Effects of EcoDrive Using "DriveManager"

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Abstract

Environmental considerations are now among the worldwide topics aimed at the prevention of global warming. Since automobiles exert an important effect on global warming due to the emission of carbon dioxide (CO_2), measures for promoting "EcoDrive" and "safe driving" are expected to gain more importance in the future. This paper is intended to introduce the fuel consumption and drive safety improvement effects of EcoDrive, which are further explained by surveys on the introduction of the EcoDrive diagnosis system. It also serves to introduce the EcoDrive diagnosis system "DriveManager."

Keywords

ITS, EcoDrive, safe driving, DriveManager

1. Introduction

As seen with the signing of the Kyoto Protocol, both national and local governments are recently very active in adopting measures that conform to the ecological point of view.

Among these, the measures that involve automobiles are the ones that should be dealt with in close cooperation between the national and local governments, private businesses and individuals because their CO_2 emissions exert important effects on global warming. The authors have therefore developed an EcoDrive diagnosis system called the "DriveManager" that promotes economical and safe driving using the technologies of the Intelligent Traffic System (ITS)*.

This paper is intended to discuss the fuel consumption and driving safety improvement effects of the "DriveManager" with reference to the demonstrated test results and analyses that have been conducted since its introduction.

2. Outline of the EcoDrive Diagnosis System "DriveManager"

A business carrier owning a fleet of vehicles should manage it efficiently by reducing the costs and improving the CSR (Corporate Social Responsibility). The vehicle-mounted EcoDrive IT equipment that makes this possible is still relatively expensive and its installation in vehicles may sometimes also be troublesome as well as being expensive.

Based on the above background details, NEC Corporation, NEC Soft, Ltd. and Techtom, Ltd. have jointly developed an EcoDrive diagnosis system called "DriveManager."

DriveManager is an ASP service that provides a real-time, integrated management system for vehicle information such as for fuel consumption and driving distances etc. This service can reduce costs by improving work efficiency and can also provide information for promoting economical and safe driving.

Its main features include:

- Automatic collection of data for promoting EcoDrive.
- An ASP service that can be used immediately after installation of the system in a vehicle.
- Vehicle-mounted equipment is easy to install and does not normally need installation work by specialists.

The functions included as standard are as follows:

(1) Drive Diagnosis Function

Displays a fuel consumption variation graph and fuel consumption ranking in order to enable the integrated management of vehicle and gasoline usage information, together with other useful information. This data has previously been managed separately.

(2) Operational Management Function

Displays the drive distance of the vehicle, that of the driver, driving time and driving history (map view) on the screen to help identify the latest information on operations.

(3) Reservation Management Function

Displays the vehicle availability schedules to enable identification of the latest information and efficient use of vehicles.

*Intelligent Traffic System (ITS)
Generic name of a road traffic system that integrates humans, roads and vehicles as an efficient system by using the latest information communication technologies to improve the safety, transportation efficiency and comfort for road traffic.

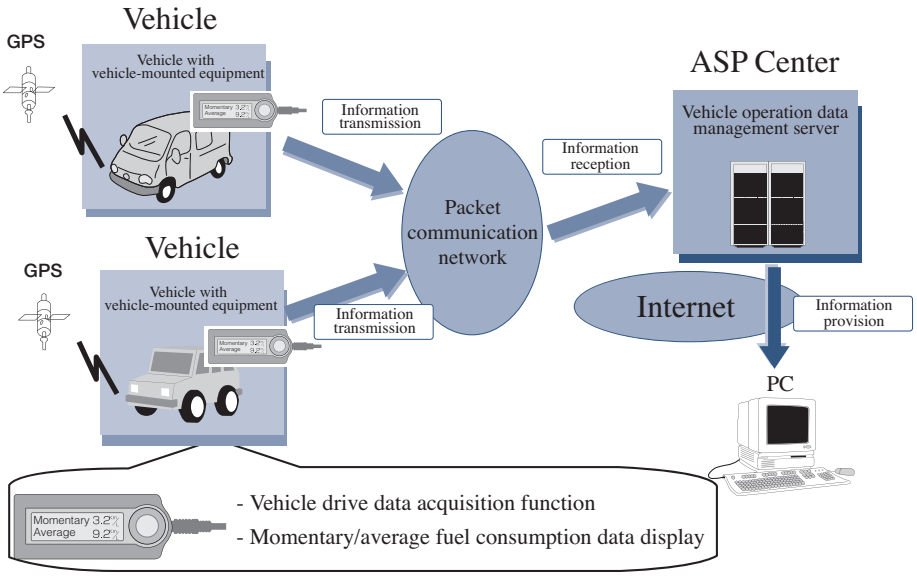

Fig. 1 Image of DriveManager.

