ERGONOMIC ANALYSIS OF TRAIN DRIVER WORKPLACE ON TRAIN ICS PENDOLINO SERIES 310

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ABSTRACT

As the rail vehicles represent a basic element of the rail transport system, their characteristics have important impact on the reliability, safety and efficiency of the rail transport. The train driver and the in-vehicle working environment are directly affected by both, design of the vehicle and the environment the vehicle operates in. The role of the ergonomic survey and analysis is to identify characteristics of the man – machine - environment system and eventual inconsistencies within this system, as well as to provide suggestions for improvements. The paper presents the results of an ergonomic survey carried out among the ICS Pendolino Series 310 train drivers.

Keywords: ergonomics, rail transport, train driver, train ICS Pendolino Series 310

1 INTRODUCTION

Trains represent a specific type of means of transport used in passenger rail transport and as such are considered as a basic element of the rail transport system. Characteristics of the basic elements of a transport system have effect on its reliability, safety and efficiency.

From the viewpoint of the ergonomics a train driver working place and its characteristics represent an important element to be considered in the train planning process as well as during its operation.

The work of a train driver takes place in the train’s cab. The interior of the cab should be designed in such way that an appropriate level of safety, efficiency and comfort of the driver’s work is assured.

The driver’s work is based on receiving signals from the environment (the track, high and low signals, obstacles) as well as information from the indication devices on the control desk which are being continuously analyzed and processed in order to make an executive decision, performed via steering devices. The steering functions are accomplished by performing short movements not requiring great precision or speed. Quick decision-taking is required in situations of possible collisions (such as unexpected obstacle on the track), driving at night or in bad weather conditions, and is combined with the requirement of making a correct judgment of the situation and correct reaction.
Within the process of rail vehicle design, ergonomic characteristics of the driver workplace are being adjusted to driver's physical and psychological characteristics in order to create a safe working environment and to reduce or prevent possible adverse effects on driver's health, thus making his work more productive, efficient, safe and reliable.

2 ERGONOMICS OF THE TRAIN DRIVER WORKING PLACE

The ergonomics of the driver’s working place in the train cab is focused on composition and layout of the cab interior, and particularly on:

- spatial structure of the work place: arrangement of control desk, steering devices and the seat should be adjusted to driver’s anthropometric dimensions and body position at work, the scope of his movements, field of vision, equipment of the working place for optimum comfort and safety, etc.,
- arrangement of the elements of equipment in the working field: should provide visibility of the track as well as signaling and steering devices; signaling and steering elements are arranged to be made visible from the driver’s seat in day light and artificial light,
- physical working environment (characterized by factors such as noise, vibrations, microclimate, lighting, air composition and pollution, etc.).

Proper values of all parameters have to be assured during construction of the vehicle as well as later in period of its operation. In case of the ergonomic analysis of the train considered in this paper, certain characteristics of vehicle operation at higher speeds have to be taken into consideration.

3 METHODOLOGY

Subjects

A total of 15 drivers of ICS Pendolino Series 310 train were surveyed using a pre-designed questionnaire in order to obtain subjective perceptions related to the ergonomics of their job and the working place. The driver’s mean age was 43,6 years (38 to 51 years old), mean work experience as a train driver was 22,8 years (12 to 36 years), and mean work experience as a train driver of the ICS Pendolino Series 310 was 5,3 years (2 to 10 years).

Procedure

The aims of the questionnaire were to determine perception of the ergonomic characteristics of the train drivers’ work and the place where they work, the cab. The drivers were asked questions focused on the following issues:

a) Controls layout on the control panel
b) Comfort and adjustability of the driver's seat
c) Performing physical exercise during the work-rest
d) Physiological disorders during the work-time
e) In-cab climate
f) Noise and its effect on driver performance
g) Visibility from the cab
h) Impact of surroundings on driver work.
4 RESULTS AND ANALYSIS

4.1 Controls layout on the control panel

Appropriate installing of controls on the control panel of the rail vehicle has significant impact on its efficient and safe operation and especially on providing proper and quick response of the driver in an emergency.

According to the survey, the train drivers consider the installing on the control panel in ICS Pendolino Series cab 310 as good (80%) or acceptable (20%), while none of the drivers finds it inadequate.

4.2 Comfort and adjustability of the driver's seat

A survey shows that a small number of drivers (20%) find the comfort and adjustability of the seat to be good, while almost half of them (47%) finds it acceptable and one third (33%) find it poor. Majority (80%) of drivers consider that driver's seat comfort and adjustability could be better and should be improved.

Absence of the driver's armrest is identified as the most important weakness. A major deficiency is also the lack of adjustable lumbar support. A common observation is that the driver's seat has very limited adjustment possibilities, is small and generally uncomfortable.

4.3 In-cab climate

The most important factor affecting the climate in the cab of a train is the temperature. The temperature is controlled through settings of the air conditioning. The survey shows that only 14% of drivers consider the in-cab climate to be good, while more than half (53%) consider climate to be acceptable, and one third (33%) consider the climate as poor or inadequate. Majority of drivers (84%) find the setting of air conditioning easy and 13% find it medium easy to adjust the air conditioning.

