id=228670.

firm, some risks could not be managed by individual firms alone—such as securing a safe tsunami evacuation site for firms located along the coast. For example, in the Akemi Industrial Park, the main road network that connects the park to the mainland is critical infrastructure needed by all firms to access disaster risk management and response services, as well as continue business operations.

Solution Design and Key Features

Solution Design

In 2008, the Akemi Industrial Park initiated efforts to develop an areawide BCP, in addition to the BCPs developed by the individual tenant firms. The development of the areawide BCP was led by a strong initiative of the Akemi District Disaster Management Committee. The main objectives of the areawide BCP were to enable effective emergency lifesaving activities, quick restoration of roads in the Akemi Industrial Zone, securing fuel for heavy equipment and construction equipment, and mutual support systems for emergency restoration of business facilities.

The effects of the GEJE in 2011 led the Akemi Industrial Park to focus its BCP more on ensuring the safety of its workers. In preparation for a devastating tsunami from the projected Nankai Trough Earthquake, the updated BCP focused on ensuring business continuity and minimizing damages through establishing tsunami evacuation protocols and evacuation drills, establishing search and rescue mechanisms, establishing and expanding information communication mechanisms, and developing measures against liquefaction and transportation disruptions.

Key Features

- **Strong and proactive leadership:** The Akemi District Disaster Management Committee led efforts to promote BCP development starting in 2008. The committee surveyed firms located in the Akemi Industrial Park and found that more than 70 percent of the firms did not have firm-level BCPs. Furthermore, the survey found that the Akemi Industrial Park's continuity of industry services and functions was important not only for the continuity of individual firms, but also for providing essential port services needed to serve as emergency postdisaster transportation nodes. Strong coordination by the disaster management committee led to the identifying of critical factors that needed to be addressed and helped develop an effective areawide BCP. The integration of the Akemi Industrial Park's areawide BCP within a subnational BCP was also identified as critical (Shinken Press 2014).
- **Coordination and communication with local and national governments:** The survey conducted by the disaster management committee highlighted another shared concern—the need for support from local government services and port authorities. It is important for local governments to understand and know what is covered and not covered by the industrial park's BCP in order to provide necessary information and support during disasters. In the Akemi Industrial Park, Toyohashi City implemented 5 MCA wireless radio devices with selected firms and conducted drills to simulate status updates and information exchange protocols in case of disaster events (METI 2015).

Results

The process of developing the Akemi Industrial Park BCP catalyzed collaboration and coordination among resident firms and provided a collective solution for enhancing business continuity capacity. The areawide BCP developed by the Akemi District Disaster Management Committee increased the safety and security of all workers in the event of a disaster, enabled securing important resources and equipment during and post disaster, and enhanced the competitiveness of area industries. Collaboration and coordination among more than 120 resident firms demonstrates that increased resilience against disasters is obtainable through identifying the common needs of many firms, and the resources that each firm may offer to a collective solution. The Akemi Industrial Park's BCP won a BCAO award (see appendix A4) in 2012 for its efforts.

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A18. ENHANCING ENERGY SECURITY AND EFFICIENCY THROUGH THE INDUSTRIAL SMART COMMUNITY “FACTORY GRID (F-GRID)” PROJECT: OHIRA INDUSTRIAL PARK, MIYAGI

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Infrastructure  Technology	<ul style="list-style-type: none"> Industry associations—associations, parks, zones 	 Earthquake  Tsunami  Flood  Storm Surge	<ul style="list-style-type: none"> Investing in disaster risk reduction for resilience Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation, and reconstruction 	<ul style="list-style-type: none"> Continue business Minimize disruptions and recover quickly Sustain and improve competitiveness

Context

Before the GEJE in 2011, Toyota’s automotive plant in the Ohira Industrial Park,¹²³ Miyagi Prefecture, relied entirely on the Tohoku Electric Power Co. for its energy needs. Unfortunately, the disaster disrupted the power supply to the Ohira Industrial Park for two weeks, leading to considerable economic losses for the industrial park as well as disruption of many supply chains.

According to the Indices of Industrial Production published by METI, the transportation equipment sector (which includes the automotive manufacturing industry) experienced the worst impacts from the GEJE. In March 2011, the sector experienced a 47.6 percent decrease in the Industrial Production Index¹²⁴ from the previous month. In order to avoid and mitigate such losses in the future, the firms located in the Ohira Industrial Park realized the importance of securing a backup power system for the industrial park.

In February 2013, nearly two years after the GEJE, Toyota Motor Corporation established a limited liability partnership (LLP) with 10 firms located in the Ohira Industrial Park. The objective of the LLP was to establish a comprehensive energy management system for the industrial park that would contribute to improved energy efficiency in the park during normal times, as well as serve as a backup power supply system during times of disaster. The LLP initiated the design of a factory grid (F-grid) with financial and technical support from METI’s “FY2013 Subsidy for Projects Promoting the Introduction of Smart Communities.”

¹²³ Established in 2001, the park covers 306.8 hectares (ha) and hosts 12 manufacturing companies (automotive, semiconductor, and food processing companies including Toyota Motor East Japan, Toyota Transportation, Central Motor Wheel Tohoku, Toyota Boshoku Tohoku, Vuteq, Skylark, VEGI-Dream Kurihara, Sanei, and Sanwa Yushi Corporation).

