SUPPLY CHAIN RESILIENCY:
A CASE OF MUSASHIMURAYAMA CITY, TOKYO PREFECTURE, JAPAN

Graduate Research Paper

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Abstract

Japan is the leading country in the effective response to natural disasters. Their supply chain process is resilient with national, prefectural, and local involvement. This study looks in-depth into one city in Japan, Musashimuraya's disaster prevention plan to understand their supply chain processes and preparations. From the initial supply and resupply system, the city has utilized its capacity and partnerships with the local organizations, associations, private businesses, and communities to provide a unified response. It describes their plan from the initial 72-hours after a disaster, shelter management, standard commuter support, and lifelines recovery. Their mutual support agreements are an essential factor contributing to response and recovery. All government documents and outside entities are evaluated and determined that the city's supply chain is ready and resilient to respond to future disasters.

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Meyliana H. Tongko

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SUPPLY CHAIN RESILIENCY: A CASE OF MUSASHIMURAYAMA CITY, TOKYO PREFECTURE, JAPAN

I. Introduction

Motivation

Natural disasters such as tropical cyclones, tsunamis, droughts, earthquakes, and volcanoes frequently occur in the pacific region. According to the 2019 Asia-Pacific Disaster Report, the total average annual loss (AAL) is around $148,866 million. Asia and Pacific's natural disasters are mainly from earthquakes (34%), floods (33%), tropical cyclones (32%), and tsunamis (2%). Japan represented 64% of the earthquakes, 47% cyclones, and 91% tsunami. Since the 1970s, the global death toll has been about 59% (around two million people) and an economic loss of $1.5 trillion. There is also an increasing number of people affected, those who need immediate lifesaving and essential survival assistance such as water, food, shelter, sanitation, and emergency medical. In Asia and the Pacific, roughly 142 million people are affected versus 38 million people for the rest of the world. Asia and Pacific countries also sit above the Ring of Fire, where the movement of tectonic plates contributed to 90% of the world's earthquake and its associated tsunami. These fault lines threaten critical infrastructures such as road networks, airports, and ports essential to supply distribution and evacuations (ESCAP, 2019: 2-22). In addition to climate change, the region could reach a tipping point beyond capacity to respond, and there is an urgent need to build greater resilience. The report suggested areas that a country should invest in to promote Disaster Risk Reduction (DDR). Investment in

critical infrastructure such as roads and housing to include land planning and post-disaster reconstruction is one of the focus areas to improve resiliency (ESCAP, 2019: 71).

The United Nations adopted the Sendai Framework to provide international guidance on disaster risk management and reduction by 2030. The previous guidance, the Hyogo Framework (2005-2015), highlighted vulnerability such as rapid urbanization, poor land management, weak policies, lack of incentive for private investment, complex supply chain, limited technology, and many others. The gaps indicated a requirement to foster disaster resilience and implementation at all levels. The new priority areas are (1) understanding risk, (2) strengthening governance to manage risk, (3) investing in risk reduction, and (4) enhancing preparedness and "build back better" in recovery. This 15 years development plan is for the international leaders and aims to reduce disaster and global mortality rates (UN, 2015). They developed an online self-monitoring system to measure the framework implementation. The seven global targets and 38 indicators that the member states measured against will determine global risk reduction and losses trends. In 2020, 195 countries reported this effort (UNDRR, 2021).

Disaster can occur at any time without warning and is dangerous to life and property. Disaster management cycles are cyclical, starting from preparedness, response, recovery, and mitigation phases. The stages incorporate shaping public policies and plans, embracing development, and immediate response and recovery (Nikam, 2018:70). A disaster supply chain is uncertain, complex, and dynamic. Having a solid resilience to the supply chain system is of utmost importance, which, accordingly, needs to be fast, agile, and flexible. Oxford dictionary defines resilience as the "ability to recover quickly...such as shock" (Oxford, 2021). Sheffi (2007) expanded that supply chain resilience is not only to bounce back but also to manage risk, be better positioned, and gain advantage from the disruption. We can achieve resiliency by

creating redundancy, flexibility, and cultural adjustment. Without supply chain resilience, damages could cascade to a catastrophic level (Sheffi, 2007). Franklin and Todt (2014) emphasized that long and wide disasters have a greater chance for recovery, not rebound back to normalcy. There is a need to immediately repair and reconstruct capital stock to start, shorten recovery, and affect favorable survival rates. Many governmental agencies' traditional emergency planning model has an inherent weakness since their focus is post-disaster resource management. They seek to predict the requirement stockpile storage location after a disaster, often too late (Franklin & Todt, 2014). Those affected individuals often forced to live in those crisis conditions are often fall too deep into poverty and become more vulnerable (Nikam, 2018:15). Humanitarian logistics and supply chain management are essential factors in disaster relief. The final and critical stage of disaster relief is known as the "last mile distribution," the delivery from local distribution centers to the affected personnel. The main problems are destabilizing infrastructure, transportation resources and emergency supplies limitation, relief actors' lack of coordination, and insufficient demand information (Decker, 2014: 1).

Problem Statement

There are only minimal research on the disaster supply chain process and preparation at the city (local) level, where many response actions begin. The resilience of the local supply chain will drive many of the additional requirements at the national level. In emergency times, the local government and citizens will need to be self-sufficient at least for the first 72-hours before outside help arrives. Many communities have many vulnerabilities, and a weak disaster plan will result in non-functional and non-cost effective management. Understanding local emergency

plans to ensure continuing essential operations is key to continuous improvement of disaster response.

Research Question

This case study examines a city in Japan, Musashimurayama's disaster supply chain process and preparedness. Specifically looking at existing distribution hubs, supply chain processes during emergencies, and collaboration with private sectors to improve supply chain resiliency. This study aims to identify weaknesses and strengths of the local emergency plan to identify lessons learned that can help policymakers and planners reduce the risks and devise a prevention and resilience culture.

The expected outcome is that the city has a resilient supply chain supported by national, regional, private industry, humanitarian organizations, and its community. The city will have support agreements to continue support and a system to keep at least the first three days after a disaster.

Methodology

This study will review their local, Japan's national and the Tokyo Metropolitan government emergency plan. Any notable cases from other organizations such as private and non-governmental businesses and associations are used to provide an example of what support it can provide to the city's plan.

