UNIVERSITY OF ŽILINA

TRANSCOM 2011

9-th EUROPEAN CONFERENCE
OF YOUNG RESEARCH AND SCIENTIFIC WORKERS

PROCEEDINGS

SECTION 1

TRANSPORT AND COMMUNICATIONS TECHNOLOGY

ŽILINA June 27 - 29, 2011
SLOVAK REPUBLIC

UNIVERSITY OF ŽILINA

TRANSCOM 2011

9-th EUROPEAN CONFERENCE
OF YOUNG RESEARCH AND SCIENTIFIC WORKERS

under the auspices of

Ing. Eugen Jurzyca
Minister of Education, Science, Research and Sport of the Slovak Republic

&

Prof. Ing. Tatiana Čorejová, PhD.
Rector of the University of Žilina

SECTION 1

TRANSPORT AND COMMUNICATIONS TECHNOLOGY

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TRANSCOM 2011
9-th European conference of young research and scientific workers

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Influence of Overloaded and Over-dimensioned Heavy Traffic to Traffic Flow Safety in Road Tunnels

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Abstract. Increased portion of heavy traffic introduces also increased risk in the area of road traffic safety in spatially closed constructions of road tunnels due to exceeding the permitted parameters of these vehicles which should be in regard to safety protection of other road traffic participants, but also protection of technological equipment of a tunnel early enough detected in order to take all efficient measures for avoiding an eventual occurrence of dangerous situation with unfavourable consequences as in regard to human lives and properties.

Keywords: overloaded heavy traffic, safety of road tunnels, measurement of traffic parameters in motion, drivers´ behaviour

1. Introduction

Hand-in-hand with growing the living standard of inhabitants as well as development of industry and services in individual regions there grows also a portion of heavy traffic (mostly truck transport) which became more interesting and much-favoured in comparison with railway traffic first of all due to its better directness. With increase of heavy traffic portion, its innovation and increasing the engine performances there has also been increased the occurrence of overloaded vehicles that introduce certain safety risk on our roads and first of all in critical road tunnels.

The overloaded heavy vehicles on the roads introduce a safety risk toward other road traffic participants by reducing their manoeuvrability and control. To the parameters that are effected by vehicle weigh belong stability of vehicle (it occurs the possibility of its turnover), braking effectiveness, sensitivity of control, technical condition of a vehicle and its parts and others. From worldwide statistics results that the accidents caused by overloading of heavy vehicles have more fatal consequences than those caused by a legal loaded vehicle. It is proved that the braking distance of overloaded vehicles is prolonged 10 – 20 times whereby the stop-point of is considerably moved forward. Increasing of heavy vehicle weighs leads mostly to considerable decreasing of speed in up gradients, to increasing of risk to overheat the brakes during intensive downhill grade and increasing of difficulties at changing the traffic lane. Increasing of vehicles leads also to premature wear of vehicles themselves and their parts. Merely a single puncture of an overloaded vehicle during its travelling can cause remarkable higher damages. Each one of these situations unfavourably influences the traffic and increases the risk and/or consequences of eventual road traffic accident [2].

2. Road tunnel environment

Contrary to the open road conditions, the user of a road tunnel gets into situation “forced” by investor, eventually operator of tunnel construction who is responsible for safety of road traffic participants. By comparison of statistics related to number of accidents in tunnels is obvious that the number of accidents for 1 km of length per year is considerably lower than number of accidents on open roads. It is, however, dependent on absence of intersections in tunnel and a lower weather influence to traffic. If the consequences of accidents are compared, however, these are much bigger in tunnels than on open roads regarding to close area in tunnel. First of all the accidents with following fire might have the disastrous after-effects, very often with substantial number of victims on human lives.

Disasters in road tunnel repeat and it is not possible to avoid them completely, therefore the measures have to be introduced (also in accordance with Directive 2004/54/EC of European Parliament and European Council) serving as prevention of occurrence the events endangering the human lives and, of course, for reducing the consequences of such events [1].

2.1. Approach to safety in road tunnels

To apply an integrated approach to safety of tunnels means to deal with whole safety chain that is created by:

1. *Pro-actions*: avoidance of situations in tunnels that are not safe, by exclusion of all primary causes.
2. *Prevention*: reduces the probability of an accident in tunnel
3. *Mitigation*: a maximal possible mitigation of accident consequences in tunnel by taking the measures for allowing an escape of endangered persons from accident area still before the emergency units arrive.
4. *Preparation*: readiness of emergency crews
5. *Repression*: providing of reasonable help from the side of public rescue staffs, if there are substantial effects.
6. *After-care*: realization of all necessary steps to a return into normal state

Safety measures should be taken as much as possible at the beginning of safety chain. In certain cases the shortcomings in one part of the chain can be compensated by additional measures in other parts of chain. Prevention is, of course, of a prime importance, it is, however, not possible to avoid all events. [1]

