

ALGORITHM OF THE INFLUENCE OF THE ROAD TRANSPORT SYSTEM ON ITS OPERATIONAL SAFETY

Piotr Bojar, Maciej Woropay

University of Technology and Life Sciences, Department of Machine Maintenance
Prof. S. Kaliskiego Street 7, 85-789 Bydgoszcz, Poland
tel.: +48 604195937, +48 52 3408495
e-mail: p-bojar@utp.edu.pl, zem@utp.edu.pl

Abstract

Safety is a priority criterion of the transport systems operation referred to as a total of means and activities connected with carrying of people and cargo. The main goal of systems of this type is safe carrying people in set quantities and over an assigned area, by means of transport means used in the system. Road transport is the most frequently used branch of transport. It is characterized by high speed and flexibility of transport tasks accomplishment resulting from a big number of roads which enable carrying passengers or cargo directly to the place of destination. Road transport can be distinguished from other transport branches by the following features: unlimited access to road transport means, high serviceability, high transport speed, providing services according to the schedule and punctually. The system environment includes all components which belong to it in terms of the carried out analysis.

External factors of the environment, due to a system approach to the analyzed system safety assessment include: weather conditions, road surface, inappropriately designed infrastructure, kinds of roads. The paper identifies the source of safety threats of transport systems caused by the influence of weather conditions on people and technical means of transport.

Keywords: transport system, undesirable action

1. Introduction

According to the theory of systems, a system is an ordered three $\langle E, R, \varphi \rangle$, where E – are components of the system, R – relations between those elements, and φ – is a function of goals to be accomplished in the system [1].

Transport system, however, is defined as a total of means and activities connected with transporting people and cargo, in set quantities and over an assigned area with the use of transport means. Transport systems are considered to belong to the class of socio-technical system of the type $\langle H-TO-E \rangle$, Human, Technical objects and Environment [2]. In Fig. 1, relations between elements of a socio-technical system have been presented.

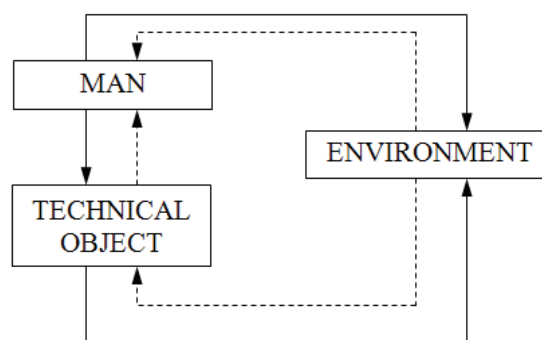


Fig. 1. Relations between elements of a socio-technical object

The main goal of systems of this type is safe carrying people in set quantities and over an assigned area, by means of transport means used in the system. Road transport is the most frequently used branch of transport. It is characterized by high speed and flexibility of transport tasks accomplishment resulting from a big number of roads which enable carrying passengers or cargo directly to the place of destination.

Road transport can be distinguished from other transport branches by the following features[3]:

- unlimited access to road transport means,
- high serviceability,
- high transport speed
- providing services according to the schedule and punctually.

The purpose of transport system operation is to accomplish transport tasks in a reliable and safe way. In order to provide appropriate level of the accomplished tasks safety it is necessary to limit undesirable influence of forcing factors affecting the system. Percentage share of forcing factors impact on occurrence of undesirable events is shown in Tab. 1.

Tab. 1. Percentage share of forcing factors impact on occurrence of undesirable events [1]

	In a built-up area	Beyond a built-up area
Undesirable impact of operating factors	16-27%	14-26%
Undesirable impact of external factors	31-34%	38-45%
Undesirable impact of anthrop-technical factors	39-53%	36-41%

2. Identification of municipal bus transport system environment

The system environment includes all components which belong to it in terms of the carried out analysis.

The environment of the analyzed transport system includes:

- other transport systems,
- people who are present beyond the analyzed system,
- infrastructure and the surface of roads on which the transport tasks are accomplished,
- weather conditions,

External factors of the environment, due to a system approach to the analyzed system safety assessment include [3, 4]:

Weather conditions:

- atmospheric falls,
- dazzling sunshine,
- low air temperature,
- too high temperature,
- good weather conditions.

A. Road surface:

- wet surface,
- icy surface,
- dry surface,
- tarmac wholes and cracks,
- bumps.

B. Inappropriately designed infrastructure:

- inappropriately located pedestrian crossings,
- inappropriately designed crossroads,
- faulty traffic lights,
- lack of lay-bys.

C. Kinds of roads:

- local road,
- regional road,
- national road,
- international road,
- highway,
- motorway.