The city of Musashimurayama is selected due to its proximity to a United States military installation. Understanding the city plan will also help the military planner tailor their support. The city also has not responded to a significant disaster, and, thus, evaluating their preparedness

will benefit an outside perspective of their disaster plan. The primary means of data collection are the open-source government documents available from their websites. Since the documents are strictly in Japanese, translation is done using a translator application (mainly Google Translate).

Thesis Organization

This research is organized in four chapter. Chapter II will cover literature review of existing and recent research on humanitarian supply chains and building resilience. Chapter III covers the data and analysis of the city's emergency disaster plan. Chapter IV is the discussion and conclusion of this research.

II. Literature Review

Overview

This chapter will review recent and previous research on humanitarian supply chain resiliency. It looks into what makes the supply chain resilient, reasons why the supply chain fails, and lessons learned from the previous disaster to improve on.

Supply Chain Impact from the Great East Japan Earthquake

The 2011 Great East Japan Earthquake (henceforth 3-11) is an extensively investigated disaster on its in-network structural changes and recovery rates. A supply chain disruption is the disturbance of the normal flow of goods due to an unanticipated event (Son et al., 2021). The damage of the 8.9-magnitude earthquake and the subsequent nuclear meltdown resulted in catastrophic supply chain disruption. It destroyed or damaged social infrastructures, such as

roads, railways, dams, ports, and power plants. This disaster disrupted Japan's domestic and global supply chain, decreasing production activities, increasing component prices, and resulting in many shut down operations, including those in the United States. The 3-11 disaster is unique compared to other severe earthquakes in Japan since it hit the Kanto and the Tohoku regions with more complex supply chain linkages. Researchers found that the decline in production in the indirect earthquake areas was due to forward linkage effects. Intermediate imperfect substitute for goods is more significant than the areas with direct earthquake damages; thus, supply chain diversification is essential. This research also highlighted having a comprehensive and diversified supply chain network in other regions of Japan helps with faster recovery (Tokui, Kawasaki, & Miyagama, 2017).

Todo, Nakajima, and Matous (2014) also emphasized the supply chain network's effects on firms' recovery during the 3-11 earthquake. They hypothesized that firms with extensive supply chains have higher network distribution vulnerability, negatively affecting their recovery. Toyota and Honda had to minimize or halt production at plants unaffected by the earthquake such as those in the United States since supplies and parts were coming from the impacted area were disrupted. However, this disruption is not always harmful, for often, impacted firms can find new partners from the information sharing of the supply chain networks changing the structural network.

Changes to Supply Network during a Disaster

Son et al. (2021) confirmed a structural supply network change after catastrophic disruptions. They found that firms reduced their network complexity once they experienced distresses. This structural change may be due to temporary difficulties in keeping existing and

attracting new consumers. Customers will have unplanned expenses, limited access to financial resources, and trouble liquidating their cash. Firms are projecting to deplete their funds and not create new customer ties. Multiple firms in the same industry will rush to secure supply and reduce the supplier's capacity allocated to the focal firm. An extensive network also means high coordination costs during the recovery period. Their study also suggested that redundancy in their supplier may be more beneficial during growth versus decline periods since the complexity of managing resources may overwhelm the system. Their finding implies that both firms and customers prefer maintaining less complex supply chain networks since there is a high level of interdependencies in managing its risks. A less complicated network promotes closer partner relationships that are useful in responding to catastrophic disruptions in the supply chain. A complex supply network can be advantageous during regular business but impedes the crisis. Companies should balance, anticipate and plan for the structural changes after disruptions.

Joint Reserve Disaster Supplies

Zhang et al. (2017) researched the most effective way to process an order and distribute emergency supply materials between rescue agencies managed by the government in China and relief organizations to the affected area. Typically, the government will store relief materials in predetermined facilities, package them, and transport them to disaster areas, with an expensive overhead cost. Relief organizations usually support post-disaster in providing supplies through a time-consuming procurement. Additionally, suppliers to the relief organizations will process the order after the disaster and transport the supplies directly to the affected areas. All modes have issues in meeting immediate needs after a disaster. Their study suggested that the best model is a joint reserve maintained by the government and the suppliers for resupply agreement. This way,

the government can focus their stocked supplies on the most urgent need. The framework with the suppliers will consist of a deal of a certain amount of initial resupplies to the government distribution center. This agreement effectively keeps the government storage cost and supply expenditure low and optimizes rescue efforts.

Humanitarian Supply Chain Resilience

Xu et al. (2021) investigated indicators affecting humanitarian supply chain resilience from a 2020 flood event in China. A humanitarian supply chain is a complex formation of initial assessment, diverse players, management, response, risk management, and supply support. Interrelationships are complicated, and decision-makers in the supply chain should actively cooperate among stakeholders, ensure effective communication and transmission of information, and develop joint strategic plans. Flexibility at different stages of a disaster event is also essential since there will be varying demand throughout the crisis. Early vigorous cooperation among stakeholders is also essential for timely relief. Building trust and collaboration are complex since there are different goals and expectations. Much research in humanitarian supply chains has increased in recent years, highlighting the need for resilience. The application of commercial supply chain management to humanitarian time was also examined and determined possible application to improve performance. Transportation capacity, human resources, standardization of data and distribution, and in-transit visibility are some factors to bolster resilience.