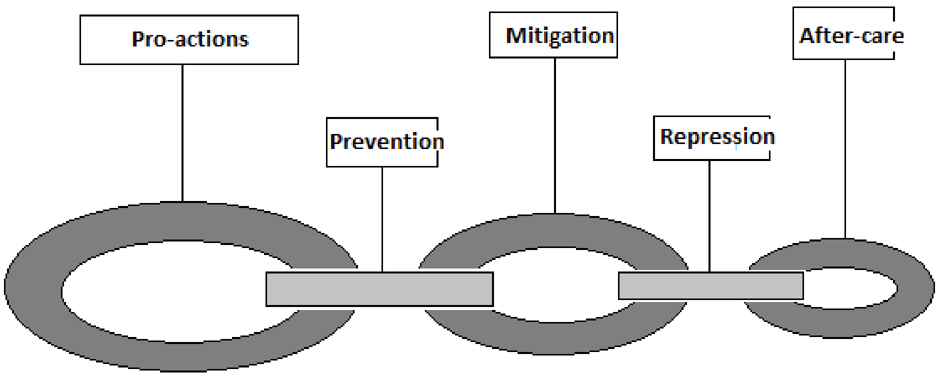

Fig. 1. Safety chain

2.2. Prevention

Contribution deals with a concrete risk in road tunnels and this risk represents the overloaded, or over-dimensioned heavy traffic that should be in the best case completely excluded from traffic flow. Stopping the vehicles from the reason of performing the measurements of permitted limits (first of all the weight of vehicles) is wasting of time and money. The Ministry of Environment in state Oregon has found out at its tests that if the vehicles do not stop it comes to about 36 – 67% lower environmental pollution and the effectiveness of fuel consumption increases about 57% [4]. Last but not least the road itself is protected, too, which is at the stopping the heavy traffic at one place subject of abnormal wear. Solution is a pre-selection system recording the passing of vehicles with pre-defined selection of excess limit vehicles in all traffic lanes of this road and this all without any speed restriction on it. The vehicles exceeding the limit are therefore identified while running and the selection of vehicles for checking station is more effective.

3. Measuring in motion

Measuring in motion is a process of assessment of total weight of moving vehicle, individual wheel, axles, or axle groups by measurement and analysis the tyre pressure of a vehicle. The most widespread are the piezoelectric sensors (a piezoelectric effect was invented in 1880 already). It goes about a change of mechanical energy to electric one. By pressuring, or deformation of piezoelectric material is created an electric charge directly proportional to force (pressure) acting on a sensor. The most widespread form of triggering the process of axle signals processing in Slovakia are inductive loops. The entrance edge of the first loop detects the entrance of vehicle into detection zone and the exit edge of the second loop the exit of vehicle from detection zone. Possible is, however, also using of a non-invasive triggering technology, such as laser.

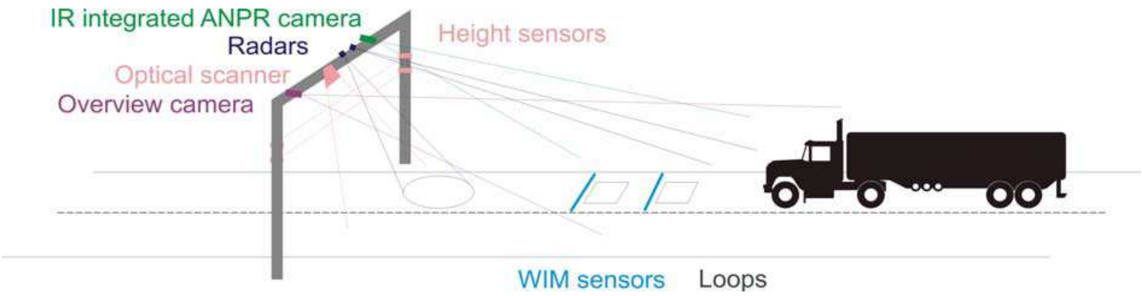

Fig. 2. Typical configuration of weighing sensors and inductive loops, optical and non-invasive sensors are placed in tunnel.

In sufficient distance before road tunnel (in front of the last intersection, in order that there is a possibility to prevent the passing of vehicle with exceeded limits through road tunnel) should be installed a measurement system consisting of measurement the vehicle weights and their individual axles, camera system for unambiguous identification of vehicle number plate, measurement of vehicle shape (height, width) and equipped with variable message signs. After the vehicle has passed the measurement point it is evaluated whether vehicle is overloaded, too high, or too wide. At the same time the camera system is launched which creates a picture of the vehicle and following that recognizes the number plate of given vehicle. The picture, recognising the number plate and information about exceeded parameters are immediately sent into the control centre to the operator and at the same time to variable message signs where the vehicle is diverted to a secondary road by means of a commanding sign with additional information relating to number plate and the exceeded parameter. It is possible to equip this place with parking space where the calibrated static scales are installed, eventually portable scales and the police officers who receive this information directly to their PC tablet, may apply specific repressions against those drivers. Disobedience of commanding sign for diversion can be monitored by camera system situated behind the last intersection and therefore directly on the road leading through tunnel where the number plate of each vehicle shall be recognized and in case in this point the number plate of this vehicle is found that should have been diverted the operator of the centre receives an alarm as a warning that a vehicle with exceeded limits is about to go into tunnel the passing of which should be monitored from safety reasons. It would be reasonable to punish the undisciplined drivers additionally based on achieved information as relating to number plate and to enforce in such a way the discipline that may contribute to higher safety of road traffic participants in tunnels [3].