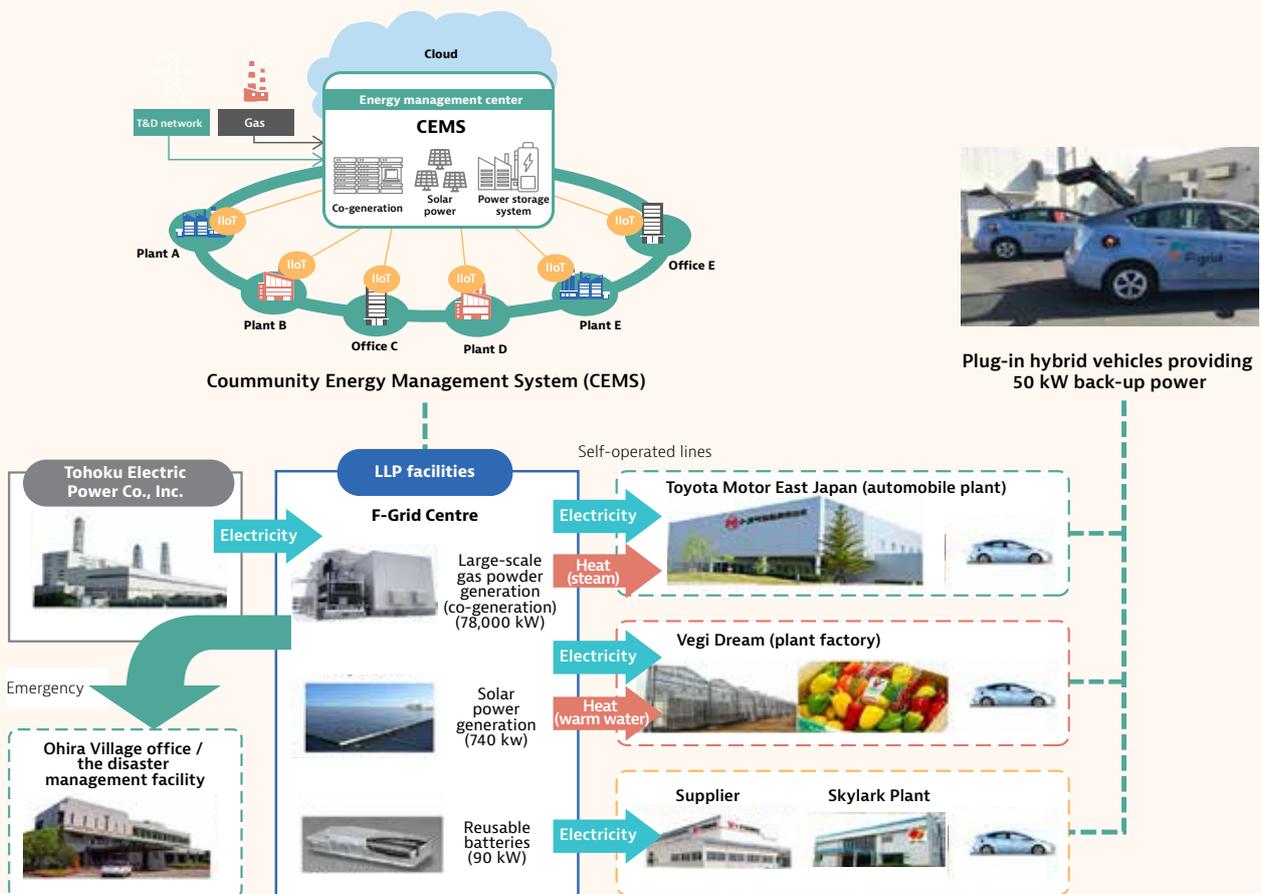
¹²⁴ For more information, see Cabinet Office (2011).

Solution Design and Key Features

Solution Design

The F-grid LLP developed its own power generation and energy management systems within the Ohira Industrial Park, as depicted in figure A18.1. During normal times, the Community Energy Management System (CEMS) installed within the F-grid enables the efficient supply of electricity and heat (hot water and steam) to the industrial park. It optimally balances electricity supplied from the Tohoku Electric Power Co. (the national grid) and the electricity and heat generated and stored by an on-site natural-gas-fired cogeneration plant with a capacity of 7.8 megawatts and a solar photovoltaic plant with a capacity of 740 kilowatts. Furthermore, an array of batteries from hybrid electric automobiles was installed as a backup power storage system. Eight plug-in hybrid vehicles are also installed in the industrial park as part of the F-grid system. Even if all other power sources fail during emergency situations, the backup power storage (plug-in hybrid vehicles) can supply enough electricity to keep satellite phones and computers running for three to four days.

FIGURE A18.1 System Diagram of the F-Grid Project in Miyagi Prefecture, Japan



Source: Created based on Toyota (2013).

Note: kW = kilowatt; LLP = limited liability partnership; T&D = transmission and distribution.

Key Features

- **Establishing a strong parkwide collaborative partnership:** Creating a backup power system only to be used during times of emergency or disasters is extremely costly. In order to develop an economically viable backup power system, a key approach is to make the power system useful both during normal and disaster times. However, designing a backup power system with goals of reducing costs and environmental impacts during normal times is still a major challenge; sufficient demand for electricity and heat needs to exist for the system to be utilized efficiently. Establishing a strong collaborative partnership between firms in the Ohira Industrial Park to consolidate power demand was essential to overcome this challenge. The F-grid system effectively uses the heat generated by the cogeneration plant for steam and hot water at the automotive and other plants. The F-grid achieves a maximum energy efficiency of 80 percent. Flexibility in the LLP structure¹²⁵ is one of the success factors that enabled the establishment of a strong parkwide collaborative partnership.
- **Revision of laws and regulations:** During the development of the F-grid project, the LLP faced a legal challenge within the definition of the “un-institutionalized Intra-Area Wheeling Service function” in the Electricity Business Act (1964). During major customer holidays it was necessary to partially stop the operation of the generation systems to enhance the energy efficiency of the mini-grid system. Power supply from the national grid (which is supplied and operated by the Tohoku Electric Power Co.) was necessary to sustain the operations of all of the consumers within the industrial park. However, until March 2013, the Electricity Business Act stated that the provision of electricity in such cases is a voluntary act and not an obligation of the general electricity utility. Until the revision was made to the Electricity Business Act in 2013 to solve such issues, this uncertainty in getting electricity from the national grid during major customer holidays was a critical challenge and an obstacle to optimizing the energy production and consumption from the mini-grid system.
- **Enhancing the disaster risk management capacity of the nearby community:** The Ohira Industrial Park’s F-grid system can also supply emergency power to local disaster response centers and evacuation shelters in Ohira village.¹²⁶ The integrated system enhances the disaster management capacity of the region, which helps in mitigating the impact of disasters at a regional level. Mitigating the impacts of disasters at a regional level enhances the resiliency of the industrial park both directly and indirectly, through protecting the lives of the people, including the employees of the industrial park and their families, and facilitating timely restoration and recovery of the critical infrastructures outside of the industrial park, such as roads and bridges. Beginning with its official launch in October 2015, the F-grid LLP has been conducting annual trainings with members of the LLP and Ohira village government officials. This ensures effective use of the F-grid emergency electricity supply system for both the industrial park and the surrounding region (Toyota 2015).

¹²⁵ The LLP offers participants flexibility in business ownership; partners have the authority to decide how they will individually contribute to business operations, and managerial duties can be divided equally or separated based on the expertise and experience of each partner.

¹²⁶ For more information, see Toyota Global Newsroom (2013).

Results

The Ohira Industrial Park's on-site energy generation systems not only enable the energy supply to be secured during power outages and shortages, but also improve energy efficiency in the park during normal times. Through on-site electricity and heat generation systems, as well as the CEMS that can optimally balance the power supply in the industrial park, in 2016 the F-grid system achieved a 24 percent increase in energy efficiency and a 31 percent reduction in carbon dioxide emissions compared with similarly sized industrial parks.¹²⁷ Members of the LLP are benefitting from a reduction in energy costs; the LLP aims to recoup its investment within 10 years of commencement of the project (METI 2018).

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A19. ESTABLISHING STRATEGY AND GUIDELINES TO MAINTAIN THE LIQUIDITY OF LOCAL BANKS DURING DISASTERS: BANK OF JAPAN

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Finance	<ul style="list-style-type: none"> Financial sector—large banks, local banks, insurance companies, other 	 Earthquake  Tsunami  Flood  Storm Surge  Volcanic Eruption  Other - such as pandemics	<ul style="list-style-type: none"> Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation, and reconstruction 	<ul style="list-style-type: none"> Continue business Minimize disruptions and recover quickly

Context

Since the 1995 Great Hanshin and Awaji Earthquake, the Bank of Japan (BoJ) has made efforts to establish a system to maintain enough liquidity in regional banking systems during times of disaster. According to the Bank of Japan Act (issued in 1997, revised in 2007), it is positioned as a “designated public institution with a central economic function.” Therefore, it is legally obligated to make disaster prevention plans, develop systems to deploy resources in emergencies, and regularly carry out disaster response drills. As stipulated in the Bank of Japan Act, the bank must meet its responsibilities in times of emergency.

