ASSESSMENT OF THE LEVEL OF UNDESIRABLE ACTIONS OF PEOPLE INVOLVED IN ROAD TRANSPORT SYSTEMS AND THEIR ENVIRONMENTS.

OCENA POZIOMU NIEPOŻĄDANYCH ODDZIAŁYWAŃ LUDZI USYTUOWANYCH W SYSTEMACH TRANSPORTU DROGOWEGO I ICH OTOCZENIU.

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Abstract: Road transport systems are socio-technical systems of the type Human – Technical object- Environment <H-TO-E>. In these systems hazards can be caused by: the man C, the technical object OT, and influence of the environment on the technical object and people who are present in the system and its environment. The authors of the paper make an attempt to evaluate the level of threats resulting from intended or not intended actions of people situated in this environment.

Keywords: social engineering system, safety working

Streszczenie: Systemy transportu drogowego są systemami socjotechnicznymi typu Człowiek – Obiekt Techniczny – Otoczenie <C – OT – O>. W systemach tych zagrożenia mogą być stwarzane przez: człowieka C, obiekt techniczny OT oraz przez oddziaływanie otoczenia O na obiekt techniczny i ludzi znajdujących się w systemie oraz w jego otoczeniu. W pracy podjęto próbę oceny poziomu zagrożeń wynikających z zamierzonych lub niezamierzonych działań ludzi usytuowanych systemach transportu drogowego oraz ich otoczeniu.

Słowa kluczowe: system socjotechniczny, bezpieczeństwo działania

1. Introduction.

Transport systems are examples of socio-technical systems in which direct realization of their tasks is performed by operational subsystems of the type Man-Technical object (operator - transport means) performing tasks within the system environment. Moreover, a man can be involved in transport systems:

- inside the transport means (passenger)
- within the transport means environment (other drivers, pedestrians e.t.c.)

Because of the man involved in the transport system, the most important criterion for assessment of the realized transports is their operational safety

Operational safety of a transport system in which values of the distinguished features describing the system in a given period of time t, $t \subset [t_0, t_k]$ are contained within established boundaries, with defined levels of actions of forcing factors.

These factors can be divided into [1,2,3]:
- *operational* - within the system-forcing factors affecting the means of transport as a result of the transport task realization.
- *external* –forcing factors characterizing the influence of the environment on the means of transport (not conditioned by its operation)
- *antropotechnical* – forcing factors affecting an elementary operational subsystem as a result of human activities, for example due to an operator's mistake, improper behaviors of passengers or pedestrians

Because of a different placement of the man in the transport system and his/her safety it is necessary to develop a method which will account for the effect of forcing antropotechnical factors on the system operational safety.

2. Aim of the paper

The aim of this work is to assess the level of undesirable influence of people situated in the road transport systems and their environment on the operational safety of these systems

3. Object and subject of examinations

The objects of investigations are general road transport systems realizing transport tasks all over Poland. The subject of investigations is an analysis of undesirable behaviors of people and their influence on the safety change levels of the system operation.

4. Developing an algorithm of assessment of influence of behaviors of people situated in road transport systems and its environment on the transport system operation

A man in a transport system can be situated inside a vehicle as: a driver, passenger and in the system environment as a pedestrian, cyclist, etc. In relation to this, threats in the transport system caused by undesirable actions of people depend on their placement in the transport system [4].

In order to make an assessment of the influence of undesirable behaviors of people on the operational safety of the transport system, an algorithm of this safety assessment which was presented in fig.1 has been built, description of particular blocks of the algorithm has been presented in table 1.
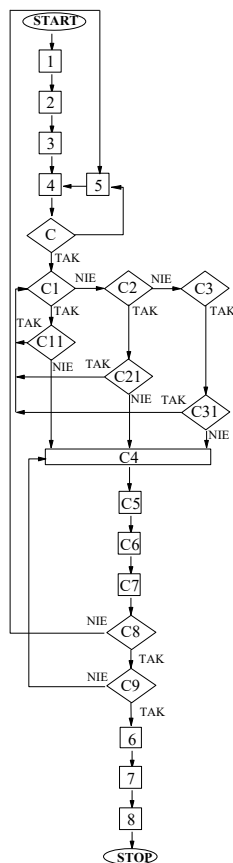

Fig.1 Algorithm of assessment of antropotechnical factor influence on the transport means system operation security.

