Ensuring an Appropriate Level of Expressway Management by Using Outcome Indicators
—Role of JEHDRA after Privatization of Highway Public Corporations in Japan—

K. Osaka, T. Yamada, K. Nakamura,
N. Yamagata, T. Maeda, R. Uehara
Japan Expressway Holding and Debt Repayment Agency
2-8-6, Nishi-Shimbashi, Minato-ku, Tokyo, Japan
kikakuka@jehdra.go.jp

ABSTRACT

The role of the Japan Expressway Holding and Debt Repayment Agency (JEHDRA) and the privatized expressway companies is to promote the establishment of a national highway network and to hand over safe and good-quality expressways to the next generation.

To this end, the six private expressway companies that came into being after the privatization of highway public corporations implement proper and efficient management of expressways in order to ensure that they are maintained in good condition. JEHDRA receives annual reports on the maintenance and management of expressways from the expressway companies and confirms, on site, how they manage expressways.

In the reports on maintenance and management, each company discloses and evaluates objective indicators (outcome indicators) that are easy to understand for customers. JEHDRA selects seven of the outcome indicators it collects from the six companies and then discloses them.

By comparing changes over years and differences between companies, more transparency in the expressway business can be achieved through the disclosure of information, and more structural maintenance work, such as seismic reinforcement, can be achieved. As a result, a more efficient business scheme can be provided by activating the management cycle based on the companies' indicators.

1. INTRODUCTION

(1) Background of Expressway Development

In the 1950s, following the end of World War II, road conditions in Japan were very poor.

Large vehicles had difficulty in passing each other on many roads, and once it rained, vehicles got stuck in mud, even on trunk roads. Road development in Japan was said to be decades behind from those in developed countries. Therefore, road development was given priority as an essential national project for the postwar rehabilitation and industrialization.

The need for road development was great, but the national budget for it was small. The national annual budget for roads was only 62 billion yen in the 1950s, though the construction cost for the expressway between Tokyo and Kobe alone was estimated to be about 450 billion yen.

Due to such circumstances, a toll-road system was introduced in 1952 that allowed financing of expressways with loans and bonds which would be repaid by the toll revenue.

In 1956, the Japan Highway Public Corporation was established as a body to develop toll roads nationwide. Under then-new laws concerning toll roads, all expressways were decided to be developed as toll roads. The construction of the Expressway from Nagoya to Kobe, the first expressway in Japan, was financed including through a loan from the World Bank.

(2) Present Situation of Expressways

Japan's first expressway (71 km long) opened in 1963. More than 46 years later, as of January 2011, about 9,500 km of expressways are in service and more than 3,000 km is under construction.

The toll rates of most expressways are determined based on distance traveled. For example, the toll for a passenger car is about 11,000 yen from Tokyo to Osaka (about 500 km). It had long been argued that toll levels on expressways in Japan were higher than those in other countries. In 2008, as a part of an emergency economic package[a], the

[a] Emergency economic package: Implementation of "Convenience-enhancing Projects for Expressways"
To enhance the effective utilization of expressways and their functions, expressway fares are reduced on a temporary basis under the package based on the Act on State's Special Financial Measures on Road Construction and Improvement Projects (May 2008 revision).
Discount rates include a 50% discount for late at night on weekdays and daytime on holidays, an upper toll limit of 1,000 yen on holidays in rural areas, and a 30–50% hourly discount on weekdays. Discounts are now applied only to ETC-equipped cars.
In June, 2011, the upper toll limit was abolished in order to secure the resources for reconstruction after the Great East Japan Earthquake disaster.

government started offering deep discount fares making it possible to travel from Tokyo to Osaka for about 3,000 yen on holidays, if an ETC-equipped car is used.
In 2010, the government started a toll-free pilot program in sections of expressways with relatively low traffic volume, which account for about 20% of the total length of expressways in Japan.[b]