The Last Mile Distribution

Decker (2014) looked into the last mile distribution of the supply for disaster relief. The main objective is to deliver the right amount at the right time and to the correct location/recipient

while saving money and resources. There are many types of supply chain setup depending on the kind of disaster and stakeholders involved. The public sector stakeholders make up can be governmental agencies and the military. The private sector is service providers, corporations, suppliers, and individual stakeholders. The society itself is a stakeholder, as they impact the private donations and non-governmental organization (NGO) support. Ineffective coordination among these stakeholders' efforts will result in conflict, hurting the overall operations. Logistical challenges during disaster time include the donations characteristics, for example, financial and in-kind contributions, procurement and pre-positioning, and governmental restrictions causing refusal of aids. Many world institutions have aligned their efforts to solve the problems mentioned above. The Fritz Institute, a non-profit organization, had hosted an annual Humanitarian Logistics conference to increase recognition of logistics in the humanitarian sector. Since 1992, Pan American Health Organization (PAHO) and World Health Organization (WHO) created the Humanitarian Supplies Management System (SUMA) to manage inbound supplies distribution priorities (PAHO, 2013). The United Nations has set up a strategic global network of six hubs worldwide to hold pre-position relief reserves to support authorized organizations. The World Food Programme (WFP) manages these depots are called the United Nations Humanitarian Response Depot (UNHRD). Due to their disaster-prone areas' proximity and transportation connection, they chose the hubs in Brindisi, Italy, Accra, Ghana, Kuala Lumpur, Malaysia, Panama City, Panama, Las Palmas, Spain, and the Dubai, United Arab Emirates (WHP, 2021). The last mile's infrastructure has many challenges, unpredictable or unknown distribution and demand, and insufficient decision time often lead to supply availability and transportation capacity constraints. Close coordination among stakeholders is imperative but has been the fundamental weakness. UNHRD has helped somewhat, but many parts need

optimization since there is no singular coordinating authority. The private sector pays extra attention to the last mile distribution difficulty because it affects customer loyalty and satisfaction. It is also the most expensive part of the supply chain accounting for up to 75% of the total logistics cost. The academic literature has also looked at this problem to innovate a more efficient and cost-effective solution. Some optimization areas include improving in-transit visibility (ITV) through the use of Intelligent Transportation Systems (ITS), alliances between the supplier and buyer, and the use of 3PL providers (Decker, 2014: 6-24).

Collaborative Networks

Another important factor in supply chain resilience is building collaborative networks. Strong supply chain partners are the "glue" that holds them together during a difficult time. Firms' networks possess diverse resources and capabilities. They have a market advantage that can reduce uncertainties. Their ability to collaborate vertically with retailers, processors, growers, and wholesalers and horizontally with competitors and governments allows them to recombine or co-create resources. Mutual dependence enables information sharing and communication to help deal with the disturbance. Vertical collaboration, such as the same horizontal level competitors, shares resources and information that often supports each other financially and finds a common solution. The research also shows that government support in food supply networks increases supply chain resilience. A high level of trust is also essential to achieving alignment, agility, and adaptability (Umar & Wilson, 2021).

III. Results and Analysis

Background

To understand Japan's natural disaster hazards, first, we need to understand its geography. Japan sits on a narrow land around 2,000 km from north to south with steep mountains longitudinally. Only 27% of the total land area is populated, and the rest (73%) is not. Japan's annual precipitation (rain) is about two times higher than the rest of the world. Their rivers are steep and short, so floods and landslides threaten heavy rainfalls. Many of their city's plains are lower than the river level, frequently overflowing and causing flooding. 51% of the land is in the heavy snowfall territory and habited by 15% of its population. Deep snowfalls will paralyze public traffic and isolate many villages (MLIT, 2017a).

According to the NOAA's National Ocean Service, about 15 to 20 moving tectonic plates are in the world (NOAA, 2021). Japan has four plates that converge and produce around 2,000 fault lines. The rest of Japan lies on the "ring-of-fire," where the high seismic (about 18.5% of the world earthquake) and volcanic activities (roughly 7%) occur (Japan Cabinet, 2021). Since multiple natural disasters have hit Japan frequently, its government has extensively researched and forecasted catastrophic earthquakes and tsunamis in various boundaries of Japan Island within the next 30 years. The two most destructive predictive earthquakes are the Nankai Trough (magnitude 8 or 9) and Tokyo Inland (magnitude 7) earthquakes (MLIT, 2021b).

Nankai Trough is a Pacific Ocean floor trench on the coast of Japan, extending from Shizuoka to Kyushu, where the Philippine Sea plate sinks under the Eurasian plate. The predicted mega-earthquake interval is between 100 to 150 years, and the last record was in 1946 (75 years ago). The biggest concern of this earthquake is the triggering successive large quakes across Japan (Nippon, 2019). Japan's Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) has estimated approximately 323,000 deaths, 40,000 people require rescue, and 170

trillion yen (estimated 1.5 trillion dollars) in economic impact for the Nankai Trough earthquake (MLIT, 2021).

The Tokyo metropolitan sits on two tectonic plates: the Pacific plate from the east and the Philippines from the south. If Japan's Southern Kanto tectonic plates spring up, anticipate for Tokyo to sustain between M7 to M8 class earthquake (TMG, 2020b). Tokyo estimated that the Kanto area earthquake would occur between 200 to 400 years, where Tokyo will be the epicenter. The Tokyo Inland earthquake (M7.3) predicted hitting the northern part of Tokyo bay directly and causing significant damage. The damage will occur around the central Tokyo densely populated area, with an estimated 180,000 houses collapsing, 410,000 wooden homes destroyed by fires, up to eight million stranded commuters, massive transportation delays, and damages (MLIT, 2021). The last activity for these tectonic plates was the Great Kanto Earthquake in 1923 around almost 100 years ago off the southwest coast of Tokyo, in Sagami Bay. The earthquake's magnitude was around 7.9 and 8.4 on the Richter scale, along with typhoons, firestorms, winds, and tsunamis resulting in over 100,000 deaths and 2 million homeless (Japan Visitor, 2021). TMG's added concerns are wind and rain damages, especially urban flooding, torrential rain damages, and typhoons. Another consideration is volcanic eruption since 21 active volcanoes out of 111 nationwide are in Tokyo. Tsunamis are another regard as seas surround them with an estimated maximum tsunami height of 30.16+ meters to their minor islands, and 2.48+ meters around the Tokyo coast (TMG, 2020b).

The liquefaction of its soil after an earthquake is another concern. After vigorous shaking, the ground saturated soil loses its strength and cannot support the building foundations. Liquefied soil pressure can also tilt and destroy ground surfaces, cause landslides, and collapse dams (Johansson, 2000). Although there is little chance that this hazard directly affects the loss

of human lives, it most likely affects their lifeline facility such as gas, water, sewerage, and electricity). Due to this, Japan developed hazard maps that guide the development of bridges and levees (TMG, 2020b).