4.4 Visibility from the driver's cab

Visibility from the driver's cab is to be considered from two aspects – as visibility in the forward direction and as visibility in the reverse direction.

Visibility in the forward direction is considered to be good by 80% of drivers, while 20% considers it as acceptable – these drivers stated that visibility on the sides of the train is poor, and the power of the head lights should be increased for driving at night, especially of the reflector.

Visibility in the reverse direction is considered as good by 40% of the drivers, while 27% of drivers consider it as acceptable and 33% consider it as poor. When the train reaches the speed of 30 – 35 km/h, the mirrors automatically close, thus making the observations in the reverse direction impossible. The rear-view mirrors are to be used only when the train is stopped and the passengers are boarding or alighting from the vehicle. Several drivers suggested the installment of cameras in the reverse direction.
4.5 Noise and its effect on driver performance

The noise in the cab of a train occurs as a result of the noise from the in-cab sources and the external noise, caused by train moving at certain speed or its surroundings.

The perceived level of noise, as reported by the drivers, is considered as low in 47%, as medium also in 47%, and only 6% of drivers perceive it as high. The same distribution applies for the perception of the noise impact on train drivers' work – in 47% it is considered to have low impact, in 47% to have medium impact and in 6% to have a major impact.

The level of external noise, caused by train moving at certain speed or its surroundings, is considered as medium by 60% of the drivers, and as low by 40% of the drivers. 60% of drivers also consider the external noise to have a medium impact on the drivers' work, while 40% of drivers consider the external noise to have low impact on drivers' work.

4.6 Impact of surroundings on driver work

The impact of surroundings on the drivers' work is considered from three aspects: from the aspect of the effect of the billboards and other means of advertising, from the aspect of dazzling headlights of road vehicles, and from the aspect of any other identified disruptive factor.

a) Disruptive impact of billboards and other forms of advertising

The billboards and other forms of advertising installed along the railway line are considered by the majority (74%) of drivers as having no disruptive impact on their work, while 26% of the drivers consider such elements as slightly (13%) to moderately (13%) disruptive.

b) Disruptive impact of light glare of the road vehicles

Dazzling headlights of road vehicles travelling along the railway line are considered as having no disruptive impact by only 7% of drivers, while the vast majority of drivers (93%) consider the road vehicles headlights to be disturbing - slightly (47%) to moderately (33%), or having a disruptive impact (13%). 7% of drivers consider the road vehicles light glare to have impact on their work only when the road and the railway line cross at the same level.
c) Other disruptive elements

As additional disruptive elements affecting the work of the train drivers the following are identified:

- easy access to the railway lines for unauthorized personnel, which has a negative impact on the performance of train ride,
- inadequate head lights (poor lighting) of the rail vehicles have a negative impact on the train ride,
- weather conditions (such as fog, storm, sleet, sun, rain, snow, ice) have a medium to very disruptive affect on the train ride,
- lighting facilities along the railway line have very disturbing effect on driving and control of the train.

4.7 Physiological disorders during the work-time

A survey focused also on physiological disorders which appear during the work-time and affect drivers' physical condition and ability to work.

Almost all drivers (93%) report presence of back pain, while almost half of them (47%) report also presence of other type of pain (40% of drivers feel pain the neck and 7% feel pain in the legs). Only 7% of drivers (one driver) report presence of no pain at all, which would affect driver physical condition during the work time, while driving the train.

4.8 Performing physical exercise during the work-rest

Performing physical exercise during the work-rest is a common practice for only a small number of drivers (13%), while most of them (87%) do not perform any physical exercise at all during the work-rest.

5 CONCLUSION

A short ergonomic survey among the drivers of the ICS Pendolino Series 310 train considered some of the most important ergonomic characteristics of the train and its operation, such as controls layout on the control panel, comfort and adjustability of the driver's seat, in-cab climate, in-cab noise, visibility from the cab as well as the impact of surroundings on driver work, physiological disorders that appear during the work-time and performance of physical exercises during the work-rest.

The results of the survey show that the control panel is well planned and the controls' layout is adequate for all drivers. Due to driver's specific posture during the work – in a sitting position, the driver's seat appears as a very important element. Most of the drivers think that the driver's seat comfort and adjustability should be better.

The in-cab climate appears as suitable only for part of the drivers, while some of them find it inadequate.

Majority of drivers perceive the in-cab noise and its impact on their work as low and acceptable. Visibility from the cab is considered by most of the drivers to be good, although some of them expressed concerns about the limited visibility in the reverse direction.

Amongst the disruptive elements from the surroundings of the train, most of the drivers highlighted particularly dazzling headlights of the road vehicles travelling along the railway line. The expressed view of the drivers regarding other disruptive elements reveal elements that could
be interesting also for their employers, as well as for the designers of the rail vehicles railway infrastructure.

The analyzed ergonomic factors of the train driver in-cab working environment represent only a part of all influential factors to be considered. The factors taken into consideration in the survey have an important impact on overall safety and efficiency of train operation. Therefore, it is very important that they (their values) are kept within the recommended values and are controlled throughout the entire vehicle operation period. Thus the necessary corrections and improvements could be made in order to improve the working conditions of the train drivers.

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