Heavy vehicles are safety critical also from the transported load point of view. The load is either over-dimensioned which can cause an endangering of other road traffic participants by its loosening, or it can seriously damage the technology installed in road tunnel, or this load is dangerous which in case of a traffic accident in close area of tunnel might mean the serious endangering of safety. Transport of dangerous products and subjects is realized on the basis of adopted European conventions for transport of dangerous substances, the “ADR Convention” (European Convention about International Road Transport of Dangerous Product). In order to be able to control the passing of vehicles transporting dangerous products it is necessary to identify automatically the vehicles designated as ADR, to be informed about their position and to know the content of transported dangerous load as good as possible [1]. Recorded data should be sent into the control centre with anticipated position of a vehicle. Such a vehicle should be continually monitored during its whole time of passing through the tunnel. In case of an accident in tunnel the quick and effective measures can be taken, since the rescue crew is informed about the kind and properties of dangerous substances inside the tunnel.

3.1. Behaviour of drivers

It is important to warn the traffic participators on the road leading to the road tunnel about the presence of the latter and this already before the last possible slip road from this road before the tunnel. This is necessary either from the reason of max. permitted height, non-permitted dangerous load, or just because of the psychic of a driver. Behaviour of a driver is the most important factor which might have a direct effect to occurrence of traffic accident and therefore it is necessary to watch the behaviour of drivers, first of all the heavy vehicle drivers. Attention is focused to heavy vehicles because of worse consequences in case of a traffic accident and also because of increased risk of occurrence the traffic accident due to non-keeping the rest times and resulting problems with concentration of tired truck drivers.

Behaviour of a driver can be evaluated on the basis of some measurement in section before the tunnel. Those measurement stations should contain at least a camera system for measurement of vehicle presence, number plate, its speed and its belonging to a traffic lane, for more precise measurement it can be equipped for instance with laser technology. Data related to a vehicle category will already be achieved in system from complex measurement station determined for measurement of parameters with exceeding limits. From thus achieved data shall be following that calculated the profile of a vehicle from which will be evaluated whether it is hazardous, or not. For instance, if a block speed of a vehicle is inadequate high as to the character of vehicle (its load and weight), or on a motorway with more lanes the vehicle often moves from one lane to the other or vice-versa. If a prospective dangerous behaviour of a heavy vehicle driver is identified, the control centre operator has to be informed about it and the passing of such a vehicle should be observed by camera system inside of tunnel, eventually it might be necessary to reduce its speed through commanding sign, or to prohibit him changing the traffic lanes.

4. Conclusion

As it has been already mentioned above prevention has in safety chain the primary meaning. It is necessary to use all possible means to avoid early enough the unwanted, prospective dangerous events. This contribution is focused on the risk that is represented in road tunnel by passing of heavy vehicles with exceeded limits, either from technical or merely human point of view. It is difficult to figure out which one factor is more likely to induce the occurrence of a dangerous situation, but it is necessary to pay a higher attention to it already in a phase of design as to how the road tunnels are to be operated.

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Univariate Time Series Theory: Application to Passenger Demand Forecasting (Passengers Carried per School Reduced Fares)

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Abstract. The methods, which are used for the purpose of passenger demand forecasting by Slovak transportation companies at the present time, are considerably simplified, and what is more, they are not already considered to be accurate. These limitations might be caused by insufficient research in this area over last years. Purpose of this paper is to identify a statistical model of passenger demand for suburban bus transport which satisfies the statistical significance of its parameters and randomness of its residuals. Three different methodologies - exponential smoothing, multiple linear regression and autoregressive models were used in order to identify more accurate and reliable statistical model compared with nowadays used ones.

Keywords: Passenger demand. Demand modelling. Short-term demand forecasting.

1. Introduction

Statistical modelling and forecasting of passenger demand by using univariate time series theory is probably one of the most common forecasting methods used for work with periodic time series data. This methodology has been successfully applied in the sphere of urban [1,2] and suburban [3,4,5,6] bus transport. The main goal of this paper is to introduce method of the statistical modelling of passenger (carried per school reduced fare) demand by using univariate time series theory which appears to be more accurate and reliable alternative to automated forecasting procedures published in the literature [3]. In accordance with the main goal of the paper was designed a statistical model which is suitable for short-term forecasting of passenger (carried per school reduced fare) demand for suburb bus transport in Žilina region. The most of analyses, modelling and forecasting procedures of the time series mentioned in this paper were worked out by using SAS LE 4.1 [7] and SAS 9.3.1 [8] software.

