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ORIGINAL SCIENTIFIC PAPER

Improvement of the Safety System in the Railway Infrastructure of Montenegro

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Abstract: Safety is an extremely important feature of railway traffic, and, at the same time, it is one of the most important criteria for the organization and functioning of the railways as a complex, technical-technological and dynamic system. [9]

Traffic safety is a basic requirement for the operation of the railway system and is based on coordinated activities at the technical and administrative level.

The administrative level includes the determination of the obligations and responsibilities of all stakeholders (Infrastructure Managers, Railway Undertakings, Suppliers, Railway Administration, Authorities), and is based on Railway Safety Directive 2004/49 / EC .

The technical level includes the definition of standards for each component of the railway system.

Continuous development of the safety system is a precondition for the future development of the Railway Infrastructure of Montenegro as a modern and reliable partner in the railway system.

The safety system is expected to recognize risks in every work area, that may affect its efficiency in operation, and to eliminate or control them. Hence the need for constant monitoring of the functioning and improvement of the Safety Management System.

This Paper presents a classification of the railway system, with all the specifics and infrastructural features. Then, the current state of the safety system in the Railway Infrastructure of Montenegro (RIoM) is analyzed. Finally, based on a comprehensive analysis, in order to improve the existing situation, the Paper presents the concept of Risk Management Models that can adversely affect the safety system.

Keywords: Safety, System, Management, Model, Infrastructure, Improvement.

INTRODUCTION

Complete traffic safety, at the end of second decade of 21st century, is not yet possible. On the other hand, traffic must be used, so the aim is to establish optimal safety with sustainable further development of traffic.

Railway traffic safety is a constant concern of the entire railway organization, including users of railway services. It is an extremely important feature of railway traffic, and, at the same time, it is one of the most important criteria for the organization management, control and functioning of the railways as a complex, technical-technological and dynamic system. [9]

The railway safety system is based on coordinated activities of two levels, as follows:

- Technical level - defining standards for each component (railway infrastructure, rolling stock, operational procedures of workers) and
- Administrative level - determining the obligations and responsibilities of all stakeholders (Infrastructure Managers, Railway Undertakings, Suppliers, Railway Administration, Authorities).

The administrative level of safety is based on Railway Safety Directive 2004/49 / EC. This Directive stipulates that all railway companies (Railway Undertakings and Infrastructure Managers) are responsible for the safe operation of the railway system, and in order to fulfill this obligation, this Directive requires them to establish their own Safety Management System.

The introduction of the Safety Management System in the railway system companies in Montenegro was preceded by several laws and by-laws: the Law on Rail-

ways, the Law on Safety, Organization and Efficiency of Railway Transport, the Rulebook on the detailed contents of the Safety Management System of Infrastructure Managers and Railway Undertakings.

The Safety Management System describes the proceedings, procedures and other elements that are implemented in the Railway Infrastructure of Montenegro, in order to ensure that the company achieves its planned business goals in a safe way. These goals must be met in today's ever-changing and complex railway environment, providing evidences that the organization meets all safety requirements that apply to it.

THE CLASSIFICATION OF RAILWAY SYSTEM

The general importance of infrastructure for the functioning of the economic and social life of the country is at the same time a framework for the international integration of economies, such as the European Union. On that basis, large projects are being formed, such as the European High-Speed Rail Project as well as the Pan-European Transport Corridors, in which the transport infrastructure of the Western Balkans also participates.

In order to organize the transport of passengers and goods, the railway system must have appropriate technical means, devices and facilities, as well as proceedings and procedures. However, commercial train traffic on the entire railway network requires, inter alia, harmonization of infrastructure and vehicle characteristics, as well as efficient interconnection of information and communication systems of infrastructure and railway undertakings, as infratsructure capacity users. Efficiency, safety, quality of services and costs accompanied by business activities depend on this harmonization and interconnection. Due to its size and complexity, the railway system is divided into subsystems. According to the European concept of interoperability and safety, there are the following subsystems: [2]

1. Infrastructure;
2. Control, management and signaling of infrastructure;
3. Energy;
4. Rail vehicles;
5. Traffic regulation and management;
6. Maintenance;
7. Telematic applications for services in the transport of goods and passengers.

