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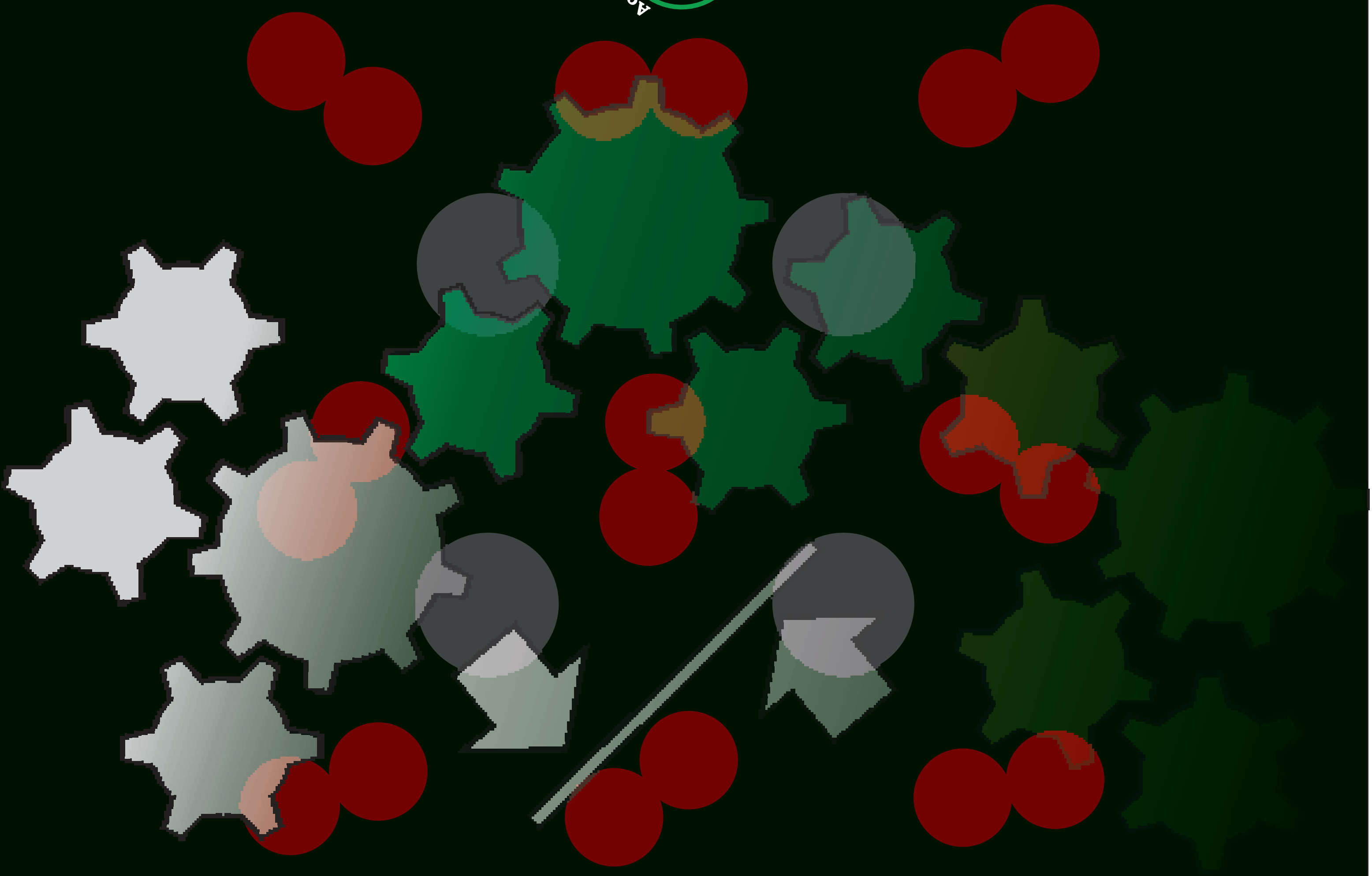

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EMPIRICAL APPROACHES OF ROAD INFRASTRUCTURE SAFETY MANAGEMENT

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Keywords: infrastructure, safety, management, empirical approaches
Abstract: The focused effort of European Union in a form of safety improvement as one of the essential quality attributes of a transport system was reflected in several legal norms governing the conditions for each element of this system. Road infrastructure is no exception, where rules and principles of safety shall be applied in the process of its preparation, implementation and within the operation as well. The Directive 2008/96/EC on road infrastructure safety management has defined the basic framework for performance of individual procedures, which was transposed into national legislation and gained detailed outlines through adoption of the Act on road infrastructure safety management and related decrees.

1 Introduction

Based on the provisions of the legislation, following procedures are considered as elements of road infrastructure safety management:

- road safety impact assessment (hereinafter Impact Assessment),
- road safety audit (hereinafter Safety Audit),
- safety management and inspection on road in operation [1], [2].