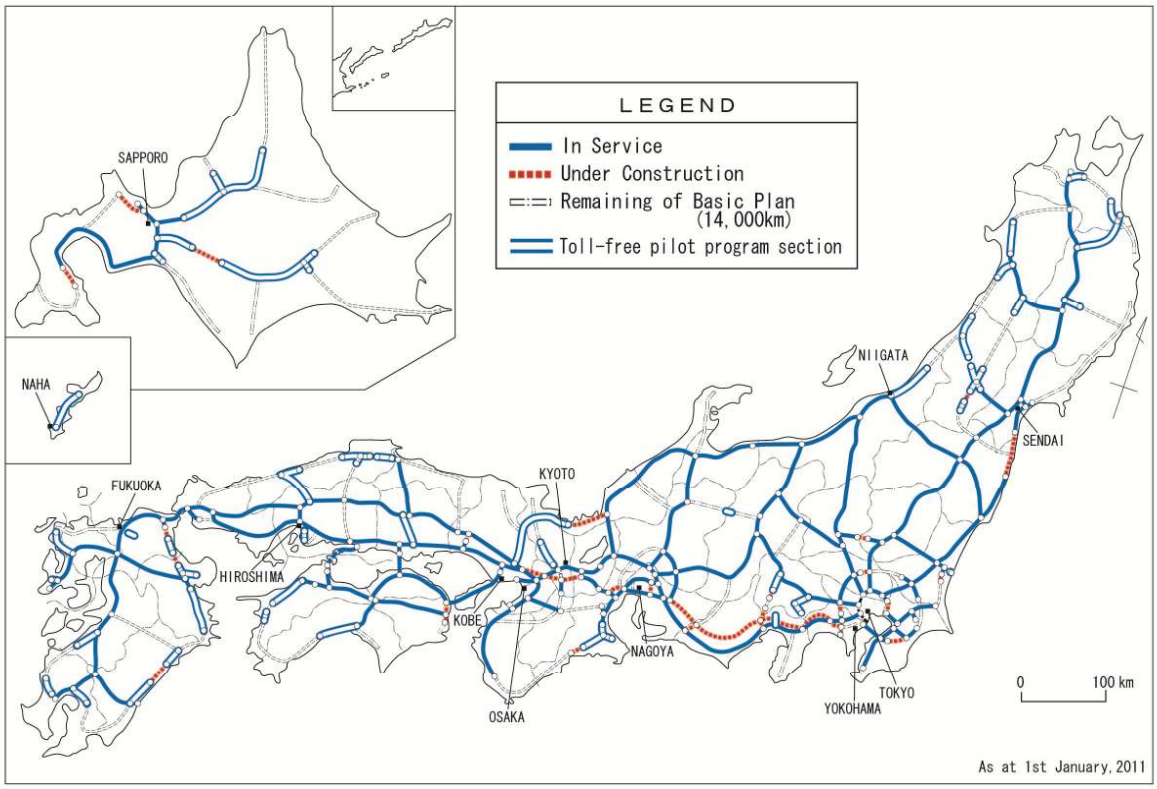

Figure 1 - Expressway Network in Japan

2. FRAMEWORK OF PRIVATIZATION OF HIGHWAY-RELATED PUBLIC CORPORATIONS

(1) Outline of Privatization

As more expressways were constructed in rural areas where traffic demand is slow, and in urban areas where enormous construction costs are required, debts owed by highway public corporations increased to 40 trillion yen, and the period of time needed to repay the debts became longer.

[b] In June, 2011, the toll-free pilot program was canceled in order to secure the resources for reconstruction after the Great East Japan Earthquake disaster.

In 2002, the Japanese government started studying a new framework for the development of expressways, as a result, the four highway public corporations were privatized in 2005, and six private expressway companies and JEHDRA were established.

The major objective of the privatization is to utilize the management knowhow of the private sector and to prepare for risks facing the expressway business in order to enhance the value of expressways and ensure the repayment of debts. Under the new law, the six expressway companies and JEHDRA are required to ensure the repayment of all debts, including new debts incurred in the construction of new expressways, within 45 years from 2005. The construction of other expressways, if necessary, is to be undertaken by the government within the limits of the budget for every fiscal year.

This cooperative scheme between the government and the expressway companies has made it possible to construct necessary roads without imposing a heavy burden on future generations.

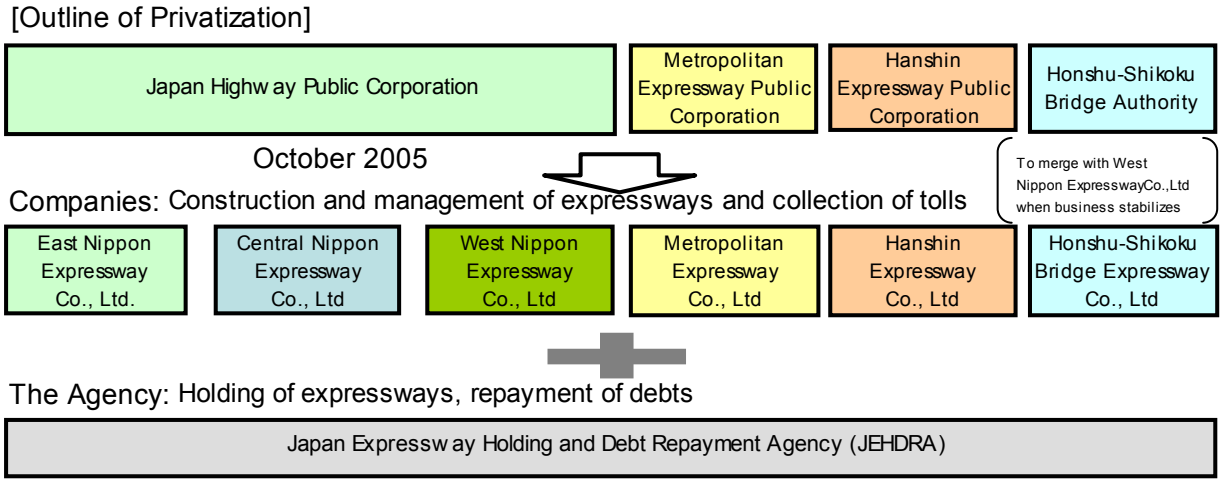

Figure 2 - Privatization Scheme

(2) Roles of Expressway Companies and JEHDRA

The role of the expressway companies and JEHDRA is to develop a national expressway network and pass down safe and good-quality expressways to the next generation. At the same time, in order to repay the debts within 45 years, JEHDRA is required to make agreements with each expressway company regarding the applicable toll rates, the expected traffic and toll revenue, the expected costs of operation, new construction and reconstruction, and the expected interest rates.

Under the agreements, the expressway companies construct and operate expressways and collect tolls. JEHDRA is required to hold expressway assets and related debts, and it

leases expressways to the companies and repays the debts with the lease fees received from the companies. The leases fees are determined by subtracting the expected operation cost from the expected toll revenue.

JEHDRA's role is to ease expressway-related burdens on the people by holding and leasing expressway-related assets and by ensuring early and steady repayment of debts, as well as to support the smooth implementation of expressway-related projects by the expressway companies.

