EX-POST EVALUATION OF NEW SHINKANSEN LINE PROJECTS (TOHOKU SHINKANSEN AND KYUSHU SHINKANSEN)

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ABSTRACT

This study conducts the quantitative analyses for Tohoku Shinkansen (Morioka - Hochinohe) and Kyushu Shinkansen (Shin-Yatsushiro – Kagoshima-Chuo) regarding change in traffic situation and effects or impacts on passengers and tourism in the fifth year after the opening. Many effects were confirmed on both of Tohoku Shinkansen and Kyushu Shinkansen, including increase in traffic volume (particularly in railway traffic), improvement of convenience such as shorter travel time and change in commuter behaviour of the local residents along the lines as a result, increase in tourists coming to the regions, and promotion of business activities. Moreover these effects were seen continually for five years since the opening.

Keywords: ex-post evaluations of railway opening, Shinkansen

1. INTORODUCTION

The construction of new Shinkansen lines has been progressing under the Nationwide Shinkansen Railways Construction Act. The section from Hachinohe to Sin-Aomori of Tohoku Shinkansen was opened on December 4, 2010, and the section from Hakata to Shin-

Yatsushiro was opened March 12, 2011. This means that the entire routes of Tohoku Shinkansen and Kyushu Shinkansen (Kagoshima route) were opened.
Opening of a Shinkansen line provides high-speed transportation service to the areas along the line, expands the range of the passengers' activities and brings about effects such as shorter travel time. These result in the activation of human communication caused by the increased inter-regional mobility and the revitalization of local social economy. Furthermore, environmental conservation effect is also expected including the reduction in carbon dioxide emission, a cause of global warming. In order to quantify impacts caused by the Shinkansen development, it is important to analyze how a Shinkansen line opening brings about the above-mentioned effects and whether or not the effects are seen continuously after that.
This study conducts the quantitative analyses for Tohoku Shinkansen (Morioka - Hochinohe) and Kyushu Shinkansen (Shin-Yatsushiro – Kagoshima-Chuo) regarding change in traffic situation and effects or impacts on passengers and tourism in the fifth year after the opening.

2. PREVIOUS STUDIES

(1) Study on evaluation of social benefit brought about by opening of Shinkansen line

The previous studies on evaluation of social benefit (effect) brought about by opening of a Shinkansen line are as follows;
Transport and Economic Research Center[1)2)] has analyzed the change in regional economic structure along the Shinkansen lines and is proposing the introduction of regional econometric analysis. Business Strategy Research Division of Mitsubishi Research Institute[3)4)], Inc. has evaluated economic ripple effect on local economy. While this study covers the change in regional economic structure same as Reference 1) and 2), the model structure and result are different from them. Research institutions affiliated to financial companies have conducted analyses to evaluate the expansion of consumption behaviour along Shinkansen lines due to the increase in the tourists coming to the regions (e.g., Nomura Research Institute[5)]). Hiraishi[6)] and Joetsu City[7)] have evaluated the development of the Shinkasnen line and the local area (or its prospect) qualitatively.
All the above-mentioned studies from 1) to 7) are prior evaluations before the opening of a Shinkasen line. In fact, there are very few ex-post evaluations after the opening of a Shinkassen line. Although Institution for Transport Policy Studies[8)] has established the method for ex-post evaluation of railway projects including Shinkasnen under the supervision of the Railway Bureau of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), there are still few case of ex-post evaluation.
The studies by Hasegawa and others[9)], Tsuzuki[10)], Matsunaga and others[11)], Suehara and others[12)] and Matsuzaki and others[13)] are a series for the ex-post evaluation of social benefit which has been brought about by the opened Shinkansen lines. The value and significance of these studies is that these are the continuous analysis which was started before the establishment of the method[8)]. Our study is the successor to 9) - 13), and analyzes the social benefit after the opening of Tohoku Shinkansen and Kyushu Shinkansen.

(2) Studies on the index of social benefit brought about by opening of Shinkansen

The evaluation indexes for public investment projects including Shinkansen have been theorized and organized by the research group formed by Morisugi, Ueda and others. The results of a vast amount of research on passenger benefit (consumer surplus) evaluation based on microeconomics are compiled in the study by Morisugi[14]. With the study by Morisugi[14] as the basic theory, the social benefit evaluation has been manualized for each area of public investment projects through the stages of the investigation[15] and instruction[16] by the government. Regarding railway projects, the Reference 17) is the first manual, and was re-examined in 18) and 19).

In the manuals 17) and 18) focus on the efficiency indexes for the cost-benefit analysis, such as passenger benefit, business benefit (railway operator benefit) and environment improvement. In these manuals, impartiality index (e.g., extra coefficient for regions), which was pointed out by Morisugi, and multi-criteria analysis or comprehensive evaluation method which weights each evaluation item according to its importance are not adopted. The indexes regarding “health and national land conservation” are also not adopted in the manuals 17) and 18). These are cited as the items whose values have not fully evaluated by Morisugi.

In the manual 8), while evaluation by the efficiency index is its basis, comprehensive evaluation method is adopted and the major review was conducted including the establishment of ex-post evaluation method. This manual, however, has practical characteristics that evaluations by the efficiency index and comprehensive evaluation are conducted separately. For example, while the analyses of effects or impacts on the areas along a railway line by regional econometric analysis are shown in comprehensive evaluation, these analysis results are not reflected in efficiency index.

In the Manuals 17), 18) and 8), the results of research that is how phased development of a traffic network is placed in the evaluation of the whole network (by Aoyama and others[20)21)], Matsunaka and others[22)] and Maekawa and others[23)]), which is common for road projects, are not reflected. Moreover, in the manual for road projects, benefit evaluation taking into account road closure in times of disaster is possible, and the redundancy in time of disaster can be adopted as an index in comprehensive evaluation. However, these are not adopted in the manuals for railway projects.

This study is on ex-post evaluation mainly adopting the indexes in the manual 8), based on the results of 9) – 13).

3. OUTLINE OF EACH SHINKANSEN LINE

Tohoku Shinkansen (Morioka - Hachinohe) is the 96.6km line from Morioka City in Iwate Prefecture to Hachinohe City in Aomori Prefecture. This is the extension of the completed section of Tohoku Shinkansen (Tokyo - Morioka). There are two new intermediate stations at Iwate-Numakunai in Iwate Town and Ninohe in Ninohe City.