A wide variety of unpredictable events happen during a large-scale disaster, putting stress on the entire financial system. For example, banks and markets often suffer from a lack of liquidity caused by massive drawdowns of savings during disasters. Banks and financial institutions can become unable to provide financial services due to damage to their own facilities, or suffer from lowered asset quality due to disaster damage suffered by their clients.

Solution Design and Key Features

Solution Design

In order to overcome the challenges that large-scale disasters can create, the BoJ established its Disaster Preparation Plan in 1967 and revised it incrementally to cope with the changing environment. Table A19.1 shows the actions that the BoJ took based on the Disaster Preparation Plan to prevent the spread of damage to the banking system following the 2011 GEJE. The BoJ has been further improving its resilience against disasters to prepare for the predicted Nankai Trough Earthquake and the Tokyo Near-Field Earthquake by introducing an information and communication technology (ICT) system backup facility¹²⁸ in Osaka and alternative business offices in Tokyo and Osaka in case of severe damage to buildings. It also increased resilience by installing emergency power systems, reinforcing essential buildings to withstand large-scale

disasters, and deploying first responders near headquarters to respond to emergencies outside of business hours.

Key Features

- **Strong initiative from the Central Bank and cooperation of private banks:** Establishment of a disaster preparation plan by the central bank prevents harm from spreading throughout the banking system in times of disaster. Costs are relatively low for establishing disaster prevention plans since they do not require large investments into hardware. Sharing the merits and the importance of disaster preparedness between central banks and smaller financial institutions was an important step in creating this kind of market-level BCP framework.
- **Disseminating information online:** The BoJ has a special website, created based on the Disaster Preparation Plan, to share information with market participants during emergency situations including disasters. The website was used in 2011 to share information with market participants during the GEJE. Maintaining a communication system with market participants helps share accurate information about disasters and necessary actions during their occurrence.

TABLE A19.1 The Bank of Japan's (BoJ's) Actions after the GEJE

Operational actions	1. Establishment of disaster countermeasures office in corporate headquarters
	2. Provision of cash to banks
	3. Institute replacement services for damaged cash
	4. Secure operation of the Bank of Japan Financial Network System (BOJ-NET) ¹²⁹
	5. Issuance of Special Measures on the Financial System ¹³⁰ under the joint signatures of the Government and the BoJ
	6. Implement measures to support financial institutions in charge of the national treasury and government securities
	7. Timely provision of accurate information to financial institutions, the government, and the public
Policy actions	1. Securing stability of the financial market
	2. Expanding liquidity
	3. Supporting damaged banks in affected areas
	4. Consideration of the effect of damage in off-site financial monitoring ¹³¹

Source: BoJ 2016.

¹²⁹ BOJ-NET is "a computer network operated by the Bank, which was established with the aim of efficiently and safely executing online funds transfers and Japanese government bond (JGB) settlements between the Bank and financial institutions that conduct transactions with the Bank." Based on: <https://www.boj.or.jp/en/announcements/education/oshiete/kess/110.htm/>.

¹³⁰ Request to financial institutions to take flexible and appropriate financial measures (such as allowing depositors who have lost their deposit certificates and/or passbooks to make withdrawals upon the verification of their identities) in accordance with the specific circumstances of the affected people. For more information, see: <https://www.fsa.go.jp/en/news/2011/20110311-1.html>.

¹³¹ Off-site monitoring is one of the Bank's operations to "grasp the state of business operations and assets of the financial institutions that hold current accounts at the Bank." Based on: <https://www.boj.or.jp/en/announcements/education/oshiete/pfsys/e06.htm/>.

Results

Based on the Disaster Preparation Plan, the BoJ successfully opened its Disaster Countermeasures Office within 15 minutes after the GEJE occurred, concurrently sharing information collected from market participants through a special website for market-level BCP. It subsequently published a press release through its website, stating that it was ready to provide enough liquidity to maintain the stability of the financial market. The same day, the bank issued “Special Measures on the Financial System.” The day after the disaster, even though it was Saturday, local banks were open based on the special measures implemented by the BoJ. The BoJ immediately started providing cash to local banks through its branches and offices in Aomori, Sendai, Fukushima, and Morioka. At the same time, it also began exchanging damaged currency notes with new ones, by opening temporary exchange offices. On the following Monday, the BoJ provided a massive amount of cash totaling ¥21.8 trillion (\$198 billion), the largest single day’s provision in its history and three times the amount provided during the global financial crisis in 2007 (BoJ 2016). The BoJ’s ability to take these actions was attributable to its Disaster Preparation Plan, equivalent to BCPs for private companies.

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A20. PROVIDING EMERGENCY GUARANTEES TO SMALL AND MEDIUM ENTERPRISES FOR QUICK RECOVERY FROM DISASTERS: CREDIT GUARANTEE CORPORATIONS

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Finance	<ul style="list-style-type: none"> Financial sector—large banks, local banks, insurance companies, other 	 Earthquake  Tsunami  Flood  Storm Surge  Volcanic Eruption	<ul style="list-style-type: none"> Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation, and reconstruction 	<ul style="list-style-type: none"> Continue business

Context

Credit guarantee corporations in Japan are public entities established based on the Credit Guarantee Corporation Act (1953). They aim to provide guarantees to SMEs so that the SMEs can conveniently borrow money from banks. Every prefecture in Japan has its own credit guarantee corporation. Four municipalities also have their own credit guarantee corporations (Yokohama, Kawasaki, Nagoya, and Gifu), making a total of 51 credit guarantee corporations in Japan. Credit guarantee corporations use this network to provide financial services to local SMEs (Japan Federation of Credit Guarantee Corporations 2018).

Generally, SMEs face a variety of difficulties when they apply for credit from financial institutions, often due to their comparatively weak creditworthiness. When a disaster occurs, credit difficulties are intensified, and even SMEs with high credit scores face challenges borrowing funds for disaster recovery. These challenges include difficulty expanding credit lines, a lack of joint guarantors and collateral, and difficulty borrowing enough money for long-term financial stability.

Solution Design and Key Features

Solution Design

In order to deal with the credit challenges faced by SMEs, credit guarantee corporations provide emergency guarantees under the Disaster-related Emergency Guarantee Program. This program provides guarantees to SMEs that experience business instability, such as reduced sales, due to an economic crisis or damages from a large-scale disaster. Under this program, SMEs can access a guarantee of up to ¥200 million (\$1.82 million), of which ¥80 million (\$727,000) requires no collateral.

In May 2011, two months after the GEJE, credit guarantee corporations jointly launched a special guarantee program called the Emergency Guarantee Program for Recovery from the GEJE. Table A20.1 shows the overview of the program. This program is based on Article 128 of the Legislation Regarding Special Fiscal Aid and Supports for Coping with the GEJE, and provides 100 percent coverage and lower guarantee fees for supporting SMEs in affected areas.