Japan National Disaster Guidance

The 1961 Disaster Countermeasures Basic Act guides Japan's disaster management framework from prevention, preparedness, response, recovery, and reconstructions. Central Disaster Prevention Council is the lead for policy development. Its chair is the prime minister and his entire cabinet, including the Minister of State of Disaster Management, heads of public institutions, and other experts. The act designated public corporations such as utilities, transportation, and communication (radios and televisions) as a part of the national plan to support the citizens. It directs at all government levels to develop a disaster prevention and communication plan back to the central government (National Land Agency, 1997). Since there are many impending risks of Japan's natural disaster occurrence, it is crucial to investigate and continuously advance its disaster resilience.

Musashimurayama City Statistics

Tokyo metropolitan comprises 23 special wards (known as Tokyo wards) and 39 municipalities, consisting of 26 cities, five towns, and eight villages (TMG, 2006a). The city of Musashimurayama, sponsoring the United States' Yokota Air Base, is a suburb of the Tokyo Metropolitan Prefecture. The city is located in the north-central of Tokyo and has around 71,951 people as of September 2021. The total area is 15.32 square kilometers (5.9 square miles) and 120 meters above sea level. The Sayama Hills, a city symbol that runs from west to east in the

city's northern part. Two small rivers, Karabori, a part of the Ara river water system, and Zanbori, a streaming to a large Tama river, flow through the city. The city is urban agriculture and provides fresh food to surrounding local towns. (Musashimurayama, 2021).

Local Disaster Prevention Plan

The Musashimurayama City Regional Disaster Prevention Plan (2014), subsequently "the plan," detailed their preparation for future earthquake disasters. The city sits on the Musashino Plateau, a vast land between Tama and Ara rivers (Tokyo, 2021). The Tama (magnitude 7.3) and Tachikawa fault zones (magnitude 7.4) earthquakes, part of a Tokyo Inland earthquake, are likely to occur 60% to 70% in the next 30 years, with an estimate that the ground will rise by two to three meters. House and building collapse, fire, suspension of public transport, and lifelines interruptions are the predicted damages, along with an estimated 310 injured, 17 seriously injured or dead, and 32,922 evacuees. Lifeline damages estimates are at 28.7% power outages, 12.4% telephone interruption, 77.3% water supply outages, and 23% sewage pipe from the Tachikawa fault zone earthquake (Musahimurayama, 2014a:10-20).

The city, along with the prefectural government, created goals for disaster preparedness. The first goal is to decrease casualties by half through building improvements, preventing pieces of furniture from falling, and strengthening local rescue system capability. Additionally, to reduce fire casualties by promoting non-combustible, i.e., wood, buildings and enhancing or strengthening firefighting capability and citizens/business establishment responses. Moreover, to minimize injuries from walls collapsing. The second goal is to reduce the number of evacuees from houses collapsing and fires. The third goal is to ensure the safety of displaced people who

cannot return home. The city promotes stockpiling water and food for at least three days by local business establishments to assist with temporary stay (Musahimurayama, 2014a: 30-40).

According to the plan, the city is responsible for establishing disaster countermeasures, evacuation, and rescue systems; and promptly rebuilding the town in the event of severe damages caused by earthquakes. The citizens are responsible for ensuring their safety, disaster preparation, supporting the local community to rebuild, and participating in preparedness activities. The business operators are responsible for implementing the city's disaster countermeasures, cooperating with preparedness, cooperating with residents, and disaster prevention and response plan. It also emphasized that the city and business should have a Business Continuity Plan (BCP) to resume business as soon as possible (Musahimurayama, 2014a: 57-58).

Once a disaster occurs, the initial action is to establish a command and control headquarters in all levels of government. They will be responsible for information gathering, managing requests, deployment of disaster support to include support from the Japan Self Defense Force through the Tokyo Governor, and relief activities (Musahimurayama, 2014a: 83). Oslo Guideline is an international guideline for using foreign military and civil defense assets for disaster relief. It mentioned that these assets should only be requested as a last resort, where no comparable civilian alternative meets a critical humanitarian need. This agreement is also reinforced in the Asia-Pacific Regional Guidelines (OCHA ROAP, 2021:19). For the city-level headquarters, the mayor is the lead, and the location is the city hall of the central government building. The city headquarter will then contact all levels of officials such as Central, Prefectural, Ministries, adjacent city mayors, NGOs, and critical business leaders to ensure an open line of communication. Musashimurayama disaster prevention council, with its mayor as the chairman,

determines the scope and establishment of the city headquarters. Securing and understanding information will be one of the headquarters' primary roles. Some of the systems to be monitored and used are the earthquake early warning system, the national instant alert system (J-Alert), the emergency information network system (Em-Net), and the Tokyo Metropolitan Disaster Prevention Administration Radio (Musahimurayama, 2014a: 83). These lines are essential to receive and collect damage reports from the survey and investigation teams and transmission to the vital workers for actions. Including in this information is monitoring the supply distribution (Musahimurayama, 2014a: 94).

In the first 72-hours after disasters, the city's focus will be saving lives. The activities will consist of rescue, firefighting, medical relief, and securing transportation routes. The initial response teams will then be dispatched to the disaster prevention bases to stage the reception of evacuees. Musashimuraya has prepared thirteen disaster prevention bases (mostly in elementary and junior high schools) with food and other disaster supplies. The response team duties include: opening up the lines of communication with city headquarters, preparing evacuation center facility, managing stockpiles supplies logistics, and managing the center's operation (Musahimurayama, 2014a: 81).

If additional support is required, the mayor can reach out to the governor of Tokyo for prefectural help. As of 2021, there are 71 mutual support agreements with the surrounding cities, towns, villages, and local organizations such as medical associations, food and beverage, lifelines (gas, water, and electricity), real estate, malls, supply stores, broadcasting, and constructions (Musahimurayama, 2014a: 103). The city has a mutual agreement with Tachikawa and Hagashiyamato cities to use their evacuation centers. Japanese character that defines cooperation is "Yui." This spirit is strong among the Japanese population, where they feel

connectedness in difficult times and often join hands to help each other (JapanGov, 2015). The city encourages the development of disaster prevention organizations within their towns. The organizations are registered to the city and provide guidance and training to help with minimizing damages and injured personnel. Three principles of this organization are self, family, and community protection. As of 2021, there are 33 registered organizations (Musashimurayama, 2021b). Support agreement with private sectors is also fundamental to disaster response since private businesses are present before the crises and as they unfold. They can leverage their resources, expertise, channels, and influence to address the crisis needs (OCHA ROAP, 2021: 37). Examples can be seen during Great East Japan (3-11) Earthquake in 2011 from Lawson, a Japanese convenience store company, and Yamato Group also widely known as black cat transport, a parcel delivery company. Their CEOs made a call to disregard costs and profitability to support the community with food and relief goods delivery (Takeuchi, 2013).

