PROPOSAL OF A METHOD TO EVALUATE OF INCLUDE OF THE UNDESIRABLE HUMAN FACTORS ON SAFETY OPERATION OF THE TRANSPORT SYSTEM

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Abstract

An anthropo-technical system is a pair Human –Technical Object performing their tasks in the environment E <H-TO-E>. In systems of this type threats can be posed by a human H, technical object TO, and the environmental impact on the technical object and people present within the system or its environment. The level of undesirable influence of the human factor on safety of the system operation depends on the human location in the analyzed system.

In the work there has been made an attempt to develop a method for assessment of undesirable errors of people situated in an anthropo-technical system and its environment. Error is an inseparable attribute of human behaviour. Depending on the situation, a human error can lead to deviations from the terms of task accomplishment, it can threaten their safety and be the cause of an undesirable event occurrence. Errors can be divided into the following groups: Training errors these are errors connected with the technique of vehicle driving, decision errors which in situations posing a threat to the system safety largely depend on the situation assessment, making and following a decision of rational control of the vehicle, and Information reception errors resulting from failing to notice signals informing about operation of the vehicle particular subsystems or a change of the road conditions or noticing them too late. For this purpose an algorithm of assessment of people's undesirable actions has been developed. The proposed method for assessment of the impact of undesirable actions of people involved in an antropo-technical system and its environment is a complex method which accounts for different human behaviours.

Key words: transport system, undesirable action

1. Introduction

A distinctive feature of people is their ability of adaptation to the work environment. It allows reacting and controlling movements in unexpected circumstances. However, a negative side of human behaviour is a possibility of making various mistakes [1]. Antropo-technical systems are systems of the type <Human-Technical Object> performing their task in the system Environment <E>.

In literature [3] there can be found a model of an anthropo-technical in a structural approach, this model has been shown in Fig. 1.

An example of anthropo-technical systems are transport systems in which there can be distinguished an anthropo-technical pair driver – vehicle also called an elementary executive subsystem which performs a transport task in the system environment. Operational safety of an elementary executive subsystem is affected by various factors resulting from the technical object (vehicle) limited serviceability state, undesirable impact of the environment as well as inappropriate actions of people present in the system and its environment.

Error is an inseparable attribute of human behaviour. Depending on the situation, a human error can lead to deviations from the terms of task accomplishment, it can threaten their safety and be the cause of an undesirable event occurrence. Errors can be divided into the following groups [2]:
- Training errors these are errors connected with the technique of vehicle driving. This type of

errors result from delayed reactions on the part of the driver, inappropriate observation of the road and its surroundings, the situation inside the vehicle and too late recognition of threats.
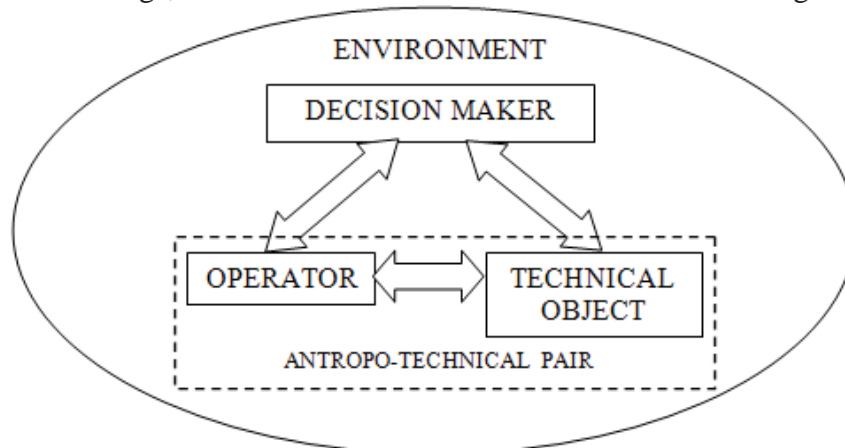

Fig. 1. Model of an anthropotechnical system in structural terms [2]

- Decision errors which in situations posing a threat to the system safety largely depend on the situation assessment, making and following a decision of rational control of the vehicle. Decision errors include the following kinds of errors: inappropriate performance of procedures, wrong interpretation of the obtained information, choice of a wrong mode of operation, wrong assessment of the situation.
- Information reception errors resulting from failing to notice signals informing about operation of the vehicle particular subsystems or a change of the road conditions or noticing them too late.

In the article there has been made an attempt to build an algorithm of assessment of inappropriate actions of people situated in the antropo-technical system and its environment. This influence is referred to as an antropo-technical factor affecting OT in result of conscious or unconscious actions of the human.

2. Identification of undesirable states and inappropriate actions of people involved in an anthropo-technical system

Action is a notion referring to the man, action means human behaviour (external and internal act), if the acting person or persons attribute some subjective sense to it. According to the author of this work [4] there can be distinguished four types of actions.