TABLE A20.1 Overview of the Emergency Guarantee Program for Recovery from the GEJE

1. Eligibility	Small and medium enterprises and small business owners that were affected both directly and indirectly in specific disaster areas* by the Great East Japan Earthquake (GEJE): <ul style="list-style-type: none"> • Corporations directly damaged by tsunamis and earthquakes; • Corporations that owned business facilities in the warning zones of the Fukushima Daiichi nuclear accident; • Corporations that suffered a reduction of more than 10% in sales due to the GEJE. *Specific disaster areas: the whole of Iwate, Miyagi, and Fukushima; part of Aomori, Ibaraki, Tochigi, Saitama, Chiba, Niigata, and Nagano.
2. Upper limit of guarantee	¥280 million (\$2.55 million), of which ¥80 million (\$727,273) was provided without collateral
3. Coverage of guarantee	100%
4. Use of credit	Business recovery and business stability
5. Guarantee fee	Lower than 0.8%
6. Interest rate	Variable based on borrowing banks
7. Guarantee period	Within 10 years
8. Collateral	Depending on the availability of borrowers
9. Guarantor	Chief executive officer or president of the corporation (no joint guarantor)
10. Availability of the program	From May 23, 2011, to the end of March 2019

Source: METI 2011.

Key Features

- **Clear eligibility standards:** The eligibility standards for the disaster-related Emergency Guarantee Program are clearly defined. These included: SMEs that lost 15 percent of sales in the first month after the disaster and are estimated to lose the same amount in the following two months; and SMEs that experience challenges relating to financial transactions and need loans for normalizing transactions (Japan Federation of Credit Guarantee Corporations 2018).
- **Special emergency guarantee programs at the prefectural level:** Prefectural credit guarantee corporations respond to disasters in their respective prefectures by launching special emergency guarantee programs such as the Emergency Guarantee Program for Recovery from the GEJE, providing credit guarantees to local SMEs.
- **Significant political will:** Developing a nationwide credit guarantee system takes a long time and requires significant political commitment. Overall implementation costs for a nationwide system are high, and ongoing credit monitoring is critical for the sound operation of credit guarantee corporations. Central and local governments must be ready to provide funding for the operation of the public guarantee system and for covering potential losses from defaults on individual loans.

Results

Guarantees are a strong financial tool for bolstering SMEs' often weak creditworthiness. The benefits of credit guarantees after disasters are of significant importance. In the case of the GEJE, credit guarantee corporations provided over 132,000 guarantees, a total credit exposure of about ¥2.7 trillion (\$24.5 billion).¹³² Ensuring a vast network of credit guarantee corporations has enabled quick response to local needs. A total of 51 credit guarantee corporations have been established in Japan, with at least one credit guarantee corporation in each of Japan's 47 prefectures. This vast network enables credit guarantee corporations to cooperate closely with regional banks, local credit unions, and the Japan Finance Corporation (JFC) before and after disaster events, providing the necessary financing to help sustain SMEs.

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A21. OFFERING SMALL AND MEDIUM ENTERPRISES LONG-TERM LOW-INTEREST LOANS FOR INVESTMENT AND FINANCING AFTER A DISASTER: JAPAN FINANCIAL CORPORATION

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Finance	<ul style="list-style-type: none"> Financial sector—large banks, local banks, insurance companies, other 	 Earthquake  Tsunami  Flood  Storm Surge	<ul style="list-style-type: none"> Investing in disaster risk reduction for resilience Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation, and reconstruction 	<ul style="list-style-type: none"> Continue business Minimize disruptions and recover quickly Sustain and improve competitiveness

Context

JFC, a public-policy bank owned by the government, has provided SMEs with long-term low-interest loans for investment and financing after disasters have occurred. The Japan Finance Corporation Act stipulates that it must provide SMEs with the necessary finances to cope with large-scale disasters. Since the Great Hanshin and Awaji Earthquake of 1995 (GHAE), JFC has provided special loan programs to SMEs in disaster areas to enable quick recovery (see table A21.1). JFC consists of 152 branches (as of March 2019) throughout Japan and works with regional banks and credit unions as a complementary financier on many projects.

After a disaster, SMEs often face challenges borrowing money from banks even if their financial standing is favorable. Prior to the GHAE, there was no postdisaster financial support system in Japan. Anecdotally, some of the SMEs playing a central role in local industries went bankrupt due to a lack of liquidity after the GHAE, and these bankruptcies strained efforts to recover from the disaster. Even for firms that were able to secure loans from private banks, conditions were challenging due to high interest rates and short loan terms. Another challenge for SMEs following the GHAE was the loan amounts available—they were often insufficient for necessary investments and daily operations. As a result, many SMEs were left without the required funding, which weakened overall resilient industry in affected regions.

Solution Design and Key Features

Solution Design

To address these challenges, JFC has been developing its emergency loan program to provide necessary loans to local SMEs in the case of an emergency. The aims of this program are to support SMEs directly and indirectly affected by disasters, through providing extra-long-term loans (8–20 years) with extended grace periods (3–5 years) to disaster-impacted SMEs and focusing on reducing the burdens of repayment. The length of the loan term depends on the severity of damages suffered—loans up to ¥720 million (\$6.55 million) were given, which is generally enough for an SME to cover the costs of investment.

Within 10 days of the GEJE, JFC set up the Great East Japan Earthquake Special Loan for Reconstruction Program for SMEs.¹³³ An overview of this special program is provided in table A21.1.

Key Features

- **Widespread coverage:** JFC, with over 150 branches all over Japan, has been providing a variety of support programs to local SMEs, including the emergency loan program, which has played an indispensable role for SMEs in Japan. JFC's familiarity with local contexts and their widespread accessibility also places JFC in a position to provide consultation services for financing during emergencies. Widespread implementation and awareness raising is vital to the success of the special loan program. Long-term loans with extended grace periods significantly ease SMEs' financial burdens, enhancing the ability of industries in affected regions to recover from disasters and continue business operations.

TABLE A21.1 Overview of Great East Japan Earthquake Special Loan for Reconstruction Program

Eligibility	Maximum Amount of Loans	Period of Loan (Grace Period)	Applicable Interest Rates
SMEs damaged directly by the disaster, SMEs in warning zone of nuclear accident, etc.	¥300 million (\$2.73 million)	For investment: up to 20 years (up to 5 years) For financing: up to 15 years (up to 5 years)	SMEs with official proof of damage can benefit from: <ul style="list-style-type: none"> • 0.5% reduction in interest rate from the benchmark interest rate* • Additional 1.4% reduction in interest rate for the first 3 years on a ¥100 million (\$909,091) portion of the loan
SMEs indirectly affected due to transactions with directly damaged SMEs		For investment: up to 20 years (up to 3 years) For financing: up to 15 years (up to 3 years)	SMEs with official proof of damage get: <ul style="list-style-type: none"> • The benchmark interest rate • 0.9% reduction in interest rate for the first 3 years on a ¥30 million (\$272,727) portion of the loan • A further interest reduction of 0.2%, 0.3%, or 0.5%, depending on conditions¹³⁴
SMEs suffering reduction in sales due to the disaster, including due to harmful rumors about the disaster	¥720 million (\$6.55 million)	For investment: up to 15 years (up to 3 years) For financing: up to 8 years (up to 3 years)	SMEs with official proof of damage get: <ul style="list-style-type: none"> • The benchmark interest rate • A further interest reduction of 0.2%, 0.3%, or 0.5%, depending on conditions

Source: Developed based on JFC's information. For more information, see: https://www.jfc.go.jp/n/finance/search/shinsaikashitsuke_t.html.