2. Materials and Methods

Properties of the used data, methods of its analysis, modeling and testing are briefly described in this section.

2.1. Properties and Adjustments of Input Data

Input data of experiments presented in the paper were counts of carried pupils and students collected by the cooperating carrier. These values were aggregated by summing so that an output of the aggregation process was monthly time series of passenger demand carried per school reduced fare $\{Q_p(t); 1 \leq t \leq 96\}$ (for period of months 1/2000-12/2007) in the Žilina Region.

Values in such a manner designed time series $Q_P(t)$ were considered to be spatially and substantially homogeneous as the carrier had changed neither his geographic scope nor transportation technology in the range affecting substantial and spatial aspects of the analysed time series within the specified period of months. “Trading day effects” were eliminated by own [9], passenger demand properties respecting, modification by Cipra [10] described calendar adjustment procedures. The output of the calendar adjustment process was fully homogeneous time series of passenger (carried per school reduced fare) demand for suburban bus transport $\{Q(t); 1 \leq t \leq 96\}$.

At first there were by subjective methods identified and later by objective methods properly confirmed – constant trend, monthly additive seasonality of $Q(t)$ time series in pre-forecasting analyses [9]. The models presented in this paper respect these properties completely.

2.2. Methods

Multiple regression, exponential smoothing and autoregressive models were used in order to statistical modelling of $Q(t)$ time series. The seasonal exponential smoothing model (method A) was developed and fitted by using exponential smoothing methodology. Smoothing state at time $t = 0$ of the model was obtained by Chatfield´s backcasting method [11]. Smoothing weights (level α, seasonal δ) were determined so as to minimize the sum of squared one-step-ahead prediction errors:

$$\sum_{t=1}^{n} \varepsilon_t^2 \rightarrow \min . \qquad (1)$$

Multiple regression was used in combination with Box-Jenkins methodology in the paper. The multiple regression (constant term with seasonal dummies) model combined with an autoregressive process of order $p = 1$ AR(1) (method B) was used for the first time and then in the case of the multiple regression (constant term with seasonal dummies) model combined with an autoregressive/moving average process ARMA (1,1) (method C). There were used practices and principles of linear stochastic models designing [10,12] in the process of developing and fitting of $Q(t)$ time series models by using Box-Jenkins methodology. Applying this methodology were designed three autoregressive integrated moving average models of seasonal time series $ARIMA(1,0,1)(0,1,1)_{12}$ (method D), $ARIMA(1,0,1)(2,1,0)_{12}$ (method E) and $ARIMA(1,0,1)(1,1,0)_{12}$ (method F) - all without intercept parameter.

The statistical models presented in the paper were tested for compliance with the requirements imposed on mutual linear independence, stationarity and the normality of probability distribution of their standardized residuals ($\varepsilon_t = 1, \dots, 96$). Mutual linear independence of models ε_t was tested by Bartlett´s test for autocorrelation [13] and Ljung-Box´s χ^2 statistics [14]. Stationarity of the residual components was evaluated by augmented Dickey-Fuller´s tests (ADF tests) [15] and Dickey-Fuller´s unit root tests of seasonal time series (SDF tests) [16]. Normality of the standardized residuals probability distribution was tested by Shapiro-Wilk´s (SW) [17] and by D´Agostino [18], Prins [19] and Filiben [13] described Kolmogorov-Smirnov´s (K-S), Anderson-Darling´s (A-D) and Cramér von Mises´s (C-M) tests. Statistical significance of estimated parameters of the models was tested by Student´s t-test [20]. These tests were conducted at significance level $\alpha = 0{,}05$ (except for the normality tests where significance levels ($\alpha = 0{,}15$) were used because of tests detection abilities).

3. Empirical results

The outputs of the forecasting procedures (analyses, modelling, testing) presented in the paper are goodness-of-fit statistics (Tab. 1), outputs of the randomness tests as well as evaluation of statistical significance of models parameters (Tab. 1). According to high volume of available outputs of computations they are presented only in considerably reduced form in the paper. Full outputs including estimates of model parameters and its statistical significance evaluation, goodness-of-fit statistics, point and interval forecasts are part of dissertation thesis [9].