- Actions rational in terms of the goal, when the acting person is motivated by instrumental rationality: the subject chooses goals from the set of values and matches appropriate means with regard to alternative costs,
- Actions rational in terms of values, contrary to the above ones, the acting subject is not motivated by calculation of the action consequences (according to the rule ' the purpose justifies means'),
- Affectionate actions, consistent with current emotional states,
- Traditional actions, based on habits.

Below, there has been presented a classification of the operator's states and behaviours which have an influence on occurrence of threats whose effect can be an undesirable event.

Operator's states:
a) Psycho-physical:
  - impaired sight,
  - impaired hearing,
  - disease,
  - delayed reflex (no reaction to a potential threat),
b) Psychological,

c) Intelligence level,

d) Habits.

Violations are conscious behaviours involving neglecting or breaking set regulations, procedures or rules. Some violations can result from lack of knowledge. Violations can be routine and sporadic.

Routine violations connected with systematic violation of binding regulations by a given driver. Acceptance of violations by the organization management leads to a situation when they become 'unwritten law'. Routine violations committed by drivers include:

Operator's behaviour

- operating of a technical object after the influence of alcohol,
- operating a technical object after the influence of drugs,
- operating a technical object under the influence of medicines decreasing reaction abilities,
- disobedience of traffic rules and signs,
- others.

The presented states and behaviours can cause undesirable events occurrence which can involve people's death or loss of their health.

3. Algorithm of assessment of undesirable actions of people involved in an antropo-technical system and its environment

A general form of undesirable actions assessment algorithm of people involved in an antropo-technical system and its environment has been presented in Fig. 2, the algorithm consists of three basic parts C1 – concerning assessment of undesirable actions of the technical object operators, C2 – assessment of undesirable actions of people situated in the system environment, and C3 – assessment of wrong actions of the technical object seers (passengers).
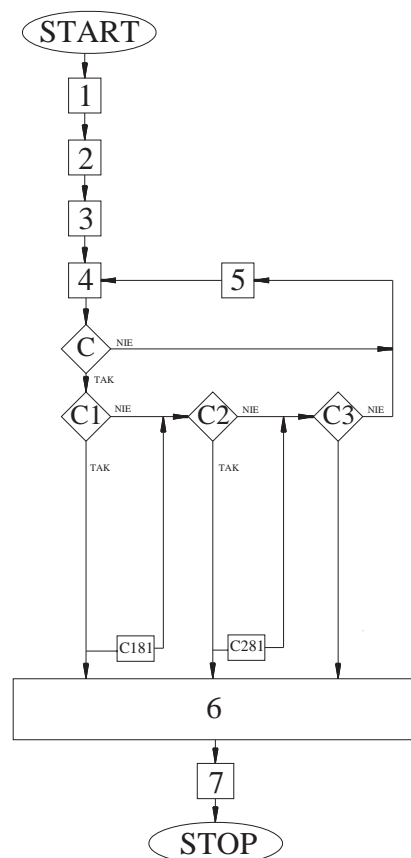