Table 1 Description of algorithm blocks of effects of behaviors of people situated in a transport system and its environment

1	determine a set of road events occurred in the analyzed time period Zi; i = {1, 2, 3, …, k}.
2	Chose events significant in terms of operational safety of the analyzed system.
3	Order the events according to their occurrence Z_1, Z_2, Z_3, …, Z_k.
4	Choose for assessment the first event Z_i, i = 1.
5	Choose for assessment the next road event Z_i + 1.
C	Was behavior of people situated in the transport system and its environment the cause of a the analyzed event ?
C1	Was improper behavior of the driver the cause of the event ?
C11	Was improper behavior of the driver the cause of a damage to the transport means subsystem ?
C2	Was improper behavior of the transport means passengers the cause of the event ?
C21	Did improper behavior of passengers have an influence on wrong actions of the driver ?
C3	Was improper behavior of people situated in the transport means environment the cause of the event ?
C31	Did improper behavior of people situated in the transport means environment have an influence on the driver's actions ?
C4	Determine a set of indicators for assessment of undesirable effects of actions of people situated in the transport means system and its environment.
C5	Determine assessment criteria of safe actions of people situated inside the means of transport and its environment.
C6	Choose a set of indicators representative for assessment of actions of people situated in the means of transport from the event.
C7	Make an assessment of safe actions of people situated inside the transport means and its environment.
C8	Is the analyzed event Zi = Zk gdzie, i = {1, 2, ..., k}
C9	Is the resultant model adequate?
6	Make a complex assessment of the transport system operational safety.
7	Evaluate costs involved in the events
8	Make assessment of costs resulting safety and their selected results

5. Road traffic safety examinations and their selected results

The examinations involved gathering information on the number of road accidents which were caused by improper actions of people situated inside the transport means system and its environment and the effects of these events. Relevant data

was obtained from the Main Police Station and referred to 01.01.2000 to 312.2007. The obtained data has been demonstrated in tables 2 ÷ 4.

Table 2 Numbers of road events caused by people situated inside in the transport system and its environment, in the analyzed period of time [5].

Perpetrator of accident	Number of road accidents							
	2000	2001	2002	2003	2004	2005	2006	2007
driver of vehicle	44835	42860	43066	41370	3794	39 730	37 129	38 434
pedestrian	3072	2791	3640	3285	8041	7 119	6 719	6 912
passenger	144	128	124	126	119	127	-	-

Table 3 Numbers of people killed in result of road accidents by people situated in the transport system and its environment, in the analyzed time period [5].

Perpetrator of accident	Number of people killed in road accidents							
	2000	2001	2002	2003	2004	2005	2006	2007
driver of vehicle	4 650	4 262	4 470	4 382	4 232	4 239	3 729	3 753
pedestrian	1 275	1 006	1 098	1 017	838	979	1007	1105
passenger	25	18	13	8	13	11	-	-

Table 4 Numbers of people injured in road accidents caused by people situated in the transport system and its environment, in the analyzed time period [5].