Note: * The benchmark interest rate is the normal rate which the JFC provides but it is lower than market available interest rates for policy incentives. SMEs = small and medium enterprises.

¹³³ For more information, see: https://www.jfc.go.jp/n/finance/search/shinsaikashitsuke_t.html.

¹³⁴ 0.3 percent reduction for companies who experienced significant fall in revenue after the disaster (e.g., average revenue during recent 3 months has been lower than the same months in the past 10 years), 0.2 percent for companies trying to maintain or expand their employment number, and 0.5 percent for companies who meet both conditions.

- **Drop-in consultation services:** JFC also provides special drop-in consultancy services for SMEs in affected areas. JFC has emphasized the importance of including easily accessible and speedy consultancy mechanisms in its financial programs in the wake of an emergency. JFC has made efforts to address immediate financial needs after disaster events by opening the special drop-in consultation services shown in table A21.2. So far, JFC has opened 14 counseling drop-in services focusing on specific disaster events, such as earthquakes, heavy rains, and volcanic eruptions. Timely financial consultation with SMEs is a critical feature of the emergency loan program.

Results

Emergency loan programs have been effective in providing necessary loans to local SMEs for maintaining business continuity and recovering quickly from past disasters. Since the program's launch, JFC has disbursed a substantial amount of loans, totaling ¥1.7 trillion (\$15.6 billion) spread among 20,000 SMEs. Table A21.3 lists examples of loan applications during past disasters.

TABLE A21.2 Ongoing Special Drop-in Services for Disaster-Related Recovery

Name of Disaster	Opening
Special counseling drop-in for the Great East Japan Earthquake	March 2011
Special counseling drop-in for the Mt. Ontake Eruption	September 2014
Special counseling drop-in for the Kumamoto Earthquake	April 2016

Source: JFC 2016.

TABLE A21.3 Number of Loan Applications during Recent Disasters

Occurrence of Events		Name of the Event	Major Disaster Areas	Result of Lending	
Month	Year			Loans granted	Value of Loans in ¥ billion (\$ billion)
January	1995	The Great Hanshin and Awaji Earthquake	Osaka, Hyogo	3,906	174.8 (1.589)
July	2004	Heavy rain	Fukui	38	0.9 (0.008)
October	2004	Heavy rain and wind	Kyoto, Hyogo	35	0.7 (0.006)
October	2004	Niigata Prefecture Chuetsu Earthquake	Niigata	135	3.7 (0.034)
July	2007	Niigata Prefecture Chuetsu Offshore Earthquake	Niigata	25	0.4 (0.004)
March	2011	The Great East Japan Earthquake	Aomori, Iwate, Miyagi, Akita, Yamagata, and Fukushima	24,800	1,694.2 (15.402)

Source: JFC 2016.

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JFC (Japan Finance Corporation). 2016. "Services for Medium and Small Enterprises." [In Japanese.] JFC, Tokyo.
<https://www.jfc.go.jp/n/company/sme/pdf/2016jfs01.pdf>

A22. EMPOWERING WOMEN'S PARTICIPATION IN INDUSTRIES THROUGH SUPPORTING PROGRAMS FOR FEMALE ENTREPRENEURS: AOMORI PREFECTURE

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Finance  Gender	<ul style="list-style-type: none"> Financial sector—large banks, local banks, insurance companies, other 	 Earthquake  Tsunami  Flood  Storm Surge	<ul style="list-style-type: none"> Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation, and reconstruction 	<ul style="list-style-type: none"> Minimize disruptions and recover quickly Sustain and improve competitiveness

Context

Aomori Prefecture is a major food producer for Japan; the main industries in Aomori Prefecture are agriculture and fisheries. However, the prefecture has a rapidly aging population, and this trend has accelerated since the GEJE. The prefectural government needs to evolve policy measures to deal with accelerating depopulation and revitalizing rural communities in the region.

Start-ups by women in agriculture, fisheries, and forestry-related businesses in villages have added value to these traditionally male-dominated industries while also revitalizing rural communities. The Aomori prefectural government has introduced a support program to offer training and support to female entrepreneurs and facilitate networking among them.

A particular policy concern for the prefectural government is galvanizing the female workforce, who are indispensable to agriculture and fisheries. Challenges include a lack of young female entrepreneurs who can develop regional industries, and a lack of networks for female entrepreneurs to share useful information.

Solution Design and Key Features

Solution Design

The Aomori prefectural government launched an initiative in FY 2014 to narrow these gaps by providing subsidies and information-sharing venues for female entrepreneurs.

Key Features

- Subsidies for projects:** The Aomori prefectural government provides subsidies for projects that support women-owned businesses in agricultural and fishery industries. These projects include collaborations between female entrepreneurs and existing business owners through holding seminars and internships to learn about key points for starting new businesses. The subsidy applies to female entrepreneurs up to the age of 55, and covers expenses relating to starting a new business using agricultural and fishery resources, such as purchasing facilities, research and development, advertising, hiring advisors, and hiring clerical workers. The coverage is up to ¥500,000 (\$4,545) (Aomori Prefecture 2016a).

- **Creating venues for information exchange:** The prefectural government provides venues at prefectural and municipal governments' offices for information exchange between female entrepreneurs and various businesses. By helping establish new professional networks, these venues support business development by women entrepreneurs.

Results

The support programs for female entrepreneurs has been an effective way for the local governments to address gender disparities in industries while also building local economies. During the fiscal years of 2015–16, 18 seminars were held, 5 internships were conducted, and 6 subsidies were provided to female entrepreneurs (Aomori Prefecture 2016b).

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A23. PROVIDING POSTDISASTER TRAINING AND CONSULTATION SERVICES TO EMPOWER WOMEN: MIYAGI JO-NET

SOLUTION CATEGORY

Solution type	Key drivers	Hazard type	Disaster risk management approach: (Sendai Framework priorities)	Resilient industry approach
 Gender	<ul style="list-style-type: none"> Public sector—national, prefecture, city Other—civil society, etc. 	 Earthquake  Tsunami  Flood  Storm Surge  Volcanic Eruption	<ul style="list-style-type: none"> Understanding disaster risk Strengthening disaster risk governance to manage disaster risk 	<ul style="list-style-type: none"> Continue business Minimize disruptions and recover quickly

Context

Women face unique issues in the disaster response and recovery process, and it is important for disaster management to address gender-specific challenges. After the 1995 GHAE and the 2011 GEJE in Japan, domestic violence and other issues faced by women were revealed in Japan. Japan's gender equity remains low; Japan was ranked 110th among the 149 countries assessed in the 2017 gender gap index by the World Economic Forum (2018). In remote areas such as Minami Sanriku town in Tohoku region, an increased occurrence of domestic violence was observed after the GEJE (Tokushima Shinbun 2015). Under these conditions, there have been few women-led initiatives aimed at enhancing gender equity in disaster contexts.

