Journal of KONBiN 1 (13) 2010
ISSN 1895-8281

DOI 10.2478/v10040-008-0149-9

TRANS-RISK – AN INTEGRATED METHOD FOR RISK MANAGEMENT IN TRANSPORT

TRANS-RISK – ZINTEGROWANA METODA ZARZĄDZANIA RYZYKIEM W TRANSPORCIE

Kazimierz Jamroz[1], Adam Kadziński[2], Katarzyna Chruzik[3], Andrzej Szymanek[4], Lucjan Gucma[5], Jacek Skorupski[6]

(1) Gdansk University of Technology, 11 Narutowicza str, 80-232 Gdansk, Poland
(2) Poznan University of Technology, 3 Piotrowo str, 60-965 Poznan, Poland
(3) Silesian University of Technology, 8 Krasinskiego str, 40-019 Katowice, Poland
(4) Radom University of Technology, 29 Malczewskiego str, 26-600 Radom, Poland
(5) Maritime University of Szczecin, 1-2 Wały Chrobrego str, 70-500, Szczecin, Poland
(6) Warsaw University of Technology, 75 Koszykowa str, 00-662 Warszawa, Poland

E-mails: (1) kjamroz@pg.gda.pl (2) adam.kadzinski@put.poznan.pl
(3) katarzyna.chruzik@polsl.pl (4) a.szymanek@pr.radom.pl (5) l.gucma@am.szczecin.pl
(6) jsk@it.pw.edu.pl

Abstract. *Many attempts have been made at risk management integration in other spheres of life. A review of risk management in the modes of transport shows some substantial differences in the terminology and the detailed rules and applications of risk management. As a result, it is important to try and integrate risk management methods in transport. This paper presents the results of the work of an interdisciplinary team working on integrating the methods of risk management. The members represented the four modes of transport listed in the project called Integrated System of Transport Safety ZEUS. The paper presents the background conditions for the integration of risk management in transport and a concept of an integrated method for risk management called TRANS-RISK.*

Keywords: *transport, safety, risk management, integration of methods.*

Streszczenie. *Podjęto już wiele prób integracji metod zarządzania ryzykiem w innych dziedzinach życia. Przegląd metod zarządzania ryzykiem w poszczególnych gałęziach transportu wskazuje na dość duże rozbieżności terminologiczne i rozbieżności dotyczące szczegółowych zasad i zastosowań metod zarządzania ryzykiem. Istnieje zatem konieczność podjęcia próby integracji metod zarządzania ryzykiem w transporcie. Niniejszy praca jest wynikiem działań interdyscyplinarnego zespołu pracującego nad tym problemem. Są to przedstawiciele czterech gałęzi transportu w projekcie Zintegrowany System Bezpieczeństwa Transportu ZEUS. Praca zawiera założenia do integracji metod zarządzania ryzykiem w transporcie oraz koncepcję zintegrowanej metody zarządzania ryzykiem TRANS-RISK.*

Słowa kluczowe: *transport, bezpieczeństwo, zarządzanie ryzykiem, integracja metod*

1. Introduction

The main purpose of integrating management systems is to minimise the number of risks and their consequences and to take advantage of the capacities and opportunities offered by integrated methods of risk management. Lack of system integration produces risks which are the result of different management structures, different management methods, poor flow of information between sub-systems, organisations and staff and inconsistent databases.

The benefits of integrating management systems include:

- organisations can be managed more efficiently if they are part of a single system,
- less documentation and uniform documentation,
- comprehensive view of the organisation and the processes within it,
- lower management costs,
- improved image and prestige of the organisation,
- crisis management can be better organised,
- effects of synergy,
- openness to other systems.

As a result, an integrated management system is a single, clearly defined, documented and consistent system that allows an effective and simultaneous management of a number of problem areas by pursuing a single policy and its objectives.

One of the components of organisational management systems (at different levels of their decomposition) is the organisation's safety management system.

A safety management system is part of organisational management systems and includes the organisational structure, planning, accountability, procedures, processes and resources for the development, implementation, delivery, monitoring and maintenance of the organisation's safety policy and its objectives.

The basic tool for delivering a safety policy and its objectives is risk management. Organisations can manage their risks in different problem areas, the right place for formulating the need for risk management integration.

There have been a number of attempts at integrating risk management problem areas in different spheres of life. These include banking, economy, public organisation management and health care (First, 2000) etc., where integration efforts are quite extensive. There have been attempts at harmonising risk management methods in technology as well (Chruzik, *et*

al., 2009; EC-JRC, 2000). Based on this experience we can identify two most significant problem areas that can be integrated as part of risk management:

- the integration of how different types of organisational risks are managed,
- the integration of risk management methods in similar areas of human activity.

