

TRANSPORT SAFETY CULTURE

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ABSTRACT

Interrelationships within control and management mechanisms, including transport safety management, of the transport system are evaluated based on the function-oriented approach to its decomposition.

Hierarchical system's levels, strategic development objectives, societal, information, and environmental aspects are analyzed within safety context. Classification of threats to transport system and its subsystems (objects) is suggested.

Keywords: transport, safety, safety culture, threat prevention, sustainable development, system perspective, corporate culture, corporate organization, social organization, function-oriented approach.

Background. The solution to the problem of ensuring transport safety, based on well-known scientific postulates, is a kind of a system (process) that provides a transition from its existing state to the «desired state», with an abstract model being the «desired state» [1–3].

The solution to the problem of ensuring transport safety, globally, as well as in Russia, is primarily affected by internal constraints that relate to financial, labour and natural resources, the values of corporate social organization, material and spiritual culture.

External constraints include first the imperative constraint that binds the humankind to preserve the Earth's biosphere. The main external constraints are associated with systemic customers (purchasers) comprising transport employees, the state, as well as organizations and individuals – consumers of transport services, which form the demand for the types and volumes of passenger and cargo transportation. The system that englobes those actors reflects the real conditions of the social and economic activity of people, the material and spiritual culture of society, the legislative and legal basis of the state, the degree of integration of its economy into the global business environment.

Objective. The objective of the authors is to classify threats to transport safety and to consider different aspects and components of proactive safety culture in transport industry.

Methods. The authors use general scientific methods, comparative analysis, evaluation approach, systems theory analysis, instruments of transport management.

Results.

System approach

We will consider a country's transport as an open, complex and purposeful system, which is a tool of achieving the objective, having the property of self-organization and consisting of a sufficiently large number of elements: set of elements, parts, inputs and outputs, functions performed [4, p. 104]. Guided by a function-oriented approach to decomposition of the system, we will select all the processes that enable it to exist according to the goal.

At the macro level, when describing processes, we can name the following functionally separate entities: input, transformation process, output, and constraints [5, p. 18; 6, p. 34].

The authors place special emphasis on safety culture as on a social motivation pattern, designed to develop a proactive attitude to emerging threats and risks during transportation of passengers and cargo. They differentiate emotional, cognitive, and behavioural (conative) components of safety culture and suggest their brief description regarding transportation sector.

The suggested framework of proactive culture makes it possible to model hierarchical systemic interconnection of its various components, providing for transport safety coupled with overall development of transport and transportation.

The function of the input is to provide the system with the resources and «values» that enter the transformer, and which are necessary to implement the process in the system.

The processing or transformation function is implementation of the process that transforms the input to the output according to the purpose of the existence of the system.

The processing is the central functionally separate essence of the system.

The transformation process itself can be divided into:

- controlling system that performs a societal function (social and organizational activity);
- communication system that performs the information function (the sphere of providing information to the processes of resource management, operational management, functioning of the natural-technical system and defining strategic goals);
- controlled system that performs the environmental function (the sphere of ensuring functioning of the natural-technical system).

The function of the output is achievement of a goal (objective, purpose), creation of corporate and material culture values, providing of passenger and cargo transportation service, since output is the result of the process.

The function of the constraint is the influence of the systemic customer on the input and the transformation process of the system. The environment has a certain impact on all transport subsystems.

Identified, functionally separated essences of transport are physically inseparable and are unified by direct and feedback flows (of labour, information, financial, material, power, and other resources) into a single whole (Pic. 1).

Further decomposition of functionally separated essences of the system should be carried out on the basis of an object-oriented approach.

Controlling («social and organizational») system of the transport can be divided into objects (subsystems) of:

- corporate organization as a set of socio-professional communities of people, subsystems of economic, administrative and social relations between them;



Table 1

Classifier of threats to transport and its subsystems (objects)

Conditions of occurrence and parameters of the impact of threats	
Classification attribute (parameter)	Threat classification
Genesis	1. Anthropogenic threats. 2. Technogenic threats. 3. Natural threats.
Place of origin	1. Endogenous – internal threats. 2. Exogenous – external threats. 3. Transboundary threats.
Mechanism of action	1. Physical and chemical factors. 4. Biological factors. 5. Social factors.
Nature of impact	1. Single. 2. Repeated. 3. Permanent.
Impact scale	1. Local. 2. Regional. 3. Federal.
Conditions of manifestation and degree of danger of threats	
Classification attribute	Threat classification
Form of manifestation	1. Full threats. 2. Direct threats. 3. Mediated threats.
Fixation in the functional area (in the field of activity)	1. Strategic (system output). 2. Ecological (controlled system). 3. Information (communication system). 4. Societal (controlling system). 5. Resource (system input).
Danger level	1. The danger to the existence of the object. 2. The danger of inefficient functioning of the object. 3. The danger of failure to ensure sustainable development of the object.