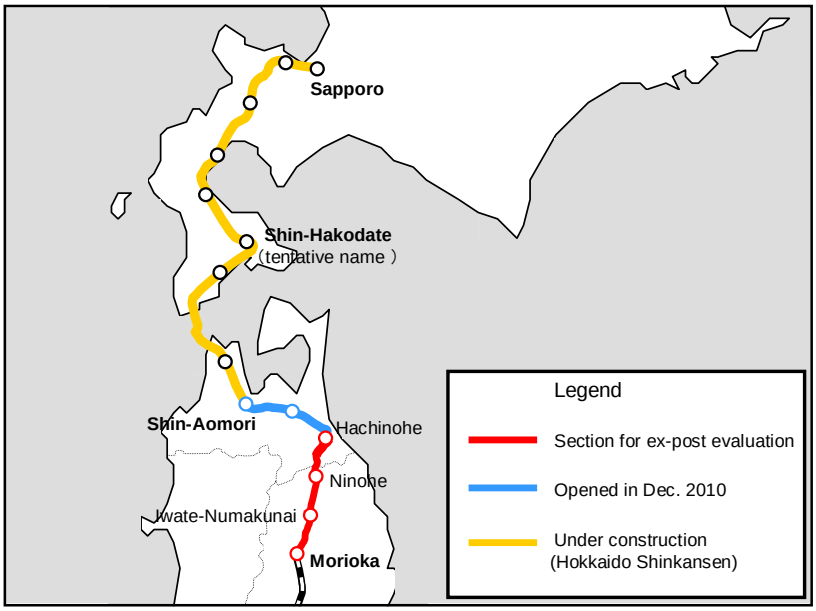

Figure 1 – Tohoku Shinkansen

Kyushu Shinkansen (Shin-Yatsushiro – Kagoshima-Chuo) is the 126km line from Yatsushiro City in Kumamoto Prefecture to Kagoshima City in Kagoshima prefecture. There are new stations at Shin-Minamata in Minamata City, Izumi in Izumi City and Sendai in Satsumasendai City.

The southern section of Kyushu Shinkansen (Kagoshima route) was constructed and opened in advance of the northern section. Therefore the passengers had to transfer at Shin-Yatsushiro station before the Hakata – Shin-Yatsushiro section was opened. However, the transfer between Shinkansen and the conventional line at the same platform has enabled the passengers transfer in only 3 minutes. This minimized the burden of transfer. As a result of the partial opening of the southern half of the entire route, Kyushu Shinkansen was not connected to the existing Shinkansen network at the time.

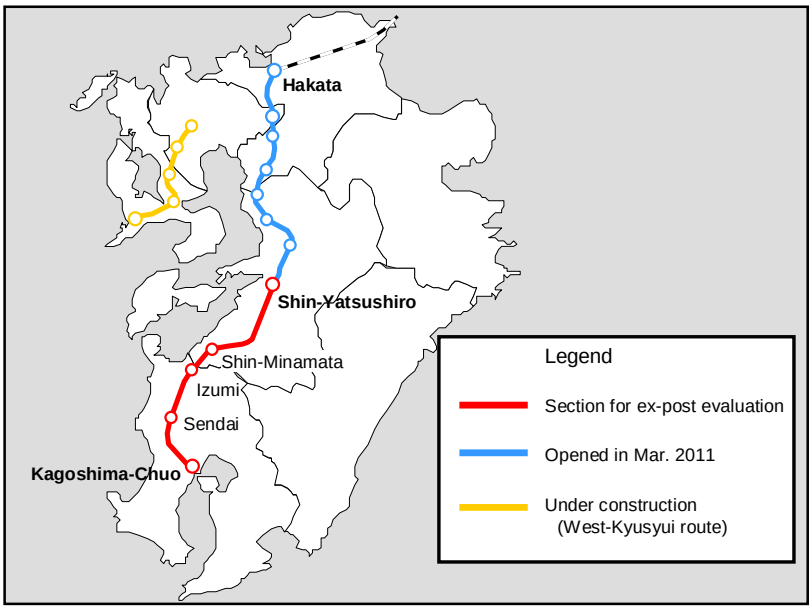

Figure-2 Kyushu Shinkansen

4. TRAVEL TIME REDUCTION EFFECT OF SHINKANSEN

(1) Change in travel time and fare

The travel time between Tokyo and Hachinohe by Tohoku Shinkasnen was 3 hours 33 minutes before the opening of the section between Morioka and Hachinohe. This has been reduced by about 40 minutes to 2 hours 56 minutes by the opening of the section. The fare is 15,350 yen. This is 800 yen lower than that of before the opening, 16,150 yen.

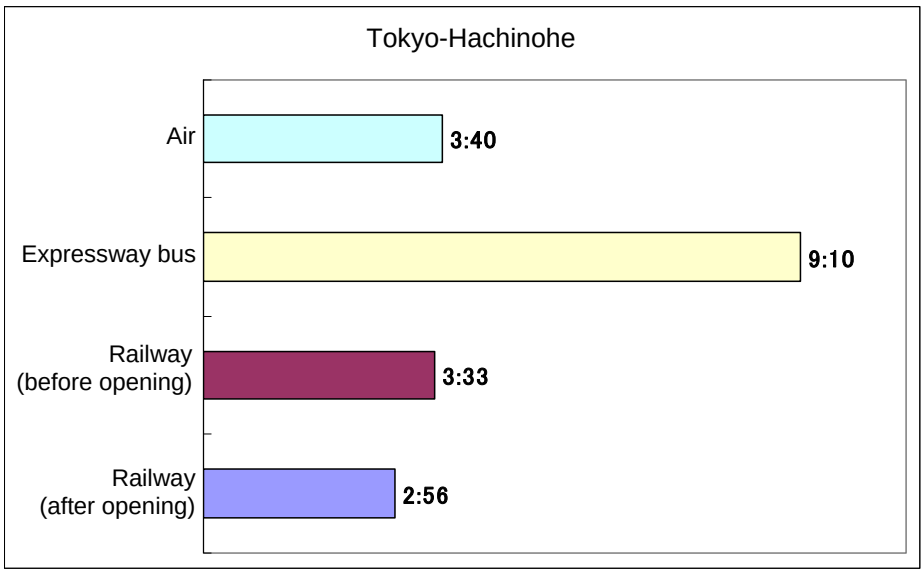

Figure-3 Change in travel time (Tohoku Shinkasnen)

The travel time between Hakata and Kagoshima was 3 hours 40 minutes before the opening of the section between Shin-Yatsushiro and Kagoshima-Chuo. This has been reduced by about 90 minutes to 2 hours 12 minutes by the opening the section. The fare is 7,800 yen. This is 2,800 yen higher than that of before the opening, 5,000 yen.

