Resiliency in tourism transportation: Case studies of Japanese railway companies preparing for the 2020 Tokyo Olympics

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ABSTRACT

Since 2011, Japan's inbound tourism continues to grow at an exponential pace. The increasing number of foreign visitors into the country will expose more people to the risk of natural hazards. As a result, in 2018 the Japanese Ministry of Land, Infrastructure, Transport and Tourism (MLIT) started urging rail operators to consider planning for tourism safety in the event of an earthquake and tsunami. Despite this, reports indicate that rail operators continue to experience difficulties in developing and adopting disaster counter-measures for tourists. In the present research the authors explored the obstacles that rail companies face, by interviewing ten rail companies throughout Japan. By utilizing a framework that examined key variables that can contribute to improved railway tourism resiliency, the authors were able to identify areas where rail operators appear to be reasonably well prepared for a disaster event, and others were their current state of preparedness appears limited. Finally, from the shared experiences of the companies the authors identified eight areas that can help to strengthen resiliency based, and make some other recommendations of their own.

1. Introduction

After experiencing a sharp decline in tourism after the 2011 Great East Japan Earthquake (GEJE), the Japanese government enacted a series of plans to promote tourism, in the hope that this would contribute to help revitalize the economy. These plans include the relaxation of visa requirements for foreign visitors and aggressive promotional marketing of local attractions [1]. Since then, inbound tourism numbers have rapidly increased, with an estimated 29 million foreign visitors to Japan in 2017, and 16 million in the first half of 2018 alone [2] (Fig. 1). The Japan Tourism Agency believes tourist numbers will surpass the 30 million mark by the end of 2018 [3]. With the government expecting 40 million foreign visitors per year by 2020, when Japan hosts the Tokyo Olympics and Paralympics, the Japanese Ministry of Land, Infrastructure, Transport and Tourism (MLIT) gathered railway operators in June of 2018 to discuss the implantation of anti-earthquake measures and the availability of disaster alerts in foreign languages [4]. Tokyo's already congested rail networks are expected to struggle under the weight of increased ridership during the Olympics [5], and news reports in 2018 indicate that railway operators were still not adequately prepared [6].

Disaster management in the tourism industry presents a number of challenges. Tourists may possess limited knowledge on the destination's hazard risks and may be ill prepared to take appropriate action in the event of a disaster [7,8]. Kozak, Crotts, & Law [9], discovered that cultural differences, such as degree of individualism, religion, societal power distance, and masculinity influenced perceptions of disaster risk. Different experiences can also lead towards different responses to disasters. Comparative research on the 2008 Sichuan Earthquake and the 2011 GEJE discovered significant differences in the level of preparedness in Sichuan, noting that the poorer seismic performance of buildings in Sichuan contributed to the higher casualty rates [10]. As a result, trust in local authorities in Sichuan following the disaster was found to be low [11]. Such cultural differences and experiences can lead to different responses during a disaster.

Japan also poses a number of challenges for inbound visitors, given that most of them possess limited to zero fluency in the Japanese language. While multi-lingual signs and information have become more common in Japan's largest cities (such as Tokyo, Osaka, Nagoya, and Fukuoka), they are often lacking outside them. Recent experiences in Hokkaido and Osaka, which were hit by typhoons and earthquakes in 2018, highlighted the lack of disaster information for foreign tourists [12].

Based on these challenges, this paper seeks to explore the barriers that Japanese rail operators face in disaster and emergency planning for foreign tourists. To date, limited research has examined the role of disaster preparedness from the perspective of tourism, despite major problems have been reported (for example those of the subway system

Overseas Residents' Visits to Japan by year (in millions)

Overseas Residents' Visits to Japan by country, 2017

China 26%
Korea 25%
Taiwan 16%
Hong Kong 8%
North America 6%
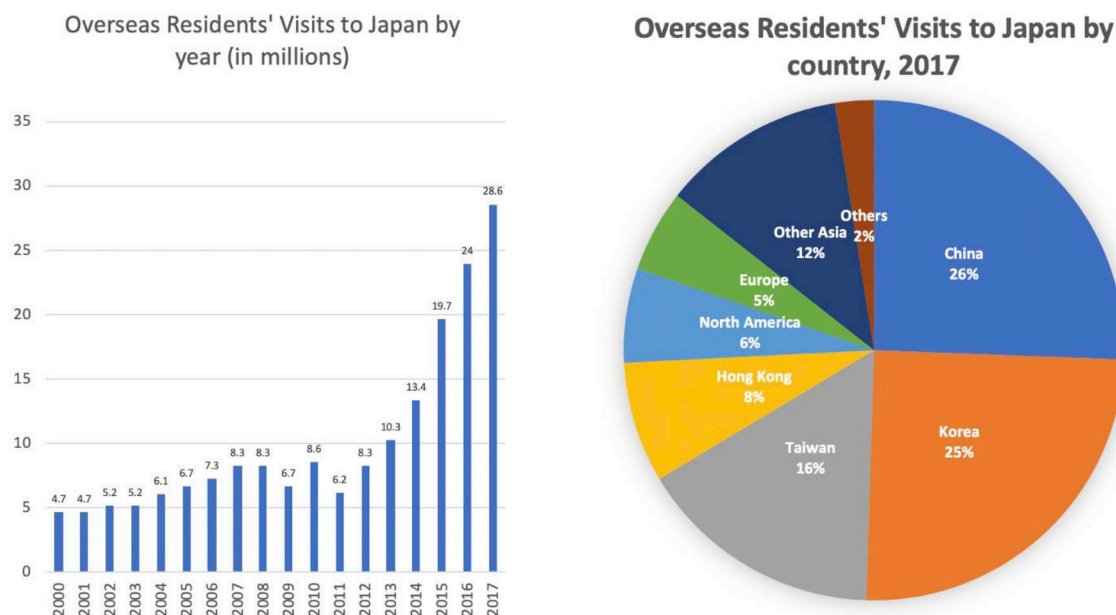Europe 5%
Other Asia 12%
Others 2%