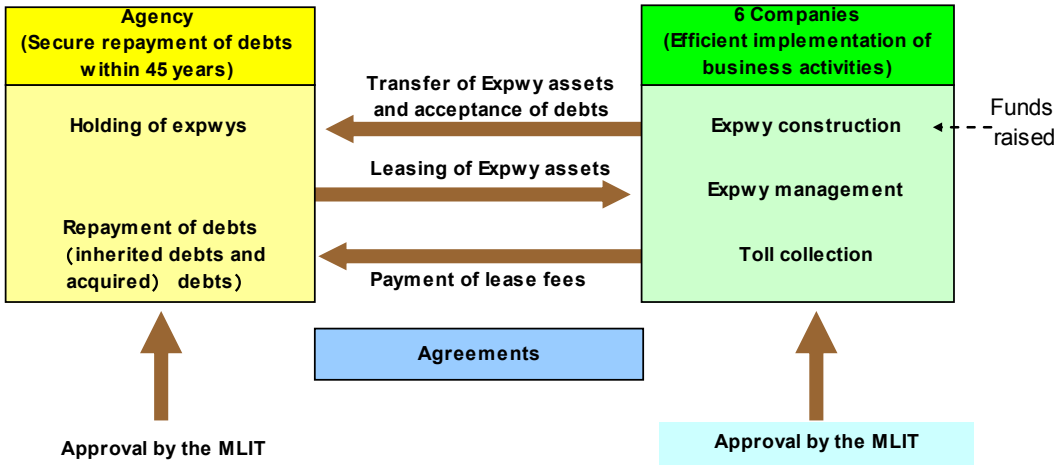

Figure 3 - Roles of Expressway Companies and JEHDRA

(3) Background Leading to Introduction of Outcome Indicators

In Japan, new road administration management has been practiced since around 2003 in response to social needs for performance-oriented administrative management.

Under the new road administration management, each highway authority establishes an outcome indicator for its policy objectives and sets quantitative targets in advance. After policy implementation, each authority evaluates the performance against targets, and the validity of the process. Furthermore, those evaluation results are published and to be reflected in business management in the next fiscal year and thereafter.

The objective of these efforts is to establish a framework of measures to appropriately distribute limited resources to suitable places and objects, and to raise staff consciousness for change, thereby contributing to efficient operations. The efforts are also aimed at enhancing the transparency of the road business by clarifying JEHDRA's outcome-oriented stance for the business and by rebuilding relationships of trust between users and authorities.

When selecting indicators, a focus is placed that indicators should be used which reflect

people's actual experience in everyday life, so that the people and the administration can share common issues and objectives. In addition, active disclosure of those processes made it possible for the people to check whether target settings, and projects and businesses themselves, are appropriate.

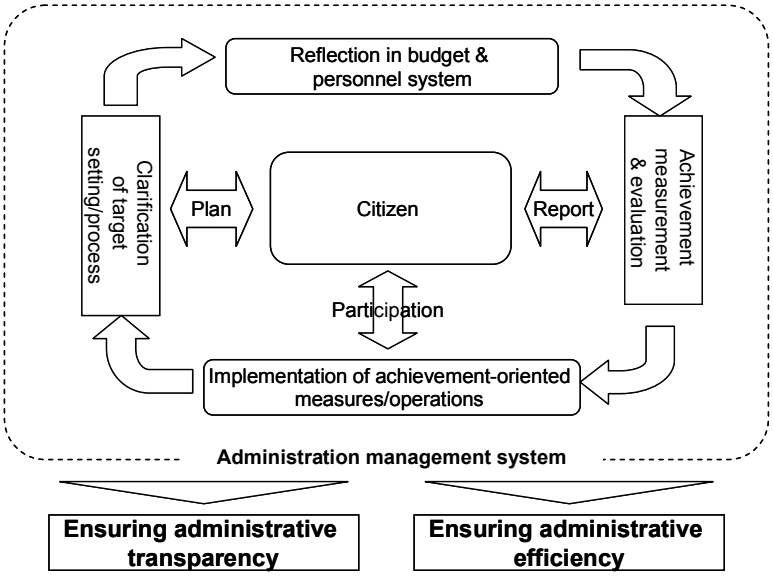

Figure 4 - Road Administration Management

When the outcome indicators were introduced to road administration, there were heated discussions about the privatization of the four expressway-related public corporations. As a result, outcome indicators were introduced to the expressway business just before the privatization.

(4) Relation between Outcome Indicators and Agreement

Based on the agreements signed by the expressway companies and JEHDRA in 2006, the expressway companies implement proper and efficient management of expressways in order to keep them in good condition, while JEHDRA receives annual reports on the maintenance and management of expressways from the expressway companies and confirms, on site, how they manage expressways.

In consideration of the background to the privatization, each expressway company, upon the conclusion of an agreement, establishes outcome indicators showing road management conditions and convenience from the standpoint of customers, and announces targeted levels. Each company reports performances of its expressway maintenance and management business to JEHDRA annually.

JEHDRA gathers outcome indicators from the six companies and then selects seven of

them for disclosure, so that users can easily understand expressway companies' efforts, which contribute to share information, and eventually, to improve their performances.

Figure 5 and Table 1 show the seven indicators that have been announced by the expressway companies. The indicators are categorized into three groups; comfort, safety and punctuality. Each indicator will be described in detail in the next chapter.

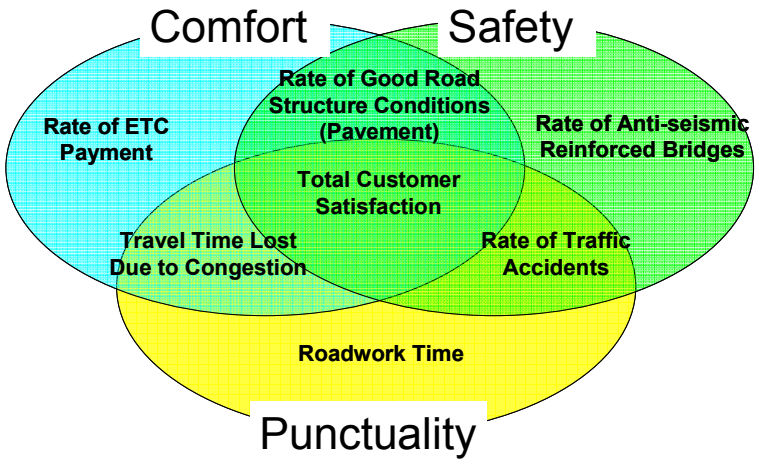

Figure 5 - Outcome Indicators and Classification

Table 1 - Comparison of Outcome Indicator Targets and Performances [1]