As for the travel time between Shin-Yatsushiro and Kagoshima-Chuo, now it is only 35 minutes after the opening, compared to 2 hours before the opening, that is, the travel time has been shortened to about 30%.

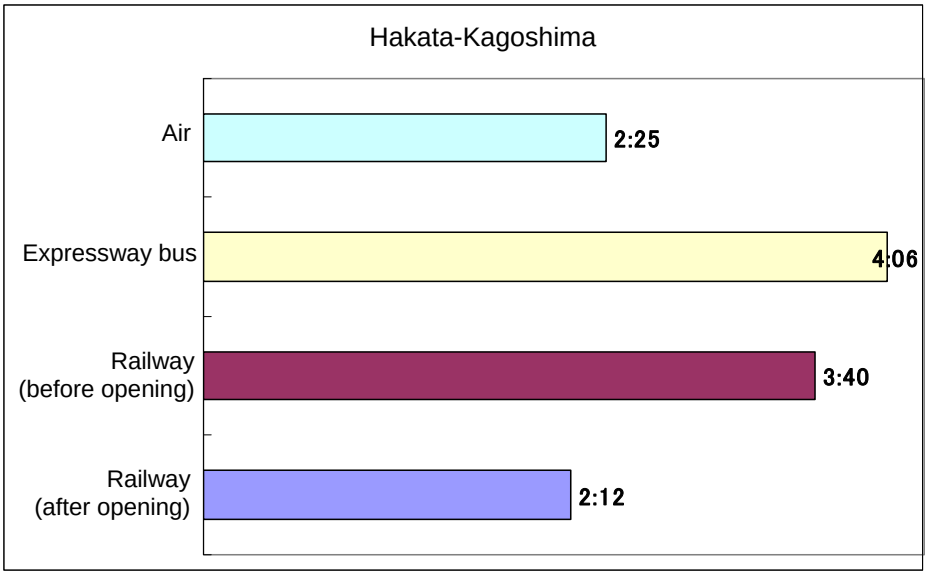

Figure-4 Change in travel time (Kyushu Shinkansen)

(2) Change in range of required time

In this study, “the range of required time” is adopted as the index for the evaluation of travel time reduction effect. “The range of required time” is to show the geographical distribution of travel time from each municipality to the center of a metropolitan area (Tokyo station for Tohoku Shinkansen, Hakata station for Kyushu Shinkansen).
As for Tohoku Shinkansen, the range of required time has expanded to the municipalities in the northern area of Iwate Prefecture and the eastern area of Aomori Prefecture after the opening. Particularly in the 4.5-hours areas, the resident population has increased to about 970,000 from about 580,000.

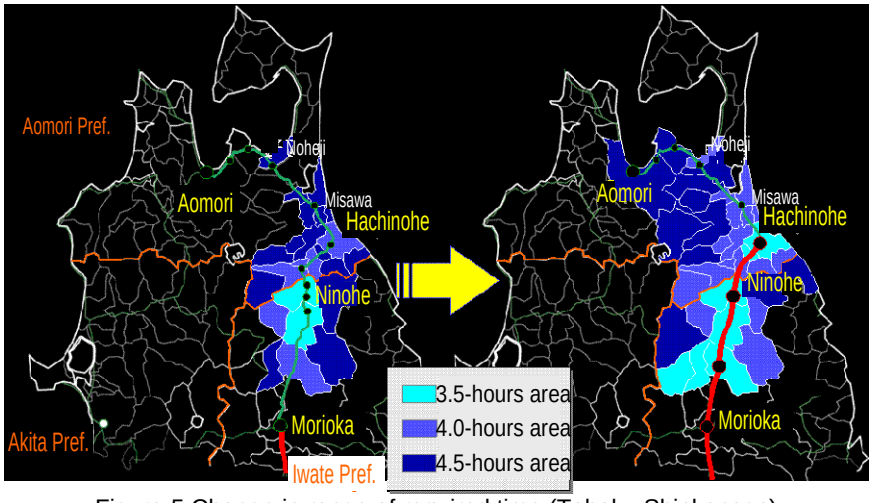

Figure-5 Change in range of required time (Tohoku Shinkansen)

As for Kyushu Shinkansen, the range of required time has expanded to the municipalities in the southern area of Kumamoto Prefecture and the western area of Kagoshima Prefecture

after the opening. Particularly in the 3.5-hours areas, the resident population has increased by about 5 times to about 1,230,000 from about 240,000.

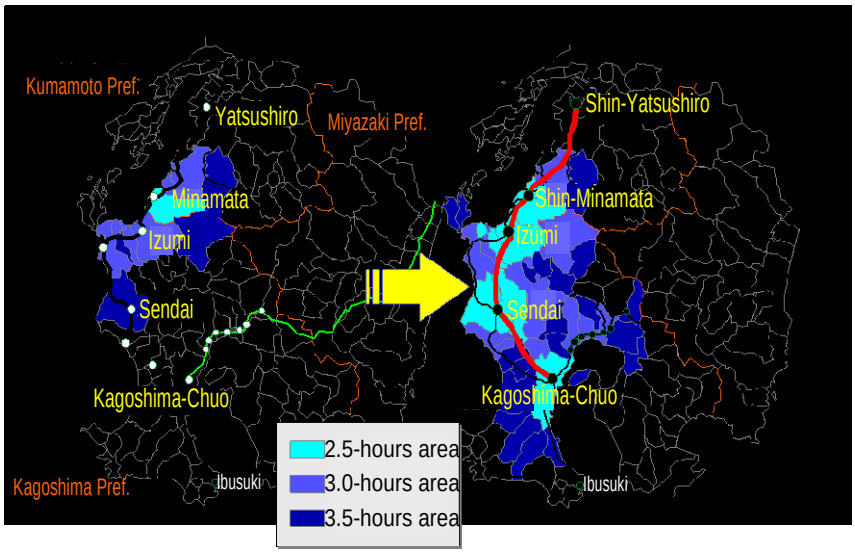

Figure-6 Change in range of required time (Kyushu Shinkansen)

(3) Change in available time to spend in destination

The available time to spend in destination for the travel from Tokyo to Hachinohe has increased to about 10 hours from about 8 hours 10 minutes by about 1 hour 50 minutes. That from Hachinohe to Tokyo has also increased to about 10 hours 10 minutes from about 9 hours by 1 hour 10 minutes.