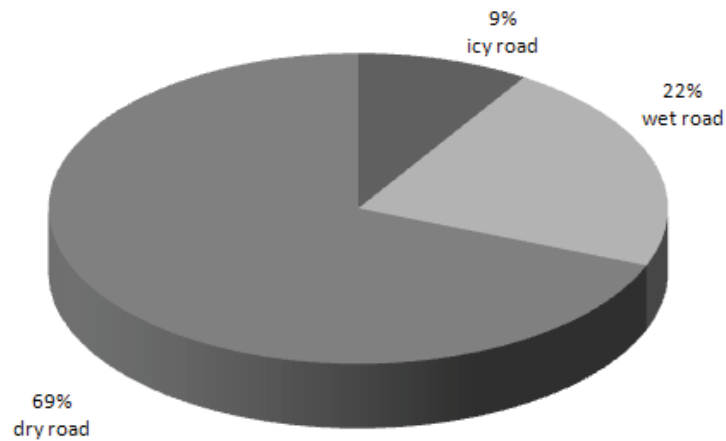


Fig. 2. Percentage share of road accidents depending on the road surface condition

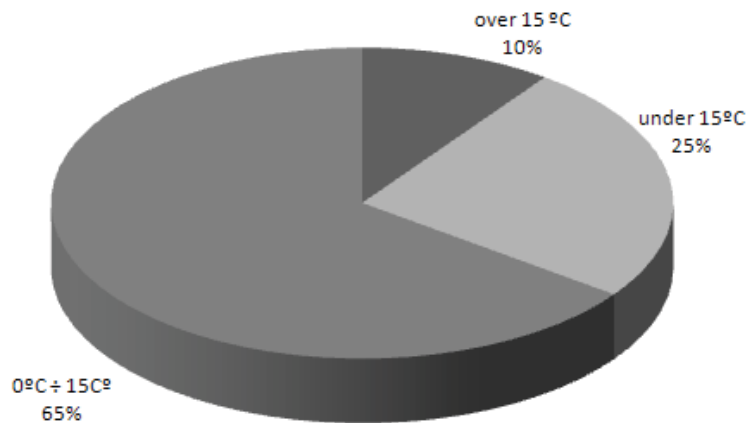


Fig. 3. Percentage share of road accidents depending on air temperature

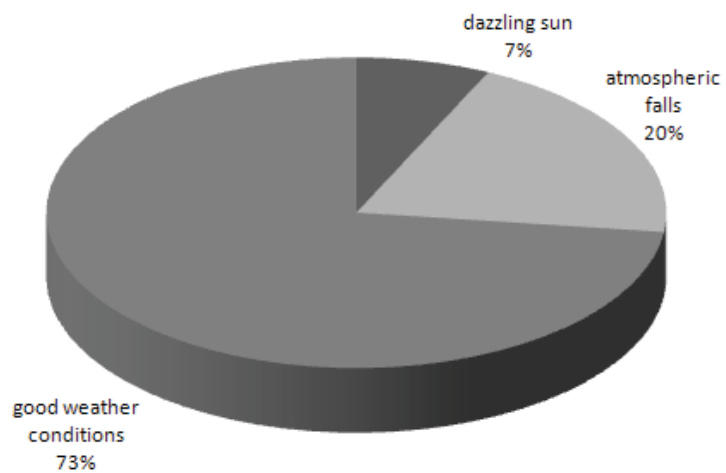


Fig. 4. Percentage share of road accidents depending on weather conditions

3. Algorithm for assessment of the environment undesirable impact on the transport task accomplishment safety

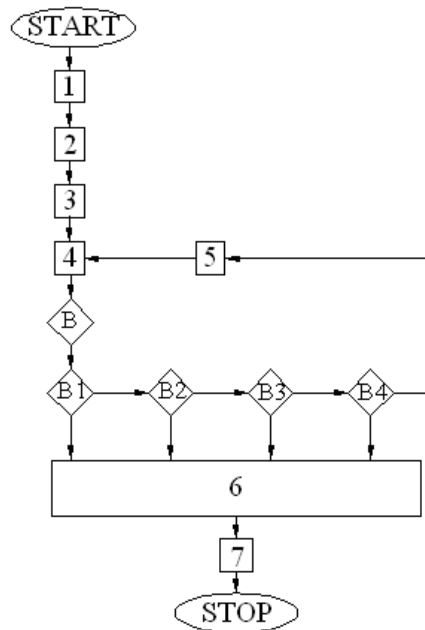


Fig. 5. Algorithm for assessment of the environment bad impact on the transport task accomplishment