Impact assessment means a comparative analysis of the impact of a new road or a planned substantial modification to the existing network on the safety performance of the road network. The impact assessment shall be carried out within the investment plan, i.e. before the development of detailed project documents [1], [2].

Safety audit' means an independent, systematic and technical safety check relating to the design characteristics of a road infrastructure project or a planned substantial modification to the existing road having effect on the traffic flow. Procedures related to the performance of safety audit shall be carried out from the phase of road planning to the phase of its operation [2].

Safety management and inspection of road in operation is a procedure comprising of regular verification of characteristics and deficiencies, which due to the safety reasons require maintenance work (hereinafter Safety Inspection) and classifications of sections with high accident rate, or classifications of network safety [3].

Each element of the road infrastructure safety management represents an independent procedure, being understood that the knowledge and principles identified through the safety inspection shall be applied within the performance of the safety audit and impact assessment. This fact presents the safety inspection as a fundamental issue as the quality of its outputs affects the quality of other safety management procedures. Therefore, this issue needs to be given more attention and this article is considering what could contribute to improvement of the status quo [3], [4].

2 Approaches to implementation of safety inspection

The content and form of implementation of safety inspection depend on the choice of approach applied for assessing the safety level of existing roads. Basic attribute, which affects the decision about the choice of approach, is the difference between perceived and observed level of safety. Preventive approach to the performance of safety inspection is aimed at the periodic detection of deficiencies (perceived level of safety), which are present on the entire considered network without a detailed analysis of accidents occurred in the past. This type of safety inspection is mandatory, conducted at least once every three years on all sections of road corridors that are part of the TEN-T network. Active approach to the implementation of the safety inspection lies in the identification of shortcomings (observed level of safety) resulting from the analysis of the accident rate and from the outcomes of the inspection at black spots, which are based on the classification of sections with high accident rate [4], [5].

The classification of high accident rate sections is presently carried out by the Slovak Road Administration on motorways, expressways and on the I. and II. class roads as well. Procedures for the management and inspection of road safety do not apply to road tunnels. It is necessary to distinguish between the safety inspection and maintenance, or repairs on roads. Maintenance and repairs mean regular process of checking of equipment and elements of roads and their subsequent repair as specified in technical regulations. The maintenance and repairs of roads may be performed by persons, who do not qualify for the performance of safety inspections referred to in the regulations [4], [5].

Active approach to the performance of the safety inspection starts with a systematic collection of data enabling the identification of problem areas. These problem areas include sections with high accident rate (hereinafter black spots), which are characteristic with high concentration of accidents compared with other sections [5].

In Slovakia, the evaluation of the safety of the road network is presently carried out by the Slovak Road Administration, which annually processes and publishes a list of black spots on motorways, expressways and on the I. and II. class roads. The identification is based on the assumption that accidents are homogeneously distributed all over the road network. They are using one parameter Poisson probability distribution characterized only by the mean value calculated as the arithmetic average of the number of accidents in previous year per standard length (e.g. 1 km) of the road [4].

Based on the presently used method, the defined frequency distribution will return the value of a cumulative probability of exceeding a certain discrete number of traffic accidents, a so-called critical number of accidents at a particular level of significance. If the value of the distribution function of a Poisson distribution beyond the critical level of the number of road accidents exceeds the level of significance, the methodology evaluates the section as a black spot. For their classification they are also using the recorded number of accidents and their consequences in a form of the sum of products of the number of fatalities, heavy and light injuries and corresponding values of economic losses from damage to life and health and the overall material damage estimated by the police [5], [6].

After the process of selection of high risk road sections measures are implemented, depending on the funds available and their cost. A specific type of measure is based on recommendations of experts from the scope of road managers or other entities (e.g. Police) that are aware of the conditions at risky road sections [5].

The efficiency of measures is not examined in a way to be able to estimate benefits in a form of savings in socioeconomic costs (e.g. reduction of the number of road accidents, emissions, noise, etc.), but to solve the problem. Whereas the funds available for this purpose are low, typically it is concerning low cost measures (e.g. modification / renewal of road markings). This approach cannot be considered as systematic for two main reasons. The current method for determining risk sections indicates that the list is also including the sites, where the high number of accidents (or a smaller number of accidents with a higher severity) was recorded only as a result of seasonal variation. In other words, the scope of actions includes also road sections, where the number of accidents in the past and likely in the future as well will not be that high. The second reason is that there is an absence of a procedure allowing the prioritisation of sections and measures with the greatest expected benefits in terms of social costs savings. It is because of the lack of resources why there is a need for optimisation, which would allow to implement a set of measures with highest benefits. Based on the latest knowledge in this field, the mathematical modelling is being preferred, which eliminates the shortcomings of the current procedures [5], [6].