Fig. 1. Annual inbound tourism numbers into Japan (left) and their countries of origin in 2017 (right) [2].

in New York during the passage of hurricane Sandy) [13]. To address this gap in the literature, the authors then investigate the experiences of rail operators in Japan following previous disasters, such as the 2011 GEJE, the 2016 Kumamoto Earthquake, and the 2018 disasters in the Kansai region [7]. The authors then inquired about the plans and actions operators have implemented so far, and the obstacles that prevent them from adopting a more effective resiliency plan. The paper will finish by summarizing common findings among the railway operators, highlighting approaches that companies have identified as being useful to overcome some of these barriers.

2. Defining resiliency

Resiliency is a widely used term that commonly describes the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner [14]. In order to guide the framework used for this research, the authors will first examine how resiliency is defined within the transportation and tourism literature, and how it can be synthesized in the use of a rail-based tourism resiliency framework.

2.1. Transportation resiliency

Kim et al. [15] identified twelve types of impacts that natural disasters can have on transportation: road closures, road damage, stoppage or suspension, accidents, gridlock, stranding of people, disruption in the transport of children, lifeline cutoff, evacuation, the need for alternative routes, damage to different modalities, and the need for sheltering. Based on eight case studies, nine specific lessons were identified which could strengthen the resiliency of transportation systems: the centrality of transportation services in all phases of disaster management, the importance of communications in resiliency, the role of social media and information technologies, aligning command, control, and coordination of emergency response systems, the need for risk vulnerability and assessment planning, the need to integrate science policy with operations, more attention to understanding the needs of vulnerable populations, the role transportation plays in recovery, and opportunities for innovation and change in the face of long-term slow-onset disasters [15].

Jen and Chang [16] identified the importance of information and communications technology in all four emergency management phases:

Prevention/Mitigation, Preparedness, Response, and Recovery. This includes the need for establishing disaster warning centers, installation of CCTV, real time information from the government, the development of a knowledge base, operation contingency plans, emergency transfer plans for each station, coordination with local governments, control and management systems, interactive communication, ticketing information, train operation and delay prediction, and passenger communications [16]. Leelawat [17] and San Carlos-Arce et al. (2015) noted that while a variety of public information on emergencies and disasters has been publicly disseminated in Japan, foreigners sometimes had little access or limited understanding of these notices due to language barriers. In the case of Thai tourists in Japan, the Thai Embassy provided citizens with information via social networking services (SNS) regarding the suspension of rail services [8,17].

In the case of local earthquakes, the proximity and quick arrival time of a tsunami (Yamao et al., 2015) may limit the effectiveness of sophisticated hazard detection equipment and disaster warning systems. As a result, while situational information may be incomplete, conclusions must be drawn immediately. Failure to reach prompt conclusions regarding alerts and warnings can have dire consequences and suggests that there needs to be redundant means of communication that can disseminate warnings in the event that the primary method of contact is unavailable [18].

2.2. Tourism resiliency

Johnston et al. [19]; have identified several key strategies that can strengthen resilience in the tourism sector: understanding hazards, risks, emergency planning issues, training, overcoming false alarms, determining people's roles, determine who should be involved, decision making procedures, and establishing roles and coordination [19]. Similarly, Becken and Hughey [20]; identified 10 suggestions on what a tourist action plan should contain for each disaster phase. This includes planning prevention and consultation/education during the reduction phase, warning systems and evacuation/communication during the readiness phase, rescue and welfare, transportation, and communications in the response phase, and rebuilding, recovery and communications in the recovery phase. Clear, constant and concise information transfer between stakeholders is highlighted as being required in all four phases [20].

For tourism-related businesses, resiliency refers to the existence of

continuity insurance, staff training, induction and disaster planning, and the development of formal disaster plans [21,22]. Orchiston's research on tourism business preparedness in New Zealand discovered a correlation between business size and the degree of resiliency planning, with smaller sized businesses lacking disaster plans. However, tourism business operators have shown strong loyalty and commitment to their communities, which has the potential to draw community stakeholders together towards a common disaster preparedness goal.

2.3. Framework

Based on the literature on transportation and tourism resiliency, the authors have identified key lessons and suggestions within the context of rail transportation and tourism. These lessons and suggestions are then applied within the international 'PPRR' framework, which describe disasters as a cycle that undergoes four key phases: Prevention or Mitigation, Preparedness, Response, and Recovery (the 4R emergency framework is another popular framework which replaces prevention and preparedness with reduction and readiness). Since the emergence of the PPRR Framework, more specialized frameworks have been developed, such as Faulkner's Framework for Tourism Disaster Management, which includes six phases which better correspond to the context of tourism [23]. However, as Becken & Hughey [20] noted, since tourism organizations and small businesses are often under-resourced, it may be more efficient to coordinate any tourism disaster management effort already in place. For this reason, the authors have chosen to use the common PPRR framework, which is well known within Japan [24]. To do so, 13 resiliency initiatives were identified in the aforementioned literature on tourism and transportation resiliency, and applied to the PPRR framework, which was then used to guide the present research (Fig. 2).