Fig. 2. Algorithm of assessment of undesirable actions of people involved in an anthropo-technical system and the environment
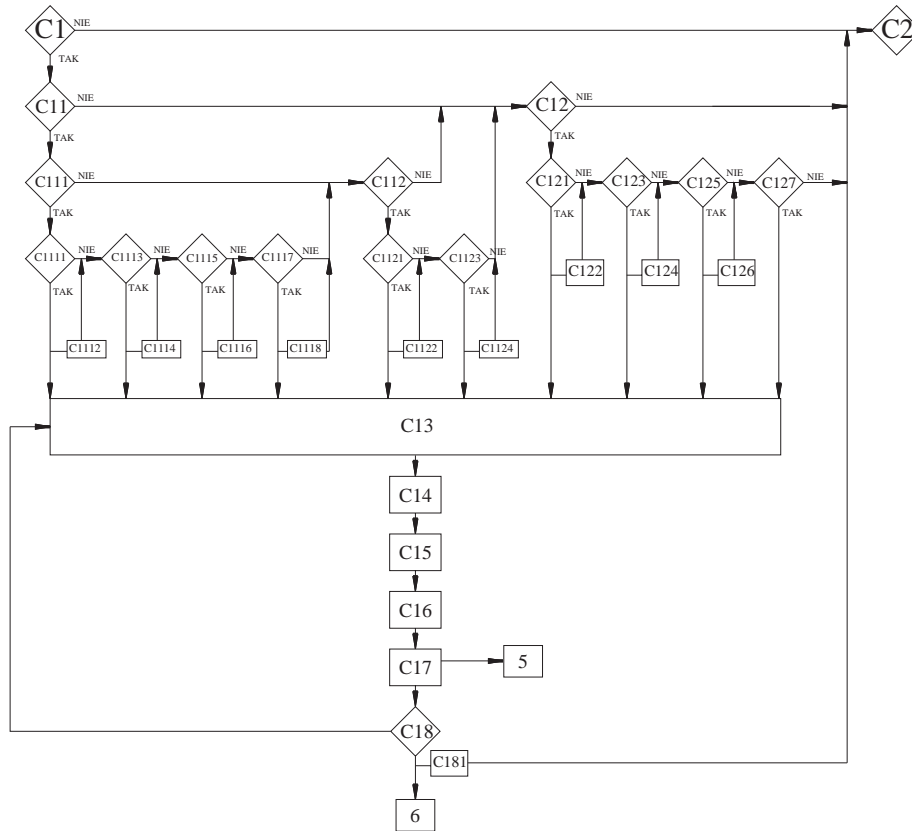
Fig. 3. Algorithm of assessment of undesirable actions of technical objects operators (drivers)
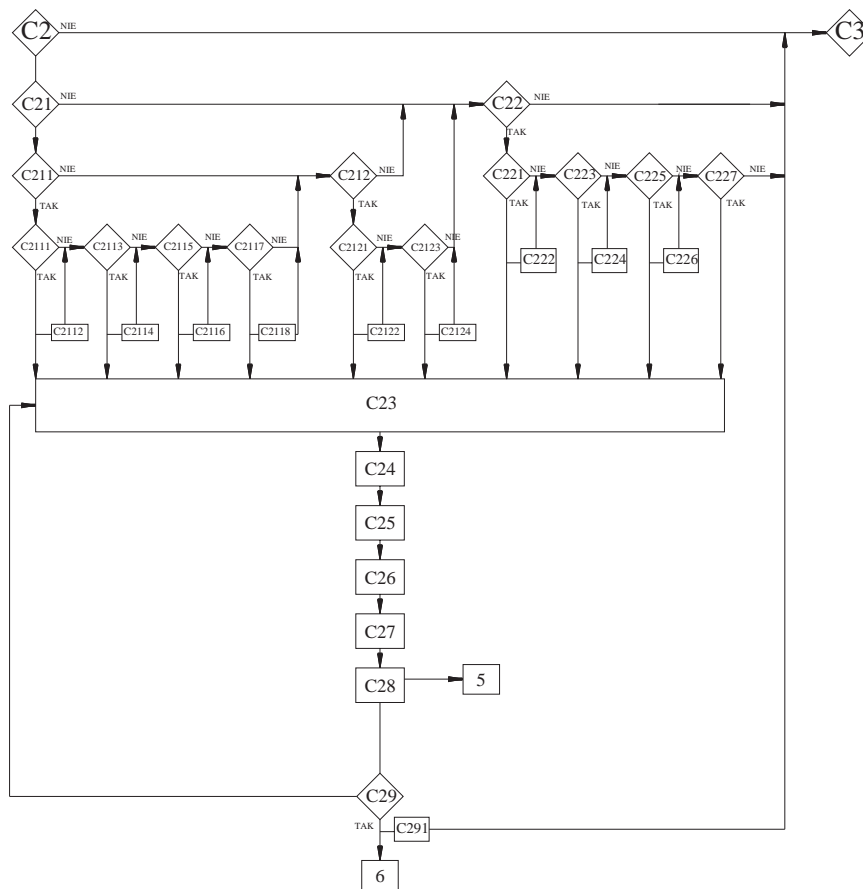

Fig. 4. Algorithm of assessment of undesirable actions of people present in the anthropo-technical system environment

Tab. 1. Description of the main algorithm

No.	Name of block of algorithm
1	Determine a set of road accidents occurred in the analyzed time period Zi; i = {1, 2, 3, …, k}.
2	Choose events significant from the point of view of the analyzed system operational safety
3	Order events according to the principle of occurrence Z_1, Z_2, Z_3, …, Z_k.
4	Choose the first event for assessment Z_i, i = 1.
5	Choose the next event for assessment Z1 +1
C1	Was inappropriate action of the driver the cause of the event?
C191	Check whether C2 event happened as well.
C2	Was inappropriate action of a human, involved in the system environment, the cause of occurrence of an undesirable event?
C291	Check whether C3 event happened as well.
C3	Was inappropriate action of the vehicle passenger the cause of the analyzed event occurrence?
6	Make an overall assessment of the anthropo-technical system operational safety
7	Show the result