All technical resources in the above subsystems can be classified into two basic groups, as follows:

a. immovable (stable) and
b. movable (mobile) resources.

The group of immovable resources includes railway lines and stations with all their facilities, electric traction substations, stable signaling technology, depots and workshops. In a word, immovable resources form a railway network. The group of movable resources includes vehicles, i.e motive power unit and hauled vehicles .

Between several divisions of the railway system, it proved to be very practical to divide the railway as a technical system into a structural and a functional part, which also represent its subsystems. The structural rail subsystem includes railway infrastructure, electric power plants, signaling - safety and telecommunication devices and railway vehicles. The functional rail subsystem includes the regulation and management of traffic, maintenance of all subsystems, as well as all telematic applications related to the transport of passengers and goods.

ANALYSIS OF THE CURRENT SITUATION OF THE SAFETY SYSTEM IN THE RAILWAY INFRASTRUCTURE OF MONTENEGRO

The Railway Infrastructure of Montenegro JSC. Podgorica (RIoM)/Željeznička infrastruktura Crne Gore AD-Podgorica(ŽICG)/ is the manager of public railway infrastructure on the territory of Montenegro.

The RioM function is determined by the Law on Railways, defining that infrastructure management is an activity of public interest and includes: organization and regulation of railway traffic, protection, maintenance of infrastructure or its part.

In accordance with the Law on Safety, Organization and Efficiency of Rail Transport, RIoM has established a Safety Management System, by adopting the SMS Manual (official title of the document for Safety Management System in RIoM).

The SMS Manual has been prepared on the basis of the Rulebook on the detailed contents of the Safety Management System of the Infrastructure Manager and the Railway Undertaking. This Rulebook defines 19 points that should be included in the Safety Management System of an Infrastructure Manager. Accordingly, RIoM has prepared the SMS Manual, 19 chapters thereof refer to the points from the said Rulebook.

The previous retroactive railroad approach, which was based on the principle that something must happen first to cause a reaction, is being changed to a proactive approach, the principle that predicts what is likely to be happened and seek to prevent it. This safety approach seeks to identify in advance the risks and factors that can lead to failings in order to take measures to eliminate or minimize these hazards.

RIoM opted for a system approach based on the process-based principle according to which the SMS is a set of processes and proceedings or procedures that enable the definition, planning, execution and control of all RIoM activities related to traffic management and regulation and infrastructure maintenance.

The systems approach is based on a preventive safety approach that seeks to identify in advance the risks and factors that can lead to failings, in order to take measures to eliminate or minimize these hazards. The system approach also enables the management and control of interactions between different processes and procedures and between different functional and hierarchical parts of RIoM as well as the continuous improvement of SMS.

Analyzing the current state of the safety system in the Railway Infrastructure of Montenegro, it can be concluded that the entire scope of work is divided into three areas, namely:

- Safety Management System - system established by the Infrastructure Manager or the Railway Undertaking for the purpose of enabling safe management of work processes,
- Control over safe traffic flow - supervision over safe, orderly, regular and undisturbed traffic in the field of traffic, construction and electrical activities and the activities of mechanization of railway infrastructure, and
- Emergency investigation - determining the causes, consequences, circumstances and responsibilities of emergencies and the preparation of analysis and statistics with purpose to prevent future incidents and accidents.

The analysis by scope of work was conducted through the time and organizational framework of action.

The time frame of action of every area is focused on the analysis of preventive and consequential action as shown in Table 1.

The organizational framework of each area is focused on the analysis of areas of application and actions within the company and outside the company as shown in Table 2.