(4) Daily Report Function

Collects the start time, end time, drive distance and average speed of each trip automatically and displays the information in the form of a daily report.

Fig. 1 shows an overall image of the DriveManager.

The vehicle-mounted DriveManager equipment is called the EDICAT. It calculates and displays the fuel consumption based on the data communicated from the vehicle's engine computer (ECU).

3. Surveys of the Effects of the EcoDrive Diagnosis System

The Environmental Restoration and Conservation Agency of Japan (ERCA) conducted the "EcoDrive diagnosis model project" using the EcoManager vehicle-mounted equipment* in FY2004. The data obtained in this survey and the data obtained from a survey undertaken while practising the EcoDrive method that was conducted by an NEC affiliated company have confirmed the effects described in the following sections.

3.1 Effects of Survey by ERCA

(1) Survey Details

1) Purpose of the survey

To promote a reduction in the emission of greenhouse effect gases, particularly CO_2, through the dissemination of CO_2, emission-reducing drive behavior (EcoDrive) of vehicles.

2) Survey periods

October 18 to 31, 2004, and January 10 to February 20, 2005. (Total 6 to 7 weeks).

3) Survey targets

40 general drivers (privately owned vehicles).

4) Survey method

The survey period was divided into two. The first period was used for collecting ordinary drive data. Then the information on the EcoDrive diagnosis was given to the drivers after the first period. The drive data of the latter period was then compared with the drive data of the first period in order to assess the EcoDrive diagnosis information and to specifically identify significant details of such information.

(2) Survey Results

1) CO_2 emission reduction effects

The results were generally favorable, though there were variations in individual performances. In the category of drivers by age, the reduction of average CO_2 emission per 10km reached 0.09kg on average in the age groups from 20's to 50's, except for the 30's and 60's groups. From the viewpoint of vehicle engine size, the reduction of average CO_2 emission per 10km was 0.12kg on average for vehicles below 1 liter and also for the 1-liter class vehicles.

When these are averaged, the period before the provision of EcoDrive diagnosis information the average CO_2 emissions

*The EcoManager is a version of the EDICAT vehicle-mounted equipment that has been customized for ECRA.

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Table Changes in absolute values of average CO_2 emission per vehicle behavior (per 10km run).

Item	Uniform velocity	Ordinary driving	Idling	Revving	Sharp acceleration	Total
Before information provision	0.81671	1.48169	0.33052	0.00060	0.00670	2.64
After information provision	0.89118	1.39051	0.28709	0.00053	0.00352	2.57
Reduction amount	-0.07447	0.09118	0.04343	0.00007	0.00318	0.07
Reduction percentage	-9.12%	6.15%	13.14%	11.44%	47.48%	2.60%

*Unit of CO_2 emission: kg-CO_2/10km

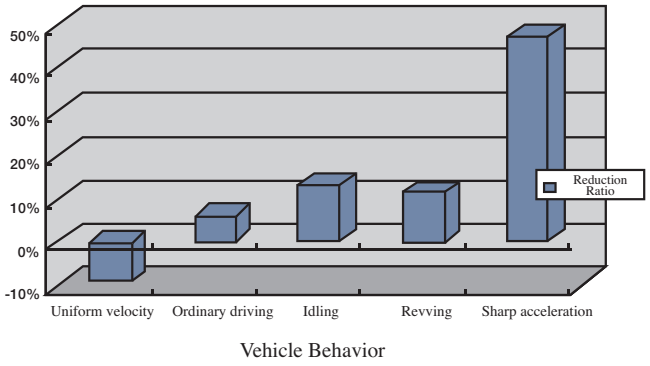

Fig. 2 Reduction ratio of absolute values of average CO_2 emission per vehicle behavior (per 10km).