Under the preparedness/mitigation phase, the authors identified the importance of conducting a vulnerability assessment (such as identifying local hazards and relevant stakeholders for collaboration) and the training of staff. Under the preparedness phase, the authors identified

the need for rail operators to secure alternative routes, present information on local hazard risks and evacuation routes in the station, as well as within the trains, and dealing with false alerts. During the response phase, the authors identified the importance of having an established rescue and evacuation procedure at the station, evacuation shelters and emergency supplies, and a plan to rescue stranded passengers in the train. During the recovery phase, the ability to repair damaged infrastructure is vital, as is the ability of the operator to promote its safety image in order to restore customer confidence, and how lessons and experiences from past disasters will guide future plans. Finally, the authors would like to acknowledge that these actions are not exclusive to each phase, as actions such as dealing with false alerts and alternative routes can also be a part of the response phase, while education/training can be part of the preparedness phase. However, for the sake of simplicity in the present work the authors have limited each action to one phase.

3. Methodology

This research utilizes a two-part qualitative methodology. The initial part began with a survey which was largely conducted by email, asking operators if they had implemented the actions listed in Fig. 2. The questions asked related to whether the operators had adopted the actions identified in the Railway Tourism Resiliency Framework (Fig. 2): Whether they had conducted a vulnerability assessment, secured alternative routes that would allow tourists to return home in the event of line closure, securing shelters or evacuation centers that could be used in the event of a disaster, managing false alerts/alarms, promoting an image of safety, hazard and evacuation information at the station, the placement of hazard information inside the train, the use of information and communications technologies for disaster management, training of staff for emergency events, and whether the operators are able to secure and evacuate passengers that are stranded in stations or inside trains. The authors did not survey three other actions listed on the framework: plans for repairing damaged infrastructure, damage
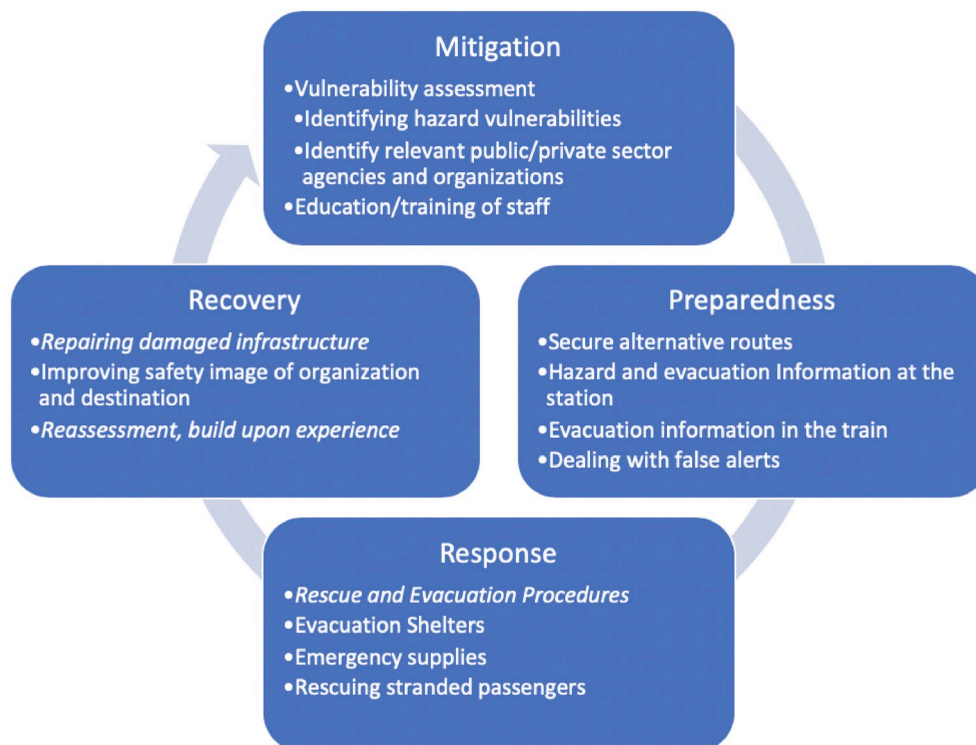

Fig. 2. Framework for promoting railway tourism resiliency. As explained in the following chapter, these will guide survey questions while the italic areas indicate topics to be discussed during the interviews.

reassessment, and rescue and evacuation procedures (which were asked them during the open-ended interviews, as detailed below).

The responses from the railway operators were then followed up by a semi-structured interview, which asked representatives to expand on the successful implementation of certain actions and to provide further details on the challenges the company faces, particularly in the areas of repairing damaged infrastructure (if any), rescue and evacuation procedures, and building upon past disaster experiences (all of which require more detailed explanations that what the initial survey could provide). In some cases, both the survey and interviews were conducted together. These interviews were conducted either in person, or through continuous exchanges over the internet. When conducted in person, interviews generally lasted about 1 h and were conducted in Japanese, and then re-translated into English by the authors themselves.

The semi-structured interview asked rail representatives about the types of problems they face when interacting with foreign tourists, planning for rescue and evacuation procedures, lessons learned from previous disasters (such as the 2011 GEJE, 2016 Kumamoto Earthquake and others) and reconstruction related issues, and how rail operators make decisions regarding a scenario where a local earthquake would provide them with only a few minutes before the arrival of a tsunami. Finally, the authors also gave operators the opportunity to freely explain any other challenges and concerns their organization faces in developing and implementing disaster management activities for tourists, as well as general tourism concerns.