Safety Management System Analysis

As an organizational unit, the Safety Management System was established in August 2016, and in compliance with that, the basis for safety policy was made, being based on the analysis of the work of the Control over safe traffic flow and the investigation of emergencies, and thus the issue of safety at level crossings is raised. The basic features of the current state of the Safety Management System are:

- Newly created jobs related to SMS in RIoM,
- The scope of work is in line with the Railway Safety Directive 49/2004 / EC and the further development of this field of work is based on the Law on Safety, Organization and Efficiency of Railway Transport and the Rulebook on the detailed contents of the safety management system of infrastructure managers and railway undertakings,
- Other railway companies do not have a well-developed Safety Management System,
- the existing safety policy is too extensive and has not improved since its adoption,
- in the countries of Western Europe, the SELCAT project has been completed, and in Montenegro it has not even yet adopted and started with its implementation.

Control over safe traffic flow

The control over the safe traffic flow is performed by the Sector for Traffic Management and Regulation, the Coordinator of the Safety Management System with associates, as well as the Internal Control Service.

Characteristics of the current state of control over safe traffic flow are:

- Partial level of control over the application of regulations in the field of traffic activity, i.e organization and regulation of traffic,

Table 1. Time frame of action

Type of analysis	Safety Management System	Control over safe traffic flow	Emergency Investigation
Preventive	Development of a new safety policy	Advisory and educational regular teaching	Improving safety through emergency analysis, statistics and causes
Consequential	Analysis of conducted controls according to the Minutes (regular and extraordinary)	Safety control in the field of traffic, construction, SS and TC devices, ETA, machinery and vehicles	Analysis and control of the Commission's investigation reports and control of the work of the Commission for the Investigation of Emergency Events

Table 2. The organizational framework of action

Type of analysis	Safety Management System	Control over safe traffic flow	Emergency Investigation
Outside the Company	Cooperation with other railway companies; Cooperation with competent Ministries and bodies; Cooperation with other railway administrations;	Cooperation with controllers of other railway companies; Cooperation with competent Ministries and bodies; Cooperation with other railway administrations;	Cooperation with the Ministry; Cooperation with other railway companies; Cooperation with the National Commission; Cooperation with other railway administrations;
Within the Company	Development of safety within railway infrastructure;	Control in basic organizational units; Operational control; Control in sectors	Advisory management of emergency investigation; Failure analysis;
Scope of work	Traffic organization; Infrastructure subsystems;	Control of application of traffic regulations, construction, SS and TC devices, ETA, mechanization and vehicles	Emergency Investigation; Communication in crisis situations;

- Partial level of control over the application of regulations and standards in the field of technical infrastructure subsystems (construction and electrical activities),
- The conclusions of the Minutes on the control of the application of regulations are not used sufficiently in preventive measures, in order to improve safety,
- Vacancy of all jobs involved in the control over safe traffic flow,
- Administrative control of regular teaching (without real knowledge of the professional qualifications of executive workers),
- Weak connection of controllers from RIoM with controllers from other railway companies, reducing business efficiency.

Emergency Investigation

The Law on Safety, Organization and Efficiency of Railway Transport, as well as the Instruction in the Event of an Emergency, stipulate that every rail emergency event must be investigated. Quality investigation and investigation of emergencies is the basis for maintaining the existing level, but also a condition for raising the level of safety.

Features of the existing emergency investigation are:

- There is no application of emergency events that would be connected between the stations and the service that investigates them (it exists in the countries of the region, in Western Europe it is an even more developed technological solution),
- The Commission for the investigation of extraordinary events conducts a consequential investigation, without a greater possibility for preventive action,
- Members of Emergency Investigation Commissions are often inexperienced in this work
- Members of the Emergency Investigation Commission often work under pressure of their superiors and are primarily in the function of their companies, rather than Emergency interrogation and investigation,
- Very frequent discrepancy of the opinion of the Emergency Investigation Commission, even when the cause is obvious.

IMPROVEMENT OF THE SAFETY SYSTEM IN THE RAILWAY INFRASTRUCTURE OF MONTENEGRO

Followed by the analysis of the current situation, in order to improve the safety system in RIoM, SWOT analysis was made showing the internal strengths and weaknesses and external opportunities and threats by work areas. Then, an analysis was made related to the identification and definition of risks that could jeopardize the further development of the safety system in RIoM.