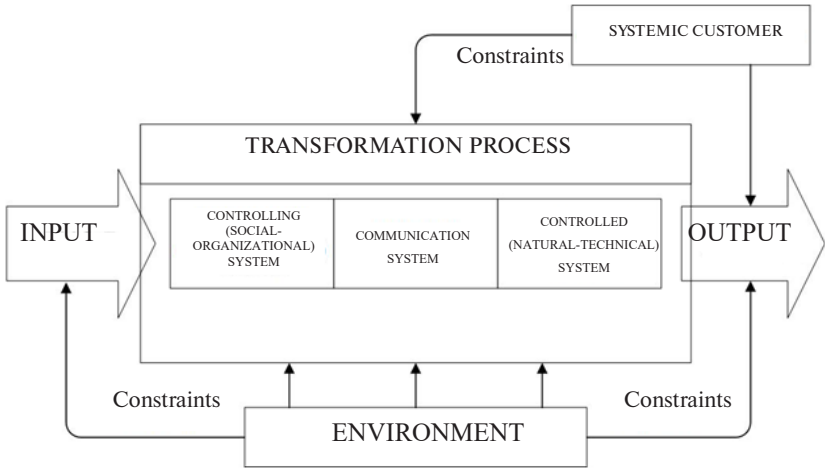


Fig. 1. Functional-oriented decomposition of the system «Transport of Russia».

• corporate culture as a system that includes subsystems of industry's science, vocational education, corporate morality and ethics.

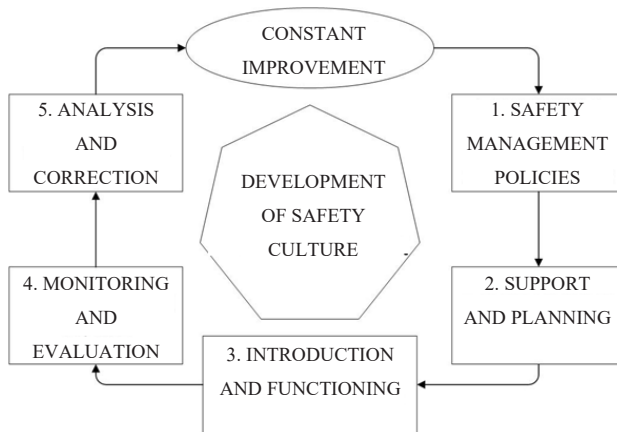
Controlled («natural-technical») system of transport, in turn, can be legitimately divided into objects (subsystems):

- material culture as a technical and social infrastructure, technology and hardware;
- natural environment consisting of natural-anthropogenic and natural ecosystems.

All distinguished macroscopic transport subsystems have no clear boundaries. But they have an area of mutual intersection, in which a person can be distinguished, representing a single social-spiritual and biophysical being, forming a lower level of hierarchy with respect to the subsystems under consideration.

Classification of threats

The overall goal of the transport development strategy of Russia is to make the processes of growth



Pic. 2. Safety culture management system.

more stable, to minimize the cost of resources, to obtain the maximum possible number of valuables and services for transportation of passengers and goods. Moreover, sustainable development should be implemented in such a way that economic efficiency, social justice and safety are combined into a triune process on a parity basis, so that to ensure that transportation needs of both current and future generations of the country are satisfied while preserving the environment [7, p. 31].

A certain combination of internal and external adverse constraints, which are factors (threats) – can result in a danger of not only failing to achieve the strategic goal, but also of giving rise to processes of stagnation, degradation, even disintegration of the system. According to S. I. Ozhegov [8, p. 1118] danger (threat) is the ability to do any harm, a threat to life and health of a person, other than his values.

Let us give our definition of a threat and construct a classification of threats (see Table 1) in relation to an open complex purposeful system (object).

Threat to an object is a phenomenon or process characterized by certain conditions of occurrence and impact parameters, which is capable, because of conditions of its manifestation and the degree of danger, to cause damage to the object.

The generally accepted approach to definition of the safety usually proceeds from the concept [9, p. 2], based on the statement: «Safety is the state of protection of the vital interests of an individual, society and the state from internal and external threats».

