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IMPROVEMENT OF RAILWAY SAFETY BY APPLYING THE ADVANCED TECHNOLOGIES

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Only modern transport can reliably perform cargo and ensure efficiency and total safety of the economic process. Information technologies provide us with new possibilities in organizing transport work.

Information systems can be used for electronic data registration of cargo. The necessity of mobile transport systems analysis is base on globalisation and integration process: interconnection of various types of vehicles and their management in order to obtain more effective, safe and mobile freight monitoring and it is the creation of intelligent transport sector.

Keywords: information technologies, mobile transport system, railway traffic management, control and security systems

1. Introduction

By the development of advanced transport technologies it is very important to accelerate the integration of the Lithuanian transport system into the economic community of Europe and of other countries of the world, it is necessary to create the information infrastructure of the Lithuanian transport system that optimally functions both internally and externally.

The information infrastructure of the transport system is understood as an integrated aggregate of informatics and communication means, standards, technical regulations and organisational procedures that enables electronic accumulation of major information resources of the transport system, their processing in a coordinated way and, with the help of computer communication means, immediate provision of reliable summarised information of different nature, form and purpose, which is necessary for technological activities of companies, comprehensive accounting, as well as for decision-making by the authorities of companies or a transport system.

2. Estimation of Advanced Transport Technologies Approach of Long-Term Development Strategy of the Lithuanian Transport System

Creation of the information infrastructure is understood not as the creation of one huge computerised information system but as the creation of the environment for the functioning of information systems of companies.

The purpose of the information infrastructure of the transport system is the efficient and optimal informational maintenance of functioning of the Lithuanian transport system. Such an information infrastructure will allow the following:

- acceleration and optimisation of the movement of material and information flows through computerisation of functioning of its elements that control the above-mentioned movement;
- integration of the Lithuanian transport system into the European transport network;
- integration into the European transport service market.

To create information infrastructure of the transport system, it is necessary to take into account the general European requirements and multilateral agreements with neighbouring countries.

The following measures in the field of advanced transport technologies development should be mentioned:

1. Development and introduction of a transport network system of traffic and user information management and control in order to optimise the use of the infrastructure;
2. Modernisation of railway transport data transmission and traffic management system, assurance of its compatibility with those of neighbouring countries;

3. Drafting of a programme for transport system management and rearrangement of information technologies and telecommunication structure of individual transport branches, also for development of intelligent transport systems while integrating the Lithuanian transport system into the EU transport information technologies and telecommunication systems;
4. Development and introduction of a computerised system that enables automatic control of a technical state of road transport, drivers' work and rest schedule, information on freight being transported;
5. Introduction of an integrated information system that would embrace all activities of the railway sector and assure an effective management of the total railway transport system. Introduction of this information system could be followed by: rational use of the available system capacity, launching of freight flows across the territory of Lithuania at the lowest cost and in the shortest period of time; rational planning and implementation of maintenance and repairs of mobile and stationary objects of the railway transport system; its connection with information technologies systems of other transport modes and its organic integration into the information system of all transport sector of Lithuania.

3. Evaluation of Information Systems (IS) Selection and Implementation in Railways

For the successful creation of Information Systems the following factors are particularly important: user's workplace, ergonomics of IS, operational convenience of the system, amount of errors and other aspects of the workplace. User's workplace often needs to meet the requirement for possibilities to reflect a large amount of information. Therefore modern systems are usually created in the Windows environment by application of graphic means for reflection of data and actions. For this reason persons working in subdivisions of management of different business sectors often use even several monitors reflecting different information necessary for decision-making. Application of typical solutions for data picturing and attraction of attention enables a significant enhancement of efficiency, speed and comfort ability for the user.