Miyagi Jo-net (MJN) is among a group of organizations that support women recovering from the 2011 GEJE. Women in disaster-affected areas often have challenges applying for grants offered by cities; they may have less education or limited experience in drafting successful grant applications or other official documents. MJN has been raising these concerns with government officials, stressing the need for a differentiated support system to give women in the community equal access to these financial services. However, MJN has faced social and political challenges and even harassment due to a culture of gender discrimination in the communities it works in. For example, when one of its staff visited an evacuation area to deliver supplies for women, they could not get permission to enter the area because they did not have supplies for men. Women were less likely to get support in the first place, and in order to get support from the government, they would need a female "link" who could listen to their voices.

Solution Design and Key Features

Solutions

Miyagi Jo-net has set up programs to provide job training for women, create venues for information sharing and mutual support among women, and also provide consultation and mental health care services.

Key Features¹³⁵

- **Salon-like and informal gatherings:** Formalized gender empowerment approaches may not work in certain contexts. In such cases, one approach for addressing gender issues in resilient industry is to address womens' concerns informally. After the GEJE, MJN took a multilayered approach. It facilitated small group workshops for women in the affected areas to help them explore the causes of and solutions to their own problems, as well as salon-like informal gatherings, such as tea parties and handicraft workshops. The salon gatherings took place daily at two or three locations, with a maximum number of participants for one event set at around 20 persons in order to ensure adequate time to address all participants' thoughts and feelings. MJN has successfully held salon-like gatherings even in small, difficult-to-reach evacuation centers and villages through this approach. Based on the needs expressed through the gatherings, MJN has been providing consultation services for women under the risk of domestic violence and unemployment.
- **Job training program for women in postdisaster situations:** MJN's disaster recovery work has highlighted a strong link between income and empowerment. MJN has provided not only consultation services for women who are unemployed, but has also started a training program specifically for women who want to be entrepreneurs; participants can benefit from business preparation and business foundation courses and consultation services for starting a business.
- **Mental Health Care Program:** The elderly women who attended the salon gatherings became significantly more active in their homes. The creation of such gatherings for the elderly has allowed for the rebuilding of the local community, and helped the younger generation to make use of their own time. After the earthquake, they had shut themselves away due to uncertainty regarding the future, but now they are able to spend their time and money on hobbies they do at the salon. Women's actions breathe life into the community.

Results

MJN has helped reveal and address the postdisaster challenges faced by women in industries in spite of a male-dominated culture. MJN has organized study sessions for women on their rights, provided job training for women, created venues for information sharing and mutual support among women, and provided various occupational consultation services. Through MJN's entrepreneur training program, nine organizations including small businesses and NPOs were created by women in Miyagi prefecture where MJN operates. These women-led organizations are now among the leading voices representing women in Miyagi prefecture, contributing to the election of female assembly members such as Ms. Nobuko Murakami in Kessennuma City¹³⁶.

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<https://www.weforum.org/reports/the-global-gender-gap-report-2018>.

¹³⁵ Based on an interview conducted with Ms. Yuko Kusano, chief representative of the Miyagi Women's Disaster Recovery Network (Miyagi Jo-net) on September 26, 2018.

¹³⁶ Ms. Murakami worked as a part-time worker at the time of the GEJE. After GEJE, she joined MJN, where through the various activities learned of the many unique challenges as well as the opportunities women face in post disaster recovery and reconstruction of the community's economy and livelihoods. To expand her experience and enhance these activities and promote empowerment of women, she decided to be a council member of Kessennuma City and was elected in 2019. For more information see: <https://chiholog.net/chiholog/gijilog/04205-20180926-ada6e1c/ja> (in Japanese) and <https://www.kessennuma.miyagi.jp/sec/s154/010/010/020/020/20170421093921.html> (in Japanese) provided by

APPENDIX B

GLOSSARY OF KEY TERMS

Note: The key terms in this glossary have been developed through referencing various sources including the United Nations Disaster Risk Reduction (UNDRR) report, ISO, and various studies. They have been adapted for the purpose of this document to serve as a reference for its readers, and are not intended to be universal.

Business continuity: the “ability to continue the delivery of previously agreed products and services within acceptable time frames at predetermined capacity during disruption.”¹³⁷

Business continuity management (BCM): a management system that “aims to prepare for, provide, and maintain controls and capabilities for managing an organization’s overall ability to continue to operate during disruptions.”¹³⁸

Business continuity plan (BCP): documented information that guides an organization to respond to a disruption and resume the delivery of products and services (such as manufactured items) consistent with its business continuity objectives. BCPs are often related to a firm’s management systems and processes.¹³⁹

Contingency planning: a management process that analyses disaster risks and establishes advance arrangements for timely and appropriate responses. Contingency planning is an important part of overall preparedness. Contingency plans need to be regularly updated and the implementation of the plans needs be practiced before disasters.¹⁴⁰

Critical infrastructure: utilities and public works essential to economic security, productivity of firms, public health, and safety. Key lifeline infrastructure includes water, sanitation, electricity, transportation and communication^{141,142} (Hallegatte, Rentschler, and Rozenberg 2019). The report uses “lifeline infrastructure” interchangeably with “critical infrastructure.”

Disaster: a serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability, and reduced capacity, leading to losses and impacts in one or more of the following realms: human, material, economic, and environmental.¹⁴³ The effect of the disaster can be immediate and localized, but is often widespread and could last for a long period of time. Disasters create emergency situations.

Disaster damage: damage occurring during and immediately after a disaster. Disaster damages are usually measured in physical units (e.g., square meters of housing, kilometers of roads, etc.), and describe the total or partial destruction of physical assets, the disruption of basic services, and damages to sources of livelihood in the affected area.¹⁴⁴

Disaster impact: the total effect, including negative effects (e.g., economic losses) and positive effects (e.g., economic gains), of a hazardous event or a disaster.¹⁴⁵ The term includes economic,

137 From: ISO 22301:2019. (en) Security and Resilience—Business Continuity Management Systems—Requirements, <https://www.iso.org/obp/ui/#iso:std:iso:22301:ed-2:v1:en>

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140 From: <https://www.undrr.org/terminology/contingency-planning>.

141 From: <https://www.cisa.gov/critical-infrastructure-sectors>.

142 From: https://www.law.cornell.edu/definitions/uscode.php?width=840&height=800&iframe=true&def_id=42-USC-1066716883-1185975015&term_occur=999&term_src=

143 From: <https://www.undrr.org/terminology/disaster>

144 From: <https://www.undrr.org/terminology/disaster>

145 From: <https://www.undrr.org/terminology/disaster>

human, and environmental impacts, and may include death, injuries, disease, and other negative effects on human physical, mental, and social well-being.