In order to measure how well different models (methods A-F) fit the data were computed traditional (root mean square error – RMSE, mean absolute percent error – MAPE) and penalty (Akaike’s information criterion – AIC [21], Schwarz Bayesian information criterion – SBIC [22]) as well as extrapolational ($MAPE_3$, $MAPE_{12}$) goodness-of-fit statistics. Computed values of these measures see Tab. 1.

statistic	unit	method					
		A	B	C	D	E	F
RMSE	[1000 passengers]	4,795	4,746	4,690	5,772	5,691	5,965
MAPE	[%]	0,511	0,500	0,489	0,640	0,638	0,657
AIC	[-]	304,992	325,004	324,710	300,500	300,142	306,045
SBIC	[-]	310,121	358,340	360,611	307,792	309,865	313,338
$MAPE_{12}$	[%]	1,076	0,866	0,989	.	0,977	0,939
$MAPE_3$	[%]	0,806	0,802	0,776	0,748	0,626	0,744

Tab. 1. Computed values of the goodness-of-fit statistics

Note: RMSE, MAPE, AIC and SBIC were computed by using the actual and forecasted values of observations in the period of evaluation (for a period of months 1/2000 – 12/2007), parameters of the models used for forecasting were estimated by applying observations from the same period of time. $MAPE_3$ and $MAPE_{12}$ were computed by using actual and forecasted values of observations in the period of evaluation (for a period of months 1/2007 -12/2007 – $MAPE_{12}$ and 10/2007 – 12/2007 – $MAPE_3$), parameters of the models used for forecasting were estimated by applying observations for a period of months 1/2000 – 12/2006 – $MAPE_{12}$ and 1/2000 – 9/2007 – $MAPE_3$.

method	statistical significance	linear independence			stationarity		normality			
		BT-ACF	BT-PACF	LB	ADF	SDF	S-W	K-S	C-M	A-D
A	-	+	+	-	+	+	-	-	-	-
B	+	-	-	+/-	+	+	-	-	-	-
C	+	+	+/-	-	+	+	-	-	-	-
D	+	+	+	-	+	+	+	+	+	+
E	+	+	+	+/-	+	+	+	+	+	+
F	+	+	-	+	+	+	-	+	+	+

Tab.2 Evaluation of tests for randomness of ε_t and statistical significance of estimated parameters of the models

Note: Statistical tests provided “+”- satisfactory “-”- unsatisfactory “+/-”-boundary (satisfactory) results.

Based on the results of the tests for mutual linear independence, stationarity, normality of probability distribution and statistical significance of estimated parameters of the models seems the method E as the only one suitable for forecasting (ex-post, ex-ante) of $Q(t)$. The model estimated by the method E showed very well fitting ability for actual data by its forecasts compared with other ones. Inappropriateness of other models to produce forecasts resulted from confirming autocorrelation of their ε_t by Bartlett´s tests (BT ACF, BT PACF) or Ljung-Box´s χ^2 statistics. Further use of the forecasted values requires consideration of the fact that model (method E) systematically underestimates reality. This accrues from the value of mean percentage error (MPE=0,087%) of this model. True values $Q(t)$; $t = n + 1 , \ldots , n + h$ are likely higher than forecasted values.

Graphical output of modelling and forecasting by using the method E see Fig. 1 where estimated values are expressed by smooth curve and empirical values by black points. The graphical interpretation of the actual (empirical) and forecasted values show that this model accurately describes the variability of empirical values of $Q(t)$. This fact is also supported by low levels of residuals of the model (displayed by the bar diagram in Fig. 1).

It was objectively proved that it is possible to reduce the confidence interval (2) around the estimator $\hat{Q}(t)$; $t = n + 1 , \ldots , n + h$ (at the confidence level of 0,95), from ±200 to ±16 thous. passengers carried, compared with outputs of computations published by Konečný [3].