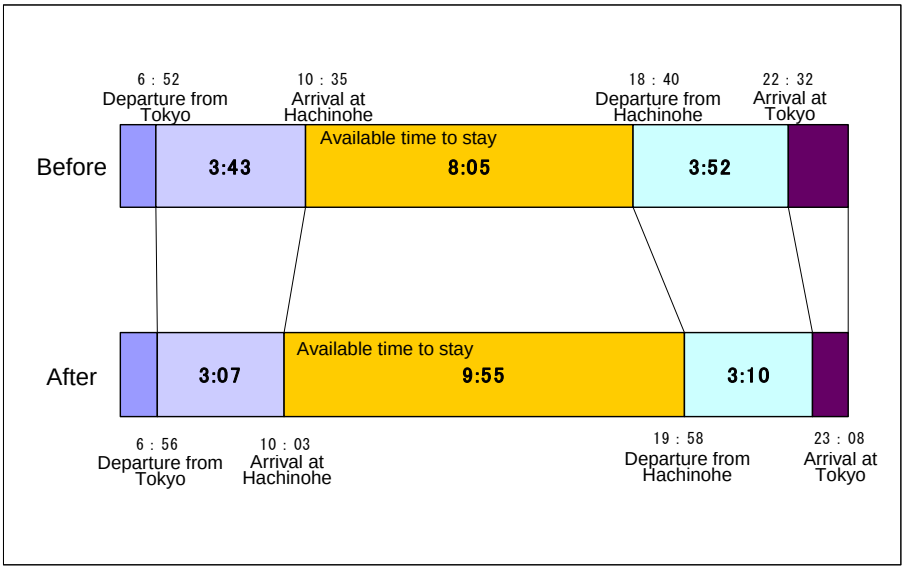

Figure-7 Change in available time to spend in destination (from Tokyo to Hachinohe) based on the data of JR timetable (Apr. 2002 for Before, Oct. 2007 for After)

The available time to spend in destination for the travel from Hakata to Kagoshima-Chuo has increased greatly to about 12 hours 40 minutes from about 8 hours 30 minutes by about 4

hours 10 minutes. That from Kagoshima-Chuo to Hakata has also increased greatly to about 12 hours 30 minutes from about 9 hours 50 minutes by about 2 hours 40 minutes.

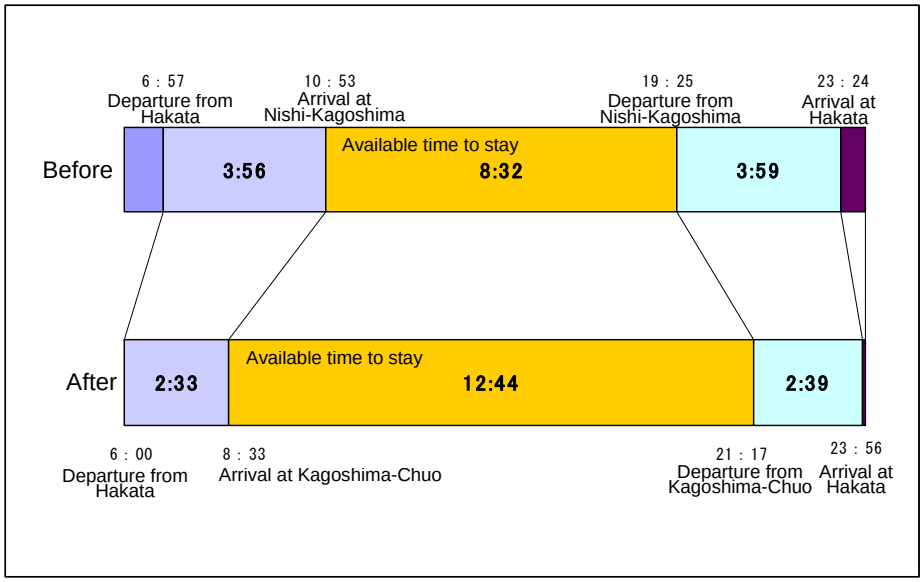

Figure-8 Change in available time to spend in destination (from Hakata to Kagoshima) based on the data of a railway route search system “Eki-spert” (Oct. 2003 for Before, Oct. 2004 for After)

5. PASSENGER TRANSPORT AFTER SHIHKANSEN OPENING

In this study, the fifth year since the opening has been set as the target for the ex-post evaluation, and hence each index has been analyzed based on the volume of passenger transport from the first year to the fourth year. As Tohoku Shinkansen was opened on December 1, 2001, the volume of passenger transport until 2005 has been analyzed. As for Kyushu Shinkansen, the line was opened on March 13, 2003. Therefore, the fiscal year starting in April 2004 was set as the first year, and the volume of passenger transport until fiscal year 2007 has been analyzed. (Japanese fiscal year: April - March)

(1) Transition of Shinkansen passenger transport

Figure-9 shows the volume of passenger transport between Morioka and Hachinohe. The volume of passenger transport before the opening is 7,600 people/day, 11,600 people/day in the first year (about 152% compared to 2002) and 12,400 people/day in the forth year (about 163% compared to 2002).