Yamato supported delivery through their TA-Q-BIN, a next day or two shipping service anywhere in Japan, to include perishables (Yamato, 2021). According to Yamato's Business Continuity Plan (BCP), this service is a part of social infrastructure and will offer nonstop service even if a disaster happens. Their focus is "maximum priority on human life" and "continuation of the TA-Q-BIN business" (Yamato, 2013). Japan's convenience store is a part of Japan's lifestyle, providing an extensive range of goods and services. They typically operate 24 hours a day and have a daily delivery of stocks. After the 3-11 earthquake, they are regarded as essential services, and many chains have local support agreements. One of their most considerable functions during a disaster is to support displaced personnel by providing information, water, and toilets. The Japan Franchise Association promotes the Safety Station (SS) program, collaborating with the local government to use the stores as a safe shelter for the

community. The city provides police patrol to support this program (Naomi, 2013). As of January 2022, there are 55,956 convenience stores across Japan (JFA, 2022) and around 20 in Musashimurayama city.

Traffic regulation during a disaster is essential to secure emergency routes allowing lifeline service support to flow smoothly. The system must be flexible to adjust to any necessary changes. Alternative ways are also essential for redundancy and reliability. It is needed for a solid systematic preparation before and after the disaster, to include establishment, maintenance, and implementation of the system of operations (Iida, 2000). The city police department will be in charge of security. Its activities will include collecting traffic information, traffic management, and dissemination of information to victims, missing person investigation, and autopsy (Musahimurayama, 2014a: 108).

Musashimurayama City has designated two different areas to receive aid and supplies as their transportation bases. The wide-area base, one location in Tachikawa city, will accept supplies from other prefectures for temporary storage before delivering to the regional headquarters. The local transportation bases, seven bases in Musashimurayama city, will connect the delivery to the disaster area. If the local area is unreachable due to damage, the city has designated a university heliport as its alternative (Musahimurayama, 2014a: 112).

During disasters, each city department's vehicles will be consolidated and centrally managed by the disaster's countermeasure department and, as necessary, will also use them to support any disaster activities. If required, the department has the authority to procure vehicles. They are also in charge of the dispersal plan, determining rental fees, securing fuel sources, determining and certifying emergency support vehicles (Musahimurayama, 2014a: 114-115).

Since the immediate need is rescue activities, the priority of support from the city will be the fire department and emergency services such as police, ambulance, self-defense force, and voluntary organizations. If the local capabilities are overwhelmed, the city will submit a support request to the central government for a hyper-rescue task force, a Tokyo Metropolitan Government's advanced firefighter task force specialized in search and rescue (TMG, 2018d). If there is any shortage of equipment or vehicles, the city will procure locally from a prearranged agreement (Musahimurayama, 2014a: 116).

Medical relief support is another crucial function in protecting lives and is expected to be significantly reduced due to mass confusion and outages. The city will prioritize efforts to help the victims while working closely with disaster prevention organizations (Musahimurayama, 2014a: 127). The city will initially dispatch its medical team and the assistance of the local medical, dental, pharmacist, and osteopathic association as required. The city will also work closely with Tokyo Disaster Medical Assistance Team (DMAT), a medical team that will respond to the disaster rescue scene medical emergency alongside the Tokyo fire department (Japangov, 2015). It comprises a doctor, two nurses, and a medical coordinator and takes about five minutes to dispatch to the disaster site, typically within the first 72-hour. The city's immediate response will also include obtaining medicine supply stockpiled in Tokyo, wide-area medical transportation, and opening an outdoor hospital (Musahimurayama, 2014: 127). If medical equipment and supplies are insufficient, the city will procure as needed. The medical association can utilize its reserves and bill the city later as an option. As of 31 March 2014, the city's stockpile inventory includes two sets of disaster medical equipment for about 1,000 people, 380 first aid kits, and 8,270 sheets (Musahimurayama, 2014a: 132). The city will establish the pharmaceutical stock center in cooperation with the pharmacist association, and supplies are

distributed based on requests from medical relief centers and institutions. The city center's initial job is to stockpile the necessary medicines within three days after a disaster. Resupply coordination with the pharmacist and wholesale medicine distributors occurs from day four and above supply. If the city and local distributor cannot support, the city will request the Tokyo Metropolitan Government's assistance (Musahimurayama, 2014a: 133).

Transportation of injured personnel will be based on the predetermined transportation order and coordination with the Tokyo Metropolitan Area Disaster Medical Coordinator. Based on support agreement, injured personnel will be transported either by the city's car, helicopter, or a request to the national government and related prefectures or cities. The city will handle the medical team's transport, equipment, and supplies. TMG has designated disaster base hospitals for secondary intermediate care for moderately ill patients outside the medical first aid station and city hospitals capability. TMG has designated 19 medical facilities in the surrounding areas and the city with one hospital (Musahimurayama, 2014a: 135).

The following essential action after saving lives is the management of evacuation shelters. Physical and mental health prevention activities in the evacuation centers are crucial. The city's care plan includes nurses, registered dieticians, and other necessary professionals. They provide mobile health consultations at the evacuation centers and other community areas. The team consists of environmental hygiene, food hygiene, and epidemic prevention group. Another important activity is to secure public baths and shower facilities, and are done through cooperation with public health centers. The securement of water is through designated disaster wells, rainwater storage tanks, etc. The team will also secure temporary toilets if there is a shortage in the centers (Musahimurayama, 2014a: 138 - 141).