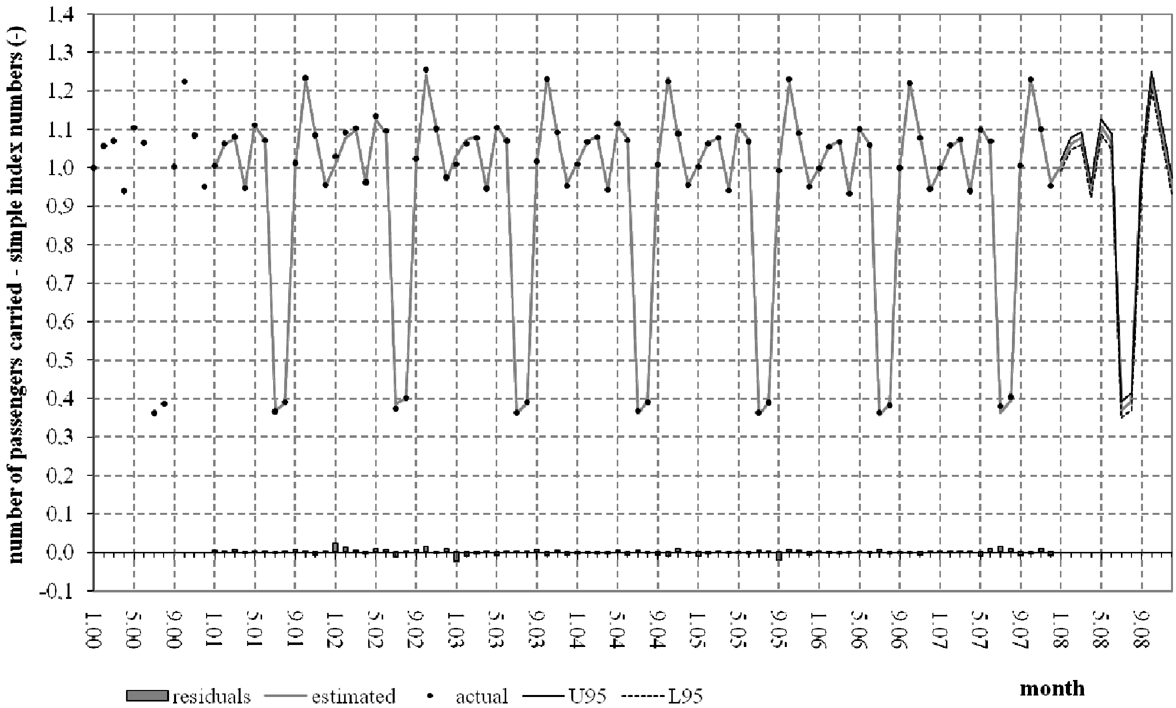

Fig. 1 Actual and estimated values of the *Q*(*t*) time series

Note: In order to protect interests of the cooperating bus transport company are values of Fig.1 presented in the form of *simple index numbers* ($I_{n/0}$). Reference value of the variable *Q*(*t*) is expressed in the base 1,0 in reference situation (t = 1, January 2000).

$$P\left(L_{95t} \leq \hat{Q}(t) \leq U_{95t}\right) = 1 - \alpha \qquad (2)$$

Where:
L_{95t} - lower limit of the confidence interval,
U_{95t} - upper limit of the confidence interval,
1-α - given probability, called confidence level of the interval,
$\hat{Q}(t)$ - estimated value of passenger demand.

More detailed comparison of forecasting abilities and statistical properties of the method presented in the paper with statistical model designed by Konečný [3] in view of goodness-of-fit statistics inaccessibility was not possible. It is obvious that the increase of statistical model (method E) reliability defined by the reduced confidence interval (2) is also the attendant phenomenon of its increasing interpolation accuracy.

4. Conclusion

Outputs of the statistical tests of standardized residuals randomness of the model and the values of goodness-of-fit statistics proved that the autoregressive integrated moving average model of seasonal time series ARIMA(1,0,1)(2,1,0)$_{12}$ without intercept parameter (method E) fulfils the requirements for statistical significance of its parameters, and what is more, mutual linear independence, stationarity and normality of probability distribution of its standardized residuals.

This model with respect to cross-regional differences cannot be considered as universally applicable throughout the Slovak republic, but only in the Žilina region.

ARIMA(1,0,1)(2,1,0)$_{12}$ without intercept parameter presented in this paper despite the abovementioned restriction represents more reliable and more accurate passenger demand forecasting method in comparison with up to this time used ones. The attendant phenomenon of application in the paper described model in relevant transport company management is the reduction of manager´s decisions uncertainty, and what is more, it can result in increase of company´s revenues. This model is partial output of dissertation thesis [9].

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Requirements for the Creation of the Piece Shipments Transport Technological Process by Road in the Slovak Republic

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Abstract. For express service transport, it is necessary to have the required rapid implementation of services. These services are based on a contractual obligation, for example: the requirement for the delivery of the items in an hour. In the Slovak Republic, the segment of express shipments is in constant development, which leads to greater efficiency. In order to achieve a higher efficiency, it is necessary to have created a suitable transport network, which is one of the major distribution problems. Another very important task of each company is to optimize its processes and determine the order of activities. For shipments to the creation of a transmission network with a number of collection points, it is necessary to have a well established information system which serves to communicate the positions of individual items in the chain transfer to the workers of the company but also to provide to their customers.

Keywords: the piece shipment, the technological process, the transport network, the information system.

1. Introduction

Express service requires the rapid implementation of services. Express services are based on a contractual obligation, for example: the requirement for the delivery of the items in an hour. In the 90´s a network of express was developed, which was based on short and long-term cooperation between the service providers and the customers. Also optimized surface network carriers were optimized to offer leading performances with high quality. In the Slovak Republic the segment of express shipments is in constant development, which leads to greater efficiency. The increasing demand for the piece shipment transport is both associated with an advantageous geographical position of the Slovak Republic in Europe and also the recent accession of our country into the European Union, which has increased imports and exports among these EU member countries.

Not only in times of crisis, making a profit is important for every company. The formula for calculating prices, it is necessary to know the value of cost which are included in the final price. It is therefore necessary to minimize the amount of costs. Of course companies should strive to achieve not only a profit but also to meet customer requirements. For the express piece shipments, it is the delivery of consignments on time to the right place with the right quality.

With respect to these two conditions, it is important to have created:

- the piece shipment transport network,
- the piece shipment transport technological process and
- the information system.