Perpetrator of accident	Number of people injured in road accidents							
	2000	2001	2002	2003	2004	2005	2006	2007
driver of vehicle	59 970	57 799	57 670	54 835	51 024	53 429	49 784	52 240
pedestrian	2677	3493	4240	2916	5 657	6 363	5 828	5 946
passenger	127	119	116	129	109	124	-	-

For evaluation of the level of the influence of undesirable actions of particular groups of people situated in the transport system or its environment the following set of indicators has been chosen:

1. The number of road accidents caused by the vehicle drivers falling on 100 road accidents

$$W_1 = \frac{L_{WK} \cdot 100}{L_W} \qquad (1)$$

where:
L_W – number of all road accidents caused by drivers in the analyzed time period
L_{WK} – numbers of road events caused by drivers

2. The number of road accidents caused by pedestrians falling on 100 accidents.

$$W_2 = \frac{L_{WP} \cdot 100}{L_W} \tag{2}$$

where:
L_{WP} – number of road accidents caused by pedestrians in the analyzed time period

3. The number of road accidents caused by passengers using means of transport falling on 100 road accidents.

$$W_3 = \frac{L_{WPA} \cdot 100}{L_W} \tag{3}$$

where:
L_{WPA} – number of road accidents caused by passengers using means of transport falling on 100 road accidents in the analyzed time period

4. The number of road accidents caused by other drivers falling on 100 road accidents

$$W_4 = \frac{L_{ZK} \cdot 100}{L_{WK}} \tag{4}$$

where:
L_{ZK} – number of people killed in road accidents caused by drivers of vehicles in the analyzed time period falling on 100 road accidents

5. The number of people killed in road accidents caused by drivers of vehicles falling on 100 road accidents

$$W_5 = \frac{L_{ZP} \cdot 100}{L_{WP}} \tag{5}$$

gdzie:
L_{ZP} – number of people killed in road accidents caused by pedestrians, in the analyzed time period falling on 100 road accidents.

6. The number of killed people in road accidents caused by passengers using means of transport falling on 100 road accidents.

$$W_6 = \frac{L_{ZPA} \cdot 100}{L_{WPA}} \tag{6}$$

gdzie:
L_{ZPA} – number of people killed in road accidents caused by passengers using the means of transport in the analyzed time period.

6. Selected results of examinations.

Results of safety examinations in road transport systems in the analyzed time period are demonstrated in table 5.They show that for every 100 road accidents 80 were caused by improper behaviors of drivers (value of indicator W) This tendency is of constant character in the analyzed time period like in the case of indicator W3, whereas in case of indicator W2 significant rise of this indicator value in the successive years of the analyzed time period can be observed.

Table 5 Values of particular indicators in the analyzed time period   in 01.01.2000-31.12.2007.

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
W_1	78,2	79,7	80,4	81,0	81,5	82,6	79,2	77,6
W_2	5,4	5,2	6,8	6,4	15,7	14,8	14,3	14,0
W_3	0,3	0,2	0,2	0,2	0,2	0,3	-	-
W_4	10,4	9,9	10,4	10,6	10,3	10,7	10,0	9,8
W_5	41,5	36,0	30,2	31,0	10,4	13,8	15,0	16,0
W_6	17,4	14,1	10,5	6,3	10,9	8,7	-	-

In table 5 also values of indicators of the number of killed persons in result of road accidents caused by different groups of people situated in the transport system and its environment have been presented.

7. Analysis of results and conclusions.

From the data obtained from the examinations it results that for every 100 road accidents caused by the vehicle drivers (indicator W) in the analyzed time period,10 persons were dead, the indicator remained on this level in particular years. As for Wd indicator, its value drop by 74% was observed being followed by its rise until 2004.

Similar changes have been noted for indicator W6 in which case a triple drop of its value can be noticed in 2003 and then, its renew rise, unfortunately a full analysis of this indicator value changes is not possible throughout the analyzed time due to the lack of data on the number of accidents and fatalities being the effect of improper behavior of means of transport passengers.

The rise of values of the analyzed indicators in 2004 is caused by an increase in traffic intensity resulting from an increasing number of vehicles on the roads.

There is a necessity of conducting further investigations aiming at identification of the most frequent reasons of improper behaviors of particular groups of people situated in transport systems in order to increase security level of the systems operation.

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