3 Definition of black spots

First of all, for the purpose of formulation of the problem it is necessary to determine criteria specifying an appropriate definition of a black spot. Research institutions are dealing with the determination of these criteria for more than 25 years. One of present analyses (Madsen, 2005) suggests following criteria for a relevant definition of a black spot:

1. Checking of random variations in the number of road accidents.
2. Considering as many known factors affecting the road safety as possible.
3. Identification of sites with extremely high share of fatalities and severe injuries.
4. Identification of sites with local risk factors related to construction layout and traffic control significantly contributing to accident rate.

The first criterion implies that the identification of black spots should be based on the expected number of traffic accidents, as opposed to actually recorded. In practice, however, it appears to be much more difficult to use the expected number of accidents, since it cannot be recorded but only estimated. Nevertheless, at present there are methods that make it possible to provide a qualified estimate (empirical Bayesian method).

The second (or the fourth) criterion also assumes the utilisation of Bayesian method for the identification of black spots, which is supported by a multi-dimensional model of accident rate forecast. The development of a model can consider several factors to explain systematic variations in accident rates (volume of traffic, characteristics of the construction arrangement and elements of traffic control). Of course, it is unrealistic to expect the model to produce exactly accurate estimates, since it does not include all the factors (local risks) because of their specific nature. The third criterion on assessing the severity of the accident clearly states that the decision-makers are trying to eliminate accidents with serious consequences.

The systematic use of empirical Bayesian method for estimating the safety of an infrastructure currently represents the pinnacle of the state-of-the-art theoretical knowledge focused on the management of black spots and on the management of road network safety. Following important elements arise from the latest knowledge:

- Black spots should be defined on the basis of expected and not recorded number of road accidents.
- Black spots should be identified by a clearly defined core set of sites,
- It discourages the use of continuous validation approach, which artificially increases the variation in the number of road accidents.
- In order to estimate the expected number of accidents, multi-dimensional models for the forecasting of the accident rate should be developed.
- The best estimate of the expected number of traffic accidents for each site is derived by combining the recorded number of traffic accidents with the model estimates for this site. Empirical Bayesian method should be applied within this procedure.
- Interpretation of alternative critical values for the expected number of accidents, which further specifies the site as a black spot should be investigated in terms of sensitivity and special characteristics, whereas an optimal criterion should be selected.
- Traditionally used criterion for black spots, which is the trend in the accident rate, has not been confirmed. Analysis of accidents at black spots is best conceived in terms of making hypotheses about the factors contributing to accidents.
- The black spots analysis should consider the possibility that the result of a random option may be an apparent behaviour pattern. Binomial tests should be applied to determine the probability that a certain number of a particular type of accident is merely a result of a chance.
- The black spots analysis should use the blind test, i.e. count with the comparison of such sites with safe sections. The aim of the analysis is to identify risk factors for the occurrence of accidents and the person performing this analysis should not be familiar whether it is concerning a black spot or not.
- Evaluation of the effects of black spots treatment should be based on empirical Bayes scheme before and after the implementation.

Current definition of a black spot is insufficient in the theoretical point of view because it is based on the recorded number of road accidents (history of adverse events on short sections of road infrastructure). However, it is considered as effective to identify those sites, where there is expected (estimated) an abnormally high number of accidents and not the sites with a presence of high number of accidents each year due to extreme statistical fluctuations. Therefore the definition of a black spot should read as follows: Black spot is a location with expected higher number of accidents than at similar sites as a result of local risk factors. Black spots are identified from a known sample set of sites representing the monitored road network in the Slovak Republic.

The condition of similarity of sites is assessed in terms of interpretative values of models for the forecast of the accident rate. Two sites can be regarded as similar in case that they have, for example, the same traffic volumes, speed limits, same number of driving lanes, etc. Within the identification of black spots, the comparison with other similar sites ensures that the interpretative factors included in models for forecasting may be regulated. Regulation of these factors is important because it is not the purpose to identify a black spot only because of higher traffic volumes. It is logical that the risk of an accident grows with the increasing traffic.

The above mentioned theoretical definition of a black spot shows that the method that can reliably identify these locations is only the one that allows to determine the impact of the three main factors on the expected number of accidents. The empirical Bayesian method meets these requirements, but it is possible that other procedures provide adequate outputs as well. On the other hand, the empirical Bayesian method allows to relativize the effect of stochastic fluctuations, general and local factors.

Empirical Bayesian approach was developed by Ezra Hauer and it can be used for estimation of objective estimates of a long-term expected number of traffic accidents for the individual elements of the road system, such as specific intersections or road sections. This method allows elimination of systematic errors that are attributable to random fluctuations in the recorded number of road accidents (errors due to a phenomenon, when each variance returns back to normal). There are several variants of empirical Bayesian approach and the most sophisticated of them estimates the number of accidents through the combination of knowledge extracted from two sources:

1. The multidimensional model for the forecast of accident rate, which describes the normal level of safety and the effects of variables that are affecting it. The most common form of the forecasting model is the negative binomial regression model.
2. Recorded number of accidents for a specific site during the same period as used within the setting of the model for forecasts of accident rate.