2. The piece shipment transport network

In developing the transport network the nodes of the same level, or nodes of different levels are connected. On this basis, a distinction is made among the polygonal transport network (here we have two possibilities how to create this network as the full polygon or the incomplete polygon), the hub and spoke model (or even radial), or circle model of the transport network.

2.1. The models of the transport network

Full polygon is characterized by each node on the transport network being interconnected with each other. If that is not met, every node that is not connected to each other, so all the nodes of the transport system, it is an incomplete polygon. Such a link can be applied at the highest level of the transport network. A third way of creating a transport network is a hub and spoke or radial transport network model, where only local nodes are associated with the main transport hub. Each local node is interconnected. The latest model for constructing a transport network is a circle model. The principle of such a model lies in the fact that the nodes are always connected by only two other nodes, forming a circle.

Although the above mentioned models of the transport system are in practice, very few cases occur in pure form. During the construction of the transport network system, it is necessary to take into account more factors that influence the selection of individual models needed to construct a suitable transport system. The design may be affected by the following factors:

- The density of the transport network - this factor is one of the necessary things but at the same time and limiting assumptions
- Horizontal and vertical organizational orderliness
- Organizational identification transport system, which is the ultimate starting point in determining the modes and routes within individual levels and between them
- Geographical breakdown and relief of the country
- Streams of individual types of packages and their size
- Capacity of the used vehicles used
- Safety and economy of the transport. [1].

2.2. Construction of the piece shipment transport network

In developing the transport network in the Slovak Republic, it is necessary to pay attention to minimizing costs. Every action and every process is carried out to optimize the process. Everyone in business wants to have a profit. This can be achieved while minimizing operating costs. If we, in the construction of the transport network, use only the full polygon model, it would be very expensive because the money is in the vehicle fleet. Such a method of constructing a transport system is logistically very difficult. It is therefore appropriate for the company to use a combination of models. From a logistical standpoint, it is useful to classify the territory into several parts and for each area to establish a major hub with the local main warehouse, where there would be the sorting of the various items. A graphic representation of the breakdown of the Slovak Republic and the main nodes is illustrated in Figure 1. Among these nodes the transport network by the grid of hub and spoke model would be created. Within each area the piece shipment transport network should be created by using the optimal route to the CPM model, taking into account the time of delivery.

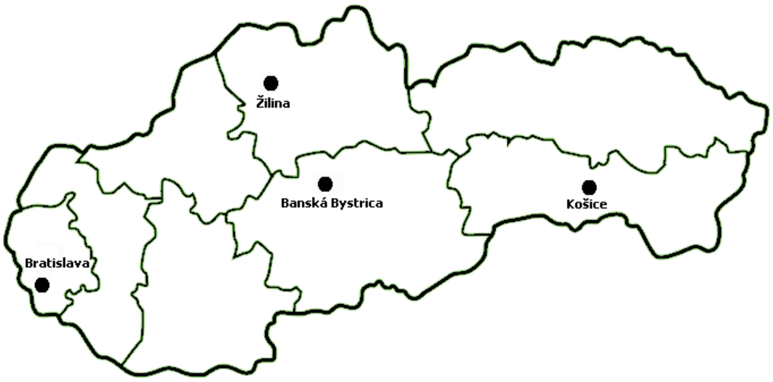

Fig. 1. The local main warehouses in Slovakia.

The advantage of using the hub and spoke model against the full polygon is in the fact that vehicles from all local main warehouses are en route to the warehouse in Banská Bystrica, where there is a sorting and exchange of items depending on the delivery addresses. After these operations, it will return to its "home" local main warehouse where it is subsequently separated and distributed according to the delivery address of the final consumers. This reduces fuel costs and increases factor driving the use of individual vehicles, which has an impact on minimizing the total cost of transportation.

3. The piece shipment transport technological process

The technological process is a structure of activities which are necessary for each company. It is a flow of activities from start to finish. According to this flow the company and workers know the order of these activities. The schedule of the piece shipment transport technological process is shown in Figure 2. In the first step it is important to receive the order from the customer and input this information into the process. It is required to have created an information system. After the deadline for receiving customers´ orders, a calculation is made and the company imagines a way how to pick up these shipments and in which order for each area. These shipments are transported to the local main warehouse. For each local area the transport network is not exactly designed. It depends on the quantity of the piece shipments, the address of the pick up and the pick up time. In the local main warehouse the piece shipments are separated according to the delivery addresses of the four groups or less according to the local main warehouses in Žilina, Bratislava, Banská Bystrica and Košice. There is not a condition to have the piece shipment for each warehouse.

Now we have to ask the question ourselves: “Is the delivery address at the same location as the pick up address?” or “Are one of these groups for our local main warehouse?” If the answer is YES, the piece shipment or group will stay in this warehouse and the others, for which the answer to this question is NO, will be transported to the local main warehouse in Banská Bystrica. Here together the groups of piece shipments for the same local main warehouse are connected and then the vehicle with them is returned back to its own local main warehouse with the group of the piece shipments. After that each local main warehouse has only piece shipments for its local area. They can separate the piece shipments and order the delivery line for the transportation to the customer according to the delivery addresses and the time of delivery.

