Driver Characteristic Using Driving Monitoring Recorder

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ABSTRACT:

A field trial has been carried out using a set of automatic recording system, Driving Monitoring Recorder (DMR) with GPS and Event Eye Camera (EEC). They were installed on total numbers of 105 vehicles in four fleets of taxi and truck in Tokyo area for 4 years in order to assess the implications in driving characteristic and traffic conditions.

DMR can record the data such as running speed vs. time continually, and frequencies of emergency behavior are counted and recorded on drive whenever hard braking exceed by 3.75m/s^2, and rapid starting and sharp acceleration exceed by 3.5 m/s^2. Also, EEC can record the driver views in pre- and post scene during 10 seconds by event detecting trigger. The 80 subjects are taxi drivers including 10 females and 30 truck drives. The drivers were monitored for some months continuously. In addition, the drivers were examined by a driving aptitude test.

The analysis result indicates that individual driver have a specific driving performance on drives, and it suggest that drivers will be able to specified their driver characteristics by DMR data. For simplicity, we defined the “Index of bad behavior” score as simply adding points of numbers of the three emergency actions per 100 km running. The drivers are classified into 4 groups, ranked A, B, C and D levels according the index score, which ranging from careless driver to model of safety driver. The ranks are compared with the results of driving aptitude test. To assess driver behavior, EEC images were examined when, where and what condition emergency behavior occurred. As results of EEC image analysis, some drivers with high bad index scores had driven at the head mostly, and frequent rapid lane changing and sharp turn actions.

In conclusion, a set of the automatic recording systems can be offer useful data to study driver characteristics. In addition, the important aspect of this study is persuasively, most drivers tend to accept these data without complaining for improve their safety drive because of digital data and image data.

1. INTRODUCTION

For the prevention of traffic accidents, it is important to clarify the relationship between the traffic situation immediately before the occurrence of a traffic accident and the characteristics of individual driver. This mutual relationship, however, is so complicated that accident investigations conducted based on conventional investigation techniques and many inspections and studies made to identify the characteristics of drivers have scarcely succeeded in clarifying it.

Driver education requires that information on these key factors leading to a traffic accident be informed to drivers in a concrete and specific manner. In this driver education, however, information on how traffic accidents occur through this complicated mutual relationship between the traffic situation and drivers' characteristics is provided only briefly and insufficiently; more practical driver education techniques need be developed. The previous report described the effectiveness of the technique of collecting data on the behavior of drivers just before the traffic accidents by using automatic recording systems. (1),(2),(3)

In the paper, the accident data recorder and driving monitoring recorder are installed on commercial vehicles and collected, and analyzed data. Specifically, the accident data recorder was used to collect physical data at the occurrence of traffic accidents, i.e., the change in speeds, impact acceleration, the state of braking and lighting, etc., just before the traffic accidents and the driving monitoring recorder was used to collect data on the everyday behavior of drivers, i.e., road speed, the frequency of rapid starting and sudden braking, etc.

In this report, one traffic accident that a certain driver encountered is taken up and the situation in which this traffic accident occurred is analyzed in full detail, focusing on the relationship between the traffic situation and the behavior of this driver. The results of this analysis indicate that they can be used as practical data for driver education. The outline of this analysis is described in the following chapters.

2. AUTMTIC RECORDING SYSTEM

2.1 Accident Data Recorder

The accident data recorder (ADR: UDS2156) is the in-car recorder developed by MANNESMANN KIEINZEL which records and stores in memory on speed, longitudinal and lateral acceleration, yaw angle, brake activation (on/off), left and right direction indicators (on/off), plus six or so on/off channels. (3),(4),(5) While a vehicle is being driven, data, sampled at 500Hz, is stored in temporary memory where it is continuously analyzed by the accident detection algorithm. When the algorithm recognizes the characteristic features of an accident, the previous 30s and after 15s of data is transferred in coded form to a permanent memory. After data is stored, this recorder stands by, waiting for the next collision. It can record data on the first and second collisions.

2.2 Drive Monitoring Recorder

The driving monitoring recorder (DMR: YAZAC-5064)(6) is a kind of digital taco-graph “safety driving check device” developed by YAZAKI METER Co., Ltd. It was the recorder capable of monitoring the running situations during cruse. In addition to running speeds, maximum speed, travel distance and time, a number of rapid driving operations can be counted during cruse. The device can detect and record events when braking exceed 3.75m/s2 and acceleration and/or sharp starting exceed 3.5m/s2, the number of events is counted during a cruse.

Also, the digital taco-graph was attached a GPS device (Grovel Position System), the data of taco-graph have the location data when events occurred during the cruse.

2.3 Event Eye Camera

The Event Eye Camera (EEC) is an image recoding system, which consist of detector of events, time lag controller and video recording system. The detector works as trigger of acceleration and/or deceleration when driver operate with abrupt changes. The trigger value can be varied in range from 3.0 m/S2 to 9m/s2.