00: Attained 00: Not-attained

Classification			East Nippon	Central Nippon	West Nippon	Metro politan	Hanshin	Honshu–Shikoku
Time lost due to mainline traffic congestion [Unit: 10,000 vehicle-hrs/year] Annual hours lost due to congestion	FY2006	Target	446	664	313	2,900	520	3
		Performance	**414**	687	383	**2,900**	547	**3**
	FY2007	Target	445	662	370	2,700	520	3
		Performance	**426**	728	**335**	**2,600**	**503**	**3**
	FY2008	Target	426	719	334	2,300	490	3
		Performance	**374**	**669**	**319**	**1,800**	**341**	**3**
	FY2009	Target	424	647	318	1,800	320	8
		Performance	616	1,002	560	2,100	343	9
Roadwork time [Unit: Hours/km per year] Annual hours of traffic restriction per 1 km of roadwork	FY2006	Target	58	59	75	290	138	66
		Performance	63	**59**	**75**	**260**	**103**	**66**
	FY2007	Target	66	59	75	250	134	63
		Performance	65	67	75	**275**	112	**68**
	FY2008	Target	61	67	75	260	110	65
		Performance	78	**66**	**74**	**206**	**107**	**61**
	FY2009	Target	78	66	73	255	107	65
		Performance	**69**	75	**73**	**210**	117	106
Rate of ETC usage [Unit:%] Number of ETC vehicles / Number of ETC vehicles that pass ETC toll gates	FY2006	Target	68	73	68	90	90	70
		Performance	63	69	62	74	68	64
	FY2007	Target	69	74	70	85	85	70
		Performance	**69**	**75**	68	80	74	**70**
	FY2008	Target	70	76	71	85	85	72
		Performance	**75**	**80**	**73**	83	79	**80**
	FY2009	Target	77	83	78	86	85	80
		Performance	**82**	**87**	**81**	**88**	**85**	**89**
Rate of fatal and injurious accidents [Unit: Case/100 million vehicle-km] Number of traffic accidents per 100 million vehicle-km	FY2006	Target	11.0	10.2	10.7	31.0	27.2	8.9
		Performance	**10.0**	**9.5**	**10.7**	31.5	29.7	**8.8**
	FY2007	Target	11.0	9.5	10.7	30.0	27.2	8.9
		Performance	**8.9**	**9.1**	**9.4**	**27.3**	29.2	**7.4**
	FY2008	Target	11.0	9.1	9.4	27.0	27.2	8.8
		Performance	**7.6**	**7.8**	**9.0**	**23.1**	**24.6**	**6.0**
	FY2009	Target	11.0	7.8	9.0	23.0	24.6	8.8
		Performance	**6.7**	8.4	9.3	**22.5**	**23.3**	**6.4**
Rate of road structure maintenance (paving) (pavement) [Unit: %] Ratio of extension of lanes showing soundness of paved surfaces	FY2006	Target	85	93	85	99	99	98
		Performance	**86**	**94**	**86**	**99**	**99**	**98**
	FY2007	Target	89	95	90	99	99	98
		Performance	**89**	**96**	**90**	**99**	**99**	**98**
	FY2008	Target	92	98	93	99	99	98
		Performance	**92**	97	**94**	**99**	**99**	**98**
	FY2009	Target	93	99	96	99	99	98
		Performance	**94**	98	**97**	**99**	**99**	94
Rate of completion of bridge reinforcement [Unit: %] Percentage of bridges for which anti-seismic reinforcement has been completed among bridges built based on old standards and requiring anti-seismic reinforcement	FY2006	Target	82	96	86	100	99	75
		Performance	78	**96**	**86**	**100**	98	69
	FY2007	Target	84	98	88	100	99	100
		Performance	**85**	**98**	**88**	**100**	**98**	**100**
	FY2008	Target	91	99	89	100	100.0	100
		Performance	**92**	**98**	**90**	**100**	99.7	**100**
	FY2009	Target	97	99	93	100	100.0	100
		Performance	**97**	**99**	**95**	**100**	99.8	**100**
Degree of overall customer satisfaction [Unit: Points] Customer satisfaction detected through CS surveys (assessment in five grades)	FY2006	Target	3.5	3.5	3.5	2.9	3.2	3.2
		Performance	**3.5**	**3.5**	**3.5**	2.8	**3.4**	**3.2**
	FY2007	Target	3.5	3.5	3.5	3.0	3.4	3.3
		Performance	**3.6**	**3.6**	**3.6**	2.8	3.3	3.2
	FY2008	Target	3.6	3.6	3.6	3.0	3.4	3.3
		Performance	**3.6**	**3.7**	**3.7**	**3.0**	**3.5**	**3.4**
	FY2009	Target	3.6	3.7	3.7	3.1	3.5	3.4
		Performance	**3.6**	3.6	3.6	**3.3**	**3.5**	**3.7**

3. SEVEN OUTCOME INDICATORS

(1) Time lost due to mainline traffic congestion

The indicator has been established with the aim of reducing the time expressway users lose due to congestion on main routes.

The indicator is calculated by multiplying the difference between the time required to pass through a congested section at a legal or limited speed and the time actually required to pass through the section at the time of congestion.

The calculation uses data measured and collected by traffic counters installed along the expressways.