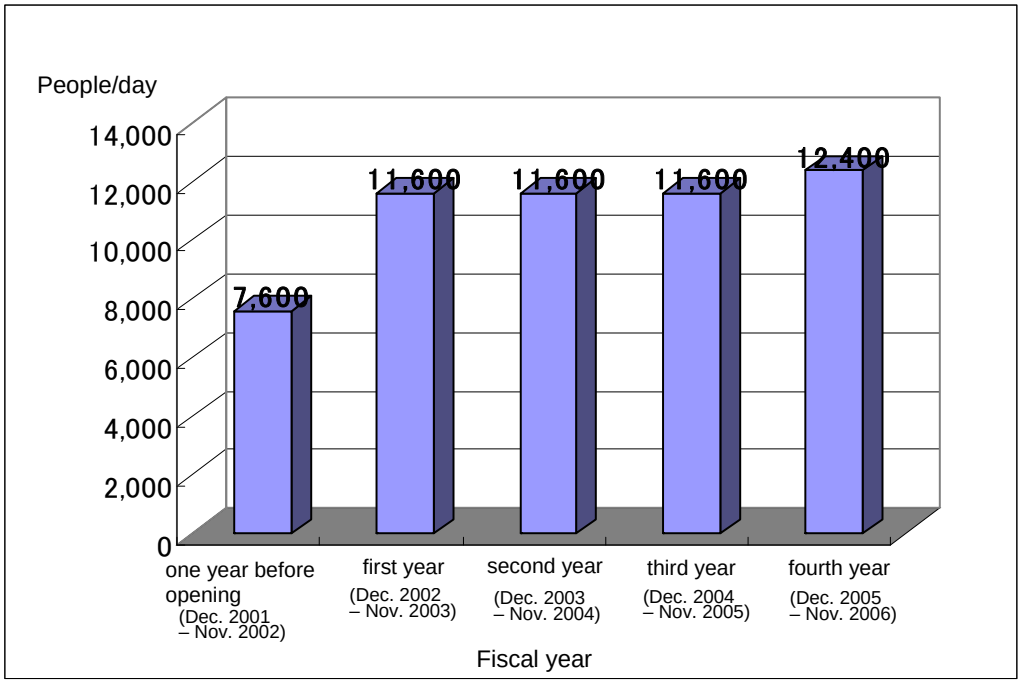

Figure-9 Transition of passenger transport volume (Tohoku Shinkansen)
based on the date of JR East News

Figure-10 shows the volume of passenger transport between Shin-Yatsushiro and Kagoshima-Chuo. The volume of passenger transport in 2003 before the opening is 3,900 people/day, 8,800 people/day in the first year (about 225% compared to 2003) and 9,400 people/day in the fourth year (about 240% compared to 2003).

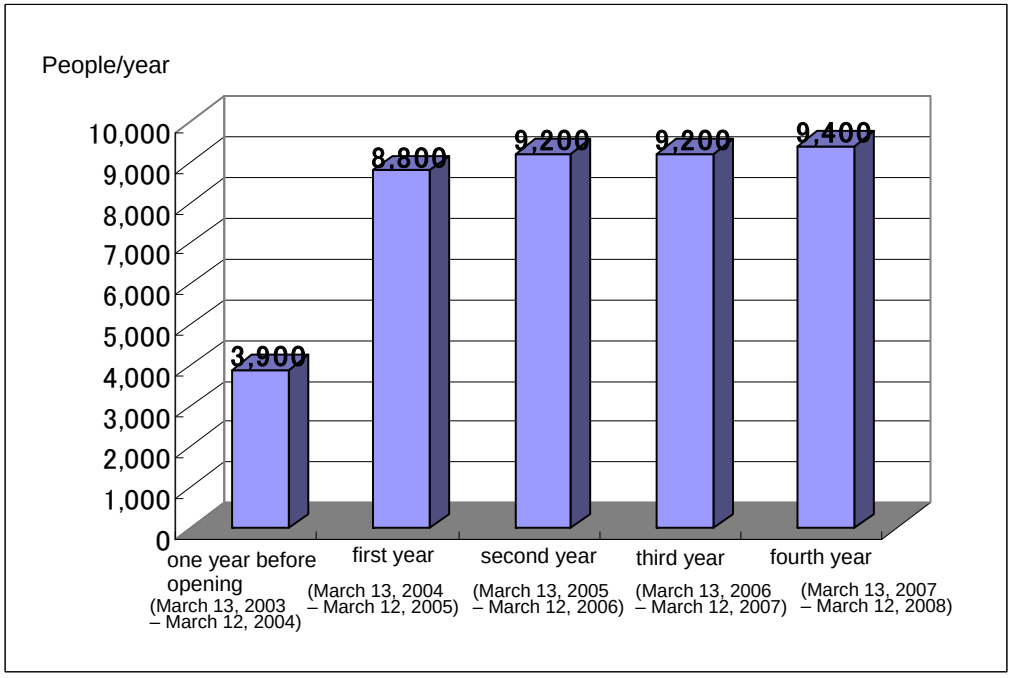

Figure-10 Transition of passenger transport volume (Kyushu Shinkansen)
based on the date of News Release of JR Kyushu

The volume of passenger transport of both of the two lines has greatly increased. Furthermore, the increasing tendency is seen in not only the first year but also the second and the following years. This means that the effect has been brought about continuously.

(2) Transition of passenger transport of each transportation mode

Figure-11 shows the transition of annual passenger transport volume for each transportation mode between Morioka and Hachinohe and the total volume of passenger transport. The volume of passenger transport of railway has increased sharply, that of air has reduced to 67% in the forth year compared to before the Shinkansen opening, and that of expressway bus has stayed about the same. The total volume of passenger transport has increased to 6.2 million people or 124% in the fourth year from 5 million people before the opening.

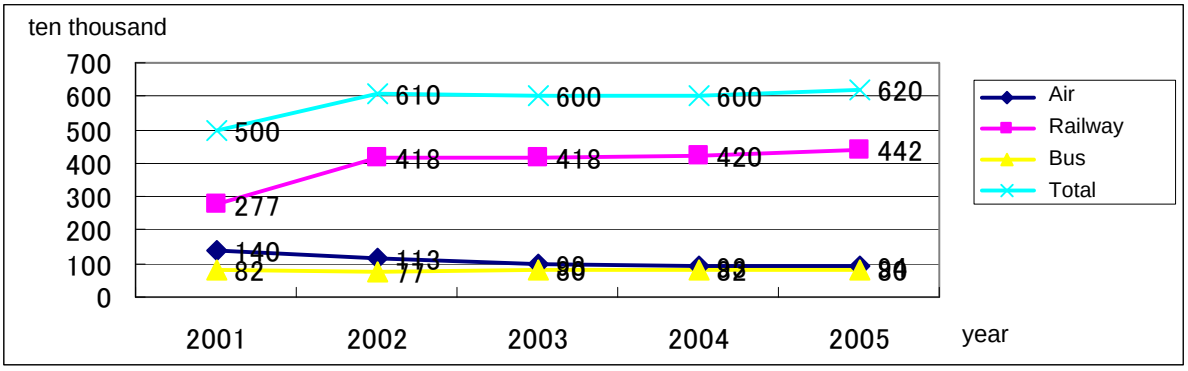

Figure-11 Transition of passenger transport volume of transportation modes (Morioka - Hachinohe) based on the data of "Research on inter-regional passenger flow" and "Annual report of air transport statics" by MLIT and "Trend of transportation in the Tohoku region" by the Tohoku District Transport Bureau

Figure-12 shows the transition of annual passenger transport volume for each transportation mode between Shin-Yatsushiro and Kagoshima-Chuo and the total volume of passenger transport. Like Morioka – Hachinohe, the volume of passenger transport of railway has increased sharply, that of air has reduced to 45% in the third year compared to before the Shinkansen opening and that of expressway bus has stayed about the same. The total volume of passenger transport has increased to 2.07 million people or 106% in the third year from 1.95 million people before the opening.