The time lag controller always works to overwrite the oldest scene to new scene on the memory of the controller. The detector catch a trigger exceed set value, the controller commend to record scenes for 60 seconds before and after the trigger to the videotape.

3. METHOD

3.1 Data collection from fleets of taxies

The accident data recorder and driving monitoring recorder were mounted on 40 taxies in two fleet companies (20 taxies each) in Tokyo area.

The accident data recorder tracks the vehicles on which it is mounted. On the other hand, the driving monitoring recorder tracks the drivers of these vehicles on which it is mounted.

The 80 regular taxi drivers in two taxi fleets were selected as subjects, that is, all 40 drivers were male in one fleet (A Co., Ltd), but in another fleet 30 drivers were males and 10 females (B Co., Ltd).

Each subject carries his/her own identification card; they insert their cards into the driving monitoring recorder each time they get on a vehicle and pull the card out when he goes off duty. Each card had a capacity of 65 KB and was withdrawn every two weeks to be integrated into a collection of actual records.

Data on all accidents during the twelve to twenty four-month were collected. In the experiment, a line of communication was established beforehand so that data on accidents that occurred could be collected immediately. After all data were collected, the accident data recorder was automatically set back in service, getting itself ready to handle the next traffic accident.

In addition, an Event Eye Camera (EEC) was installed a taxi to record the scene when events occurred. 10 drivers belong to the B Co., Ltd droved the taxi installed EVC for one day or two days. The image data of events were collected during cruse.

Photo. 1 Digital taco-graph (left) and Safety checker device (right).

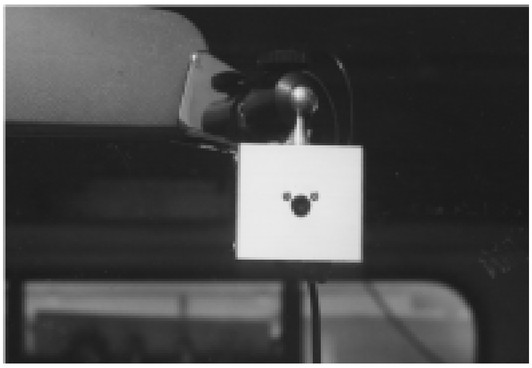

Photo 2. Event Eye Camera Device consists of time lag controller and VTR. The camera was installed in back miller of truck.

3.2 Data collection for fleets of trucks

A set of DMR with GPS was installed in 30 small trucks (2 ton) in two fleets of trucks. The 20 trucks were selected from 60 trucks in one fleet (C Co., Ltd), and all of 10 trucks were selected in another fleet (D Co., Ltd).

The change in speeds and all other travel behavior were recorded by DMR. It is possible to analyze and/or calculate how many times of the speed limit is exceeded, the number of times of rapid starts and sudden braking according to trigger level.

3.3 Data Analysis

Based on DMR data collected, the number of times of events such as hard braking (exceeded by 3.75m/s2), rapid acceleration and starting (exceeded by 3.00m/s2), were counted for 6 months in all subjects and they were calculated to obtain average values. The changes and /or differences of the values during experiments were studied to assess individual driver's characteristic.

We defined the "Index of bad behavior" score as simply adding points of numbers of the three emergency actions per 100 km running. The drivers are classified into 4 groups, ranked A, B, C and D levels according the index score, which ranging from careless driver to model of safety driver. The ranks are compared with the results of driving aptitude test.

As an attempt to assess the driving characteristics of each subject objectively, the relationship between frequencies of the events 100 km and income in a month.

To assess thoroughly driver characteristic, traffic situations and road conditions when/where and what events occurred were examined by EEC images and GPS data.

4. RESULTS

4.1 Evaluation Driver Behavior in Taxi Drivers

(1) DMR Data

Data on the driving behavior of drivers collected with the driving monitoring recorder over a period of about one year were evaluated, focusing attention on the number of times of events (hard brakes, sharp accelerations and rapid starts) at every cruse. Figure 1 shows the event numbers of some taxi drivers.

Driver 1 is characterized as careless driver because driving behavior with high frequency of rapid braking, start and acceleration. Total score as index of bad behavior is approximately over 80 points, is classified into a bad manner driver group.

He has three times accidents in the experiment period for 6 months. All of the accident causes arise from carelessly attention in the traffic situations (7).