Disaster mitigation: “the lessening or limitation of the adverse impacts of a particular incident caused by hazards and related disasters.”^{146,147} Disaster mitigation measures include engineering techniques and hazard-resistant construction as well as improved environmental and social policies and public awareness. It should be noted that in climate change policy, “mitigation” is defined differently, being the term used for the reduction of greenhouse gas emissions that are the source of climate change.

Disaster risk: “the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity.”¹⁴⁸

Disaster preparedness: “knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions.” Preparedness action is carried out within the context of disaster risk management and aims to build the capacities needed to efficiently manage all types of emergencies and achieve orderly transitions from response to sustained recovery.¹⁴⁹ Also known as readiness, disaster preparedness measures include activities decided prior to an incident and that support prevention of, protection and recovery from disasters.¹⁵⁰

Disaster recovery: “the restoring or improving of livelihoods and health, as well as economic, physical, social, cultural and environmental assets, systems and activities, of a disaster-affected community or society, aligning with the principles of sustainable development and ‘build back better’, to avoid or reduce future disaster risk.”¹⁵¹

Disaster response: “actions taken *directly before, during or immediately after a disaster* in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.”¹⁵²

Emergency preparedness: “measures and action taken *in advance* to mitigate the effects of possible destructive events. This includes drawing up a disaster response plan.”¹⁵³

Emergency response: “immediate phase in the aftermath of an event, consisting of gaining control, limiting the extent of the emergency and minimizing further damage.”¹⁵⁴

Emergency preparedness and response plan (EP&R): documented information that guides an organization to manage emergencies by emergency preparedness and response.¹⁵⁵

146 From: <https://www.undrr.org/terminology/mitigation>.

147 From: <https://www.iso.org/obp/ui/#iso:std:iso:22300:ed-2:v1:en:term:3146>.

148 From: <https://www.undrr.org/terminology/disaster-risk>.

149 From: <https://www.undrr.org/terminology/preparedness>.

150 From: <https://www.iso.org/obp/ui/#iso:std:iso:22300:ed-2:v1:en:term:3172>.

151 From: <https://www.undrr.org/terminology/recovery>.

152 From: <https://www.undrr.org/terminology/response>.

153 From: ISO 21110:2019(en) Information and Documentation—Emergency Preparedness and Response <https://www.iso.org/obp/ui/#iso:std:iso:21110:ed-1:v1:en>.

154 From: ISO 21110:2019(en) Information and Documentation—Emergency Preparedness and Response <https://www.iso.org/obp/ui/#iso:std:iso:21110:ed-1:v1:en>.

155 Definition developed by authors based on ISO 21110:2019 terms and definitions used in the World Bank operations. <http://documents.worldbank.org/curated/en/895671585952003880/text/Ghana-COVID-19-Emergency-Preparedness-and-Response-Project.txt>.

Firm: a discrete entity that operates and creates value based on the collection of resources, capabilities, or routines that generate value, and buys and sells good and/or services in the market to make a profit. A firm is predicated on systems of law governing contract and exchange, property rights, and incorporations. It generally takes one of three forms: individual proprietorships, partnerships, or limited-liability companies (or corporations). In this report, “firm” is interchangeably used with “business,” “business enterprise,” and “business organization.”

Global value chain (GVC): refers to the “series of stages required to produce a good or service that is sold to consumers, with each stage adding value and with at least two stages conducted in *different countries*” (World Bank 2020). A manufacturing eco-system of a bike, which is assembled in Finland with parts from Italy, Japan, and Malaysia and exported to the Arab Republic of Egypt, is an example of a GVC. By this definition, a country, sector, or firm participates in a GVC if it engages in (at least) one stage of a GVC (World Bank 2020).

Geological or geophysical hazards: natural hazards that originate from internal earth processes. Examples are earthquakes, volcanic activity and emissions, and related geophysical processes such as mass movements, landslides, rockslides, surface collapse, and debris or mud flows. Hydrometeorological factors are important contributors to some of these processes. Tsunamis are difficult to categorize; although they are triggered by undersea earthquakes and other geological events, they manifest as oceanic processes and cause coastal water-related hazards.¹⁵⁶

Hazard¹⁵⁷: refers to a process, phenomenon, or human activity that may cause loss of life, injury, or other health impacts, property damage, social and economic disruption, or environmental degradation. Hazards may be natural, anthropogenic, or socio-natural in origin. Natural hazards are predominantly associated with natural processes and phenomena. Several hazards are socio-natural, in that they are associated with a combination of natural and anthropogenic factors, including environmental degradation and climate change. According to the Sendai Framework on Disaster Risk Reduction 2015–2030, hazards include (in alphabetical order) biological, environmental, geological, hydrometeorological, and technological processes and phenomena.

Hydrometeorological hazards: hazards of atmospheric, hydrological, or oceanographic origin. Examples are tropical cyclones (also known as typhoons and hurricanes); floods, including flash floods; drought; heatwaves and cold spells; and coastal storm surges. Hydrometeorological conditions may also be a factor in other hazards such as landslides, wildland fires, locust plagues, epidemics, and in the transport and dispersal of toxic substances and volcanic eruption material.

Industrial parks: also known as economic zones, industrial areas, industrial zones, industrial investment regions, special economic zones, industrial corridors, etc. Industrial parks are planned, developed and managed for the purpose of industrial and associated commercial, infrastructure, and service activities. Through the grouping of firms in a defined location, industrial parks offer collaborative and efficiency gains.¹⁵⁸

Industry: formed through various sectors that consist of firms or organizations that produce goods or services. Many sectors make up a country’s industry, which contributes to the economy. Industries and sectors are not discrete entities, whereas a firm is. Sector refers to the classification or high-level grouping of the (changing) composition of economic activities based on the types of goods and services produced.¹⁵⁹

156 From: <https://www.undrr.org/terminology/hazard>.

157 From: <https://www.undrr.org/terminology/hazard>.

158 For more information, see World Bank, An International Framework for Eco-Industrial Parks (Washington, DC: World Bank, 2017), <http://documents1.worldbank.org/curated/en/429091513840815462/pdf/122179-WP-PUBLIC-AnInternationalFrameworkforEcoIndustrialParks.pdf>.