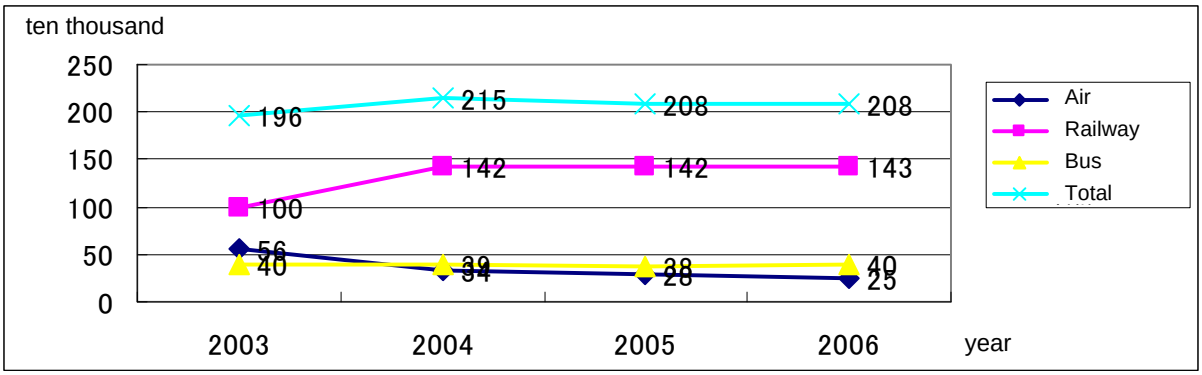

Figure-12 Transition of passenger transport volume of transportation modes (Hakata - Kagoshima) based on the data of "Research on inter-regional passenger flow" and "Annual report of air transport statics" by MLIT and "Situation of expressway bus" by the Kyushu District Transport Bureau

This analysis confirmed that the total volume of passenger transport has increased in both of the two lines and the increasing tendency was seen in the second and the following years. The increase in volume of passenger transport of railway (Shinkansen) has largely contributed to this.

6. EFFECTS ON COMMERCIAL AND BUSINESS ACTIVITIES

"The population in trade area", which is the total of residential population in an administrative area and inflowing population from outside the area, has been increasing since 2000 (Hachinohe Chamber of Commerce and Industry[27]). The residential population of Hachinohe City is declining. As for the population of trade area, however, it is still the largest in Aomori Prefecture with the number of conventions held in the city and its participants have increased after the Shinkansen opening.

Table I – Change in the population in trade area of major cities in Aomori Prefecture (thousand people)

year	Hachinohe City	Aomori City	Hirosaki City	(Reference) Residential popuration of Hachinohe City	
2000	658.3	417.0	606.8	250.5	Opening
2003	668.6	446.5	587.9	251.0	
2006	670.7	515.2	398.3	248.8	

source : "Report on the trade area of Hachinohe City (2006)" by Aomori Chamber of Commerce and Industry

On the occasion of the Shinkansen development, the many hotels have been constructed in Kagoshima Prefecture since 5 years before the opening. The number of hotels has increased by 26% and the number of guest rooms has increased by 35% in 2006 compared to 1999. In addition to that, the average occupancy rate of 9 hotels in Kagoshima Prefecture has been staying about the same after the decline in the second year of the Shinkansen opening, in spite of the great increase of the number of guest rooms since then. This means that the number of the guests has been increasing.

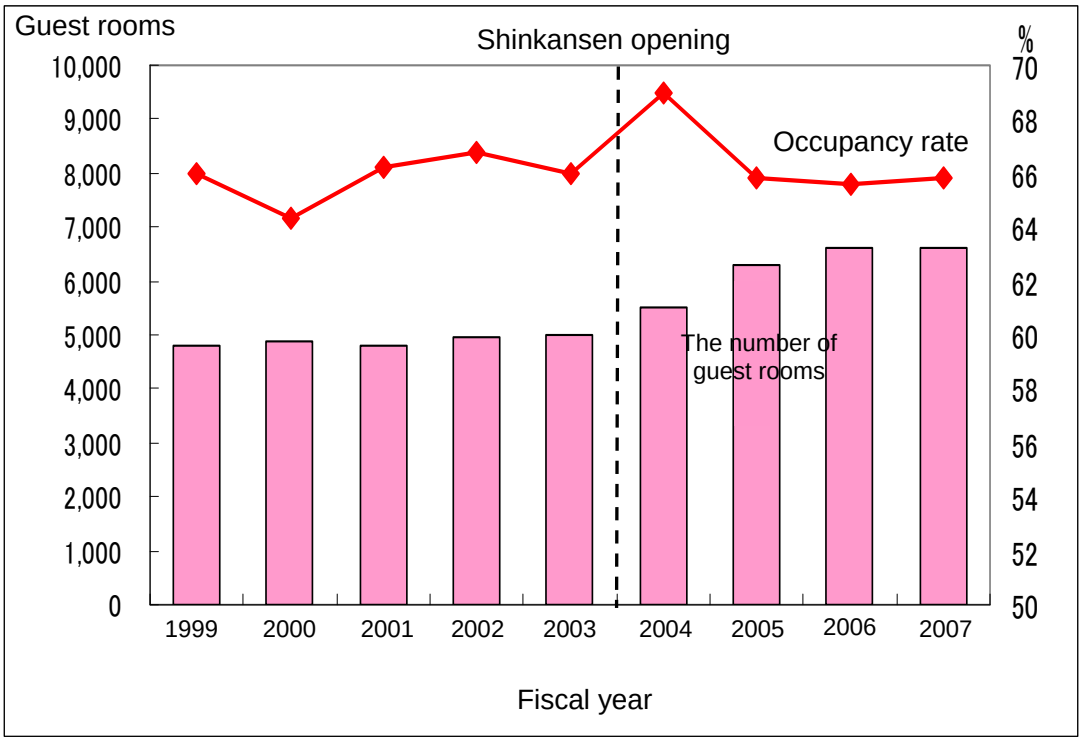

Figure-13 The number of guest rooms in Kagoshima City and its occupancy rate
based on "Public Health Administrative Report" by the Ministry of Health, Labour and Welfare and "Regional Economic Information (May 2008)" by Kagoshima Regional Economic Research Institute

7. EFFECTS ON TOURISM

The transition of the number of visitors to the major festivals after Tohoku Shinkasnen opening shows the increase in all the festivals in 2003. After that, the visitors of all the festivals are increasing with the exception that the visitors of Aomori Nebuta Festival is gradually declining because its scale of 3.5 million people is remarkably larger than the other festivals. The visitors of Hachinohe Sansha Festival and Towada Winter Festival are greatly increasing in particular.