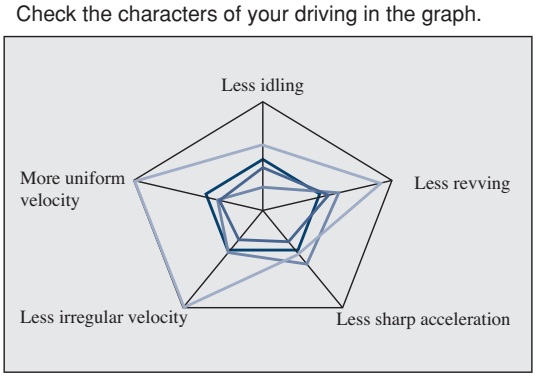

Fig. 3 An example of a driving characteristics diagnosis chart.

after the information provision was reduced on average by 0.07kg.

2) Safe Drive Effects

A comparison of average CO_2 emission per vehicle behavior (drive behavior) before and after the provision of EcoDrive diagnosis information indicated that the emission during a uniform velocity drive increased with increases in the uniform velocity time, while that of vehicle behaviors other than for uniform velocity driving were decreased. In particular, the reduction in the emission due to sharp acceleration was as large as 47.48% (see **Table** and **Fig. 2**).

The above results confirmed that the information generated by the system can promote safe driving. In addition, it can also be regarded that safe driving can result from the enhancement of EcoDrive consciousness of the driver (**Fig. 3**).

3.2 Effects Survey on Business Vehicles

(1) Survey Details

1) Purpose of survey

To demonstrate the vehicle behavior and fuel consumption improvement effects based on the acquisition of quantitative data using the EcoDrive diagnosis system.

2) Survey period

March 8 to June 30, 2005.

3) Survey target

2 professional drivers (business vehicles)

4) Survey method

Normal driving data was collected from March 8 to April 24, 2005, the drive data of each driver was analyzed and the EcoDrive training was given to the two drivers on May 18. After this, the driving data that followed the training was compared with that obtained before it, in order to identify the effects.

5) Contents of EcoDrive training

We divided the survey period into two, analyzed the quantitative drive data collected in the first period, and gave guidance on energy-saving driving to the drivers. We then compiled a report on the drive attitudes before and after the training and assessed possible improvements for each driver, confirmed the possibility of putting EcoDrive into practice, and had the drivers perform EcoDrive continuously during the second period.

(2) Survey Results

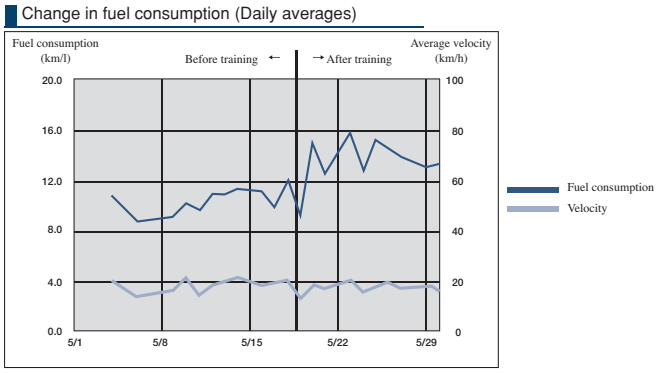

Fig. 4 Change in Fuel Consumption Brought About by EcoDrive Consciousness (Vehicle No. 1).

Risk events per 100 km	Acceleration	Deceleration	Over-speed	Long-hour	Total
Average number	41.2	34.1	1.1	0.0	76.5
9: Driver 1	18.3	28.7	1.3	0.0	48.3

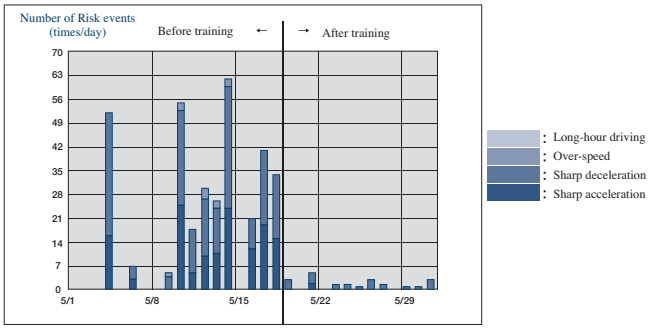

Fig. 5 Change in Risk events Brought About by EcoDrive Consciousness (Vehicle No. 1).