The objective of this paper is to present a concept of an integrated method for transport risk management, the problem areas which can be integrated and the proposed paths of integration. This paper is one of the results of a study conducted by an interdisciplinary team into the possible integration of several problem areas of transport risk management. Each member of the research team has a background in one of the four modes of transport (road, rail, aviation and water) represented in the project Integrated System of Transport Safety ZEUS (Jamroz, *et al.*, 2010; Lowe, 2009).

2. Problem areas to be integrated as part of transport risk management

The following are the problem areas for considering the possibility of integrating transport risk management:

- ways to integrate risk management in the modes,
- levels of transport risk management,
- terminology of risk management,
- methods of risk management,
- measures of risk.

Ways to integrate risk management in the modes - an important problem area which looks at the pace of risk management integration processes in the modes of transport. This may include internal and external conditions of organisations at different levels of transport system decomposition.

Levels of transport risk management – based on the assumption that organisations manage risk at different levels of transport system decomposition or that the results of risk management are used at many levels of transport management. Some levels of transport management produce conditions which are right for specific elements of risk management.

Terminology of risk management – when used in transport means the use (integration) of terms and risk management of personal, economic and environmental risks.

Methods of risk management – includes deliberate actions for the purpose of delivering the safety policy of an organisation (as identified by the decomposition of the transport system) and its objectives expressed/described with measures of risk.
Measures of risk – in transport – a problem area of risk management which assumes that the result of risk estimation expressed with measures of risk depends on the particular risk model. The estimated risk expressed with measures of risk highlights the properties or features of the organisation's safety system (at a specific level of transport system decomposition).

3. Basic assumptions in integrating transport risk management

The concepts (or even applications) of risk management in rail, aviation, and water transport are more advanced than in road transport. In addition, the number of casualties of road transport accidents is significantly higher than in the other modes. There is no pan-European standard for transport risk management. This sets the context for proposals voiced in Europe to try and integrate risk management methods in two separate channels following the 3+1 model (rail, air and water transport jointly and road transport separately).
The development of an integrated method of risk management across all modes will draw on the concepts and applications of risk management in rail, air and water transport and the experience from implementing risk management methods in all modes.
The integration of transport risk management does not have to happen at the same time or with the same degree of involvement in the problem areas specified above. Following from that the problem areas are identified based on how transport risk management integration is to be developed. Next, the assumptions are given for other problem areas which are the basis for the directions of integration. Figure 1 shows the relations between selected terms of risk management integration.
The time horizon, how risk management integration will be introduced and how advanced it will be depend largely on internal and external conditions of the particular modes of transport. The following is the proposed integration of transport risk management:

- joint development of the concept and directions of risk management integration in transport,
- adoption of a shared and basic terminology and development of common general principles of the integrated method of transport risk management,

– the particular modes will have dedicated and separately developed detailed procedures, models and measures of risk to be applied in the framework of general principles of the integrated method of transport risk management.

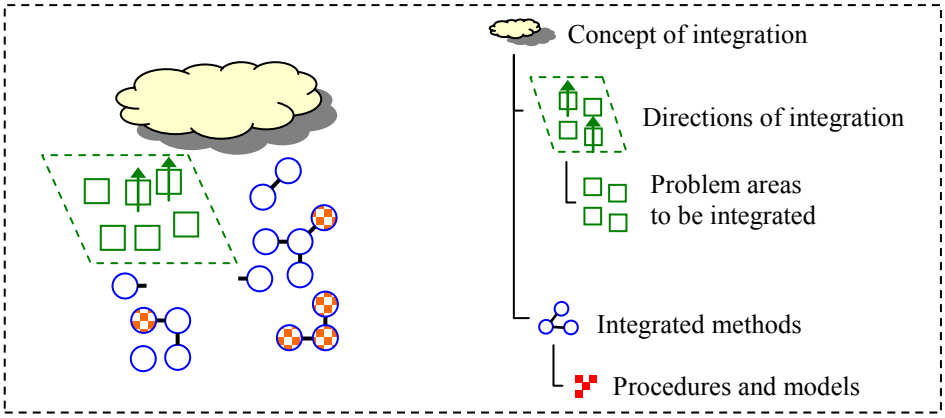


Fig. 1 Diagram of the relationships between selected terms of risk management integration. Own work based on the idea from (Gill, 2007)

It is proposed that the integration of transport risk management should be twofold: integration of risk management terminology and integration of methods of risk management.
There is a relation between levels of risk management, the agreed time horizon and the position of risk management entities within organisational structures of transport. Table 1 lists risk management entities at different levels of transport organisations and the corresponding time horizons of (strategic and operational) management and types of risk.