The indicator had been on a downward trend due to a decline in traffic volume caused by the economic recession in addition to the effects of various measures implemented, such as the provision of information on speed restoration at congestion-prone locations, the opening of new routes, the easing of congestion at toll gates due to an increase in the use of the ETC system, and the provision of information on congestion forecasts on the Internet. However, since the introduction of the holiday discount program in 2009, the indicator has been on a rising trend due to heavy inbound traffic resulting from the 1,000-yen upper toll limit program.[c]

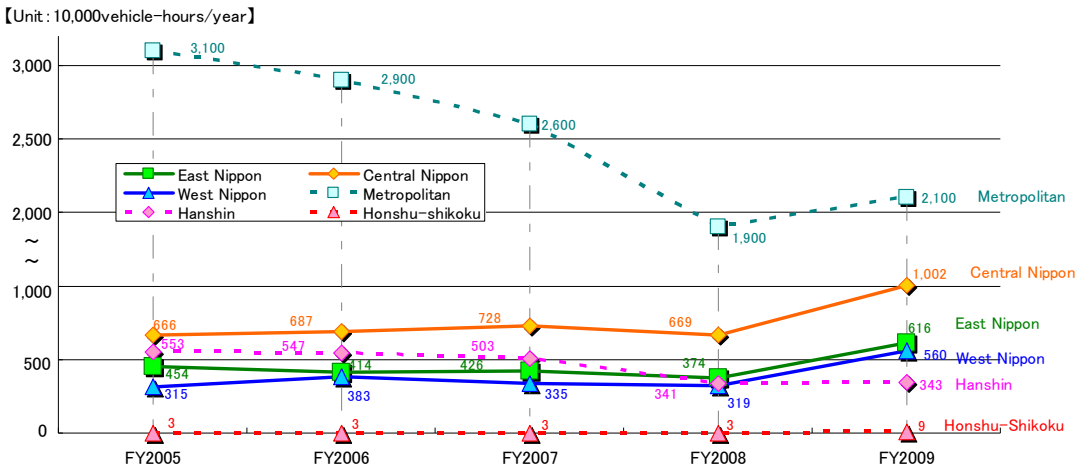

Figure 6 - Changes in the Time lost due to mainline traffic congestion

[c] The holiday toll discount is one of the convenience-enhancing projects for expressways (See Footnote [1]). On Saturdays, Sundays and holidays, tolls for ETC-equipped vehicles are discounted by 50% with an upper toll limit of 1,000 yen in rural areas. This discount system does not apply to busy expressways in urban areas. Therefore, the toll for Tokyo–Osaka travel does not come to 1,000 yen; instead, it amounts to about 3,000 yen. In June, 2011, the upper toll limit was abolished in order to secure the resources for reconstruction after the Great East Japan Earthquake disaster.

(2) Roadwork time

This indicator has been established with the aim of making traffic flow smoother and easing congestion caused by roadwork by reducing traffic lane restrictions for roadwork.

The annual hours of lane restrictions per 1 km is calculated by dividing the total hours of lane restrictions for roadwork by the total length of the route.

Each expressway company has been striving to reduce lane restriction hours by consolidating roadwork, such as concentrated road repair, and by announcing sections to be restricted for roadwork. However, the indicator rises depending on the fiscal year due to such factors as an increase in disaster-relief work and front-loading of repair work.

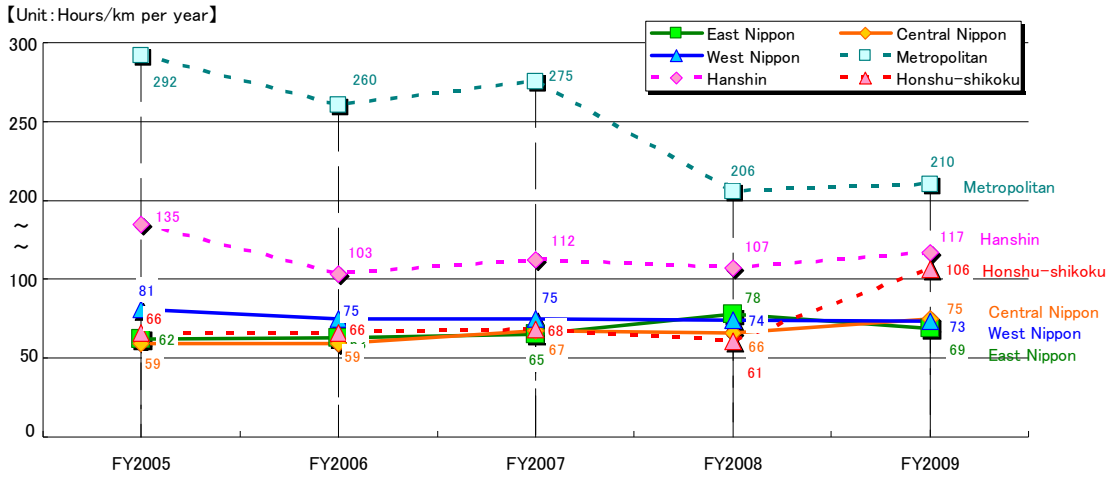

Figure 7 - Changes in the Roadwork time

(3) Rate of ETC usage

This indicator has been established with the aim of making traffic flow smoother and reducing traffic congestion by promoting the use of the electronic toll collection system (ETC). The indicator shows the rate of ETC-equipped vehicles passing through ETC toll gates.

The rate of ETC payment has consistently been rising thanks to the introduction of discount programs, such as time discount and discounts for large-lot, frequent users, and tax breaks for buyers of ETC-equipped vehicles. In addition to these efforts, programs aimed at enhancing the convenience of ETC vehicles have helped to increase the indicator. As a result, all six expressway companies have achieved the upper limit of their targets.