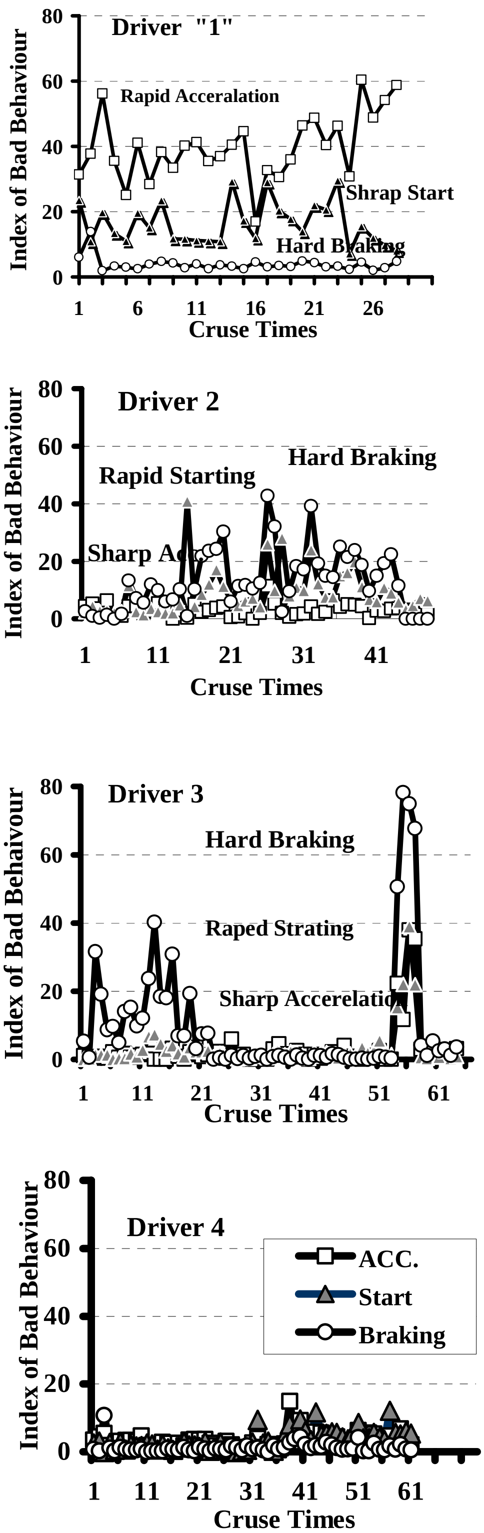

Fig.1 Examples of changing of bad index behavior at the cruses for 3 months. The change of the index of individual driver tends to show a proper pattern.

Driver 2 grouped into good driver because of bad index score under 20 points. Some times he applied hard brake and rapid starting, but few sharp acceleration during driving.

Driver 3 belongs to good driver group as average of bad index score, but he has gotten high score some times. He had met twice accidents for one year.

Driver 4 is an excellent driver because of low score at every cruse. He had not applied hard brake, rapid start and sharp acceleration.

As an attempt to assess the driving characteristics of each subject objectively, the relationship between frequencies of the events 100 km and income in a month. Figure 2 shows the distribution of the taxi drivers.

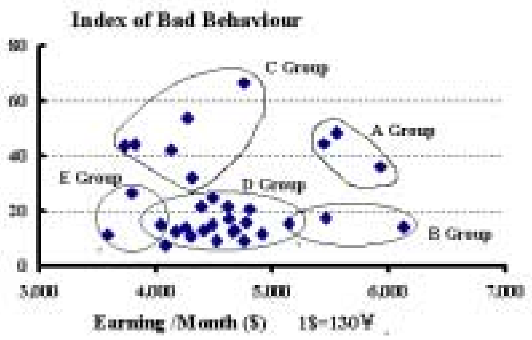

Fig. 2. Driver characteristics; Drivers in A Co., Ltd are classified into 6 groups by earning and bad index.

A group indicates high bad index and good earning, high risk and high return. Driver 2 classified into the A group, who show high bad index and high earning

B group indicates very low bad index and good earning, low risk and high return. Driver 4 classified into the B group, who is excellent driver evaluated by a manger of the company.

C group indicates high bad index and not much earning. Driver 1 belongs in this group, who is a kind of careless driver.

Most drivers are grouped into D group, who earn average money and show good manner. But some of them indicates bad manner sometimes look like Driver 3. He is mild characteristic most time, but sometimes shows strong emotion he said and the manger indicate it.

Elder drivers belong in E group shown mild manner, but less earning. Most of them drive for short time (less than 6 hours per a day) and short distance (less than 150km pre a day).

After a year the field trial, experiments results were shown to 15 drivers to recognize them driver characteristic and to improve safety drive attitude themselves. Most drivers were surprised at the results of the DMR. They said that it was the first experiment to reorganize their driver characteristics, if it is called. They would be able to understand their drive characteristic compare with group data in the same company because of personal acquaintances.

After the counseling, an additional field data collection was carried out for one month. The five drivers of the 15 drivers appeared a kind of improvement, eight drivers showed same manner, and two drivers indicate worse score. Figure 3 indicates the change of index of three elements of Driver 3 after the counseling. Note no hard brake and sharp acceleration are observed.