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 Z_i ; $i = \{1, 2, 3, \dots, k\}$.
2	Choose events significant from the point of view of the analyzed system operational safety
3	Order events according to the principle of occurrence $Z_1, Z_2, Z_3, \dots, Z_k$.
4	Choose the first event for assessment Z_i , $i = 1$.
5	Choose the next event for assessment Z_{i+1}
B	Was an undesirable impact of the environment the cause of the considered event occurrence?
B1	Was the influence of weather conditions the cause of the undesirable event occurrence?
B11	Were rain falls the cause of the undesirable event occurrence?
B111	Was falling rain the cause of the undesirable event occurrence?
B112	Check whether rainfalls contributed to wrong reactions of people involved in the system or its environment.
B113	Check whether B113 event also happened.
B114	Were snow falls the cause of the undesirable event occurrence?
B115	Check whether snow falls contributed to wrong reactions of people involved in the system or its environment.
B12	Was dazzling sunshine the cause of the undesirable event occurrence?
B122	Check whether B31 event happened as well.
B13	Was inappropriate temperature the cause of the undesirable event occurrence?
B131	Was too low temperature the cause of the undesirable event occurrence?
B132	Check whether B2 event also took place.
B133	Was too high temperature the cause of the undesirable event occurrence?
B134	Check whether B2 event happened as well.
B135	Make an overall assessment of undesirable events which occurred because of bad influence of weather conditions.

Tab. 1. Description of the main algorithm (cont.)

B2	Was poor road surface the cause of the undesirable event occurrence?
B21	Was the road wet surface the cause of the undesirable event occurrence?
B211	Check whether B24 event happened as well.
B212	Check whether B25 event happened as well.
B22	Was the undesirable event caused by ice on the road?
B221	Check whether B24 event happened as well.
B222	Check whether B25 event happened as well.
B23	Was the undesirable event caused by dry road surface?
B231	Check whether B24 event happened as well.
B232	Check whether B25 event happened as well.
B24	Were tarmac cracks and wholes the cause of the undesirable event occurrence?
B241	Check whether B25 event also happened.
B25	Were bumps and wholes on the road the cause of the undesirable event occurrence?
B251	Check whether B3 event also happened.
B252	Make an overall assessment of undesirable events occurred because of poor road surface.
B3	Was inappropriately designed road infrastructure the cause of the undesirable event occurrence ?
B31	Was inappropriate location of pedestrian crossings the cause of the undesirable event occurrence?
B311	Check whether B32 event happened as well.
B32	Was inappropriate location of bus stops the cause of the undesirable event occurrence?
B321	Check whether B33 event happened as well.
B33	Was inappropriately designed crossroads the cause of the undesirable event occurrence?
B331	Check whether B34 event happened as well.
B34	Was faulty traffic light the cause of the undesirable event occurrence?
B341	Check whether B35 event also happened.
B35	Was lack of a bus lay-by the cause of the undesirable event occurrence?
B351	Check whether B4 event also took place.
B352	Make an overall assessment of undesirable events occurred because of inappropriately designed infrastructure
B4	Did the kind of road have an influence on the undesirable event occurrence?
B41	Did the event happen on a local road?
B411	Check whether B45 and B456 events happened as well.
B42	Did the event happen on a regional road?
B421	Check whether B45 and B456 events happened as well.
B43	Did the event happen on a national road?
B431	Check whether B45 or B456 events happened as well.
B44	Did the event happen on an international road?
B441	Check whether B45 and B456 events happened as well.
B45	Did the event happen on a highway?
B46	Did the event happen on a motorway?
B461	Choose for analysis the next event from the set of undesirable events.
B462	Make an overall assessment of undesirable events occurred because of the kind of road.
6	Make an overall assessment of occurrence of undesirable events caused by inappropriate impact of the environment.
7	Show the assessment result.

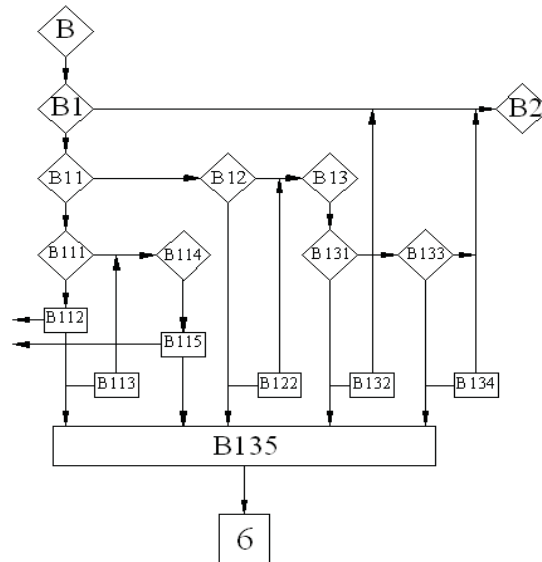


Fig. 6. Assessment algorithm of of bad influence of weather conditions on the transport task accomplishment safety