SWOT analysis

Table 3 (SWOT analysis) shows internal strengths and weaknesses, as well as external opportunities and threats by work areas. Based on the input elements, strategic guidelines were also identified:

- **Safety Management System -** maximizing activities towards other railway companies and other railway administrations.

Table 3. SWOT analysis for safety system

SWOT analysis	Safety Management System	Control over safe traffic flow	Emergency investigation
Internal strength	Professional staff; Good business cooperation with the environment; Computer literacy; Willingness to improve; Work experience;	Work experience; Knowledge of different professions; Establishment of a Safety Management System; Professional attitude towards safety;	Work experience; Expertise and competence; IT skills; Analysis and statistics;
Internal weaknesses	A few people; Insufficient teamwork; Non-involvement in the work of professional bodies; Non-involvement in the work of state bodies:	Insufficient teamwork; Long period of business stagnation; Outdated work processes; Absence of IT applications; Small number of controllers;	Insufficient connection with the field work; Dislocation from the scene; Lack of technical and IT support; Insufficient authority power;
External opportunities	Safety Law; Directive 49/2004 / EC; Rulebook on the detailed contents of the safety management system of the infrastructure manager and the railway undertaking; Work experience;	Cooperation with other companies; Safety control in order to make rationalisation; Application of safety regulations; Development of new regulations; Greater railway safety compared to other modes of transport;	New Emergency Instruction; Safety Law; Safety Directive; Public sensitivity to railway safety; Existence of investigation experts in the field ;
External threats	Absence of established rules; Closedness of other companies; Weakness of the information system; Lack of funds;	Organization of control in other affairs; Insufficient funds for safety; Non-compliant regulations; Resisting technological changes; Poor organizational positioning;	Ignorance of new technologies; Reducing the number of workers; Insufficient quality of work of the Commission and investigation bodies; Increased number of disturbances and failures; Negative public attitude towards level crossings;

- **Control over safe traffic flow -** maximizing activities within RIoM.
- **Emergency investigation -** synergy of all stakeholders in railway companies.

In addition to implementing the provisions of Directive 49/2004 / EC concerning railway safety, in order to establish good relations with other railway companies, the Safety Management System should be developed based on positive experiences of internal control, establishing good relations with other organizational units and participating in drafting missing by-laws related to traffic safety.

Development of control over safe traffic flow in the future is possible with harmonization and definition of control of application of regulations in all professions (within jobs), harmonization and definition of control of application of regulations with other organizational units, harmonization and definition of control of application of regulations with other railway companies, then strengthening activities related to active monitoring of the implementation of conclusions and solutions and active participation in the development of new regulations.

The development of a joint Emergency Instruction by all railway companies was the basis for significant activities related to the development of emergency investigation. Also, an important part for the quality of reporting, notification and investigation of emergencies is the development of an IT application for emergencies.

Risk analysis

The existing safety system of RIoM includes the management of risks that may affect the safety of traffic and the entire system, however, the analysis of the current situation and emergencies indicates that risk management must be improved.

For this reason, an analysis has been performed related to the identification and definition of risks (Table 4) that could jeopardize the further development of the safety system in RIoM. Risk analysis consists of:

1. Risk identification - identification and description of at least ten possible risks,
2. Risk exposure assessments - the result of risk opportunities and risk impacts,
3. Risk management planning - research, acceptance, avoidance, mitigation, risk randomness and
4. Preparation of a review of measures - adoption of measures to eliminate or mitigate the identified risks.

Measures to eliminate or mitigate the identified risks consist of defining a clear way of cooperation with other organizational units, getting acquainted with the characteristics of workers, defining the way of working in all areas, quantifying railway safety, clearly separating the scope of work of services and defining relations between them, defining the scope of work of management of the safety management system (tactical level) and scope of work of employees (operational level), optimization of the scope of work in accordance with the capabilities of the company, defining ways of cooperation with other railway companies, developing a plan for technical means and organizing educational training.

It can be said that the key word in the railway safety system today is a proactive approach to risk management.

Pursuant to the ISO 31000 standard, in order to manage risk in the safety system, it is necessary for RIoM to develop, implement and constantly improve the Framework which purpose is to integrate the risk management process in the entire organization, i.e at the company level (in management processes, defining strategy and planning, reporting processes, policies, company values and corporate culture).