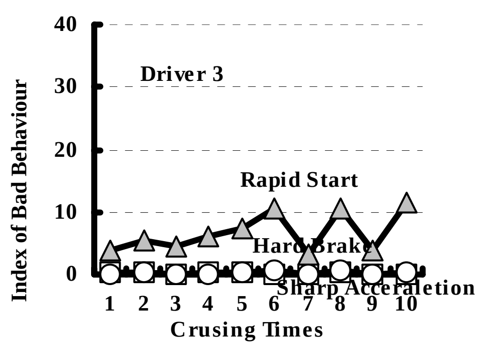

Fig.3 An example of driver characteristics (Driver 3); It is changed after the counseling.

Table 1 DMR data of drivers in B Taxi Co., Ltd.

Drivers	Runing Distance km	Runing Hours Minutes	Averag e Speed km/h	Max. Speed km/h	Speed Over hours Minutes	d Over Hrs. %	Sharp Acc. /100k Times	Rapid Start /100k Times	Hard Brake /100k Times	Total Events /100k Times	Earnning /Cruse (¥)	Evaluation
301	337.2	1099	18	98	41.2	3.7	0.8	5.4	0.3	6.4	57480	Excllent
302	400.1	1006.4	24	94	39.12	3.9	0.2	2.8	0.6	3.6	78950	Excllent
303	376.2	1056.3	21	91	37.29	3.5	1.5	7.2	0.1	8.8	65560	Good
304	321.0	955.91	20	97	41.54	4.3	1.6	2.5	0.3	4.4	54750	Good
305	346.7	1067.2	20	104	40.86	3.8	0.2	18.0	0.4	18.5	47900	Standerd
306	322.1	1022.3	19	97	32.67	3.2	0.5	27.0	0.8	28.3	52830	Standerd
307	344.4	1000.3	21	97	39.09	3.8	0.2	12.2	0.3	12.7	54300	Standerd
308	375.4	1119.3	20	97	29.14	2.6	8.3	27.4	0.5	36.2	43620	Standerd
309	318.8	1028.1	19	91	32.63	3.2	0.1	27.6	0.6	28.3	37430	Standerd
310	350.6	1130	19	85	23.68	2.0	0.4	33.3	0.6	34.4	64430	Semi Sd.
311	266.6	830.73	19	94	28.17	3.4	2.5	59.7	1.1	63.3	45720	Careless 1
313	353.5	1095.2	19	101	48.24	4.4	0.6	36.3	1.1	38.0	58770	Careless 3
314	270.1	890.86	18	99	21.92	2.3	0.1	36.3	1.1	37.5	56020	Careless 3
315	396.2	1126.7	21	106	50.86	4.5	3.3	8.8	1.5	13.6	66350	Careless 4
316	270.6	909.51	18	105	46.11	5.1	1.7	47.2	0.6	49.5	52940	Careless 5
401	350.2	928.96	23	108	53.43	5.7	1.4	33.7	0.5	35.6	56810	Careless 5
402	153.5	577.4	16	76	5.25	0.9	0.1	2.4	0.2	2.7	25240	Excellent
403	112.0	452.11	15	73	6.17	1.3	0.6	11.0	0.2	11.8	21960	Standerd
404	139.9	526.09	16	78	7.53	1.4	0.6	27.7	0.5	28.9	26900	Standerd
405	145.1	553.24	16	90	17.62	3.3	2.5	23.9	0.4	26.8	32300	Standerd
406	157.3	568.71	17	87	18.57	3.5	0.7	32.7	0.6	34.0	29400	Standerd
407	180.1	635.56	17	95	21.76	3.5	0.8	34.1	0.8	35.7	35000	Semi Sd.
408	155.5	559.79	17	87	13.29	2.4	1.5	41.1	1.3	43.9	19073	Careless 5
409	202.4	648.28	19	84	14.36	2.2	0.2	2.5	1.5	4.2	63588	Careless 5
410	138.0	560.03	15	79	5.93	1.0	1.4	40.5	0.9	42.7	24080	Careless 5
411	131.9	530.64	15	81	10.14	1.9	3.1	71.8	0.9	75.8	41000	Careless 6
412	146.8	621.98	14	74	4.82	0.8	2.0	54.4	0.5	56.9	28640	Careless 6
501	228.2	604.55	23	97	32.53	5.4	0.3	2.4	0.5	3.2	53700	Excellent
502	252.0	584.56	26	111	58.63	10.0	0.6	25.0	0.9	26.4	35645	Standerd
503	301.9	942.32	19	105	43.15	4.5	0.7	42.3	0.2	43.2	27820	Standerd
504	212.8	553.7	23	104	31.4	5.5	0.6	43.7	0.4	44.7	60080	Standerd
505	227.0	533.72	26	107	53.77	10.0	0.7	39.9	0.7	41.2	44000	Semi Sd.
506	240.2	552.69	26	112	56.26	10.0	0.3	23.3	1.3	24.8	37160	Careless 2
507	248.6	492.29	31	110	77.61	16.5	0.8	9.8	0.8	11.4	44410	Careless 6
508	190.0	373.05	30	109	64.82	17.2	6.0	29.9	0.6	36.4	50780	Careless 6
509	232.4	514.07	27	111	63.77	12.3	1.2	11.1	0.4	12.7	47470	Careless 6
510	215.4	387.66	33	134	77.3	19.8	1.5	46.8	2.0	50.2	44530	Bad
512	201.5	438.49	28	116	67.85	15.7	2.3	39.1	2.4	43.8	25550	Bad
Averag	253.0	749.41	21	97	35.74	5.48	1.37	27.38	0.74	29.5		