159 From: <http://pubdocs.worldbank.org/en/538321490128452070/Sector-Taxonomy-and-definitions.pdf>.

Industry sector: corresponds to the industrial activities related to mining and quarrying, manufacturing, electricity, gas, water supply, and construction.¹⁶⁰

Industry competitiveness: the ability to compete in national or international markets, which can be measured at the firm, sector, or country level in terms of productivity, skills, innovations, reputation, net exports, and investment flows, that affect economic performance (Deloitte 2016; Kechichian et al. 2016; UNIDO 2019; McKinsey & Company 2012). Industry competitiveness can be expressed and assessed at various levels, including:

- **Firm-level competitiveness:** a firm or business is considered competitive if it can innovate, and produce better and higher-quality products or services at more competitive prices, and more reliably than its domestic and international competitors both during normal times and disasters, thereby increasing trust from customers, market demand, revenues, and reputation in the long term. Firm-level competitiveness can be measured in terms of sales values or global market size.
- **Sectoral-level competitiveness:** how attractive different countries are for a particular sector. This is often measured in terms of tangible economic performance in international trade such as net exports, investment flows, and so on, as well as intangible performance measures such as brand recognition, reputation, and attractiveness. Industrial policy, supply chain linkages, standards and the availability of raw materials are among the key drivers of sector-level competitiveness.
- **Country-level competitiveness:** the capacity of countries to compete in international or domestic markets, expand their market opportunities, and help private/industry sectors innovate and create jobs.¹⁶¹

Industry resilience: the ability of industry (including manufacturing sectors) and industrial parks to increase competitiveness by minimizing losses and damages, and achieving continuity and growth in the face of ever more frequent and intensifying disasters.

Manufacturing: the making of goods or wares through manual labor or with machinery, especially on a large scale.¹⁶² **Manufacturing sector** includes industrial activities related to manufacturing of automobiles, food products and beverages, textiles and apparel, electronic products, electrical machinery, wood products, refined petroleum products, and chemicals and chemical products, etc. The scope of manufacturing sector activities varies by country.¹⁶³

Multi-hazard: the range of hazards that a country faces. It also means the specific contexts in which hazardous events may occur simultaneously, cascadingly, or cumulatively over time, and takes into account potential interrelated effects.¹⁶⁴

Nonstructural measures: in the context of disaster mitigation and preparedness, nonstructural measures are those that do not involve physical construction, but that use knowledge, practices, or agreements to reduce disaster risks and impacts, in particular through policies and laws, public awareness raising, training, and education. Common nonstructural measures include building codes, land-use planning laws, research and assessment, information resources, and public awareness programs.¹⁶⁵

160 From: <https://data.worldbank.org/indicator/NVIND.MANFKN>.

161 From: <https://www.worldbank.org/en/topic/competitiveness/overview>.

162 From: <http://pubdocs.worldbank.org/en/538321490128452070/Sector-Taxonomy-and-definitions.pdf>.

163 The World Bank's definition of the manufacturing sector follows the International Standard Industrial Classification of All Economic Activities (ISIC) Rev. 3, Divisions 15–37.

164 From: <https://www.undrr.org/terminology/hazard>.

165 From: <https://www.undrr.org/terminology/structural-and-non-structural-measures>.

On-site infrastructure: infrastructure provided by a developer inside an industrial park. Types of infrastructure may vary but generally include internal roads, utilities (captive power plants, common effluent treatment plants, sewage treatment plants, and water supply networks, telecommunications, etc.) coastal defense, common facilities such as warehousing, factory buildings, emergency response facilities such as fire stations and disaster/emergency shelters, and so on. On-site infrastructure also includes social infrastructure, childcare facilities and services, medical facilities, schools, and safety and security systems.

Off-site infrastructure: the infrastructure and utilities provided outside an industrial park by government authorities, including public utility, transport, and other infrastructure connections. Off-site industrial infrastructure often provides services to surrounding cities and communities. Ports are often located close to industrial parks, and also considered important off-site infrastructure that services industries.

Small and medium enterprises (SMEs): definitions of SMEs vary by country. The World Bank Group defines a firm as an SME if it meets two of the following three requirements: (i) has fewer than 300 employees, (ii) has less than US\$15 million in assets, and (iii) has less than US\$ 15 million in annual sales. As some financial institutions are unable to report data based on any of these three criteria, loan size is also used as a proxy. In such cases, a firm is considered an SME if the size of its outstanding loan from a financial institution is less than US\$1 million.¹⁶⁶

Structural measures: in the context of disaster mitigation and preparedness, structural measures are any physical construction to reduce or avoid possible impacts of hazards, or the application of engineering techniques or technology to achieve hazard resistance and resilience in structures or systems. Common structural measures for disaster risk reduction include dams, flood levees, ocean wave barriers, earthquake-resistant construction, and evacuation shelters.¹⁶⁷

Supply chain: a network of connected and interdependent firms and business organizations mutually and cooperatively working together to control, manage, and improve the flow of products, services, finances, and/or information from suppliers to end customers/users (Sheffi 2005; Christopher 2011; Mentzer et al. 2001). Supply chains include all production activities, functions, and facilities of upstream (firms that are distant from end users) and downstream suppliers (firms that are close to customers and end users), including multinational manufacturing firms and global buyers/retailers.

Value chain: a term coined by Michael Porter (Porter 1985) that refers to the full range of value-adding activities required to bring a product or service through different phases of production, including design, production (e.g., procurement of raw materials and other inputs, assembly, and physical transformation), marketing, distribution (e.g., acquisition of required services such as transport or cooling), and ultimately response to consumer demand (Webber and Labaste 2009).

Vulnerability: “the conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.”¹⁶⁸

166 From: <https://databank.worldbank.org/data/download/g20fidata/G20%20Set%20Methodology.pdf>

167 From: <https://www.undrr.org/terminology/structural-and-non-structural-measures>.

168 From: <https://www.undrr.org/terminology/vulnerability>.

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World Bank Finance, Competitiveness and Innovation Global Practice

The World Bank Group's Finance, Competitiveness & Innovation Global Practice (FCI) combines expertise in the financial sector with expertise in private sector development to foster private-sector led growth and help create markets in client countries. Its work on Competitiveness focuses on four areas: firms, entrepreneurship and innovation; markets and technology; investment and competition; and business regulations. This area of work helps promote entrepreneurship and small business development, support business environment reforms as well as investment policies. The work also focuses on sector-specific policies, value chains and product markets, looking in particular at how new technological disruptions affect market structures and sectoral policies and regulations. Website: <http://www.worldbank.org/en/topic/competitiveness>

World Bank Tokyo DRM Hub

The World Bank Tokyo Disaster Risk Management (DRM) Hub supports developing countries to mainstream DRM in national development planning and investment programs. As part of the Global Facility for Disaster Reduction and Recovery, the DRM Hub provides technical assistance grants and connects Japanese and global DRM expertise and solutions with World Bank teams and government officials. The DRM Hub was established in 2014 through the Japan–World Bank Program for Mainstreaming DRM in Developing Countries—a partnership between Japan's Ministry of Finance and the World Bank. Website: <https://www.worldbank.org/en/programs/tokyo-drm-hub>

GFDRR

The Global Facility for Disaster Reduction and Recovery (GFDRR) is a global partnership that helps developing countries better understand and reduce their vulnerabilities to natural hazards and adapt to climate change. Working with over 400 local, national, regional, and international partners, GFDRR provides grant financing, technical assistance, training, and knowledge sharing activities to mainstream disaster and climate risk management in policies and strategies. Managed by the World Bank, GFDRR is supported by 36 countries and 10 international organizations. Website: <https://www.gfdr.org/en>

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RESILIENT INDUSTRIES IN JAPAN

Lessons Learned in Japan on
Enhancing Competitive Industries
in the Face of Disasters Caused
by Natural Hazards