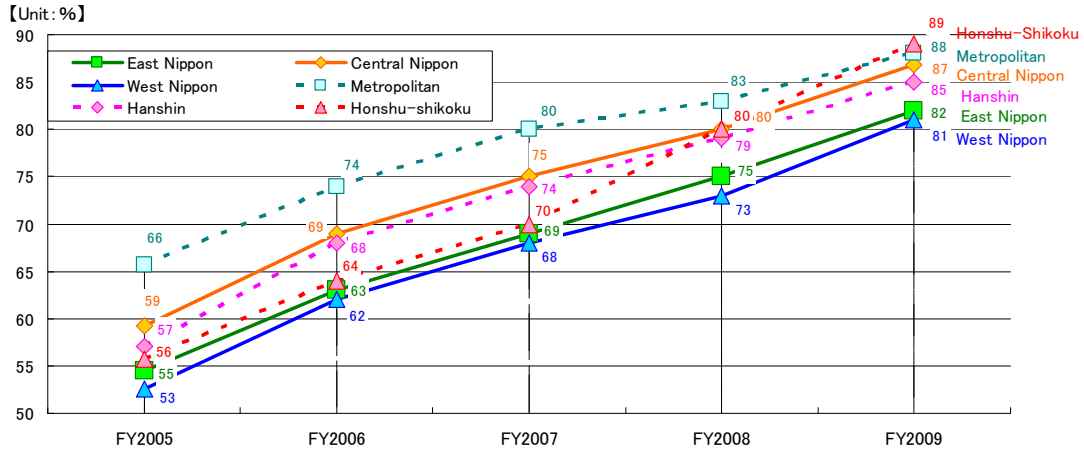

Figure 8 - Changes in the Rate of ETC usage

(4) Rate of fatal and injurious accidents

This indicator has been established with the aim of reducing the number of accidents causing fatalities or injuries by ensuring smooth traffic and promoting safety measures.

The rate of traffic accidents is defined as the number of accidents causing fatalities or injuries per 100 million vehicle-km, which is obtained by dividing the total number of such accidents occurring on each expressway by the total vehicle-km on each respective expressway.

The main projects implemented so far include the installation of high-performance (or porous asphalt) pavement to prevent accidents on rainy days, reinforcement of guard rails constructed in the median strip of expressways, the installation of anti-slip pavement and visual guidance signs in sharp curve sections, and the promotion of safe-driving education.

As a result, the six expressway companies saw their traffic accident rates decrease at one stage. In 2009, however, some of the companies saw their traffic accident rates rise, as traffic volume on holidays increased due to the effect of holiday toll discount programs.

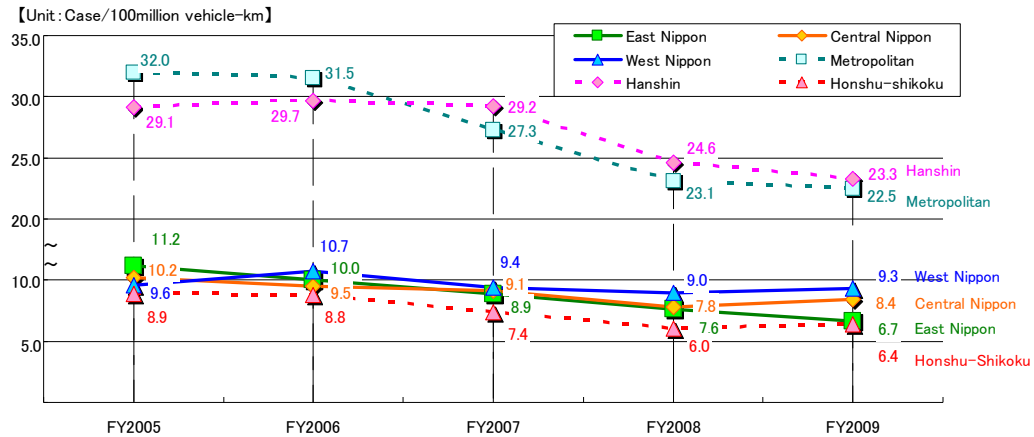

Figure 9 - Changes in the Rate of fatal and injurious accidents

(5) Rate of road structure maintenance (paving)

This indicator has been established with the aim of providing safe and comfortable road surfaces by ensuring sound pavement surfaces.

The ratio of lane extensions shows the soundness of pavement surfaces. The three NEXCOs (East, Central and West Nippon Expressway companies) and the other three expressway companies use different methods to calculate the indicator.

The three NEXCOs calculate the indicator by dividing the length of sound pavement surfaces (excluding those sections that fall short of repair targets and those that will reach repair targets in about five years) by the total length of pavement surfaces.

The other three expressway companies use so called the “maintenance control index” (MCI), which indicates a comprehensive evaluation of pavement surface conditions (rutting, cracking ratio, and evenness） on a scale of 1 to 10. The rate is calculated by dividing the length of road surfaces with MCI at 4.0 or higher by the total length of pavement surfaces. It indicates that the lower the MCI is, the more dilapidated the pavement is, while an MCI of 4.0 or higher suggests that the pavement has been maintained in sound conditions.

This indicator has an immediate impact on expressway driving. The six expressway companies have almost achieved their repair and maintenance targets. However, Honshu–Shikoku Bridge Expressway Co. saw its maintenance rate decline in FY2009, because the length of pavements that needed repair increased due to an increase in traffic volume and rapid deterioration of pavements. The company said it would strive to raise the rate by front-loading its repair and maintenance schedule.