4. Case studies

For this research, the authors examined 10 rail companies located across Japan, from the Kyushu region in the south, to the Tohoku

Region in the northeast of Japan (Fig. 3). The criteria for the selection of these ten companies was based on two factors: First, the authors selected companies with rail stations that provide the closest and most direct access to either an Olympic or Rugby Venue. Second, both the venue and the rail station should be exposed to tsunami hazards, based on information from local government hazard maps, (although exposure to other hazards were was also taken into consideration). For this reason, all of the venues examined are serviced only by local and express lines and not by high-speed rail (or Shinkansen in the Japanese language). Between August and December of 2018 the authors contacted all rail companies that fall within these criteria. Of the 15 rail companies contacted, 10 agreed to the interview, representing a response rate of 67%. A list of the companies interviewed is given below, listed geographically from north to south. Rail lines that recently suffered physical damage to their infrastructure are listed as damaged, in addition to the disaster events that caused it.

Sanriku Railway: A third-sector rail company (mixed ownership of local governments and private businesses) whose rail lines span the entire coastline of Iwate Prefecture. The company is currently rebuilding its rail infrastructure after suffering devastating damage from the 2011 GEJE. Reconstruction is expected to be completed in 2019, in time for the Rugby World Cup. One of the venues for this will be the Kamaishi Unosumai Stadium, which is located next to the bay and within a walking distance of Unosumai station.

Sendai Airport Transit: A third-sector rail company that operates a single line connecting Sendai Airport to Sendai Station. Although the company does not operate any lines that directly connect passengers to the Olympic Venue, a majority of visitors to Sendai are likely to enter the city through one of these two stations before continuing further. As with Sanriku Railway, their rail line was also inundated by the 2011
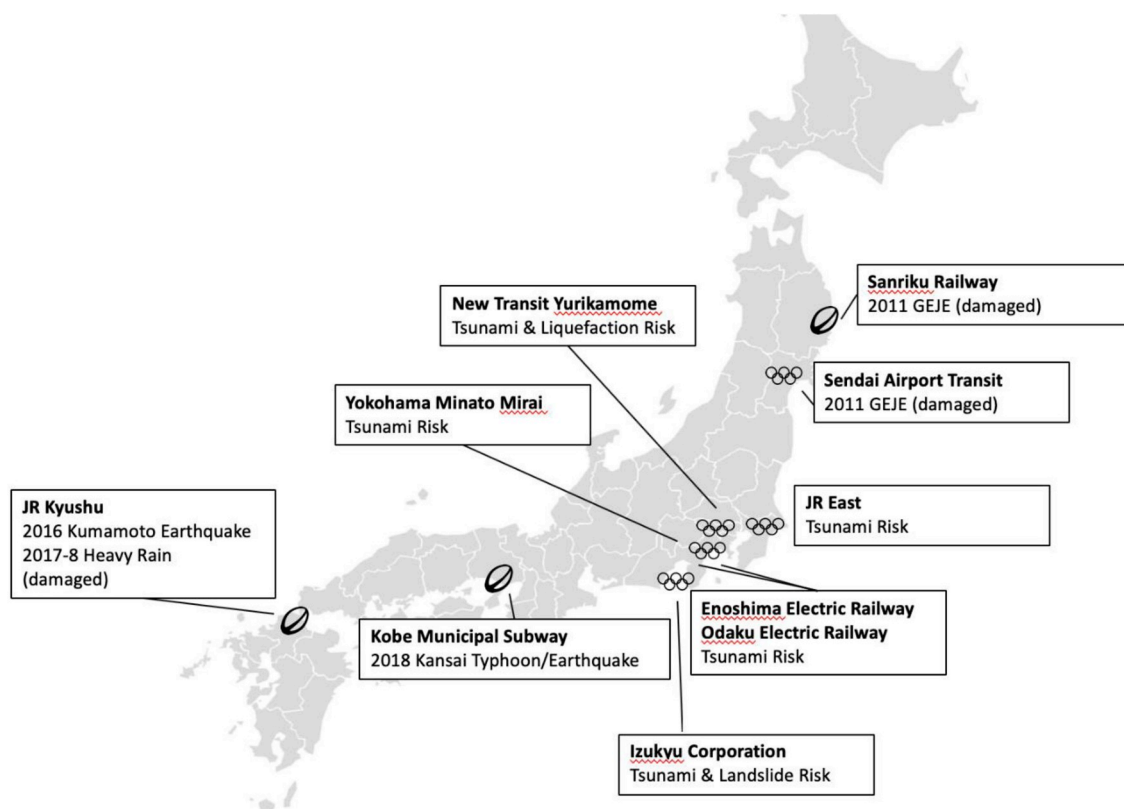

Fig. 3. Locations of rail companies interviewed, and their proximity to the venue of major sporting events. The 2019 Rugby World Cup is represented by a rugby ball icon, while the 2020 Tokyo Olympics and Paralympic venues are represented by the five ringed Olympic symbol. Note that while there are more venues and rail operators, the present work only focuses on rail lines located near the venues which are also located in tsunami hazard zones. Sites listed as 'damaged' indicate operators that have experienced the response and recovery phases, with the specific disaster causing the damage listed next to it (i.e. 2011 Great East Japan Earthquake or the 2017-18 Kyushu Heavy Rain and landslides).

GEJE tsunami, but suffered significantly less damage. The line is jointly operated with JR East.

East Japan Railway: Also referred to as JR East, is the largest private rail company in Japan, with services spanning the entire eastern half of the country. For this research, the authors focused on their Sotobo Line, which is the closest line to Tsurigasaki Beach in Chiba Prefecture, the venue for the Olympic's surfing events. The venue, rail station and line are all located within the tsunami inundation zone.

New Transit Yurikamome: Also known as Yurikamome, the company was established by the Tokyo Metropolitan Government in 1995, and operates a single monorail line connecting Tokyo to the artificial island of Odaiba. The island is one of the main sites for the 2020 Olympics, hosting nearly half of the venues in Tokyo. Parts of the island are considered at risk for earthquake-induced liquefaction.