4 Conclusions

Current trends in research in this area are drawn towards the prediction of expected effects of the implementation of actions by means of mathematical - statistical methods and on the basis of relevant data. The estimate of effects of a particular measure can be quantified if we know the costs related to its implementation as well as the benefits in the form of a reduction in social costs, which represent a monetary effect of the accident rate at given site / road section, where that measure is being implemented.

The reduction of social costs of traffic accidents can be quantified if we can estimate the change in the number of traffic accidents, which is the result of the measure. The latest procedures used to predict the expected number of accidents are working with the term Accident Modification Factor - AMF, which is used to calculate the expected number of accidents following the implementation of the measure on that particular site / road section. It is virtually a coefficient multiplied by the expected number of accidents at the considered site without the implementation of the planned measure. AMF estimate values higher than 1.0 represent an increase in accident rate (negative development) and values lower than 1.0 indicate vice versa the decrease in the accident rate (positive development). For example, for the value of AMF estimated at 0.8 we can talk about the reduction of the number of traffic accidents by 20%.

The methods, by which it is possible to derive the values of AMF can be generally classified into two groups according to the way of the data collection. Experimental studies using comparison between sites that are selected for the implementation of the measure and sites, where the measure is not to be implemented. Both groups are created before the implementation of the measure. In the case of observational studies, the data collection is carried out retrospectively through the recording of changes to road infrastructure, where relevant measures were implemented. For both types of studies, the method of measure efficiency is usually preferred to the cross sectional method. The modification factor of the accident rate is then estimated from the change in frequency of occurrence of traffic accidents before and after the measure implementation. Within this estimate, it is necessary to consider the effects of general changes in traffic accidents, which are not directly related to the measure.

The group of sites without implemented measure can be identified retrospectively and used for the consideration of changes in the level of safety due to factors other than the measure itself. In this regard, there are several types of observational effectiveness studies, which differ from each other by the usage of a control group for consideration of confounding factors. Naïve effectiveness method includes a simple comparison of the frequency of traffic accidents before and after the implementation of the measure without considering the changes that are unrelated to this measure. This deficiency is the reason why the method is not considered credible. There are two methods - comparing group's method and full Bayesian method - for the derivation of the modifying factor of the accident rate from the measure effectiveness study. The method of comparing groups is a simpler way compared to the empirical Bayesian that is, on the other hand, more complex and thorough. The so-called full Bayesian method can be also considered, which an extension of the empirical Bayesian method is.

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PROTECTION OF ROAD INFRASTRUCTURE - DYNAMIC WEIGHING OF VEHICLES

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Keywords: weighing in motion, legislation, system requirements
Abstract: The reason of the construction of the official measurement of axle loads through dynamic weighing of the trucks and buses on the road is to prevent damage to roads and shortening their lifespan and operational capability due to the crossing of axle loads on trucks' and buses' limits with a gross weight of 3.5 tons. Article provides an analysis of legislation for the establishment of a system for driving vehicles weighing (weighing in motion - WIM) at high speed, the identification of essential requirements and the issue of strict liability in the field. Description is also considering the usage of the part of the technical infrastructure of the existing toll system.

1 Introduction

The analysis reveals, the weighing issue itself in applicable legislation concerns immediately only the SR Act. 135/1961 Coll. on roads (Road Act), as amended (the "Road Law"), which contains provisions governing the issue of weighting, security establishment, the establishment and operation of scales and weighing treatment.

The introduction of changes to the official measurement will entail Road Act, under which it will be necessary to define exactly the terms low-speed and high-speed weighing, conditions for their establishment and operation as well as the rights and obligations of the various parties. The recommended solution is to include the treatment of the basic conditions for the establishment of weights and weighing in road law, respectively in the new draft Road Act and any details left to subordinate legislation through empowering provisions in the law.

2 The official gauges

Definition of official instruments, method of metrological control, technical and metrological requirements are regulated in Decree of the Office for Standards, Metrology and Testing of the Slovak Republic no. 210/2000 Z. z. on measuring instruments and metrological control, which Act no. 142/2000 Coll. on Metrology and on amendments to certain acts (hereinafter the "Law on metrology"). The legislation of the Metrology Act is sufficient, with the necessary legislative changes encompassed only within the framework of implementing regulations. The accuracy of the scales cannot be lower (worse) than maximal permissible overload (currently 3%). Therefore, current standards do not allow the use of high-speed weighing on the market with an accuracy of 5 %.

To enable high-performance measurements should MDVRR SR:

1. insist on high-speed precision weighing 5 %, or
2. Increase max. congestion of vehicles permitted to 5 %.

3 System Requirements

In general, the data obtained from WIM system can be stated that:
- It is large amount of data,
- Records for each type of vehicle may be of different lengths.

