Development of a Workload Evaluation Scale for Drivers

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The work of train drivers is irregular because it is determined in accordance with the requirements of train operation. To take account of this when determining the workload of train drivers, many railway companies specify standards such as the length of a duty, late night working, and the duration of uninterrupted driving. However, most of these standards have been drawn up through accumulation of experiences, and it is hard to say that there are sound reasons behind particular standards. Although work schedules taking account of workloads are prepared using these standards, they largely depend on the experiences of the staffs in charge.

A number of attempts have been made to develop techniques for supporting the workload management of drivers. One of these includes a "Workload Evaluation Scale" which predicts the workload experienced by drivers. This scale evaluates a degree of fatigue at an arbitrary point in time as a proportion of the accumulated workload on the basis of the human's standard physiological rhythm for 24 hours. The scale allocates marks in a table to estimate the effect of times and hours of operation and sleeping, multiplied by the weighting coefficient depending on the kind of operation and the condition of rest (Table 1). It also uses a correction factor (Table 2) for main line driving that is the core of railway operation in Japan. The adequacy of this scale has been verified by the work of 36 drivers over 18 days. However, there were problems with the use of this scale such as:

(1) It only handles average workloads at normal times;
(2) The mark allocated for the effect of resting at home is obtained assuming that the driver sleeps for all the time spent at home; and
(3) The evaluation standard does not identify when the workload reaches a level that may compromise safety.

Accordingly, thanks to an experiment using a train operation simulator, we have made it possible to reflect, in the scale of marks allocated, the effect of operations being accelerated in order to recover from delays to the timetable. Further, we applied the new calculation method to the marks allocated for the resting effect, and we also added the evaluation standard for the mark given for the various workloads. Making use of this improvement, we created a new scale which increases the accuracy of the process of evaluating the driver's workload and which allows evaluation of the workload in a variety of different circumstances, for example when a driver is making up lost time after a delay.

As for utilization of this scale, for example, when several work diagrams are considered, it is possible to evaluate which one is suitable for a driver. Figure 1 shows the workload curve when a driver works continuously for two nights from the first day to the third day, and then continuously for two nights from the fifth day to the seventh day when the work flow is the opposite to that of the former work. By obtaining the total of the maximum values of the respective workload marks for the work occupying two nights, the former work corresponds to a score of 188 and the latter work corresponds to a score of 205. It is understood that the former two nights of continuous work with the smaller total value of the workload mark is suitable for a driver.

In addition, it is possible to simulate the workloads for various conditions, such as the case of driving a one-man train, the case of driving both on a single track and on a double track line, and the case of accelerated operations to make up for delays to the timetable. The new scale can also be utilized to identify train services where the driver needs to pay particular attention to safety for accident prevention and to draw the driver's attention to particular priority rosters for rest management.

Table 1 Weight coefficient for types of operation and rest conditions (Extract)

Name of operation	Busy line with dense traffic	Ordinary line
On-train working	1.00	1.00
Shunting	0.81	0.84
Entering and exiting depots	0.78	0.82
On-train without working	0.41	0.54
Preparation	0.36	0.65
Sort-out time	0.31	0.46
Turn-back	0.70	0.62
Training	0.70	0.79
Additional time	0.61	0.69
Rest at a private room in own depot	-0.70	-0.73
Rest at a private room in other depots	-0.62	-0.67
Rest at a shared room in own depot	-0.44	-0.49
Rest at a shared room in other depots	-0.42	-0.44
Rest in own depot	-0.41	-0.39
Rest in other depots	-0.33	-0.33
Rest at home	-1.00	-1.00
Outfitting	0.00	0.00
Commute	0.60	0.67

Table 2 Weighting coefficient of correction factor for main line driving (Busy line with dense traffic)

Kind of vehicle, train		Average nonstop (time)		Others	
Item	Coefficient	Item	Coefficient	Item	Coefficient
EC	1.00	Less than 3 min	1.05	One-man	1.18
DC	1.03	Less than 6 min	1.00	Mixture of single/double	1.08
EL, passenger	1.03	6 min or more	0.95	Recovery operation	1.30
EL, freight	0.95			Passing type	0.83
DL, passenger	1.02				
DL, freight	0.93				
TEC	0.89				

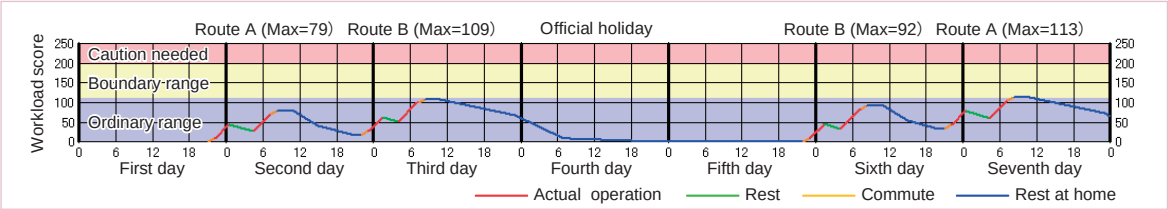

Fig. 1 Example of display of workload curve