Yokohama Minatomirai Railway: A third-sector rail company that operates a single subway line that spans much of Yokohama City's coastal areas. One of the stations on the line is within walking distance of Yokohama Baseball Stadium, which is one of the Olympic venues for baseball. The line is also jointly operated with Tokyo Metro and the Tokyo Corporation as part of a through-service, connecting the Minato Mirai Line with other lines that extend into Tokyo.

Enoshima Electric Railway: Also referred to as Enoden, this private rail company operates a single coastal line in Kanagawa Prefecture, spanning from Kamakura to Fujisawa. Although the area is considered Kanagawa's most popular tourism destination, it is also the most vulnerable to tsunami inundation in the prefecture [7,25]. Enoden is one of the two rail companies that provides direct access to the yachting venue for the Olympics, the other being the Odakyu lines.

Odakyu Electric Railway: A large private railway company that operates throughout eastern Japan. Like Enoden, Odakyu operates a line to the Olympic's Yachting Venue. In addition, Odakyu also operates a line to Hakone, a popular mountain resort that is highly vulnerable to volcanic eruptions.

Izukyu Corporation: A private rail company that operates along the coastal line of Izu Peninsula in Shizuoka Prefecture. Although Shizuoka is the venue for the Olympic's cycling event, the event is held at the Izu Velodrome, located inland on a high elevated area with no direct rail access. However, this line was chosen for this study as it is one of the only two ways to access the site by rail, requiring a transfer by bus from the station. The peninsula is considered to be highly vulnerable to tsunami inundation.

Kobe Municipal Railway: A subway system that is operated by Kobe Municipal Government. The line provides direct access to Kobe Misaki Stadium, which is one of the venues for the Rugby World Cup. The stadium and parts of Kobe Municipal Railway's Kaigan line are located within tsunami inundation zones. The company was affected by the 1995 Great Hanshin Earthquake, which took them three months to fully recover from.

Kyushu Railway Company: Also known as JR Kyushu, this private company is the largest rail operator in the Kyushu region in southern Japan. Several of their lines were damaged during the 2016 Kumamoto Earthquake, while others are highly exposed to both tsunami and volcanic risks. In 2018 several lines were damaged by heavy rains and flooding. There are three Rugby venues located within Kyushu.

5. Survey results

Table 1 provides a compilation of the ten railway companies contacted showing that, overall, they had already in place a substantial number of resiliency actions, but none had fully adopted all ten actions. In terms of the mitigation phase, all ten operators had conducted vulnerability assessments, which include identifying hazard risks and vulnerabilities, as well as relevant stakeholders and establishing a collaborative relationship with them. Similarly, nearly all operators acknowledged they have some forms of staff training for emergency/crises situations.

In terms of the preparedness phase, while most operators installed signs presenting information on local natural hazard risks and evacuation routes, these were not available at Sendai Airport and Minato Mirai line, both of whom stated that they would implement them in the future. Nearly all operators stated that they provided information inside the trains, though they also explained that this information was not always present, or that it may only be displayed or broadcasted during an actual event. JR Kyushu, which has prepared disaster pamphlets for passengers, provided them only on some routes. Most operators were able to provide some form of alternative routes in the event of a stoppage, which includes cooperating with other rail operators, buses, and taxis. In the case of Sendai Airport, after the 2011 GEJE they worked with bus operators and taxis to evacuate tourists stranded at the stations. Finally, while many of the rail operators interviewed had a system in place for dealing with false alerts, nearly half chose not to answer, or gave vague remarks regarding such problems.

In terms of the response phase, nearly all operators were limited in their ability to function as shelters (including the provision of supplies) or evacuation sites (with the exception of Enoden line). Companies such as Odakyu said that they are able to provide supplies to evacuees but do not consider their station as an evacuation or refuge site. In most cases, operators would instead direct people to nearby public evacuation shelters. Despite their limited ability to shelter evacuees, nearly all operators were confident in their ability to rescue stranded passengers. This is notable in the case of the Yurikamome line, as it is the only operator in the study that operates a monorail system, which poses a considerable difficulty to offloading passengers. Sendai Airport Transit sent personnel to each station to collected passengers stranded during the 2011 GEJE and walked them back to Sendai Airport, which acted as a refuge site due to the presence of abundant food supplies, in spite of the flooding that took place at the airport [13].

In tourism, the recovery phase often requires the rehabilitation of a destination's image and its businesses [26]. Thus, the authors also asked rail operators if they had developed any kind of strategy to improve the image of the company's (in terms of its ability to provide a safe environment for its passengers following a disaster). All operators stated that they had developed a variety of promotional material to ensure passenger safety in the event of a disaster, and updates on the recovery process for those operators who had recently been affected by a disaster. At the time of writing, out of the 10 rail operators interviewed JR Kyushu and Sanriku Railway are still repairing lines damaged by recent disasters. JR East, while agreeing to the interview, was unable to provide a complete explanation for all resiliency actions. Experiences from these disasters will be explained in detail in the following section.

6. Experiences and barriers

6.1. Language and cultural problems

Based on the interviews conducted, language barriers were identified as the most common barrier, with all railway companies acknowledging challenges in this respect. The situation is worse in rail lines situated predominantly in rural areas, such as JR Kyushu, Sanriku Railways, Izukyu, and Sendai Airport Transit, where there are very few foreign residents available to help with translation. Although some companies have relied on professional translation services, others have resorted to utilizing non-fluent speakers or internet-based automatic translation services, often with poor results [27–29]. Rail operators are struggling to adjust to the rapid rise in tourism numbers, as rail staffing remains relatively stable with time. Although many companies have focused on bi-lingual information in Japanese and English, there is a lack of preparedness and great demand for Chinese and Korean language capability, as the majority of foreign visitors originate from Chinese speaking regions or South Korea (see Fig. 1).