Requirements for data management can be formulated as follows:
- Supporting for multiple formats of data files,
- Rigorous quality assurance process,
- Data is recorded by way „vehicle after vehicle",
- Aggregated data for unified presentation system (e.g. GIS use)
- Vehicle relational database (tables of the vehicles and their axles)
- The distribution of the database by location (location)
- Distributed "layers" for extensibility: Data - application - presentation,
- Stored data is continuously online,
- Customizable solution - the ability to add additional users, sites and hardware.

For the purposes of search, creation, analysis and statistics the system should provide for data filtering by various criteria, e.g.:
- vehicles' size,
- vehicles' class,
- (Dis) approval with mass data.
- (Dis) approval with the permissible size,
- Locality,
- Time
- Vehicles' registration,
- Repeatedly overloaded vehicles and their operator

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- Declared (approved) excessive traffic,
- Vehicles with the exception,
- Specific vehicles (dangerous goods).

Requirements for road equipment:

The system must ensure single threshold weighing and proper operation in a wide range of vehicle speeds and other boundary conditions. Weighing shall consist of weighing scales in each lane. Weight sensors should cover the entire width of the lane. WIM system consists of the following components:

- Wheel weights record data on weight for each track width (right and left axle load); the weighing data to be uniform over the whole width scales,
- The control unit (road unit, RSE - Road Side Equipment), which is installed in a cabinet, comprises equipment and software for the calculation, storage and transmission of all the specified data to the host computer (WIM in centre); the control unit further comprises:

- the tools to access control system (e.g. keyboard and monitor or computer means to secure access, possibly hardware key) delivered as a packaged unit,
- the unit has to work with an external source of electrical power with battery backup to provide continuous power for at least 1 hour. (Ed .: in case of power through the toll enforcement gates should be based on the specifications of the toll system, whether it be addressed backup in the control unit or power supply as a whole is left to the enforcement gate of the toll system as power consumption of the weight control unit comparing to the gate one is a little),
- the modem compatible with the communication network and with the modem in the WIM centre is only necessary when communication does not take place within a supervisory communication network subsystem toll system

- Protection against disturbances (light and electricity) is necessary so far as it is not provided by the other way (e.g. lighting of camera and interference power of the power source need not be so long as such matters as a surveillance of the goal).

Functional system requirements can be formulated as follows:

- WIM system must be able to assess vehicles and vehicle combinations for a total of 12 axles and must be automatically determined for each vehicle in the lane:

- the load on each axle with a load of left and right wheel speed, axle spacing and length of the vehicle,
- the classification of the vehicles - WIM system must provide a resolution of 15 classes of vehicles, with the first 13 classes are defined exactly 14 class presents special vehicles, 15 class is allocated to other vehicles which can not be classified in the first 14 classes; classification criteria are programmable as defined by the user,
- an error of measurement - the measurement should be evaluated as invalid if:
  - for the measurement conditions have not been respected certification,
  - left and right wheel load of any axle varies by 40% or more,
  - any wheel load of that axle exceeds 8.9 kN.

Both values are programmable by the operator. No vehicle, which was carried out for erroneous measurement shall not be considered to be "weighed" vehicle, but may be classified and accounted for and all data are stored in the vehicle record.

- the detection of the offense - for the vehicle's weight WIM system must to determine which (if any) axles, axle or axle group weight exceeds the limits set out in "table being exceeded"` the values in the table are generally pre-set limits, however, the weight can be defined by the user,

- Control unit quantify and retain all the necessary data to storage media - storage medium of the WIM station must have a capacity to store at least 14 daily records of the number of vehicles and individual vehicle data; the storage medium should be of a type which will not cause a state of data e.g. due to interruption of power supply. The controller must continuously compute and store data for all vehicles passing through the system. WIM controller must keep the following data:

- an hour numbers of vehicles by lane by class and by speed intervals for each 24-hour period,
- the single record of the vehicle shall contain at least the following information:
  - time and date,
  - registration number of the record created,
  - lane, direction of travel,
  - vehicle registration number,
  - vehicle speed,
  - vehicle classification (category),
  - weight of each wheel or dual wheel under the vehicle and under the axles, axle and total weight,
  - axles, spacing (wheelbase) between each of the following numbered axle,
  - the overall length of each vehicle or assembly, time of separation from the previous vehicle,
  - the code of the offense in the field of overrun by mass,
  - the code for erroneous measuring / weighing
  - photo document,
  - additional information (e.g. the outside temperature if necessary. Other meteorological data, recognized ADR tables, etc.).

- Data must be calculated and formatted such that all data can be accessed, and all required entries generated by using application software WIM system,
- All WIM control units must operate correctly at atmospheric temperature range of - 40 to + 70 ° C.