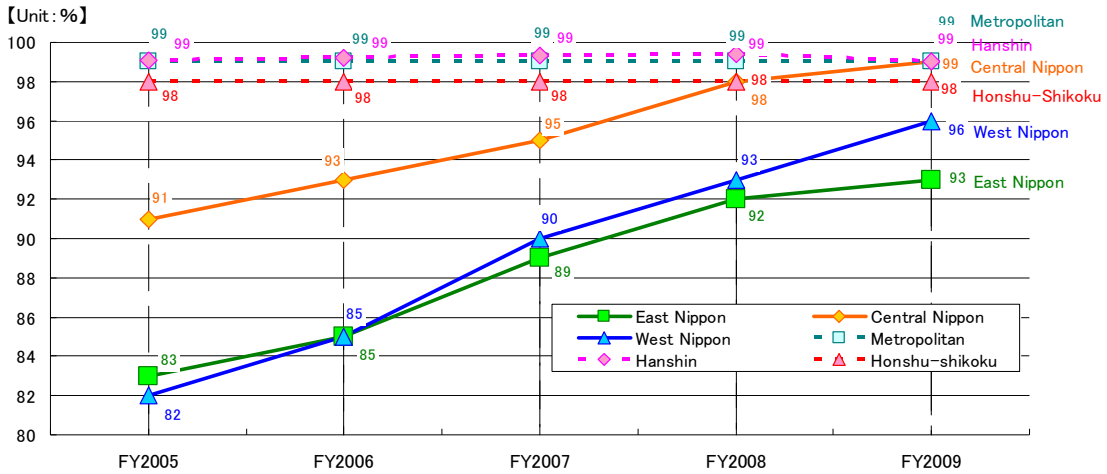

Figure 10 - Changes in the Rate of Road Structure maintenance(Paving)

(6) Rate of completion of bridge reinforcement

Japan is one of the world's most seismologically active countries. Therefore, much higher quake-resistance standards are employed for designing roads in Japan than it used to.
The rate of completion of bridge reinforcement is an indicator that has been established with the aim of developing earthquake-proof road networks by reinforcing piers built to old standards, based on the lessons from the Great Hanshin Earthquake in 1995. The indicator shows the percentage of bridges for which anti-seismic reinforcement has been completed among the bridges that were designed to 1980 or earlier standards and that require anti-seismic reinforcement on a priority basis.

Metropolitan Expressway Co. and Honshu–Shikoku Bridge Expressway Co. have already completed support reinforcement for all of their bridges. Other expressway companies, though having difficulties in consultation and coordination with some parties concerned, have also been striving for pier reinforcement.

(7) Degree of overall customer satisfaction

This is an indicator that has been established with the aim of enhancing customer satisfaction by reflecting users' assessments of expressway maintenance and management.

Customer satisfaction is assessed on a scale of one to five through surveys on five items, including maintenance and comfort. Each expressway company receives about 2,000 to 10,000 responses to the surveys.

The surveys are conducted in the form of questionnaires mainly via the Internet. In addition to the questionnaire surveys, Metropolitan Expressway also distributes survey sheets to drivers at toll gates, and to transportation companies and limousine rental companies. As the three NEXCOs cover wide areas, they aggregate questionnaires by expressway route and give weights according to the length of expressway route.

A comparison of customer satisfaction level in the initial year of the privatization (2005) and at present shows that six expressway companies all increased customer satisfaction. This was brought about by their efforts to reflect customers' voices to their better services and businesses, to increase driving comfort through works such as pavement repair, and to improve services in service areas including refurbishment of restrooms..

However, some of the expressway companies saw their customer satisfaction level decline in FY2009 due to traffic jams and congestions in rest areas caused by the introduction of

holiday toll discount programs.

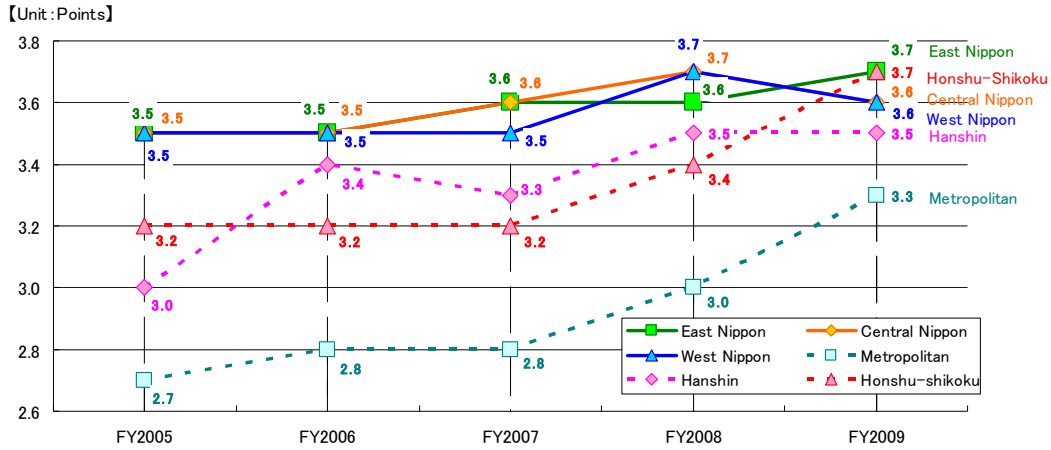

Figure 11 - Changes in the Degree of overall customer satisfaction

4. EXAMPLES OF OUTCOME INDICATOR IMPROVEMENT

By comparing changes over years and differences between companies, more transparency in the expressway business can be achieved through the disclosure of information, and more structural maintenance work, such as anti-seismic reinforcement of pavements and bridges, can be achieved. As a result, a more efficient business scheme can be provided by activating the management cycle based on the indicators of the companies. Some of the examples of measures taken by the expressway companies based on the plan-do-check-act (PDCA) cycle are described below.