By proper implementation of the risk management process, according to ISO 31000, RIoM would have multiple benefits:

- Increasing the probability of achieving the set safety goals,
- Encouraging proactive action of management,
- Raising awareness and understanding of the need to identify and treat risks impacting safety,
- Improving the ability to identify opportunities and threats,

Table 4. Risk review according to exposure assessment

Risk analysis		
Safety Management System	**Control over safe traffic flow**	**Emergency Investigation**
Insufficient cooperation within company	Non-acceptance of changes	Insufficient cooperation within company
Absence of teamwork	Insufficient control within company	Absence of teamwork during the interrogation and investigation
Non-acceptance of suggestions from other services	Absence of teamwork	Non-acceptance of suggestions within the service
Poor communication at all levels	Poor communication at all levels	Poor communication at all levels
Insufficient administration support for changes in the safety system	Insufficient administration support for changes in the safety system	Insufficient administration support for changes in the safety system
Insufficient cooperation with other railway companies	Insufficient cooperation with other railway companies	Insufficient cooperation with other railway companies
		Changes in the manner of interrogation and investigation
		Poor organizational positioning of the investigation area

- Increased harmonization with relevant legal norms and international standards,
- Improving safety management and reporting,
- Establishing a reliable basis for decision-making and planning related to safety,
- More efficient use of resources,
- Improving the health and safety of employees, improving business, environmental protection,
- Improving the organization's capability to resist the problems, etc.

Also, in order to manage the risks related to the safety system in qualitative way, which means their complete elimination or mitigation, according to the ISO 31000 standard, it is necessary for RIoM to adhere to the following:

a. Continuous improvement,
b. full ultimate responsibility for risks,
c. Application of risk management in every decision-making,
d. Constant communication,
e. Full integration into the management structure of the organization.

Based on the results of the performed analysis, it is possible to define - set the following model of management of risk which in any way can jeopardize the efficient functioning of the safety system of RIoM, Figure 1.

CONCLUSION

Railway Infrastructure of Montenegro (RIoM)/ Željeznička infrastruktura Crne Gore (ŽICG)/ is a complex technical-technological system, consisting of a large number of complex organizational units as structural elements (subsystems), where appropriate planning decisions are made. In order for the safety system to function effectively, which means eliminating or bringing under control all risks that may negatively affect it, it is necessary that each organizational part of the system is interactively connected and function efficiently with each other.

Based on the analysis made, it can be concluded that it is necessary to increase both the time and organizational framework of work, in order to improve the administrative level of interoperability of railway lines, especially railway lines of international importance. The adoption of a new safety policy based on explicit analysis is the first step in the implementation of the set guidelines and the adoption of quantitative and qualitative safety goals.The continuous development of the Safety Management System is a precondition for the future development of the Railway Infrastructure of Montenegro as a modern and reliable partner in the railway system. The main task of the future work of the Safety Management System is to document, to allocate responsibilities and to determine the manner of ensuring control by the management in the traffic and infrastructure subsystems in order to ensure continuous improvement of the Safety Management System.