- WIM control unit must also have communication capabilities that enable the personnel outside the WIM to keep track of operation at WIM site and allow data transmission to the WIM centre (remote access); WIM controller must also be able to join the staff present in the station for the purpose of diagnostics and downloading the data.

Other functional and technical requirements

- the fulfilment of metrological requirements,
- WIM stations are without the physical presence of support staff
- checking the compliance with the limit conditions to ensure the accuracy of weighing (i.e. whether it is generated by "certified" measurements)
- sorting and filtering data,
- the creation of analytical outputs.
- the creation of protocols in different languages,
- comparison the control data towards the current database of the allowed excessive rides,
- comparison of the data towards current databases of vehicles excepted,
- the generation of statistics on WIM area not connected directly with WIM (weather conditions, vehicle speed, traffic volume, the proportion of vehicles by category, ...)
- secured communication outside WIM centre (i.e. from the WIM centre towards the WIM stations, external users),
- the user-friendly interface system
- access to data according to defined permissions,
- the backup WIM database data in a data warehouse physical located outside WIM centre,
- the data logging of WIM operation site and its continuous mapping into WIM centre
- the logging of WIM operation centre
- system provides in a real time the overview of the functionality of the system and its components.

Note .: if dynamic weighing will be implemented (i.e., detection of overload) only for trucks and buses (other parameters can be provided for all registered vehicles), it is possible some aspects (incorrect measurement, detection of the offense, vehicle record) to be evaluated after fulfilling the conditions of minimum load on the front axle wheels (e.g. 15.6 kN).

Strict liability - legislative amendment

Strict liability means the duty of the holder of the vehicle to ensure compliance with the rules of the road selected by the driver to whom the vehicle is entrusted. For an offense committed with the vehicle will be responsible just the holder of the vehicle. The new responsibilities of the holders of the vehicle are valid from July 1st. 2012.
The provision of § 6a of the Act no. 8/2009 on Road traffic in the present Act introduces so called other administrative offense that may be committed by the holder of the vehicle.
If it is undoubtedly determined that an administrative offense has been by the car committed by specific holder, the Police authority without further action immediately issue an order imposing a fine for an administrative offense (the "Warrant"), whose content requirements will apply accordingly § 47 of the Administrative Code.

4 Solution after detection of overloaded vehicles

The official measurement of the dynamic axle load and total weight of motor vehicles and buses at high speed with strict liability allows to immediately punish the offender by imposing a fine. The fine will be imposed on the owner of a motor vehicle that was evaluated as overloaded by high-speed dynamic weighing axle loads and total weight.
For vehicles that leave the Community's external border (SK / UA) will be necessary before the exit from the Slovak Republic to pay the fine through the Department of Border Police PPZ SR and then release the vehicle to the customs clearance.
Motor vehicles detected by a high-speed dynamic measurement of axle load and total weight of vehicles assessed as overloaded and facing the inner border of the Slovak Republic and the Community is necessary to address the fine imposed by strict liability and recover it before leaving territory of the Slovak Republic Department at toll police PPZ SR.
Passenger cars which are registered in the Slovak Republic must be addressed after finding overload condition of a motor vehicle through the Institute of strict liability.
Particular attention will be paid to motor vehicles which very significantly excess overloading the axle load or total weight. These should be addressed with a system low-speed weighing or official measurement of the static axle load and total weight of motor vehicles using:
1. vehicle immobilisation,
2. transferring a motor vehicle escorted to a designated location because of transhipment and solutions recourse,
3. proposal for the closure of the carrier or to exclude the possibility of entry of a motor vehicle to the Slovak Republic.

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AUTOMATION MONITORING OF RAILWAY TRANSIT BY USING RFID TECHNOLOGY

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Keywords: automatisation, RFID, railway transport, electronic waybill
Abstract: Aim of thispaperispresentedthepossibility of using RFID technology by railway transport monitoring. First part of thearticledescribes a comprehensivesystemfortheapplication of RFID technology in theenvironment of Slovak railways. Second part of thepaperdescribestheprinciple of informationsystem and design of theelectronicway-bill. The big problem is related to railway transit, where problem is in the transferring many information, e.g. waybill, technical condition of the wagon, date of the maintenance and repairs, etc. So, there is a possibility of using RFID technology. If we want to introduce RFID technology, it is necessary to create the entire concept of automatic data collection;
this can determine the tracking location of wagons and collecting information about the car.

Introduction

In today's, it is obvious to focus on the automatisation. The big problem is related to railway transit, where problem is in the transferring many information, e.g. waybill, technical condition of the wagon, date of the maintenance and repairs, etc. So, there is a possibility of using RFID technology. If we want to introduce RFID technology, it is necessary to create the entire concept of automatic data collection; this can determine the tracking location of wagons and collecting information about the car.