The evacuation order typically comes down from the governor. If the danger is imminent, the police station or fire department can also provide a local order to the residents. The city police will also provide security guards at evacuation roads during fire and evacuation sites. The evacuation method is a two-step process to avoid confusion, typically led by the police or fire department. First, the evacuees temporarily gather in the nearest evacuation areas such as shrines, temples, parks, green spaces, housing complex open spaces, etc. before moving to the evacuation sites. This temporary area protects from dangers such as fire and falling objects (Musahimurayama, 2014a: 145-148). The city has designated 37 outdoor evacuation areas of 13 schools, 22 parks or playgrounds, one gymnasium, and one citizen center. If directed, the nearest (AEON) mall and farmlands can also be used as evacuation areas based on support agreement (Musahimurayama, 2021b). The evacuees will go directly to the evacuation shelters (Musahimurayama, 2014a: 142). Evacuation centers are typically indoor facilities for a longer-term stay due to a loss of a residence. There are 27 centers of 13 schools, six halls, seven centers, and one gymnasium. Two other metropolitan schools can be used based on support agreement (Musahimurayama, 2021b). The minimum size for an evacuation area is at least 2,000 square meters. The building must have a reinforced concrete and fireproof structure for an evacuation site in the school playground. Once designated as an evacuation area and shelter, the city will make efforts to improve the roads and facilities along the area to ensure the safety of the evacuees, for example, fire prevention water tanks and earthquake resistance road materials. The evacuation center requirement is two people per 3.3 meter square of living space. The city will also stockpile food, equipment, and material in the designated centers. Secondary evacuation centers, currently four, will support the elderly, disabled, and infants and provide medical and long-term care support. The city will pre-identify individuals and families that require this

support. The city will determine, procure and distribute water, food, and emergency supplies once the shelter's operation starts and until a system is established for each site. Once the disaster shelter is at total capacity, the city can request and coordinate a transfer move with the neighboring ward, city, town, or village (Musahimurayama, 2014a: 145-147).

Another concern of the city is stranded personnel who have difficulty returning home. Businesses and schools are guided to keep people and children in place to avoid confusion. Enhanced measures are necessary around the three of the city's train stations for an estimated one to three million stranded people. The "mutual help or Yui" concept is indispensable during this time and coordination with other prefectures, cities, wards, towns, villages, and private businesses. Business is encouraged to establish a plan for shelter-in-place, stockpiling food and emergency supplies at least three days, along with their employees. The city relies on local businesses for support in which they will help manage rest stations to help disseminate information and provide meals, water, and toilets to stranded people. Tokyo's capital has sixteen designated routes primarily for walking to their major cities. The city will ensure safe passage, such as no utility poles, free of barriers, etc. (Musahimurayama, 2014a: 155-159).

The city manages two emergency water storage facilities and can support the distribution of three liters of water per person for 500,000 people. They have secured 202 water supplies bases: stations, tanks, etc. Water trucks will retrieve water from the city bases and distribute it, serving evacuation areas within two kilometers of the residential complex. Medical and healthcare facilities' needs are prioritized when requested. Japan Self Defense Force is also expected to provide additional emergency water stations. The Tokyo Metropolitan Waterworks Bureau has established three water distribution locations for tap water.

The city sewerage division and volunteer group will begin the initial setup and distribution but desire the residents to take the operation. Residents are encouraged to bring their water containers to receive drinking supplies. The city is in charge of procurement, maintenance, testing, and upgrades of the city's water bases, pumps, taps, lighting equipment, etc. Their current inventory is 32 units of filtration devices, 50 units of emergency road water dispensers, 630 pieces of twenty liters tank, 15,050 sheets of five-liters water storage bag, 22 water buckets with lids, 25 pieces of an assembled one-ton water tank, four units of one-ton of water supply tank, two sets of other equipment (Musahimurayama, 2014a: 160-161).

The city expects a soup kitchen to be fully ready by the fourth day once the road is clear and restoration of the transportation system. Until then, the city prepares three days of food supplies for maximum evacuees of 14,939 and 9,711 living in evacuation centers. During the initial disaster, Staples food of crackers, rice, instant noodles, porridge, and formula milk powder will be the primary meal source. Resupply procurement of rice has been coordinated with the rice retailers' association. If unable to support, the city will request TMG to support procurement from other areas. Once the logistics are complete, the city will procure side dishes and consider handicapped, women, and children's needs. There are five collection points for the food supplies delivery, mostly in various cities' facilities. The city also will procure and stockpile supplies of daily necessities such as clothing, bedding, and others (Musahimurayama, 2014a: 62).

Waste disposal, urine treatment, and debris processing will occur immediately within the first hour after the disaster. Within the first 24 hours, temporary toilets for one per 75 evacuees and garbage collection points will be determined and set up. Residents are still responsible for garbage separation and delivery to the collection points. The city's environmental group is responsible for the operation plan and coordination with the garbage contractors. It is vital to use

the current four city's facilities to process garbage waste as much as possible. The city's goal is to stockpile temporary toilets and supplies for three days. Human waste will be delivered directly to the metropolitan reclamation center in Tama (Musahimurayama, 2014a: 168).

Debris from the disaster, such as wood, concrete, etc., will be used as much as possible for restoration and reconstruction. The urban development countermeasure department is responsible for developing the debris removal plan. Immediately after the disaster, they will work with the city's construction association and the Tokyo Civil Engineering Union branch to assist with debris removal and dismantling of collapsed buildings. In theory, the owner is responsible for their building dismantling by submitting a request to the city for a permit then finding a contractor for the job. The limit for search and rescue activities is a maximum of ten days. For extension in operation, the city will submit a request to the metropolitan office with a reason, and a specific number of bodies is needed. The city will set up a temporary corpse camp and assign a manager to provide the initial response for a maximum of ten days. Any identified corpse will be recorded and cremated coordinated. The city will keep the unidentified ones in storage for up to one year before moving them to the city's ossuary vault, storage for human skeletal remains. The mayor can request the metropolitan if additional assistance is required (Musahimurayama, 2014a: 178).