In the course of IS development the cooperation of IS and functional staff becomes particularly complicated. In the integrated case the requirements for systems and their functionality are created by functional units responsible for the reaching of business goals – IS is an instrument for improvement of delivery of services and reaching the aims. In a defined way provider is selected in the railway terminals and the system starts to be implemented. In this period appears the railway terminal's IS division staff, which has to take care of the system's integrity, its availability for operation and further maintenance and development. After implementation of the system it is transferred to IS subdivision for taking care of maintenance. Often proposals for further IS development are provided by IS subdivisions, which are also taking care of the stability and development of the system, as well as of the maintenance and administration of users, and communication with providers.

Best practices of IS management occur in transport company, however it is also purposeful to use the best global practices that have proved as successful and that are constantly being improved. One of such practices is the so-called "Information Technology Infrastructure Library", which in the period of system's existence comprises the following processes: on tactical level and operational level.

Tactical level:

1. Management of services standards;
2. Management of accessibility;
3. Management of resources volumes;
4. Management of succession;
5. Management of finances.

Operational level:

1. Management of configurations;
2. Management of prompts registration service;
3. Management of incidents and problems;
4. Management of modifications;
5. Management of versions.

The above-mentioned processes are not all required and not for all transport institutions prises necessary – however each of them can also be used for the management of a concrete system. The following scheme is required for the attainment of desirable state of the system (Fig. 1).

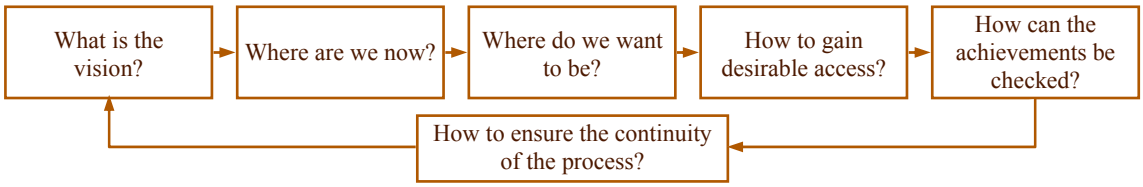

Figure 1. Scheme is required for the attainment of desirable of the system

This process includes several the above-indicated stages – identification of vision, short description of existing situation, definition of directions, action plan and creation of system for checking of condition.

4. The Application of Technologies in Traffic Management and Control in Railways

Perspective technological solutions should be first of all implemented on the main railway sections thus enabling the reduction of amounts of road installations on side tracks and allowing maximum use of microprocessor equipment at stations and locomotives, meeting European requirements, ISO and other reliability and safety standards. This should enable a centralised management basing on the implementation of a computer network and data transmission system, the use of discrete information transmission channels, including the optical fibre and radio communication. For the replacement of the old equipment it is necessary to:

- implement European traffic management and safety systems by leaving the existing automatic locomotive signalling code transmission track road system (TTRS);
- semiautomatic blocking (SAB) installed on certain rail road sections by automatic blocking (AB) in the entire railway sector. The AB should improve the control of train movement between stations on side tracks, provide quicker possibility for restoring normal train traffic after rail road equipment disorders (damages), increase passing capacity of trains – in fact the passing capacity on double-track lines with automatic blocking and electric centralisation of switches at stations should increase up to 220 couples of trains per 24 hours, which is by 2.5 times more than with the semiautomatic blocking.

For the evaluation of AB advantages over the SAB, regarding the passing capacity, certain methods can be applied. Limitary passing capacity of single track side track section between stations in case of semiautomatic blocking is calculated by the following formula:

$$\Pi = v/(L+l), \tag{1}$$

where v – the average speed of the train between stations, km/h; L – the length of the stretch between stations, km; l – the average length of the train, km.

In case of double-track railway road the passing capacity increases twice as much.

The increase of passing capacity of three-digit automatic road blocking is calculated by the following formula:

- for double-track side track section between stations:

$$\Pi = 2(v/(2L_{BR}+l)); \tag{2}$$

- for single track side track section between stations:

$$\Pi = 2(vn/(2L_{BR}(n-1)+l+L)), \tag{3}$$

where n – the number of trains starting one by one in the same direction (the traffic of opposite direction trains being stopped); L_{BR} – the length of blocking section of side track in AB case.