1 System location of the RFID technology in the railway transport

The introduction of RFID technologies in railway transport specifies the regulations and standards relating to rules and how you can apply this technology in compliance with certain standards. RFID tags located on the wagon have to in accord of ISO rules during its positioning to avoid unread information on the porter. It is necessary to take care on position of application reading device which must be able to read the information stored on the tag and at a higher speed [1], [2].

The required speed is adapted to frequency band, or i tis possible to locate the brand of speed reduction on the line and due to reader was able to read the RFID tags on the car or on the transport unit. When RFID tags are positioning on the wagon in the railway transport, it is known that the location of passive RFID tags (see Fig. 1) on the sides of the wagons is such that the reader can read the identification number of the wagon [2], [4], [6]:

- A1 minimum height of the RFID tag center is 500 mm,
- A2 maximum height of the RFID tag center is 1100 mm.

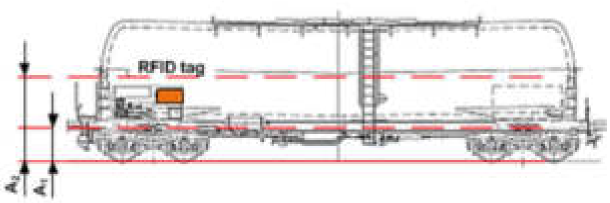

Figure 1 The possible way of height placement of RFID tags

Graphical interpretation on the Fig.2 shows suitable location of RFID tag in real conditions according to railway cargo transport [5], [7]. Location of RFID tag meets all of the standards under directive number 861/2006.

Figure 2 Aplication of RFID tag in real conditions of railway cargo transport

RFID reader located near the railway, must be placed (Fig.3) at a distance in order to read the identification number of the wagon , which is located inside the RFID tag:

- D1 minimum length distance of RFID reader is 1000 mm,
- D2 maximum length distance of RFID reader is 10 000 mm,
- Maximum travel speed of trainset is 30 km / h.

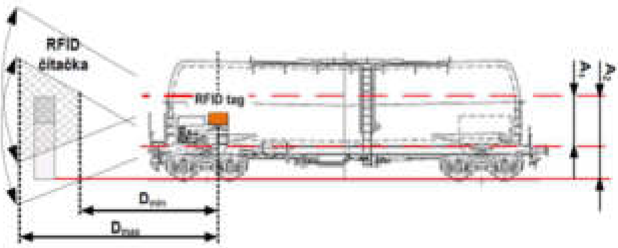

Figure 3 Way of linear placement of RFID readers

RFID reader construction must be resistant to weather and climate conditions. Changes in climatic conditions (wind , humidity, sunshine, snow) can damage the RFID reader , therefore it is necessary to think about when installing on all aspects that may damage the functioning of the system. Construction of stationary reading device is mounted on a solid concrete foundation to be extremely resistant to climatic conditions and also against theft. Connections (communication) between RFID tags, reader and a computer unit that contains the appropriate program for the processing and evaluation of the received information, they must communicate seamlessly together [7], [9].

Transmission can be performed with the help of optical cable line that railways are already using, or using wireless transmission, which is also commonly used. Optical cables are laid in the ground and have a higher capacity to digital broadcasting, which is several times faster and have better quality than an analog signal.

Vibrations or weather conditions affect wireless transmission, but eliminating adverse effects is possible by using the antenna and the amplifier device that is able to improve and enhance a number of times transmission of the signal [2], [8], [9].

Positioning system tracking of wagons is now positioning system tracking of wagons built on the basis of simple software application (information system operation - ISO) that, based on interaction with humans eventually ensure the data collection. Information concerning the wagon train set are identified by competent worker, who this information undergoes to the next worker for subsequent computerization of the data collected in a central data base. This identification process of all cars is carried out only in the starting and final destination for review. From this perspective at present, it is not possible to say exactly the position monitoring system of wagons in railway cargo transport. With more complex process it is possible to work towards the current position of the trainset . On the other hand, the current position of individual wagons, does not record stolen wagon or trainsets during transport. The most important part in terms of tracking wagon position in railway cargo transport is necessary to meet the basic functionality of the RFID system.

In order to meet the RFID system architecture , this concept (Fig.4) consists of the design of hardware and software components , which operate on the interaction principle. The hardware equipment and all part of the system in more detail are described in the following sections. The software product is in this case understood as a computational device as a server with a database.

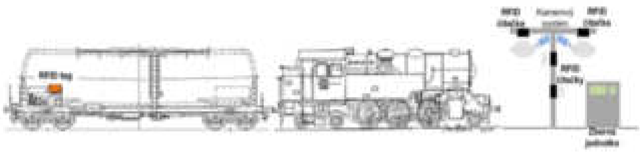

Figure 4 System of wagon tracking position

The way of wagon position tracking is carrying out continuous running through the trainset via a reading device, thereby activating the radio communication module [9], [10].