4. Integrated method for risk management in transport

4.1. Background

Based on the selected method for transport risk management integration and two directions described above, the following are presented:
– comments on the integration of terminology of transport risk management,
– general principles of the integrated method for risk management in transport.

Table 1. List of risk management entities at different levels of organisational structures of transport

No.	Risk management entities within organisational structures of transport	Types of risk				
		Strategic			Operational	
		Societal	Collective	Individual	Collective	Individual
1.	International organisations	**X**	**X**			
2.	Government and central authorities	**X**	**X**			
3.	Regional and local governments	**X**	**X**	**X**	**X**	
4.	Universities, research centres, transport safety observatories	**X**	**X**	**X**	**X**	**X**
5.	Regional and local transport and transport infrastructure authorities		**X**	**X**	**X**	**X**
6.	Manufacturers and repair shops of means of transport and transport infrastructure				**X**	**X**
7.	Providers of transport services				**X**	**X**
8.	Operators and users of means of transport and other users of transport infrastructure					**X**

X – analysis and risk evaluation

4.2. Terminology of risk management in transport

The answers to risk questions are usually not very definitive. How risk is perceived depends largely on who assesses risk, what information they have, what algorithms of methods and models they recognise and what acceptance criteria they use. Key to risk management is clarity of terminology.

Earlier in the project the definitions of some transport risk management terms were adopted and presented (Lowe, 2009). These include:

- sources of risk, damage (loss), risk, undesirable event, hazardous event,
- risk (individual risk), risk model, risk measures, risk management,
- system of transport safety, system of safety management.

For the sake of clarity and comprehension it is important to explain the following terms: operational risk, strategic risk, individual risk, collective risk and societal risk.
Strategic risk is a long-term risk involved in taking long-term decisions on the work of organisations which manage transport safety in a specific area.
Operational risk is a short-term risk and the result of the day-to-day operations of a transport organisation. In transport this risk involves personal, technical and organisational hazards.
Individual risk is defined as:

- in the operational sense it is the uncertainty of an individual road traffic user when travelling on a road network,
- in the strategic sense it is the average probability of damage suffered by one member of a community (per one unit of miles travelled) in a specific area and over a specific period.
- Collective risk is defined as:
- in the operational sense as the probability of more than N number of fatalities in one hazardous event,
- in the strategic sense as the average loss in a hazardous event.

Societal risk is the possibility that a specific category of consequence will occur (personal or economic cost) in the analysed area (transport network, a country) over a specific unit of time.

4.3. General principles of the integrated method for risk management in transport

4.3.1. The idea of an integrated method for risk management in transport

The purpose of risk management is to continue to improve areas of human activity from the perspective of the risk in these areas. The classic concept of risk management methods assumes that they bring together two phases (Figure 2):

- risk assessment phase,
- risk response phase.

For those areas of human activity that involve transport processes, the natural move is to adopt general principles of the integrated method for risk management based on the classic approach (Figure 2).

4.3.2. The components of the integrated method for risk management in transport

The components of the phases of the method for risk management in transport were identified within the general framework of the phases (Figure 2). The phase of risk assessment includes two components: risk analysis and risk evaluation. The risk response phase takes account of risk treatment, risk monitoring and risk communications. That was the basis for developing the original integrated method for risk management called TRANS-RISK.

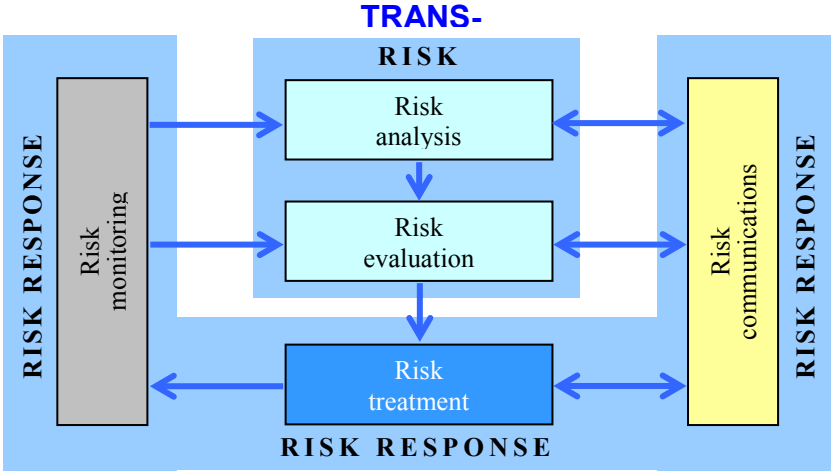


Fig. 2 Diagram of the components of the phases of the integrated method for risk management in transport TRANS - RISK

Below are the definitions of the other components of TRANS-RISK and some general rules of the relevant algorithms, models and procedures.