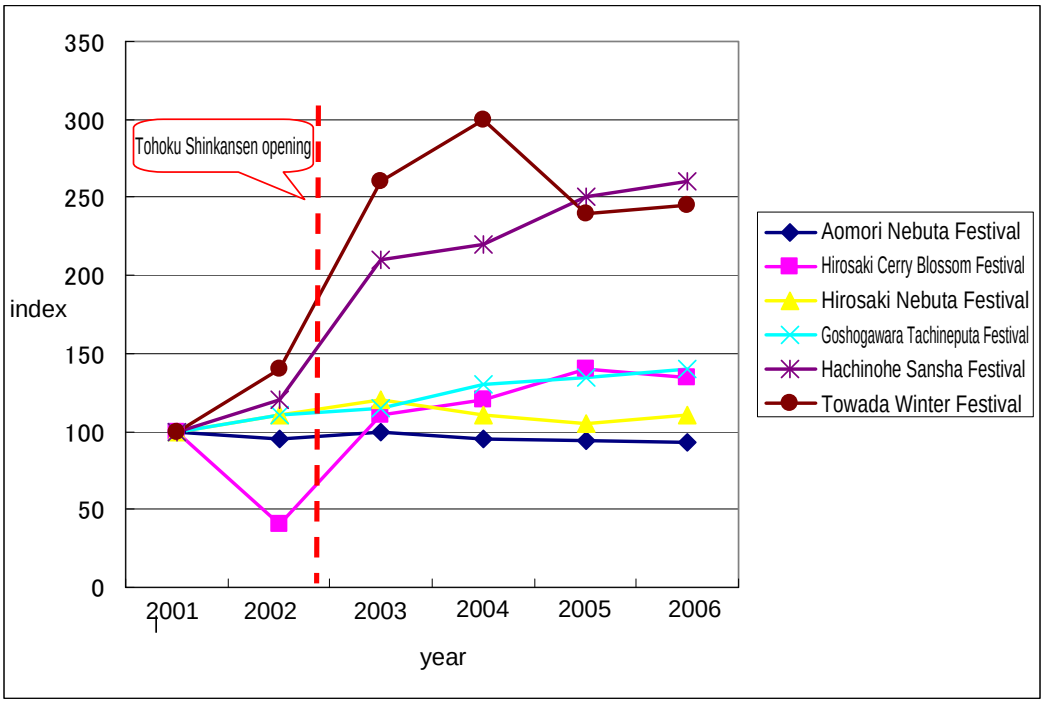

Figure-14 Transition of the number of visitors of major festivals in the northern part of Tohoku region (index)
based on "Outline of Tourism Statics of Aomori Prefecture" by Tourist Bureau of Commerce, Industry and Labour Department, the Aomori prefectural government

After the opening of Kyushu Shinkansen, the number of hotel guests of Kagoshima prefecture coming from the outside the prefecture has increased to about 7.8 million people in 2004 by about 2% from 7.6 million people in 2003 before the opening. As the annual variability is large, it declined in the second year of the opening. However, it has been increasing since the third year. (It increased to about 7.9 million guests in 2007, or 3% more than that in 2003.)

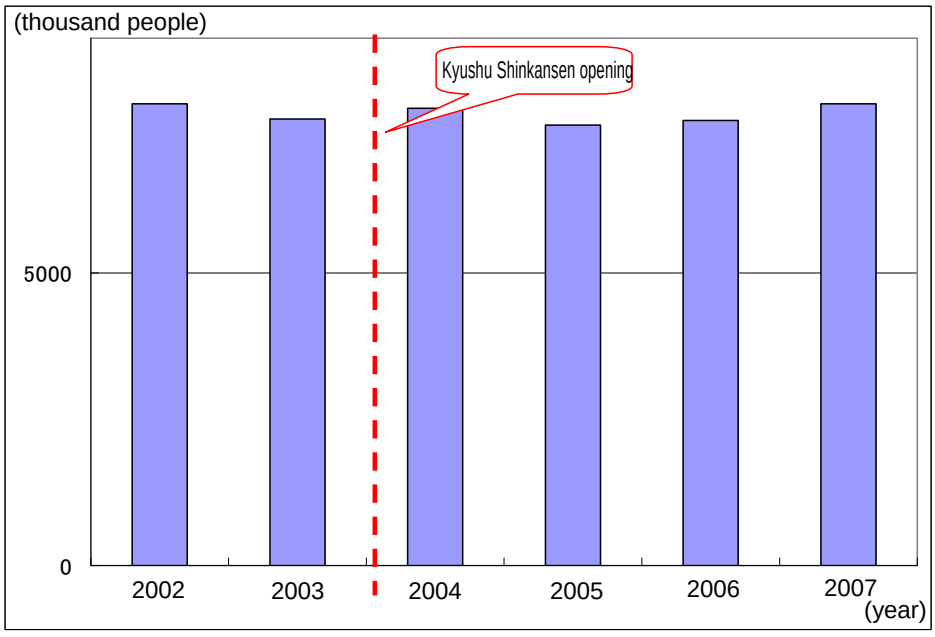

Figure-15 Transition of the number of hotel guests of Kagoshima Prefecture coming from the outside the prefecture
based on "Tourism Statics of Kagoshima Prefecture" by Kagoshima Prefecture

8. EFFECTS ON LIFE OF LOCAL RESIDENTS

Aomori Prefecture and the northern part of Iwate Prefecture, where Tohoku Shinkansen is running through, are in cold climate and have heavy snowfall. In winter, therefore, flights are cancelled and train services are disrupted some times. Figure-16 shows the numbers of train service disruption and flight cancellation due to snow disasters between 2002 and 2006. As for Tohoku Shinkansen, measures against snow disasters are taken and the total length of tunnel section is long, and hence, the higher level of punctuality is attained throughout the year than the other transportation services.