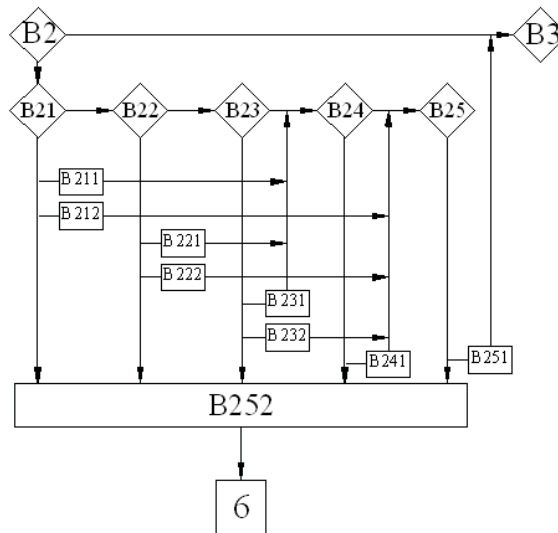


Fig. 7. Assessment algorithm of the influence of road surface condition on the transport task accomplishment safety

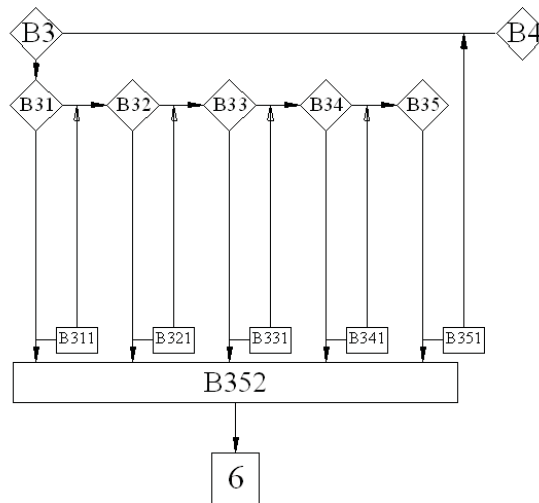


Fig. 8. Assessment algorithm of the influence of inappropriately designed road infrastructure the transport task accomplishment safety

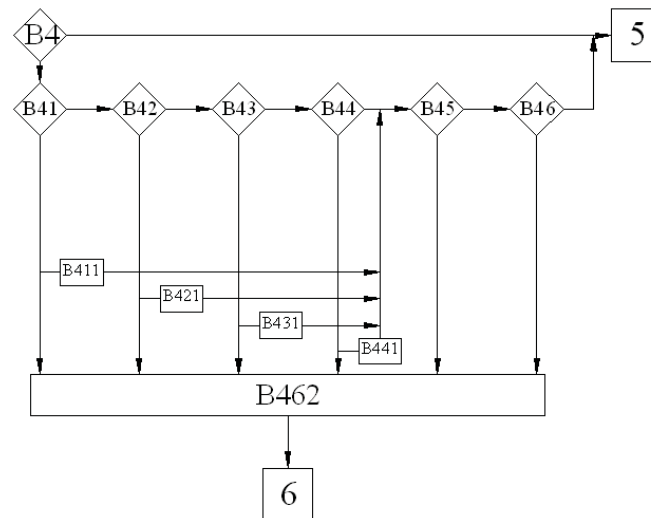


Fig. 9. Algorithm of assessment of the influence of the road kind on the transport task accomplishment safety

The impact of external factors has a large influence on the level of transport tasks accomplishment safety and accounts for more than 30% of all causes of road events occurrence. It is necessary to carry out operating tests aiming at identification of all undesirable forcing factors connected with the environment and affecting the transport system safety. This will enable elaboration of an overall method for assessment of transport systems operational safety.

References

- [1] Woropay, M., Bojar, P., *Structuring of the safety evaluation model for the road transport system*, Journal of KONES, Vol. 15, 2008.
- [2] Woropay, M., Bojar, P., *Vehicle operator as a threat source*, Journal of KONES, Vol. 14, 2007.
- [3] Woropay, M., Bojar, P., *Evaluation of the effects of weather conditions on the transport system safety*. Journal of KONBiN, 2006.
- [4] Woropay, M., Bojar, P., *Analiza przyczyn powstawania zagrożeń w systemach transportu drogowego*, Zeszyty naukowe Problemy Bezpieczeństwa w Pojazdach Samochodowych, Wydawnictwo Politechniki Świętokrzyskiej, Kielce 2006.