Table 2 DMR data of drivers of Table 1 arranged by total event times.

Drivers	Runing Distance km	Runing Hours Minutes	Averag e Speed km/h	Max. Speed km/h	Speed Over hours Minutes	d Over Hrs. %	Sharp Acc. /100k Times	Rapid Start /100k Times	Hard Brake /100k Times	Total Events /100k Times	Earnning /Cruse (¥)	Evaluation
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409	202.4	648.28	19	84	14.36	2.2	0.2	2.5	1.5	4.2	63588	Careless 5
304	321.0	955.91	20	97	41.54	4.3	1.6	2.5	0.3	4.4	54750	Good
301	337.2	1099	18	98	41.2	3.7	0.8	5.4	0.3	6.4	57480	Excllent
303	376.2	1056.3	21	91	37.29	3.5	1.5	7.2	0.1	8.8	65560	Good
507	248.6	492.29	31	110	77.61	16.5	0.8	9.8	0.8	11.4	44410	Careless 6
403	112.0	452.11	15	73	6.17	1.3	0.6	11.0	0.2	11.8	21960	Standerd
307	344.4	1000.3	21	97	39.09	3.8	0.2	12.2	0.3	12.7	54300	Standerd
509	232.4	514.07	27	111	63.77	12.3	1.2	11.1	0.4	12.7	47470	Careless 6
315	396.2	1126.7	21	106	50.86	4.5	3.3	8.8	1.5	13.6	66350	Careless 4
305	346.7	1067.2	20	104	40.86	3.8	0.2	18.0	0.4	18.5	47900	Standerd
506	240.2	552.69	26	112	56.26	10.0	0.3	23.3	1.3	24.8	37160	Careless 2
502	252.0	584.56	26	111	58.63	10.0	0.6	25.0	0.9	26.4	35645	Standerd
405	145.1	553.24	16	90	17.62	3.3	2.5	23.9	0.4	26.8	32300	Standerd
309	318.8	1028.1	19	91	32.63	3.2	0.1	27.6	0.6	28.3	37430	Standerd
306	322.1	1022.3	19	97	32.67	3.2	0.5	27.0	0.8	28.3	52830	Standerd
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406	157.3	568.71	17	87	18.57	3.5	0.7	32.7	0.6	34.0	29400	Standerd
310	350.6	1130	19	85	23.68	2.0	0.4	33.3	0.6	34.4	64430	Semi Sd.
401	350.2	928.96	23	108	53.43	5.7	1.4	33.7	0.5	35.6	56810	Careless 5
407	180.1	635.56	17	95	21.76	3.5	0.8	34.1	0.8	35.7	35000	Semi Sd.
308	375.4	1119.3	20	97	29.14	2.6	8.3	27.4	0.5	36.2	43620	Standerd
508	190.0	373.05	30	109	64.82	17.2	6.0	29.9	0.6	36.4	50780	Careless 6
314	270.1	890.86	18	99	21.92	2.3	0.1	36.3	1.1	37.5	56020	Careless 3
313	353.5	1095.2	19	101	48.24	4.4	0.6	36.3	1.1	38.0	58770	Careless 3
505	227.0	533.72	26	107	53.77	10.0	0.7	39.9	0.7	41.2	44000	Semi Sd.
410	138.0	560.03	15	79	5.93	1.0	1.4	40.5	0.9	42.7	24080	Careless 5
503	301.9	942.32	19	105	43.15	4.5	0.7	42.3	0.2	43.2	27820	Standerd
512	201.5	438.49	28	116	67.85	15.7	2.3	39.1	2.4	43.8	25550	Bad
408	155.5	559.79	17	87	13.29	2.4	1.5	41.1	1.3	43.9	19073	Careless 5
504	212.8	553.7	23	104	31.4	5.5	0.6	43.7	0.4	44.7	60080	Standerd
316	270.6	909.51	18	105	46.11	5.1	1.7	47.2	0.6	49.5	52940	Careless 5
510	215.4	387.66	33	134	77.3	19.8	1.5	46.8	2.0	50.2	44530	Bad
412	146.8	621.98	14	74	4.82	0.8	2.0	54.4	0.5	56.9	28640	Careless 6
311	266.6	830.73	19	94	28.17	3.4	2.5	59.7	1.1	63.3	45720	Careless 1
411	131.9	530.64	15	81	10.14	1.9	3.1	71.8	0.9	75.8	41000	Careless 6
Averag	253.0	749.41	21	97	35.74	5.48	1.37	27.38	0.74	29.5		

In Table 1, drivers from driver 301 to 316 work 18 hours from 6:00 AM to 3:00 AM in next day. The next day is of for their group. And next group works on a day period only from 8:00 AM to 6:00 PM. All drivers are female in this group. The business hours are a night period from 7:00 PM to 5:00 AM in the next day of the third group.