Rail operators have also noticed challenges relating to cultural differences, which may stem from differences in risk perception and

Table 1
Summary of replies from ten rail operators with regards to 10 resiliency actions. O denotes that said actions have been adopted, X denotes said action could not be adopted, Δ denotes said action has been adopted with the limitations explained in the text, while – denotes operators that were unable to answer (due to a variety of reasons).

	Vulnerability Assessment	Alt. Routes	Shelter/Evac	False Alert	Safety Image	Info at Station	Info in Trains	ICT	Training	Stranded Passengers
Sendai Airport	O	O	Δ	O	O	X	O	O	O	O
Sanriku	O	O	Δ	O	O	O	Δ	O	O	O
JR East	O	O	O	O	X	O	O	O	O	O
Yurikamome	O	Δ	Δ	–	O	O	O	O	O	O
Minato Mirai	O	O	Δ	–	–	X	O	O	O	O
Odakyu	O	O	X	O	O	O	O	O	–	O
Enoden	O	–	O	–	O	O	O	–	O	–
Izukyu	O	O	Δ	O	Δ	Δ	Δ	O	–	O
Kobe Subway	O	O	X	Δ	O	O	O	X	O	X
JR Kyushu	O	O	Δ	O	O	O	O	O	O	O

experiences with hazards. JR Kyushu and Kobe Subway have mentioned frustrations with passengers who could not understand evacuation information and wandered off from the site, becoming lost. Enoden surmised that differences in disaster culture has led to different reactions among various groups. For example, passengers from Korea may be unfamiliar with evacuation actions, as the Korean peninsula is less vulnerable overall to natural hazards than Japan.

6.2. Lack of human resources

The next most common barrier identified was a lack of human resources, where companies state that they do not have enough staff in stations or the trains that can manage tourists during a disaster. For example, the Minato Mirai Line only maintains two staff members in each station. In rural areas, Sanriku Railways and JR Kyushu often operate one-man trains (i.e. there is no other staff in the train other than the driver), with stations left unattended. During the Kumamoto Earthquake, JR Kyushu mentioned difficulties in taking care of stranded passengers, as they tended to leave trains and stations by themselves and get lost (as mentioned earlier), leading to significant increases in the time it took to account for all passengers.

6.3. Power outages

Dealing with power outages was an issue that affected many rail operators in Eastern Japan during the 2011 GEJE. While the greater Tokyo Metro area (which includes Chiba, Tokyo, Kanagawa, and parts of Shizuoka) did not suffer extensive damage unlike the Tohoku Region of northern Japan, (Mori et al., 2012), impacts to powerplants resulted in extensive and prolonged blackouts. The larger population and passenger base in this area led to great confusion due to rail stoppages and a lack of ability to transmit information between stakeholders and the public. Despite the lack of damage to rail infrastructure, Tokyo area rail operators such as Enoden, Odakyu, and Yurikamome, reported that a significant amount of time was required to unload passengers and restore services, due to power issues and heavy traffic congestion.

6.4. Cooperation

While all rail operators work closely with local authorities in a variety of areas (from monitoring environmental changes to policy making, among many others), the degree of cooperation varies significantly. For example, in Miyako City, which was severely damaged by the 2011 GEJE, JR East and the municipal government had significant disagreements, leading to reduced collaboration. The challenges in cooperation impacted the recovery time of rail infrastructure, which also affected Sanriku Railway (which shared stations with JR East). Limitations in cooperation also extend to other rail operators, such as the Minato Mirai Line, which offers through service to three other rail operators, (and who admitted that beyond general traffic

communications, it had limited cooperation with them in the area of emergency management). The company expressed a willingness to expand cooperation with the other operators in order to introduce a standardized crisis manual for disasters and other emergencies, but continues to wait for a reply from the other operators.

6.5. Organizational size

Based on the responses from the ten rail operators, larger companies such as Odakyu, JR East and JR Kyushu had adopted a larger number of disaster resiliency actions than smaller ones. For instance, amongst the larger operators JR Kyushu only faces limitations in securing shelter and evacuation sites (instead relying on collaborating with local governments to provide shelters), Odakyu in using its own stations as evacuation sites, and JR East does not yet having develop promotional campaigns to improve its safety image (otherwise these companies have implemented all other resilience actions). The remaining seven operators had at least two or more actions that have either not been adopted, been adopted with limitations, or opted not to disclose information on them. These operators are essentially much smaller companies, with networks that span only one or two prefectures, and are either publicly owned or third sector companies (that are jointly owned by both the public and private sectors).

In general, the larger companies possessed greater resources, allowing them to conduct research and develop plans in-house. JR East, for example, was able to not only conduct training for natural hazard events, but also terrorism related issues [30]. Smaller operators, in contrast, could not afford or plan for a range of threats due to a lack of manpower, expertise or technology. However, it is worth noting that during the interviews most of the operators did not mention limited budgets as a constraint on the adoption of resilient activities, and instead focused on manpower and expertise issues. The one exception was Sanriku Railway, which had undergone an expensive recovery process during the past 8 years, with much of its rail infrastructure destroyed by the 2011 tsunami.

7. Rail operator strategies

Based on the answers provided by the rail operators during the interview stage, this section summarizes the approaches operators have used in overcoming the challenges mentioned in section 6. These approaches can be categorized into those at the operational level and those at the strategic level (Table 2). Operational level approaches are activities concerning day to day operations which directly affect passengers, such as the presence of bi-lingual or multi-lingual information, appropriate levels of staffing, hazard and evacuations signage, the ability for rail drivers and conductors to have flexibility in decision-making during emergencies, the presence of food stock piles and back-up power sources during an emergency, and redundancy. Strategic approaches are generally long term plans, such as developing

Table 2
Operational and strategic approaches rail operators have developed and adopted based on experiences from previous disasters.