These formulae are correct under the condition that side track roads are divided into blocking sections of equal length. If these lengths differ, then in the formula (3), instead of $2L_{BR}$, is inscribed the largest length of two the nearest adjacent blocking sections of the side track. Then the formula (2) will be as follows:

$$\Pi = (v/(L_L + l)) + (v/(L_N + l)), \quad (4)$$

where L_L and L_N – the maximum lengths of two adjacent blocking sections on rail roads of odd and even routes.

5. The Application of Technologies in the Field of Traffic Safety

The research deals with the implementation of one of the traffic safety and control systems – the locomotive safety system – in traction force operating at Lithuanian railways. This is the Locomotive safety system ALSN. Table 1 presents the main functions of ALSN system.

Table 1. Functions of the ALSN system

1) reception of codes of road light signals
2) reiteration of signals by the locomotive light signals
3) drivers watchfulness control
4) indication of time
5) factual speed of the locomotive, km/h

With ALSN system implemented, such registration is performed with the help of 3SL-2M speed-indicator, contact and registration equipment. This speed-indicator is electromechanical.

The equipment of speed-indicator is applied during the movement of locomotive for the registration of the following components:

- on/off electric air valve (EAV) condition;
- the moment of applying the warning handle;
- reading of locomotive light signals;
- speed of the locomotive;
- time.

Grounding of implementation of new technologies and expected economic and social effect. The main objective of implementation of new technologies in railways means not only the economic efficiency, but also the improvement of traffic safety and traffic management, due to the fact that Lithuania is obliged to reach EU standards in the field of traffic safety and traffic management.

Modernisation of telecommunications, signalling and electric supply in Lithuanian railway network will enhance the supply for railway transport. Together with the change in supply, the demand tends also to change and influence the traffic in the following way:

- the transit mode to which investment is made acquires increased demand among people that are not using transport at all;
- users that are using other transport modes are attracted to the railway transport. The demand for railway transport is influenced by as follows: transportation (travel) costs, quality and travel time.

Demand for freight transportation is influenced by the following factors: tariffs, travel time, value-added services.

Modernisation of railway network boosts transport capacities and reduces travel/transportation time, as well as extends traffic flows, which results in the growth of revenues from transportation tariffs.

Benefits of implementation of new technologies:

Direct benefit

1) Railway tariffs.

Due to investments, the enhanced passing capacity of main railway corridors will enable delivery of better quality services.

2) Economy of expenditure on staff maintenance.

Railway modernisation will enable reorganisation of labour force both in stations and other railway units, and will allow the discharging of unnecessary staff.

Because of the high level of the technologies a demand will grow for more qualified labour force.

Indirect benefit

1) Reduction of freight transportation time; the reduction of transportation time contributes to the growth of traffic intensity.

2) Reduction of time intended for freight transportation influences cost of production: storage will need less warehousing of goods and less time, which will result in more efficient reaction to market demands; decrease of railway traffic accidents.

6. Conclusions

1. The article shows that for the successful creation of Information Systems the following factors are particularly important: user's workplace, ergonomics of IS, operational convenience of the system, amount of errors and other aspects of the workplace.
2. The analysis made in the article shows that perspective technological solutions should be first of all implemented on the main railway sections thus enabling the reduction of amounts of road installations on side tracks and allowing maximum use of microprocessor equipment at stations and locomotives, meeting European requirements, ISO and other reliability and safety standards.
3. For the evaluation of automatic blocking advantages over the semiautomatic blocking, regarding the passing capacity, certain methods can be applied. Limitary passing capacity of single track side track section between stations in case of semiautomatic blocking is calculated by the following formula: $\Pi = v/(L+l)$.
4. The main objective of implementation of new technologies in railways means not only the economic efficiency, but also the improvement of traffic safety and traffic management, due to the fact that Lithuania is obliged to reach EU standards in the field of traffic safety and traffic management.

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