The drivers are classified six groups by the total event's score, speed over percentage, maximum speed and some others elements. The drives characteristic of the three groups are mixed in the table, it means that drivers characteristic does not depend on business hours.

(2) EEC Data

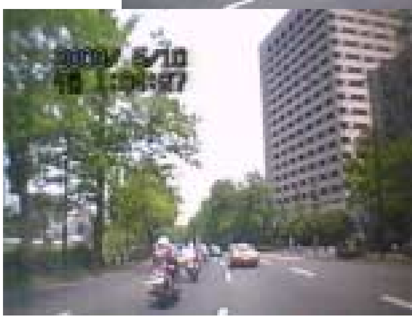
An Event Eye Camera (EEC) was installed a taxi to record the scene when events occurred. The image data were collected for 10 drivers belong to the B Taxi Co., Ltd. As examples of the image data, five scenes are shown in Photo 4, Photo 5 and Photo6 when the device detected a trigger of EEC in Driver 411 (female driver).

Photo 4 shows a rapid start situation. The signal changed from red to green, she started rapidly because of a top line placed at intersection.

Photo.4 An example of rapid start scene.

Photo 5-1 indicates the scene of hard braking, in where a white box type car was driven an interruption motion. Photo 5-2 shows a kind of hard braking scenes. Some motorcycles and taxi running with some high speeds in a merge road in front of the way, she applied a hard brake to avoid the motorcycles.

5-1



5-2

Photo. 5 Examples of hard brake scenes.

5-3

5-4

Photo.5. Examples of hard brake scenes.

The taxi ran in the narrow road in downtown Tokyo. She applied the hard brake before the intersection because of a black passenger car crossed in cross road as shown in Figure 5-3. And Figure 5-4 shows the scenes the taxi applied the hard brake because a passenger car in front of the taxi stopped suddenly.

6-1

6-2

Photo.6. Quick turn right motions in signal intersections.

Photo 6 indicates the scene of quick right turn motion. Few times of quick right turn action was recorded because of Japanese traffic system. In the cruse from 8:00 AM to 6:00 PM, quick right turns recorded are counted eight times in a day. Most of the actions occurred in a wide signal intersections.

Photo.6. Quick turn right motions in signal intersections in the evening.

On the other hand, quick left turn motions happened. Figure 7 shows an example of the motions. She played at 48 times of the quick left turns in a day.

Table 3. Numbers of events recorded in a day cruse by Driver 411.

	Hard Brake	Rapid Start Times	Sharp Acc.	Quick Left Turn Times	Quick Right Turn Times
Morning	7	13	5	4	10
Afternoon	18	35	5	4	13
Total Times	25	48	10	8	23

The total events are counted 115 events in a day from 8:00 AM to 6:00 PM. In the afternoon, the numbers of hard brake and rapid start actions are occurred than in the morning.

Photo. 7. A quick left turn motion.

4.2 Evaluation Driver Behavior in Truck Drivers

(1) DMR Data

Data on the driving behavior of drivers collected with the driving monitoring recorder over a period of about six months were evaluated, focusing attention on the number of times of events (hard brakes, sharp accelerations and rapid starts) at every cruse.

Table 4 shows the data of some truck drivers. In two transportation companies, 42 truck drivers (2 tons truck) were investigated by DMR.

Drivers are classified into three groups in two companies, respectively. The total event scores per 1000km are ranged from 10 times to around 500 times. We defined the levels of driver characteristics from level 1 to level 3 in shown Table 4. Two data of different company show relative contents of numbers of hard braking and sharp starting motions. But the total event time per 1000km is similar characteristics. The big difference is the data of taxi drivers and truck drivers. Probably it comes from different business type, that is, running distances, running speed and so on. Most important factor may be maximum running speed; taxi's is a 120km/h, truck's is 60km/h.

Table 4 DMR data of truck drives in two transportations companies.