Operational Approaches	Strategic Approaches
Language	Establishing cooperative relationships
Staffing	Improving safety image
Signage and other information	
Flexible decision- making	
Emergency supplies and power	
Redundancy	

cooperative relationships with other stakeholders (which can lead to new plans that improve resiliency), and improving the safety image (which leads to improved branding), allowing rail operators to strengthen consumer confidence in the company and contribute to quicker market recovery after a disaster.

7.1. Language

A variety of strategies have been developed to mitigate some of the language barriers that rail operators face when dealing with foreign tourists, Several companies, such as JR East and Odakyu, have developed software that could be used on tablets, providing instantaneous text-based translation. JR East and Enoden also hold annual workshops to train staff on how to interact with foreign passengers, especially in emergency situations (the leading author was invited to participate and lead one such workshop in 2017). In addition to resolving language barriers, these workshops also seek to instill confidence among rail staff who behave timidly around foreigners. JR East is also experimenting with a video chat service in some of their information booths, where station staff and foreign passengers can call a tourism office in northern Japan that can provide free translation services from its multi-lingual staff (including languages other than English and Japanese). Operators such as Minato Mirai are considering outsourcing translation to private companies.

7.2. Staffing

As mentioned previously, staffing is a major concern with most rail operators, especially those operating in predominantly rural areas. In order to address these limitations in human resources several rail companies have developed innovative approaches that can improve manpower capabilities with regards to disaster management. Sanriku Railway, which operates entirely in rural and depopulating areas of Japan, has less than 50 staff. In order to address human resource shortcomings, the company has adopted the following strategies: During a disaster, such as the 2011 GEJE, train drivers had passengers become involved in the response stage, asking them to assist each other to evacuate from the train and help at the evacuation areas. Sanriku's rail stations, while unmanned, contain evacuation and shelter information for passengers. Izukyu, which also faces staffing limitations, are collaborating with municipal governments and local residents residing near its line, to assist passengers and train staff in the event of a tsunami.

7.3. Signage and other information

Enoden had developed the most detailed signage among all the operators interviewed. Located in every station, Enoden's signs contain a detailed map that provides information on the station's elevation, tsunami inundation areas, evacuation shelters, and evacuation routes from the station. These maps are bi-lingual, in English and Japanese. In addition, at the ticket gate passengers can pick up a free disaster manual which provides the same information for every station on the route. Kobe developed icon based signage utilizing international hazard signs that identify hazard risks and evacuation locations, and could be easily understood by a wide variety of tourists regardless of whether they are English or Japanese speaking. JR Kyushu, on its long-distance lines that fall within volcanic or tsunami hazard zones, provides bi-lingual disaster/evacuation pamphlets in the back of each passenger seat (Fig. 4).

Fig. 4. Bi-lingual (Japanese and English) hazard and evacuation guide located behind the seat of a JR Kyushu Train (left). Simple icon signs used at a Kobe Subway station (center). Hazard information and evacuation map at an Enoden station (right). (all pictures taken by the author, with the Kobe Subway icons being provided courtesy of Kobe Subway).

7.4. Establishing cooperative relationships

For rail operators that operate lines that include through service into other lines, cooperation between the different companies is essential for the smooth running of services, especially during emergency situations. Of the 10 Interview subjects two companies operated lines with through service, the Minato Mirai and Sendai Airport lines. While Minato-Mirai representatives admitted that cooperation on disaster management with other rail operators on its through trains had been limited, Sendai Airport reported close cooperation with JR East. While Sendai Airport manages four of the train stations along the line (including all the stations that were flooded in 2011), JR East controls all the stations west of the line, including Sendai Station, as well as providing the train drivers. In order to ensure smooth operations, including during emergency events, the companies exchange staff, allowing for the permanent presence of employees in each other's companies. A number of personnel had also formerly worked at the other company, providing both JR East and Sendai Airport with a strong knowledge on how they each work. As a result, both JR East and Sendai Airport were quick to respond during the 2011 disaster and were able to confirm the status of its trains and passengers immediately. By cooperating with other stakeholders, rail operators can address areas where they possess limited abilities, such as Yurikamome working with rival rail companies to provide alternative options out of Odaiba, or cooperating with other organizations and institutions to secure evacuation sites.

For smaller operators, cooperative relationships can allow them to adopt resiliency initiatives that they would otherwise be unable to underatke alone, as seen with Minato-Mirai and Sendai Airport lines. Izukyu (which operates exclusively in the Izu peninsula) and Sanriku Railways (which operates exclusively on the Sanriku Coast), actively collaborate with the communities they serve in order to overcome human resource limitations or to address difficulties in securing evacuation shelters on their own.

7.5. Flexibility in decision making

Based on the experiences of 2011, several rail operators have acknowledged the need for station staff and train operators to take decisions promptly, which also means acting before receiving instructions from the company. Due to the short intervals before the arrival of a nearshore tsunami (which could arrive at places like Kamakura within 30 min of an earthquake [7]), operators have little leeway in terms of time. Additionally, damages to communication infrastructure can limit contact between the trains and headquarters. Train drivers for Sanriku Railways acted autonomously during the 2011 GEJE, with situations they decided by themselves where to evacuate the train to, based on their experiences and knowledge of the local terrain. Enoden, Sanriku and Sendai Airport Transit have since adopted a flexible approach by training their personnel to be able to make decisions independently during a crisis, and to adapt themselves to local situations.