Risk analysis. In the area of transport system analysis, it is a systematic use of all available information to identify the sources of hazards, identify hazards, estimate and hierarchise risk. Risk analysis should be carried out by a team of experts usually in three steps:

Step 1: identify the area, objective and scope of analysis. The area, objective and scope of risk analysis depend on the position of the risk management entity within the organisational structure of transport and on the type of risk and phase in the life cycle of the object under analysis (transport infrastructure, means of transport, the environment, those using means of transport or co-users of transport infrastructure).

Step 2: identify the sources (factors) of hazards and the hazards. This process involves a systematic procedure designed to identify hazards which if released may cause damage (loss) in the analysed area of the transport

system. The process to identify a single hazard consists of these operations: identification of the sources of hazards, formulation of the hazard and initial determination of the consequence (loss) incurred when the hazard becomes released in a hazardous event. The sources of hazards are identified based on a review of the technical documentation of objects and processes in the analysed area of the transport system, a review of norms and standards of safety, site visits and interviews, available accident statistics and results of specialist investigations into the events. The tools for hazard identification include expert opinions, brain storming and check lists.

Step 3: selection of risk models and measures and risk estimation and hierarchisation. The selection of risk models and measures depends on the position of the risk management entity within the organisation and on the type of risk. Risk estimation uses qualitative or quantitative methods. When qualitative methods are used risk measures are arranged in a hierarchy at different risk levels (e.g. negligible, low, significant, high, very high). In quantitative methods, the values of risk measures are real numbers which may be arranged in a hierarchy at different risk levels.

Risk evaluation. In a specific area of transport system analysis, the purpose of risk evaluation is to check (through evaluation, comparison) the class (category) of risk (acceptable, tolerable, unacceptable) which the estimated risk falls under (expressed in quantitative terms or by identifying the levels of risk following its hierarchisation). To identify the boundaries of the classes (categories) of risk, we can:

- use standards or risk acceptance and non-acceptance,
- use engineers' knowledge,
- use criterion values identified in the known qualitative methods of risk assessment,
- estimate the boundaries of the classes (categories) of risk in quantitative methods of risk assessment.

TRANS-RISK uses quantitative methods for estimating the boundary values of the classes (categories) of the measures of types of risk.

Risk treatment. This involves an active attitude towards the hazards in the area of transport system analysis and the risk they generate. Active attitude implies activities designed to:

- avoid risk,
- reduce (control) risk,
- transfer risk,
- retain risk at a specific level.

The steps described can be applied in all modes of transport taking account of the type of risk and phase in the life cycle of an object (transport infrastructure, means of transport, the environment, those using means of transport or co-users of transport infrastructure) which generates hazards

and risks. Maps and risk matrixes can help with the task. Figure 3 shows the activities (tactic) which are part of risk treatment against the risk matrix.

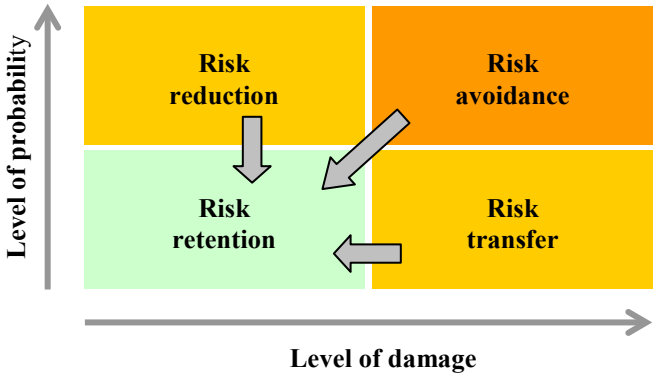


Fig. 3 Risk treatment versus risk matrix

In real situations using just one of the four tactics in the "pure" form is usually not possible (Figure 3). In practice risk is partly reduced (controlled), some of the risk is transferred and the remainder of the risk (a specific level) is retained. The choice of tactics and how they will participate in risk treatment depends on the type of hazards and level of risk. It is advisable to use the cost and benefit method when selecting activities and how they will treat risk in the different modes.