FEMA defined lifelines as operations "that enable critical business and government" and "is essential to human safety and health or economic security" (FEMA, 2019). The city's lifeline is water, sewage, electrical, gas, and communication facilities. The city aims for a complete recovery for water function within 30 days, tap water supply in three days, and purification functions. The sewage restoration plan is for the main facilities, branch pipes, and attachment pipes last. Installation and evacuation shelters are the priority for electrical restorations. The city

requests residents' support in reporting gas leaks to respond appropriately. The city has prepared mobile generators, digital satellite vehicles, portable satellite communication devices, and other materials and equipment for emergency measures and temporarily restoring communications facilities. The telecommunication restoration priority is in the following order: meteorological, flood control, disaster relief, police, defense, transportation, communication, electric power supply organizations. Secondary order is gas, water, government administration, newspapers and broadcasters, financials, any other national or local public organizations (Musahimurayama, 2014a: 183-188).

Major roads restoration is expected within three days. The city will work with Tokyo Metropolitan's Construction Office to collect damage reports on roads and bridges guide and provide technical support on emergency works. The goal of emergency restoration is to secure traffic and prevent the spread of the damage. Obstacles to emergency measures will be primary and outsourced to contractors. Urgent restoration orders include the collapse of revetments and natural river banks, risk of levee breakage, obstruction of running water, or any risk to the destruction of the riverbank (Musahimurayama, 2014a: 190).

The city will assess residential buildings and lands for damages to prevent secondary disasters from the aftershocks. Structures and areas will be categorized with stickers as “dangerous,” “need attention,” and “investigated.” The labels will be displayed in an easy to see places, i.e., entrance or exit, for better risk assessment. Once complete, the city can issue a disaster certificate and prepare an application for reconstruction support (Musahimurayama, 2014: 193-196). As of October 2021, the city signed an agreement with the Tachikawa Branch of the metropolitan to help process the application (Musashimurayama, 2021b).

For those residents who completely lost their house, the city will request to the metropolitan for temporary emergency housing. If needed, the capital can construct temporary housing for the victims. There are three pre-identified locations within the city and the surrounding neighbors. The new building will either be a one- or two-story lightweight steel-framed or wooden prefabricated unit with 29.7 meters squared area per floor. The start of the construction is within 20 days after the disaster. Tokyo Construction Building Association and the Prefabricated Building Association will assist with the logistics coordination, including material procurement. The Ministry of Agriculture, Forestry, and Fisheries will coordinate and supply any timber requests. There is an expected need for a large labor force to support all emergency activities. The city can request the metropolitan labor bureau for manning and be responsible for transportation to the sites. The city can accept donations once its distribution committee determines the need. The committee is in charge of creating a plan to receive, store and distribute to the victims. (Musahimurayama, 2014a: 197 -204).

IV. Discussion and Conclusion

Discussion

The Musashimurayama city disaster prevention plan has revealed that its supply chain plan is resilient. The city focus on the first 72 hours to supply their rescue activities and road recovery. Thirteen disaster prevention bases are prepared with three days of food and disaster supplies to support the initial evacuees. Pre-identified supply points will serve as a hub-and-spoke for the resupply to the disaster evacuation points. The distribution of food and other emergency supplies will occur soon after the center is open, and resupply will focus only on the essentials such as rice, crackers, etc. Once supply lines are re-established, the city will begin

ordering side dishes in a just-in-time supply chain. Support agreements are in place with local organizations and businesses to assist with resupply and communication. This joint agreement allows the city to maintain only the necessary and most urgent supplies, which reduces overhead costs. The city also has medical supplies stockpile and will prioritize the retrieval of resupply through the metropolitan stockpile storage for the medical team. Their plan also mentioned sock of baths, showers, and water reserves in their respective agencies and a way to secure and replenish those supplies.

Their plan also defined the recovery process, which is vital to get out of disaster quickly. Businesses are encouraged to have a continuity plan to assist with the recovery of services. The plan is driven by collaboration and partnership with national, local, and private sectors. The community awareness and involvement strategy are influential to efficiently managing disaster response and recovery. For example, the city leverages specialized associations to coordinate response and resupply support. Utilizing internal resources available in their immediate surrounding area is also a sign of a resilient reaction until significant aid arrives. Agility is the ability to respond quickly to short-term changes (Umar & Wilson, 2021: 3). The plan shows that the city has considered changing rapidly in response to any scenarios, for example, coordination with other cities and metropolitan to request any additional assistance.

Conclusion

This research is an in-depth look into one of Japan's city disaster prevention plans that can help further understand Japan's strategy for disaster management. The city of Musashimurayama's website contributed significantly to this research. The limitation of this research includes limited information on inventory levels within the city's storage or offices such

as vehicle, disaster supplies, manning, etc. and Tokyo Metropolitan, and neighboring cities' disaster plans. Future consideration of separate case studies of the neighboring city and metropolitan's disaster plan to expand and understand each relation to help strengthen the overall supply chain. Leaders, policymakers, and planners can find this valuable research to promote their preparation to avoid supply chain disruption.

Bibliography

Decker, M. (2014). Last Mile Logistics for Disaster Relief Supply Chain Management: Challenges and Opportunities for Humanitarian Aid and Emergency Relief. Anchor Academic Publishing. Hamburg.

ESCAP. (2019). The Disaster Riskscape Across Asia-Pacific: Pathways for Resilience, Inclusion, and Empowerment. Asia-Pacific Disaster Report 2019. Retrieved from https://www.unescap.org/sites/default/d8files/knowledge-products/Asia-Pacific%20Disaster%20Report%202019_full%20version.pdf.