C Co., Ltd. data

Drivers	Runing Hours	Running Dist .(km)	Rapid Acc. Times	Hard Brake Times	Sharp Start Times	Events Times	R. Acc. /1000km	H. Brake /1000km	S. Start /1000km	Total Events Times /1000km
101	12:47:36	54	1	39	21	61	18.5	722.2	388.9	1129.6
102	36:31:19	643.6	0	231	12	243	0.0	358.9	18.6	377.6
103	9:59:37	56	0	16	1	17	0.0	285.7	17.9	303.6
104	69:31:01	1841.7	0	461	27	488	0.0	250.3	14.7	265.0
105	65:44:24	1238.5	0	256	32	288	0.0	206.7	25.8	232.5
106	87:57:49	1970.9	0	409	38	447	0.0	207.5	19.3	226.8
107	89:50:51	2451.3	2	377	35	414	0.8	153.8	14.3	168.9
108	81:00:51	1718.3	0	225	18	243	0.0	130.9	10.5	141.4
109	108:32:06	3458.9	2	384	54	440	0.6	111.0	15.6	127.2
110	102:37:04	3047.8	0	240	59	299	0.0	78.7	19.4	98.1
111	12:20:48	239.1	0	13	10	23	0.0	54.4	41.8	96.2
112	84:37:01	1785.8	0	139	8	147	0.0	77.8	4.5	82.3
113	55:01:23	1076.9	0	64	24	88	0.0	59.4	22.3	81.7
114	100:01:34	2582.8	0	202	6	208	0.0	78.2	2.3	80.5
115	40:36:34	1008.5	0	58	3	61	0.0	57.5	3.0	60.5
116	100:01:51	2911	0	157	17	174	0.0	53.9	5.8	59.8
117	76:52:49	1787.9	0	67	23	90	0.0	37.5	12.9	50.3
118	92:45:36	1938.3	0	72	9	81	0.0	37.1	4.6	41.8
119	80:31:29	1691.6	0	63	1	64	0.0	37.2	0.6	37.8
120	5:05:19	93.1	0	3	0	3	0.0	32.2	0.0	32.2
121	110:53:07	2884.2	0	59	9	68	0.0	20.5	3.1	23.6
122	121:29:31	3748.3	0	48	40	88	0.0	12.8	10.7	23.5
123	37:04:03	689.2	0	12	4	16	0.0	17.4	5.8	23.2
124	20:52:31	625.4	0	8	2	10	0.0	12.8	3.2	16.0
125	56:47:48	1398.7	0	16	2	18	0.0	11.4	1.4	12.9
126	120:21:39	3053.8	0	26	8	34	0.0	8.5	2.6	11.1
127	31:21:29	519.9	0	2	0	2	0.0	3.8	0.0	3.8

D Co., Ltd. data

Drivers	Runing Hours	Running Dist .(km)	Rapid Acc. Times	Hard Brake Times	Sharp Start Times	Events Times	R. Acc. /1000km	H. Brake /1000km	S. Start /1000km	Total Events Times /1000km
201	55:09:17	1018.8	5	200	465	670	4.9	196.3	456.4	657.6
202	35:56:30	660.9	18	37	227	282	27.2	56.0	343.5	426.7
203	32:22:29	704.4	31	14	227	272	44.0	19.9	322.3	386.1
204	50:48:22	1030.6	5	63	255	323	4.9	61.1	247.4	313.4
205	5:57:44	99.5	0	8	23	31	0.0	80.4	231.2	311.6
206	55:37:04	1093.9	3	63	184	250	2.7	57.6	168.2	228.5
207	49:52:00	884.1	0	41	122	163	0.0	46.4	138.0	184.4
208	80:12:34	1893.3	3	11	315	329	1.6	5.8	166.4	173.8
209	60:08:17	1432.8	0	20	224	244	0.0	14.0	156.3	170.3
210	46:21:40	847.1	0	1	130	131	0.0	1.2	153.5	154.6
211	51:33:10	971.1	1	31	115	147	1.0	31.9	118.4	151.4
212	57:48:43	1059.7	0	15	84	99	0.0	14.2	79.3	93.4
213	38:03:55	672.6	0	1	56	57	0.0	1.5	83.3	84.7
214	44:10:06	923.4	3	5	21	29	3.2	5.4	22.7	31.4
215	46:16:55	860.4	0	0	1	1	0.0	0.0	1.2	1.2

(2) GPS Data

GPS data recorded in the data of DMR shown in Figure 8. In bottom of the Figure 8, some bars can be observed, which indicate events occurred. The bars of the top are rapid starting, middle bars sharp accelerations and the bottom hard braking motion, respectively.

When the bar is clicked, a map appeared in the screen of display of the computer linked GPS data shown in Figure 9. A triangle mark indicates where event occurred.