1) Fuel reduction improvement effects
Compared to the period before the EcoDrive training, the fuel consumption after it was improved by 35% with Vehicle 1 and 16% with Vehicle 2. **Fig. 4** shows the daily changes in fuel consumptions of Vehicle 1.
2) Safe driving effect
Fig. 5 shows the record of reduction of risk events (long-hour driving, over-speed driving, sharp acceleration and sharp deceleration) of Vehicle 1 thanks to the EcoDrive training.
Comparison of the average value in March/April with that in May/June shows that the number of risk events per 100km has reduced by 69% for Vehicle 1 and 30% for Vehicle 2. The reduction in the risk events with both vehicles shows that, in spite of certain individual differences, EcoDrive training can make a driver more conscious of EcoDrive benefits, reduce the number of risk events and improve safe driving effects.

4. Considerations

(1) Fuel Consumption Improvement Effect
This effect consists of the following two points.
1) CO_2 emission reduction thanks to fuel consumption improvement
Based on the driving data of the two business vehicles that has been described above, the CO_2 emission reduction effect can be calculated as follows.
Assuming that a business vehicle drives 1,300km per month and 15,600km per year in average, the annual CO_2 emission without EcoDrive awareness is about 3,680kg*, but that with EcoDrive-aware driving it is about 2,919kg, so an annual CO_2 emission reduction of about 761kg can be expected per vehicle.
The surveys by ERCA also showed a 47.48% reduction in the average CO_2 emission due to sharp acceleration and a 13.14% reduction in that due to idling, confirming that the introduction of the EcoDrive diagnosis system can contribute greatly to the reduction of average CO_2 emissions.
2) Reduction in gasoline usage thanks to fuel consumption improvements
This can also be calculated based on the drive data of the two business vehicles as follows.
Assuming that a business vehicle drives 1,300km per month and 15,600km per year on average, the annual gasoline usage without the EcoDrive consciousness is 1,586.2 liters and that with EcoDrive-conscious driving is 1,258.0 liters. Thus, an annual gasoline usage reduction of 328.2 liters can be expected per vehicle.
For reference, if the gasoline price for Tokyo in July 2005, which was ¥127/liter, is applied, the above means that a gasoline cost of ¥42,000 per year can be saved.
(2) Safe Driving Effect
As both the ECRA and business vehicle surveys showed that the EcoDrive diagnosis system can allow the driver to identify the quantitative data on their driving and thereby improve the vehicle behavior, it can be concluded that EcoDrive is capable of promoting safe driving.

5. Conclusion

In the above, the analyses of the CO_2 emission and vehicle behavior based on the survey involving the practicing of EcoDrive by drivers showed that the EcoDrive diagnosis system is effective for the promotion of both fuel consumption improvement and safe driving. The Tokyo Municipality has started the

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EcoDrive Project in 2005 to evaluate those who practice Eco-Drive and to disseminate the system among a wider range of vehicle drivers including privately owned vehicle users. The staff of DriveManager is also being involved in the EcoDrive Project and is expected to contribute further to the dissemination of EcoDrive by extending the types of applicable vehicles including diesel vehicle compatibility.

The authors intend to also develop ITS systems that will make a greater contribution to society and further improve the business performance of the entire NEC Group.

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*CO_2 emission calculation formula
It is assumed that the CO_2 emission per liter of gasoline is 2.32kg. This value is based on the "Environmental Account Book" issued by the Japanese Ministry of Environment.
*EDICAT is a registered trademark of Techtom, Ltd.

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Related URL :
DriveManager website: http://www.necsoft.com/solution/its/
ERCA website : http://www.erca.go.jp/index.html
Tokyo Municipality EcoDrive Project website :
http://www.kankyo.metro.tokyo.jp/