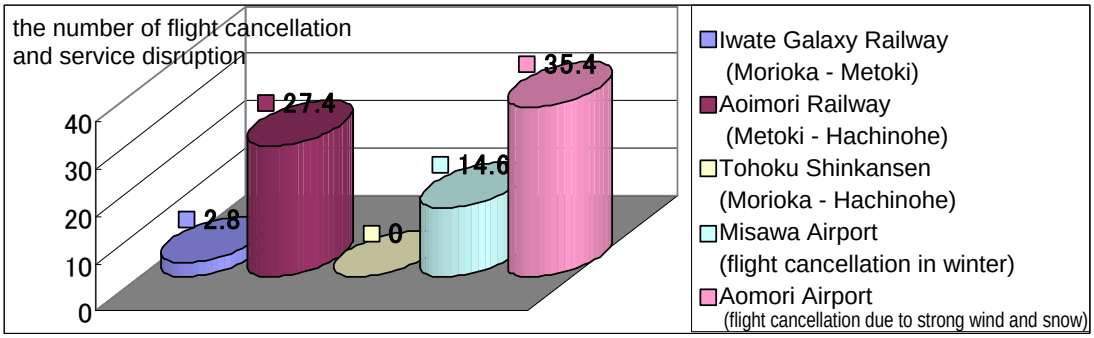

Figure-16 The number of service disruption (railway) and flight cancellation (air) due to snow disaster (Morioka - Hachinohe)

※1 the numbers of railway service disruption and flight cancellation are average values of the past 5 years (fiscal 2002 – fiscal 2006)

※2 the numbers of railway service disruption is cancellation or delaying of 30 minutes or more due to snow disaster

※3 flight cancellation is due to bad weather in winter

based on the data released by JR East, Iwate Galaxy Railway, Aoimori Railway and Aomori Prefecture

As for Kyushu Shinkansen, the commuters from Imizu City and Satsumasendai City to urban areas including Kagoshima City have greatly increased, and the passengers using commuter pass are about 1,100 people/day in the third year after the opening or about 11 times of that before the opening. This is one example of the effect of Shinkansen that drives the change in not only middle-distance but also relatively short-distance inter-regional traffic.

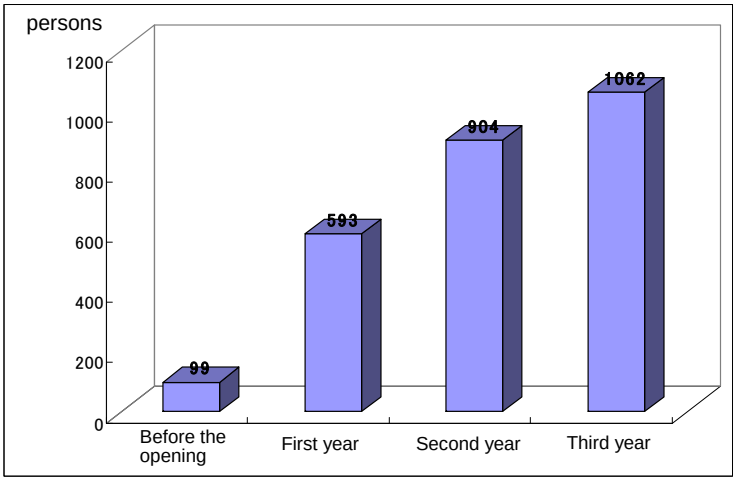

Figure-17 Transition of the number of passengers with commuter pass

based on “Annual report of railway transport statics” by MLIT

9. CONCLUSION

The effects including increase in traffic volume (particularly in railway traffic), improvement of convenience such as shorter travel time and change in commuter behaviour of the local residents along the lines as a result, increase in tourists coming to the regions, and promotion of business activities are seen in both of Tohoku Shinkansen (Morioka - Hachinohe) and Kyushu Shinkansen (Shin-Yatsushiro – Kagoshima-Chuo). Moreover these effects were seen continually for five years since the opening.

While Tohoku Shinkansen is the extension of the existing line, Kyushu Shinkansen was not connected to the existing Shinkasen network because the southern section was constructed and opened in advance. This means that these two lines were not developed under the same conditions. However, same effects by development are seen in the quantitative comparison and confirmation of effects.

It is considered that the time reducing effect has contributed to this largely. Tohoku Shinkansen has reduced the travel time from Tokyo to Hachinohe by 40 minutes, and eliminated the need to transfer. Kyushu Shinkansen has reduced the travel time between Yatsushiro and Kagoshima to 35 minutes from 2 hours by the conventional line, and the travel time from Hakata, the largest city in Kyushu region, to Kagoshima has been reduced by 90 minutes. Although there was the need to transfer between the conventional line and the Shinkansen line, the transfer at the same platform made the burden on the passengers minimized. This has brought about equivalent effects in the exceptional case such as Kyushu Shinkansen compared to the case of extension of an existing Shinkansen line.

Newly constructed sections on both of the two lines were opened in fiscal year 2010, and the Kyushu Shinkansen was connected to the existing Shinkasnen network. We will continue to research the change in the indexes used in this study.

The indexes adopted in this study are mainly quantitative ones. At this time, however, there are indexes which have great social significance but are hard to quantify as mentioned in 2.(2).

In the serious earthquake which hit the Tohoku region in Japan in 2011, the region was suffered unprecedented damage. Although the train service on Tohoku Shinkansen was suspended all along the line for a while after that, in the section north of Morioka, where the damage was not severe compared with the other section, the train operation was resumed earlier. It is reported that the restoration and creation of the Shinkansen network between the regions has not only improved the flow of people but also had great effects on the people as a foothold for the restoration and recovery.

The need for redundancy of the high speed rail is also one of the issues faced in this earthquake. As mentioned 2.(2), disaster response is considered as a index in the manual for road projects[24]. “Securing transportation means at the time of disaster” can be evaluated in the manual for airport projects[28] as well. On the other hand, those indexes can not be evaluated in the current manual for railway projects[8].

As above, with the objective of “reflecting ex-post evaluation results on the planning and study of projects and the re-examination of project evaluation methods”, it can be said that it is important to review even indexes which are currently hard to quantify taking the fact and the actual effects into consideration.

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