Risk monitoring. This is a component of the integrated method of risk management. Its purpose is to check the specific area within the transport system covered by risk management. Risk monitoring:

- identifies possible new sources of hazards,
- runs regular risk analyses, risk evaluation and risk treatment,
- checks for possible changes in the levels of risk acceptance and/or lack of acceptance,
- studies the adequacy of risk management results and the progress towards agreed risk treatment results.

The results of regular checks of an area within the transport system can be the basis for launching (apart from the regular dates) risk analysis and/or risk evaluation and risk treatment.

Risk communications. This involves the giving of information on risk in a one way or two way exchange involving:

- entities responsible for risk management at different levels of transport organisational structures (Table 1),
- those participating in the process of transport and customers using the services of the different modes,
- the mass media and other stakeholders via the media.

5. Summary

The proposed general concept of TRANS-RISK provides the basis for:

1. Integration of how different types (aspects) of risk are managed in an organisation (international organisations; central national organisations – ministry, agencies, central authorities; local authorities, transport infrastructure authorities, etc.) mainly at the level of strategic risk management .
2. Integration of how operational risk is managed in the process of transport by different types of transport (carriage of hazardous materials, carriage of passengers, etc.) based on the experience of supply chain risk management.
3. Integration of how risk is managed in the types of transport taking account of general and framework principles developed jointly based on good practice from other fields of technology and modes of transport.

More research is needed into the areas of risk measures, methods for risk measure estimation, risk evaluation criteria and risk evaluation and risk treatment procedures in the modes of transport to extend the general concept.

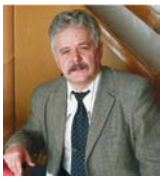
References

1. Chruzik K., Gucma L., Jamroz K., Kadziński A., Skorupski J., Szymanek A.: Integracja metod zarządzania ryzykiem w transporcie. Rozdział 7 w pracy zbiorowej: Zintegrowany System Bezpieczeństwa Transportu, T.2 Uwarunkowania Rozwoju Integracji Systemów Transportu. WKŁ, Warszawa 2009.
2. EC-JRC International Workshop on Promotion of Technical Harmonisation on Risk-Based Decision Making, Stresa & Ispra, Italy 2000.
3. First report on the harmonization of risk assessment procedures. European Commission. Health & Consumer Protection Directorate-General. Brussels 2000.
4. Gill A.: Procedury decyzyjne w obsługiwaniu obiektów systemów technicznych uwzględniające analizę ryzyka. Rozprawa doktorska, Politechnika Poznańska, Wydział Maszyn Roboczych i Transportu, Poznań 2007.
5. Jamroz K., Chruzik K., Gucma L., Kadziński A., Skorupski J., Szymanek A.: Zarządzanie ryzykiem. Rozdział 4.3.1 w pracy zbiorowej: Zintegrowany System Bezpieczeństwa Transportu, T.3 Koncepcja Zintegrowanego Systemu Bezpieczeństwa Transportu w Polsce (w

przygotowaniu do druku). WKŁ, Warszawa 2010.
6. Lowe M.F.: Globally Harmonized System of Classification and Labelling of Chemicals (GHS). US Environmental Agency, Arlington USA, 2009.

Kazimierz Jamroz PhD Eng. Gdansk University of Technology, Highway Engineering Department, specialization: transportation and traffic engineering, road safety, intelligent transport systems.

Adam Kadziński PhD Eng. Poznan University of Technology, Institute of Combustion Engines and Transport, specialization: railway transportation, reliability of railway vehicles, safety of railway transportation, risk management in transport, modelling and analysis of transport processes and systems.



Andrzej Szymanek PhD Eng. Radom University of Technology, Faculty of Transport and Electrical Engineering, specialization: road safety, mathematical modeling of safety transport.

Jacek Skorupski PhD Eng. Warsaw University of Technology, Faculty of Transport, Air Transport Engineering Department. Scientific interests: modeling of air traffic processes, analyzing of safety and risk in air traffic management, quantitative methods of safety assignment.

Lucjan Gucma PhD Eng. Maritime University of Szczecin, Faculty of Navigation, specialization: marine traffic engineering, navigational safety, navigational safety systems.

Katarzyna Chruzik PhD Eng. Railway Engineering Department Silesian Technical University of Technology, specialization: railway transport, safety, Safety Management System