Tab. 2. Description of C1 algorithm

No.	Name of block of algorithm
C1	Was inappropriate action of the vehicle driver the cause of the analyzed event occurrence?
C11	Was the driver's unfitness the cause of the analyzed event occurrence?
C111	Was the driver's bad psycho-physical condition the cause of the analyzed event occurrence?
C1111	Was the driver's impaired sight the cause of the analyzed event occurrence?
C1112	Check whether C1113 event happened as well.
C1113	Was the driver's impaired hearing the cause of the analyzed event occurrence?
C1114	Check whether there also happened C1115 event.
C1115	Was bad health condition the cause of the analyzed event occurrence?
C1116	Check whether C1117 also happened.
C1117	Was the driver's delayed reflex the cause of the analyzed event occurrence?
C1118	Check whether C1112 event also happened.
C112	Was the driver's poor psychical condition the cause of the analyzed event occurrence/
C1121	Was the driver's low intelligence level the cause of the analyzed event occurrence?
C1122	Check whether C1123 event also happened.
C1123	Were the driver's bad habits the cause of the analyzed event occurrence?
C1124	Check whether C12 event also happened.
C12	Was the driver's inappropriate action the cause of the analyzed event occurrence?
C121	Was driving the vehicle under the influence of alcohol the cause of the analyzed event occurrence?
C122	Check whether C123 event also happened.
C123	Was driving under the influence of drugs the cause of the analyzed event occurrence?
C124	Check whether C125 event also happened.
C125	Was driving under the influence of medicines reducing reaction abilities the cause of the analyzed event occurrence?
C26	Check whether C127 event also took place.
C127	Was the driver's disobedience of traffic rules the cause of the analyzed event occurrence?
C13	Specify a set of indexes for assessment of inappropriate actions of TO operators.
C14	Establish criteria for assessment of inappropriate actions of TO operators
C15	Specify a set of representative indexes for assessment of inappropriate actions of TO operators.
C16	Make an overall analysis of assessment of inappropriate actions of the driver.
C17	Is the analyzed event the last from the set of elementary events?
C18	Is the resultant model adequate?
C181	Check whether C2 event has also happened.

Tab. 3. Description of C2 algorithm

No.	Name of block of algorithm
C2	Was inappropriate action of a human involved in the system environment the cause of the analyzed event?
C21	Was bad condition of a human present in the system environment the cause of the analyzed event occurrence/
C211	Was poor psycho-physical condition of a human present in the system environment the cause of the analyzed event occurrence?
C2111	Was impaired sight of a human present in the system environment the cause of the analyzed event occurrence?
C2112	Check whether C2113 event also took place.
C2113	Was impaired hearing of a human present in the system environment the cause of the analyzed event occurrence?
C2114	Check whether C2115 event also happened.
C2115	Was bad health condition of a human present in the system environment the cause of the analyzed event occurrence?
C2116	Check whether C2117 event happened as well.
C2117	Was delayed reflex of a human involved in the system environment the cause of the analyzed event occurrence?
C2118	Check whether C212 event happened as well.
C212	Was poor psychical condition of a human involved in the system environment the cause of the analyzed event occurrence?
C2121	Was low intelligence level of a human involved in the system environment the cause of the analyzed event occurrence?
C2122	Check whether C2123 event happened as well.
C2123	Were bad habits of a human involved in the system environment the cause of the analyzed event occurrence?
C2124	Check whether C22 event happened as well.
C22	Was inappropriate action of a human involved in the system environment the cause of the analyzed event occurrence?
C221	Was inappropriate action caused by alcohol consumption of a human involved in the system environment the cause of the analyzed event occurrence?
C222	Check whether C223 event happened as well.
C223	Was inappropriate action of a man present in the system environment caused by drug intoxication the cause of the analyzed event occurrence?
C224	Check whether C223 event happened as well.
C225	Was inappropriate action of a human present in the system environment caused by consumption of medicines decreasing reaction abilities the cause of the analyzed event occurrence?
C26	Check whether C227 event happened as well.
C227	Was disobedience of traffic rules by a human present in the system environment the cause of the analyzed event occurrence?
C23	Make an overall assessment of inappropriate actions of people present in the system environment.
C24	Establish criteria for assessment of inappropriate actions of people present in the system environment.
C25	Specify a set of representative indexes for assessment of inappropriate actions of people present in the system environment.
C26	Make an overall analysis of inappropriate actions of people present in the system environment?
C27	Is the analyzed event the last in the set of elementary events?
C28	Is the resultant model adequate?
C281	Check whether C2 event happened as well.

4. Summary

The proposed method for assessment of the impact of undesirable actions of people involved in an antropo-technical system and its environment is a complex method which accounts for different human behaviours. Component elements of the algorithm can provide basis for development of separate models for assessment of people's actions for Drivers –algorithm C1, people involved in the system environment – C2 and passengers C3. The next stage of building the system model for assessment of transport systems operational safety will be to develop an algorithm of assessment of undesirable influence of the environment on the safety of the transport tasks.

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