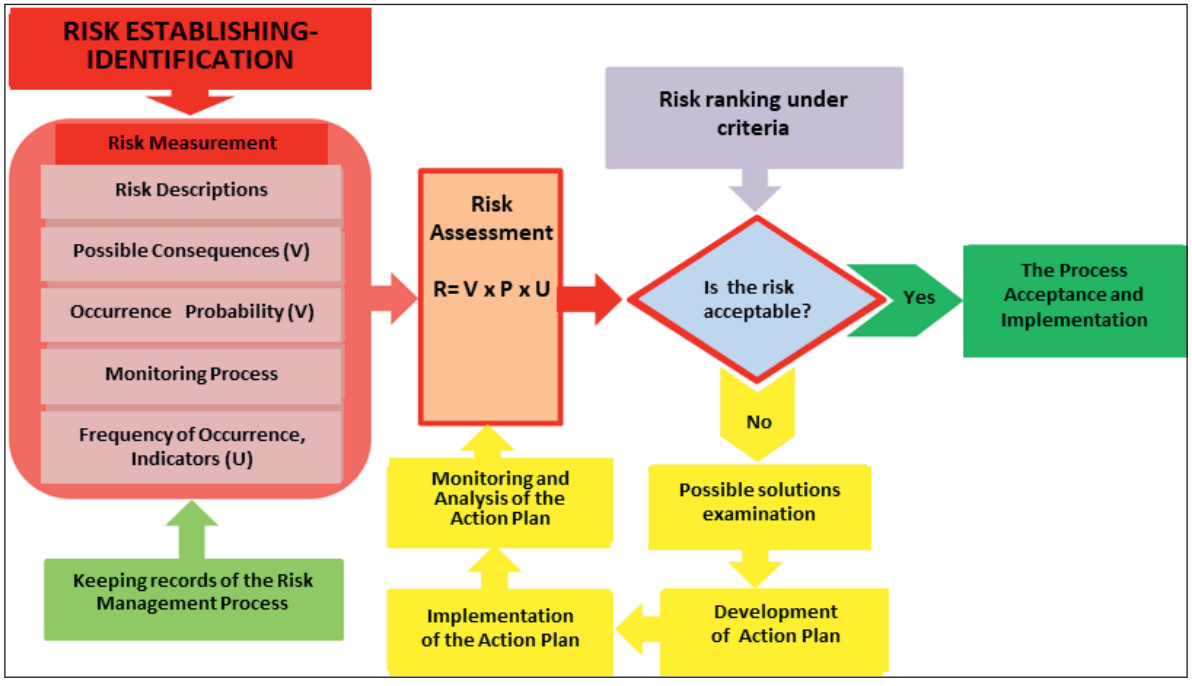

Figure 1. Risk Management Model in the Safety System
(Source: Authors)

Supervision over safe traffic flow, as a safety corrector, in the future, should have the following tasks: organization and permanent implementation of supervision over safe traffic flow in the field of traffic, construction and electrical activities, and activities related to railway vehicles, with an aim of safe, order, regular and undisturbed railway traffic operations. Employees, with their experience, will continue to participate, in quality way, in drafting of regulations and in providing expert advices, comments and suggestions on all regulations that are being drafted.

The main tasks in the future work of emergency investigations should be the organization, permanent control and development of interrogation and investigation of emergencies, establishing their causes and circumstances, consequences and responsibilities in order to determine measures to eliminate the consequences, and development of analytical and statistical indicators to reduce the number of emergencies and the number of the consequences and thus increase the level of railway traffic safety. Raising the level of work quality in the field of emergency investigation, will contribute to a greater extent to increasing the level of traffic safety.

Future tasks will also relate to cooperation between all areas:

- Safety Management System and control over safe traffic flow: preparation of analyzes based on performed regular and extraordinary controls, preparation of analyzes in order to prepare for regular and extraordinary controls, and the main goal is risk identification and preventive action to railway traffic safety.
- Safety Management System and emergency investigation: analysis of the causes of emergencies, failures of technical subsystems and emergencies analysis by place and by time. The main objective is to develop and harmonize the emergencies investigation with the provisions of Directive 49/2004 / EC concerning railway safety.
- Supervision over safe traffic flow and investigation of emergency events: mutual coordination in performing regular and extraordinary controls of investigation of emergency events. The main goal is to reduce the number of emergencies based on the recognition of the relationship between the safety situation in the basic technological and business processes and the number of emergencies.

The development of the safety system will also depend on the development of the safety system in other companies of the railway system. Accordingly, the part of the task of improving the safety system relates to the development of cooperation with Montenegrin railway undertakings.

The safety system is expected to recognize risks in each scope of work, that may affect its efficiency in operation, and to eliminate or control them. Hence the need for constant monitoring of the functioning and improvement of the safety Management System. To this end, Risk Management Model has been set up, identifying the elements and factors that affect an efficiency of the safety system and identifying areas where processes and procedures can be improved, and thus contributes to the efficient functioning of the safety system.

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