If we use this approach to the definition of transport safety for implementation of a sustainable development strategy, it turns out that there are two independent activities separated from each other – main (ensuring functioning and development of transport) and auxiliary (ensuring transport safety) activity. Meanwhile, transport safety should be ensured not only with the help of protection, but taking into account the trend of innovative development, should also be a self-sustaining process, reducing existing threats and not generating new ones [10, p. 26]. In this case, sustainable development of transport will organically combine the tasks of ensuring safety, and transport safety will contribute to the sustainable development of transport.

In this context, ensuring safety of an object is a technological process (a system of measures) with the purpose of limiting either eliminating existing and of preventing potential threats, which is an organic part of the overall process of functioning and

development of an object, implemented in accordance with the adopted industry strategy.

Functional safety of an object is a technological process (a system of measures) with the purpose of limiting either eliminating the existing and of preventing potential threats causing probability of non-performance or inefficient execution of a given function.

This definition made, the safety system should permeate all areas of transport (functionally separate essences) and all object-expressed elements (objects). The decomposition of the system «Transport of Russia» and the demonstrated approach to interpretation of safety show that the safety system of transport as a whole has a hierarchical structure. The highest level of hierarchy is represented by functional (resource, societal, informational, ecological, and strategic) transport safety, and the lower level is represented by functional (resource, social – spiritual, informational, biophysical, and strategic) human safety. At intermediate levels of hierarchy, according to the principle of self-similarity for complex systems [11, p. 12], the functional (resource, societal, information, ecological, strategic) safety of an object should also dominate.

Then safety can be viewed as activities of the managerial actors with the purpose of limiting either eliminating existing and of preventing potential threats to an object, and it will be possible to consider fulfillment of such a responsible mission as an organic part of the overall process of managing operation and development of the transport system. At the same time, each hierarchical level of the system supposes organization in accordance with the methods and approaches of Deming [12], when managers of various levels and transport employees, directly involved in the operation of the facility, act as managerial actors.

Purposeful, cautious and proportionate to the emerging safety problem influence of a person on a control object directly depends on the social attitude, on personal predisposition to perceive the existing threat in a certain way and to act in the safest way regarding the object. Such an approach to safety is identified by modern science by the concept of a «safety culture» [13–18].

Components of safety culture

Safety culture as a social attitude consisting in a proper proactive attitude to safety is the unity of three traditional components: emotional, cognitive and conative (behavioural) [18, p. 202].



Table 2

Transport and safety culture

Transport safety											
Resource transport safety (system input)		Societal transport safety (controlling system)				Information transport safety (communication system)	Environmental transport safety (controlled system)			Strategic transport safety (system output)	
Provision of all kinds of resources in quantities necessary to achieve the goal of sustainable development		Safety of corporate organization		Safety of corporate culture		Safety of information support in developing a strategy	Safety of material culture			Safety of natural environment	Compliance of system output with the goal of sustainable development
		Safety of economic relations	Safety of social and administrative relations	Safety of sectoral science	Safety of corporate morals and ethics		Safety of technical infrastructure	Safety of social infrastructure	Safety of natural anthropogenic ecosystems		
		Safety of social and professional communities		Safety of industry vocational education		Safety of transfer, storage and processing of information	Traffic safety			Safety of components of ecosystems	
		Social and spiritual human safety					Biophysical human safety				
Resource human safety						Information human safety					Strategic human safety
Human safety											
Emotional component of safety culture						Cognitive component of safety culture		Behavioural component of safety culture			
Safety culture (person as an agent of safety culture)											

All the participants in the transportation process, transport employees and end-users of transport services, including passengers, are agents of safety culture.

The formation and development of the safety culture should be ensured by a management system organized in accordance with Deming cycle (Pic. 2), as well as by implementation of the principle of priority of safety at all management levels, by adherence to the values of safety culture.

The emotional component of safety culture reflects the critical, wary attitude of its agent to fulfillment of professional and other tasks, the feeling of «healthy fear», an instinctive sense of potential danger.

This component is purposefully shaped and maintained through a combination of external means and methods (technical, organizational, ergonomic, pedagogical, psychological), the widespread implementation of the precautionary principle, as well as by timely advanced effective safety measures, emergency prevention, particularly through prevention of environmental disasters.

The cognitive component of safety culture is the conscious psychological attitude of the person to ensuring safety, his personal responsibility for it.

This attitude is the result of greening of the consciousness and worldview of transport employees and passengers, of targeted orientation of the system of vocational education, corporate morality, culture, industry science and technology.

The behavioral (conative) component of safety culture supposes the consistent behaviour of a person in relation to the safety object in accordance with a given prototype, sample.