7.6. Emergency supplies and power

Many of the rail companies interviewed do not keep emergency stocks at their own stations. Some, such as Sendai Airport, instead rely on utilizing nearby public evacuation centers (such as schools), which already maintain their own inventory of supplies for evacuees. Odakyu, based on the experiences of 2011, has developed an inventory of supplies for passengers in the event of a disaster. This includes mylar blankets, drinks, food, and first aid supplies. Kobe Subway built a large capacity battery in 2009 to store enough energy to move its trains, for use during an earthquake and tsunami emergency. As the company does not maintain any evacuation shelters in its stations, it has instead focused on maintaining its ability to operate its trains in all situations, in order to allow passengers to arrive safely to one of its stations. Odakyu has also emphasized the development of back-up energy sources, due to

lessons from the power outages caused by the 2011 disasters.

7.7. Improving safety image

Sanriku Railways has used the tragedy of 2011 and transformed it into an opportunity to educate the public about hazard risks and railway disaster planning. The company hosts annual open houses, where school children throughout Japan visit it and view safety information in the trains as well as damage, response, and recovery since 2011. These events are open to the general public, and not only demonstrate progress towards safety and recovery, but also how businesses can turn tragedy into educational and tourism opportunities. Further south, Odakyu has established an extensive PR section which broadcasts the company's safety initiatives, in addition to rail status and evacuation information. Developing an image of safety and stability not only alleviates fears and misconceptions over natural hazards, but demonstrates the rail operator's commitment to ensuring passenger safety, which can be used to improve and better market its brand and image.

7.8. Redundancy

Due to the massive power outage in Eastern Japan, many rail operators experienced significant difficulties in transmitting timely information to their passengers, as well as within the organization. As a result, many companies have developed multiple means to relay transportation information to passengers. For example, Odakyu provides information on its homepage, twitter, facebook, and many other forms of media. Other companies such as Sendai Airport, Izukyu, JR East, and JR Kyushu also have expanded methods to transmit current rail status beyond their home pages, and into popular social media platforms. According to Sato [31]; during the 2017 heavy rain and floods in Kyushu there were over 1,000 tweets with the hashtag for rescue [31]. Another study discovered that LINE, a popular messaging application in Japan, was the third most common method to gather emergency information [32]. As LINE has evolved from a simple messaging application into a media ecosystem, many major businesses and companies have since created official accounts on the platform, including JR East, JR Kyushu, among many others.

7.9. Recommendations

During the interviews several brain storming sessions were conducted with rail representatives with regards to how to approach communicating disaster information to tourists and normal passengers. A common concern that was revealed through this dialogue is how foreign tourists would perceive and interpret disaster information in-train and at the stations. Multiple tourism operators have been reluctant to display such information for fears of driving away risk-averse tourists. This was also observed among hotel industry practices [33,34]. A solution to this was to use mascot characters, as they were non-threatening, racially ambiguous, and highly popular [35]. Currently none of the rail operators interviewed have developed disaster information utilizing characters. However, examples of mascots in trains or disasters can be found in Japan, such as in the case of Tsukuba Express (which operates lines from Tokyo to Ibaraki, and adorns the interior of its trains with pictures of mascots explaining proper train etiquette to passengers). Japan has become renowned for its use of cute-mascot characters, which can be utilized to draw the attention of foreign visitors. The Tokyo Metropolitan Government and Aomori Prefecture use a variety of animal mascots in their disaster preparedness manuals intended for residents (Fig. 5).

8. Conclusion

The rapid rise of inbound tourism has drawn attention to the need to take into consideration increasing exposure of tourists to natural

Fig. 5. Mascot characters. The left are characters from Tsukuba Express, which teaches appropriate behavior in the trains or at stations. The right is a Tokyo Metropolitan Government mascot teaching local residents on how to prepare for disasters (via Tsukuba Express and Tokyo Metropolitan Government websites).

hazards in Japan. The country's geography means that it is exposed it to a variety of natural hazards, including tsunamis, volcanic eruptions, earthquakes and typhoons. With the 2019 Rugby World Cup and the 2020 Tokyo Olympics approaching, Japan's MLIT has urged the country's rail companies to consider disaster countermeasures and how to communicate hazard information to tourists.

In the present work the authors interviewed a number of railway companies that are particularly vulnerable to tsunamis. The case studies provide insights on the problems rail operators face in developing and adopting disaster management strategies for normal passengers and tourists, which include challenges stemming from language barriers, limitations in human resources, and collaboration. Through the interviews conducted the authors illustrated best practices in nine areas which could help rail operators to overcome some of these challenges.

Generally speaking, Japanese rail operators all were aware of the hazard vulnerabilities to their rail lines, stations, and passengers. Experiences from the disasters in 2011, 2016–2018 have allowed operators to identify weak spots in their previous emergency management planning. As a result, all operators interviewed had conducted vulnerability assessments and most were engaged in the emergency training of their staff. However, some companies were unable to either partially or fully adopt initiatives relating to the provision of evacuation shelters, control false alerts, provide information at the station, promote an image of safety and security, or suffered from language limitations. At the same time, these operators also provided insights on how they could cooperate with local governments, communities, and other rail operators to strengthen areas they were struggling with.

For rail operators, it is not only imperative to include initiatives that can lead to increased transportation resiliency, but to also plan for tourism resiliency. This should involve a stronger focus on education and communication activities at the operational level, and collaborative partnerships with the public and private sectors and branding/image marketing at the strategic level. As Japanese inbound tourism continues to rise, the use of rail transportation by tourists will increase, requiring rail companies to implement both transportation and tourism resilient planning.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.ijdrr.2019.101222.

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