FEMA. (2019). Community Lifelines - Factsheet. Retrieved from https://www.fema.gov/sites/default/files/2020-05/LifelinesFactSheetandPosterv2.pdf

Franklin, Charlotte & Todt, Kiersten. (2014). Community resiliency through recovery resource supply chain planning. Journal of Business Continuity & Emergency Planning. 2014 (7, 3), 193-204

Iida, Y., Kurauchi, F., & Shimada, H. (2000). Traffic Management System against Major Earthquake. Retrieved from https://www.iatss.or.jp/common/pdf/en/publication/iatss-research/24-2-01.pdf

Japan Visitor. (2021). Tokyo Kanto Earthquake 1923. Retrieved from https://www.japanvisitor.com/japanese-culture/history/tokyo-earthquake

JFA. (2022). Convenience Store Statistic Data, January 2022. Retrieved from https://www.jfa-fc.or.jp/folder/1/img/20220221113616.pdf

Johansson, J. (2000). Soil Liquefaction. University of Washington. Retrieved from http://depts.washington.edu/liquefy/html/main.html

MLIT. (2007a). Land and Climate of Japan. Retrieved from https://www.mlit.go.jp/river/basic_info/english/land.html

MLIT. (2021b). Find Out! Japan's Preparations for Earthquakes. Retrieved from https://www.mlit.go.jp/river/earthquake/en/nankai/index.html

Musashimurayama. (2014a). The Musashimurayama City Regional Disaster Prevention Plan: Earthquake Edition. Retrieved from https://www.city.musashimurayama.lg.jp/_res/projects/default_project/_page_/001/000/059/sinnsai2.pdf

Musashimurayama. (2021b). Musashimurayama City. Retrieved from https://www.city.musashimurayama.lg.jp/index.html

Sheffi, Y. (2007). Building a Resilient Supply Chain. Retrieved from https://hbr.org/2007/08/building-a-resilient-supply-ch%20May%2011

Naomi, K. (2013). Quality with a Japanese Flair: Convenience Stores. Retrieved from https://web-japan.org/niponica/niponica10/en/index.html

Nikam, S. (2018). Fundamentals of Disaster Management. Astral International Pvt. Ltd. New Delhi.

Nippon. (2019). A Disaster to Dwarf 3/11? The Predicted Nankai Quake. Retrieved from https://www.nippon.com/en/news/fnn20190524001/a-disaster-to-dwarf-311-the-predicted-nankai-quake.html

OCHA ROAP. (2021). Disaster Response in Asia and The Pacific: A Guide to International Tools and Services. Retrieved from https://www.unocha.org/sites/unocha/files/ROAP_DisasterGuide.pdf

PAHO. (2013). The LSS/SUMA Initiative: 20 Years after its Launch. PAHO/WHO Emergencies News. Retrieved from https://www3.paho.org/disasters/newsletter/index.php?option=com_content&view=article&id=515:the-lsssuma-initiative-20-years-after-its-launch&catid=243&Itemid=314&lang=en

Son, B., et al. (2021). Catastrophic supply chain disruptions and supply network changes a study of the 2011 Japanese earthquake. International Journal of Operations & Production Management. 2021, Vol. 41 Issue 6, p781-804. 24p.

Tokyo. (2021). Tokyo Cultural Heritage Map. Retrieved from https://www.syougai.metro.tokyo.lg.jp/bunkazai/heritagemap/kitatama/

TMG. (2006a). About Our City: The Structure of the Tokyo Metropolitan Government. Retrieved from https://www.metro.tokyo.lg.jp/ENGLISH/ABOUT/STRUCTURE/structure03.htm

TMG. (2020b). Tokyo Metropolitan Government Disaster Prevention Guide Book. Retrieved from https://www.bousai.metro.tokyo.lg.jp/content/book/guidbook_pocketguide/2020guid_e.pdf

Tokyo Metropolitan Government (TMG). (2021c). Disaster Preparedness Tokyo. Retrieved from https://www.metro.tokyo.lg.jp/english/guide/bosai/index.html

TMG. (2018d). Fire Rescue Task Force. Retrieved from https://www.metro.tokyo.lg.jp/ENGLISH/ABOUT/DATELINE/MOVIE/hyper_rescue.htm

Todo, Y., Nakajima, K., & Matous, P. (2014). How Do Supply Chain Networks Affect the Resilience of Firms to Natural Disaster? Evidence from the Great East Japan Earthquake.

Journal of Regional Science, 55(2), 209-229. https://onlinelibrary.wiley.com/doi/10.1111/jors.12119

Tokui, J., Kawasaki, K. & Miyagama, T. (2017). The economic impact of supply chain disruptions from the Great East-Japan earthquake. Japan and the World Economy, Vol 41, p. 59-70. https://www.rieti.go.jp/jp/publications/dp/15e094.pdf

United Nations. (2015). Sendai Framework for Disaster Risk Reduction 2015 - 2030. Retrieved from https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf

UNDDR. (2021). Measuring Implementation of the Sendai Framework. Retrieved from https://sendaimonitor.undrr.org/

Umar, M. & Wilson, M. (2021). Supply Chain Resilience: Unleashing in the Power of Collaboration in Disaster Management. Sustainability 2021, 13, 10573. Retrieved from https://doi.org/10.3390/su131910573

Xu, W. et al. (2021). Evaluation of Humanitarian Supply Chain Resilience in Flood Disaster. MDPI Water Journal. 13(16), 5218. https://doi.org/10.3390/w13162158

National Land Agency, Japan. (1997). Disaster Countermeasure Basic Act. Retrieved from https://www.ifrc.org/docs/IDRL/Japan_DMAct_1961.pdf

WFP. (2021). UN Humanitarian Response Depot. Retrieved from https://www.wfp.org/unhrd

Yamato. (2013). Yamato Group: Corporate Social Responsibility Report 2013, Company Profile. Retrieved from https://www.yamato-hd.co.jp/assets/pdf/YAMATO-HD_CSR2013E_All.pdf

Yamato Transport. (2021). TA-Q-BIN. Retrieved from https://www.kuronekoyamato.co.jp/ytc/en/send/services/takkyubin/

Zhang, J. et al. (2017) Solving an Emergency Rescue Materials Problem under the Joint Reserves Mode of Government and Framework Agreement Suppliers. Public Library Science 12(10), 1-20.

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14. ABSTRACT
Japan is the leading country in the effective response to natural disasters. Their supply chain process is resilient with national, prefectural, and local involvement. This study looks in-depth into one city in Japan, Musashimuraya's disaster prevention plan to understand their supply chain processes and preparations. From the initial and resupply chain process, the city utilized its capacity and partnerships with the local organizations, associations, private businesses, and communities to provide a unified response. It described their plan from the initial 72-hours after a disaster, shelter management, standard commuter support, and lifelines recovery. Their mutual support agreements are an essential factor contributing to response and recovery. All government documents and outside entities are evaluated and determined that the city's supply chain is ready and resilient to respond to future disasters.

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