Such a component is purposefully formed and exists through development of an appropriate regulatory framework and environmentally oriented management principles in the field of nature conservation, environmental management, and prevention and elimination of emergency situations.

Conclusion. The approach demonstrated in the framework of proactive culture makes it possible to see the hierarchical systemic interconnection of its various components, ensuring transport safety coupled with overall development of transport, which should be a self-sustaining process, reducing existing threats and not generating new ones (see Table 2).

The safety culture is important for implementing safety issues while developing sustainable transport development strategy. Also, the safety culture is becoming increasingly important from the point of view of its influence on implementation of strategic goals of transport associated with the growth of freight traffic in the country, with increase in transport accessibility of remote areas.

REFERENCES

1. Optner, S. L. Systems analysis for business and industrial problem solving. Prentice-Hall, Inc., New Jersey. 1965, 116 p.

2. Ackoff, R. [Russian title] Planning in large economic systems [*Planirovanie v bolshikh ekonomicheskikh sistemakh*]. Moscow, Sovetskoe radio publ., 1972, 223 p.

3. Ackoff, R. The Art of Problem Solving [*Iskusstvo resheniya problem*]. Moscow, Mir publ., 1982, 224 p.

4. Good, H. H., Machol, R. E. System Engineering. An introduction to the design of large-scale systems [*Sistemotekhnika. Vvedenie v proektirovanie bolshikh sistem*]. Moscow, Sovetskoe Radio publ., 1962, 383 p.

5. Popov, V. G. Safety, Security and Stable development. *World of Transport and Transportation*, Vol. 2, 2004, Iss. 3, pp. 18–28.

6. Popov, V. G. On the choice of approach to improving the efficiency of energy saving in the systems of technical maintenance and repair of rolling stock [*O vybore podkhoda k povysheniyu effektivnosti energosberezheniya v sistemakh tekhnicheskogo soderzhaniya i remonta podvizhnogo sostava*]. *Vestnik VNIIZhT*, 1998, Iss. 1, pp. 34–39.

7. Transport strategy of the Russian Federation for the period up to 2030. Approved by the order of the Government of the Russian Federation dated 22.11.2008 No. 1734-r [*Transportnaya strategiya Rossiiskoi Federatsii na period do 2030 goda. Uverzhdena rasporyazheniem pravitelstva RF ot 22.11.2008 No. 1734-r*].

8. Ozhegov, S. I. Dictionary of the Russian language [*Slovar' russkogo yazyka*]. Moscow, Russkiy yazyk, 1992, 2296 p.

9. Federal Law «On Safety» dated 05.03.1992 No. 2446-I [*Federal'niy zakon «O bezopasnosti» ot 05.03.1992 No. 2446-I*].

10. Ursul, A. D., Romanovich, A. L. Prospects for a safe future of civilization [*Perspektivy bezopasnogo budushchego tsivilizatsii*]. *Vestnik RAEN*, 2002, Iss. 4, pp. 27–33.

11. Nicolis, G., Prigogine, I. Exploring Complexity [*Poznanie slozhnogo*]. Moscow, Mir publ., 1990, 342 p.

12. Niv, G. R. The Space of Dr. Deming [*Prostranstvo doktora Deminga*]. Book 1. Moscow, MGIET (TU), 1996, 344 p.

13. IAEA. Summary Report on the Post-Accident Review Meeting on the Chernobyl Accident. Safety Series, No. 75-INSAG-1. IAEA, 1986.

14. IAEA. Safety culture. Safety Series. No. 75-INSAG-4. IAEA, 1991.

15. Mashin, V. A. Modern bases of the concept of safety culture [*Sovremennye osnovy kontseptsii kul'tury bezopasnosti*]. *Elektricheskie stantsii*, 2014, Iss. 10, pp. 2–10.

16. Oboznov, A. A., Bessonova, Yu. V., Petrovich, D. L., Enina, E. S., Serikov, V. V. Safety Culture in Railway Transport [*Kultura bezopasnosti na zheleznodorozhnom transporte*]. *The Human Factor: Problems of Psychology and Ergonomics*, 2014, Iss. 4, pp. 45–52.

17. ICAO. Safety Management Manual (SMM). Doc-9859, AN/474. 2009.

18. Oboznov, A. A., Bessonova, Yu. V., Petrovich, D. L. Safety Culture of Passengers in Public Transport [*Kultura bezopasnosti passazhirov obshchestvennogo transporta*]. *Organizatsionnaya psikhologiya i psikhologiya truda*, 2016, Iss. 1, pp. 200–226. ●

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