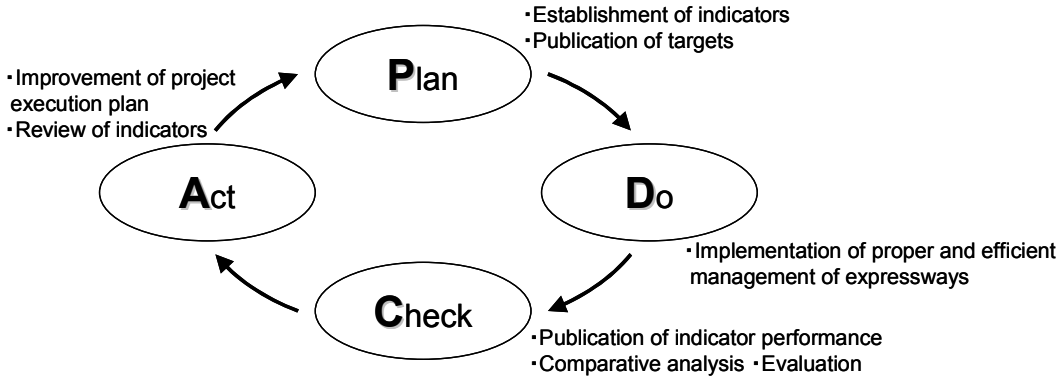

Figure 12 - Management Cycle Utilizing Outcome Indicators

In order to reduce time lost due to traffic congestion, the expressway companies have been promoting not only hardware measures, such as increasing the number of lanes to mitigate/solve traffic jams, but also software measures that are expected to have the effect of mitigating congestion at low cost.

For instance, drivers unconsciously reduce the speed of their vehicles in the sag or upslope sections of expressways, causing traffic congestion. The expressway companies are trying

to reduce the occurrence of congestion by setting up bulletin boards asking drivers to restore speed near the beginning of the congested section. With this measure, even if drivers are caught in a traffic jam, they can experience higher average speed in congestion than they do without it.

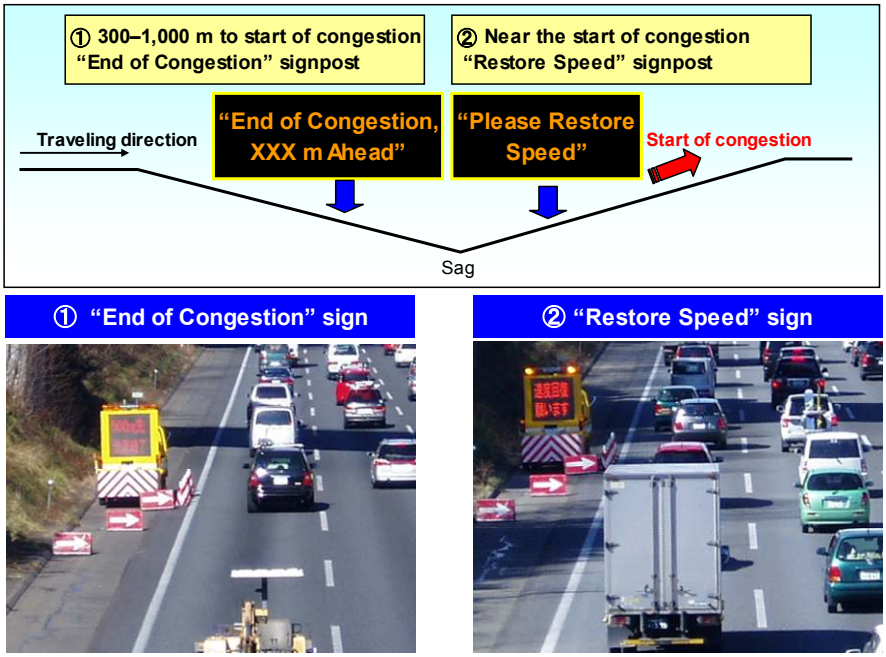

Figure 13 - Mitigating Congestion in a Sag Section by setting up "Restore Speed" Signs

The expressway companies have also implemented various measures to reduce the rate of fatal and injurious accidents. Representative examples are the installation of high performance pavements to prevent accidents on wet roads, the installation of anti-slip pavements in a sharp curve sections, the adoption of luminous lane markers to prevent late-night accidents and careless driving, the promotion of traffic-safety campaigns, and the distribution of traffic-safety brochures.

NEXCO-West has been engaged in a joint research project with a major Japanese carmaker to develop a car navigation system equipped with a device to warn drivers traveling in the wrong direction.

Figure 14 - High-Performance Pavement

Figure 15 - Safety Device in a Sharp-Curve Section

Figure 16 - Development of Car Navigation System to Warn about Driving the Wrong Way

In this way, the expressway companies are striving to overcome each challenge by combining various safety measures. These efforts lead to the improvement of the maintenance and management business through the PDCA cycle with outcome indicators, which contributes ensuring appropriate management standards of expressways.

5. REVIEW OF OUTCOME INDICATORS

Using outcome indicators is not free of problems. Outcome indicators are not absolute and it is necessary to review them flexibly in accordance with the nature of problems. At present, JEHDRA and the expressway companies are preparing countermeasures against two issues.

One is that there are some indicators whose definitions have yet to be standardized due to individual factors of the expressway companies such as their regional characteristics and/or management policies, or due to their need to ensure the continuity of operations from the past. In other words, it is almost impossible to make an accurate comparison among companies by the targets or performances of their outcome indicators. It is necessary for us all to strive to standardize indicators as much as possible.

The other issue is that it is difficult to explain all expressway management conditions and convenience with only the seven indicators. For this reason, JEHDRA and the expressway companies are studying the adoption of new indicators in order to provide information on the convenience and safety of expressways in an easy-to-understand manner. In order to support the study, JEHDRA has been conducting investigative research on latest concession contracts, etc. in other countries.

REFERENCE

1. Japan Expressway Holding and Debt Repayment Agency. (2010) “Japan Expressway Holding and Debt Repayment Agency 2010,” p.19. Available at: http://www.jehdra.go.jp/english/pdf/others/114.pdf.