Transfer of data from RFID tags placed on wagons is provided by stationary reader. It is executed in parallel video recording, which is transferred to the collection unit positions near the track, together with obtaining wagon data by opto - electrical connection. The accumulated information can be periodically sent to the nearest station that will use this information for tracking the wagon position. The local station conveys the information thus obtained regional offices , which sent the obtained information to a central hub in the east, central and western Slovakia. The process largely automates the transmission of information, but is conditional upon the reader, which has to be installed in every station on entry and exit, not only on the starting and final station.

2 The proposal of implementing RFID into the information system

In the present state, workstation of cargo treasury comprises a number of workers who have the task of receiving individual waybills. Mainly there are waybills for domestic traffic , international transport designated as CIM or for international railway transport to the East SMGS. The worker has access to a computer with a installed Windows XP operating system and the appropriate browser (Internet Explorer) to trigger the necessary information system [3], [8].

Each worker has access only to the individual items he need for the registration of his requirements pertaining to that waybill. After receipt of the waybill in the national transport, worker handles different parts of the waybill, which contain data e.g .:

- customer data (name, address, registration number),
- sending station,
- date, required time of wagon attending,
- goods (type and weight)
- wagon (number, series or alternate series)
- station and destination railway or border crossing stations
- the requirement to borrow canvas (or amount),
- customer confirmation.

All these data and other data from waybill are manually entered into the information system ISP into the traffic order application. Worker lists all further necessary data and codes that are in boxes of various applications such as processing shipments, treasury and transport restrictions. Detailed description of these applications and the necessary data can be found in the previous chapters [4].

After these steps, the specifics entered in the ISP are transferred to the information system SAP R3. Subsequently, the original waybill is leaves to recipient at the arrival station, duplicate invoice is sent to Discontinue sales of railways (DSR), and duplicate gets in the sender departure station. After operation, collecting and processing individual waybills, accounting waybills are transferred from Centre of cargo transport in the form of a truck to discontinue railway sales at the station of Railway Company. According to high level of development of information, communication technology and level of automation in enterprises, it would be benefit to use electronic waybill transferred to RFID tags.

Electronic waybill replaces fully or partly its paper form in the national, international respectively SMGS transport. A customer who orders the transportation (sender) will might enter all the necessary data on shipments in the electronic waybill and subsequently with the help of EDI (Electronic Data Interchange) sent information to the railway system in the comfort from his own computer at own company. Transportation order will be created in the information system for specific customer and worker fills in all other particulars. Electronic waybill is entered into a database and worker processes price offer. Feedback to the sender will be in the form of price offer acceptance and on that basis shipper confirms or rejects the start of the transportation. Another alternative would be easier for a customer it will be registration of the company in the database of the information system of the railways.[6,8] Customers, who are registered in the online system of transport order, they will be entered only minimum amount of data:

- End time of transport
- Product name
- Type of transport
- Quantity of goods

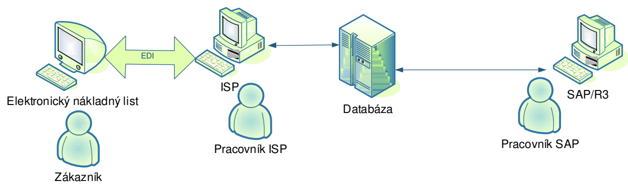

Figure 5 Using the electronic waybill

This order will be registered by using EDI into the order database of the customer. The customer should have access to their own orders, to repair or change data. This database would further exploit the SAP / R3 for accounting purposes. Worker should be assigned after receipt of the order to the transportation quote and sent it to customer and then the customer would confirm or cancel the given order shipment [3], [7].

Benefits of implementing an electronic waybill and EDI:

- reduction mistakenly entered data,
- speeding up the processing of documents,
- acceleration of documents delivery
- shortening the time when complaint procedure,
- removing the need for physical storage,
- removal of intensive search in the archives,
- automation of accounting with the correct settings for the processing of electronic documents would be automatically recorded,
- clarifying the whole process,
- facilitate and speed control,
- acceleration of customer communications – railway,

- improving customer service,
- accelerating the whole process of transport.

Savings in the implementation of electronic waybills and EDI:

- reduced operating costs for printing documents,
- save money on mailings,
- saving work of employees,
- cost savings for the operation of the archive and archiving,
- savings on office supplies,
- labor saving,
- saving labor costs [1], [2].

Based on the principle of introducing RFID systems in rail traffic, the electronic waybill will be written using Middleware for RFID tags. It would contain all the necessary information for the client side and the receiver side. It would also be possible to check the position of railway wagons and provide this information to the client in the information system at any time.

Conclusions

This paper describes the main principles for the installation of RFID technology into the railway background.

The first part of this article presents summary requirements for installation tags and antennas according to the legislation in force in Slovakia. Article also describes a complex system involving tag - antenna - middleware - computer. The second section describes the principle of operation of an information system and design of electrical waybill. Article offers perspectives of application of RFID technology.

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