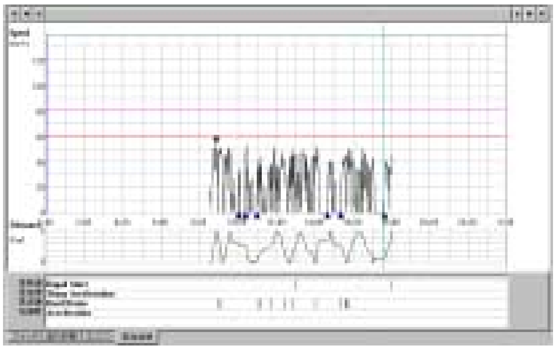
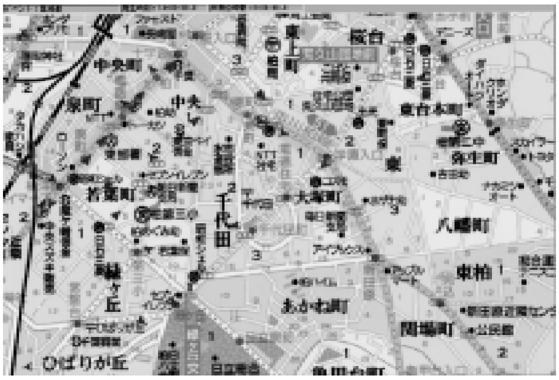


Fig.8. An example of DMR data chart.

Figure 9 shows GPS maps marked events occurred for two and/or three days in four drivers. Figure 9-1 is the map of Driver 105 in Table 4. Most of makes (arrows) can be seen on the city road in the map.



9-1. Data of Driver 105 (1/20000)

Figure 9-2 is the map of Driver 113 in Table 4. Several makes (arrows) can be seen on the city road and town road in the map.

Figure 9-3 is the map of Driver 113 in Table 4. Several makes (arrows) can be seen on the city road and town road in the map.

Figure 9-3 is the map of Driver 102 in Table 4. Most of makes (arrows) can be seen on the national road in the map.

Figure 9-4 is the map of Driver 113 in Table 4. Several makes (arrows) can be seen on the town road in the map.

9-2. Data of Driver 113 (1/20000)

9-3. Data of Driver 102 (1/10000)

9-4. Data of Driver 112 (1/70000)

Fig.9. Examples of maps by GPS. Several marks (arrows) on the map indicate where events occurred.

5. DISCUSSION

5.1 Relation between DMR Data and Driver Characteristic

According to data collected by the driving monitoring recorder, most drivers show similar data for six and/or twelve months as shown in Figure 1. This means that analysis data from DMR data may be indicate a kind of driver characteristics. Especially, drivers classified into careless driver group have met accidents during field tests (5).

Even greater volumes of data are required to study the relationship between the driving behavior under a normal driving situation and traffic accidents and, at the same time, various studies need be conducted to identify how such volumes of data can be analyzed.

The relation with the conventional driver aptitude test in particular is now listed as one of subjects that require studies. The results of the present study indicate that a high frequency of sudden braking and other types of driving behavior generally considered the factors of ineligibility as a driver can be one of the indexes to identify the characteristics of drivers.

5.2 Efficiency of Counseling based on DMR Data

Data collected with the driving monitoring recorder shows detailed information on individuals' everyday driving and can possibly be used to point out dangerous ways of driving objectively and improve them.

Fifteen subjects were interviewed and results of analysis made on their individual driving data were shown to them. They were advised to improve their driving behavior with respect of two to three driving deficiencies, a greater number of times of sudden braking, for example. Explanations were given as to how the driving monitoring recorder is monitoring their driving behavior at all times and that drivers are required to be well aware of their deficiencies and to have the positive attitude to improve themselves.

The number of driving deficiencies pointed out to each driver is limited to only two or three which may be the limits he can manage to improve at one time. Also such driving deficiencies to be pointed out are limited to the type of behavior that is obviously considered an unsafe driving pattern, such as sudden braking. Also each driver's attention was called to how different his driving data is from data of other subjects, so that each driver as a subject can have a good understanding of the characteristics of his driving behavior.

In previous mentions, after counseling five drivers can be observed some improving aspects from the DMR data. It is important for counseling or management of safety driving education to find these results to improvement because of professional drivers.

If it is possible to acquire data attesting to the possibility to improve the driving behavior of professional drivers by giving such simple instructions, the type of education based on data collected by the driving monitoring recorder will be considered worth notice and a new demonstrative approach to the safety education.

6. CONCLUSION

The DMR data collected during 6 and/or 24 months from taxi drivers and truck drivers. The data may be indicated the driver characteristics because of similar behavior for long enough period. If it becomes possible to relate the results of this close investigation driver characteristic and some factors such as earning of taxi drives and accident data from accident recorder.

In addition, GPS data and Event Eye Camera images are informative data to depth-investigate driver behavior and/or driver characteristics.

This new approach to the driver education can be an important of a tool breakthrough in the prevention of traffic accidents. It is expected that this approach to the driver education based on the effective use of information collected by these automatic recording systems can be a powerful means of practical driver education and can offer convincing clarification on how and why traffic accidents occur through complicated combinations of drivers' characteristics and situation-specific factors.

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