4. The information system

As previously written, having the information system is very important. It is useful in communication among the other local main warehouses. For the warehouse it is necessary for the creation of the pick up line. However each local main warehouse has to know the order of the other local main warehouses because it needs to know how many shipments and from which area its vehicle brings them back from and to the warehouse.

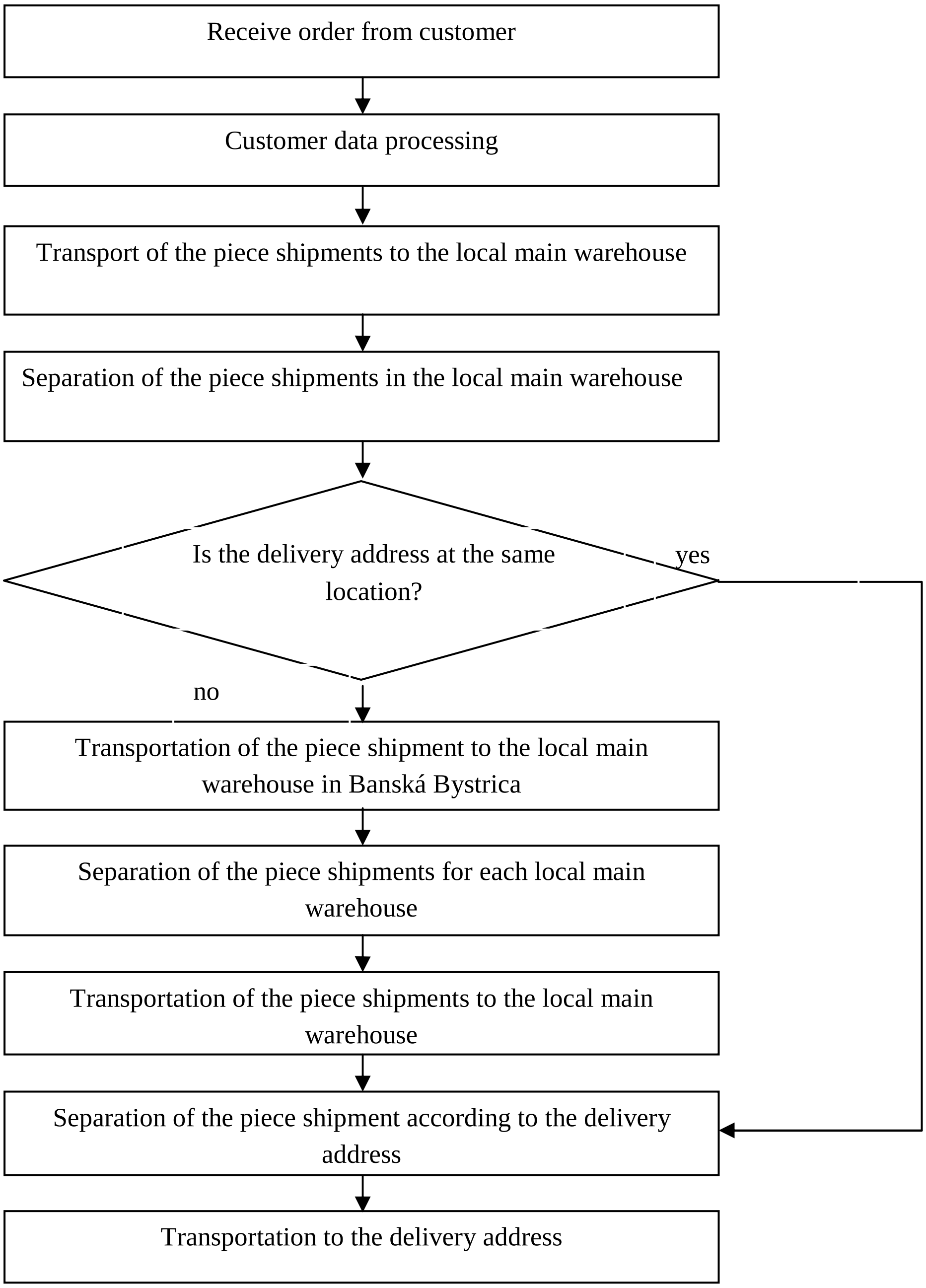

Fig. 2. The piece shipment transport technological process.

5. Conclusion

This article is a partial result of the final thesis "Formation of Price for the Piece Shipment Transport Service by Road in the Slovak Republic".

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Synchronization of Public Transport Lines in the Max-plus Algebra

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Abstract. The paper deals with the synchronization of joint departures of bus stops by the Max-plus algebra. The first part is a theoretical analysis of max-plus algebra. The next section is based on Max-plus algebra modeled synchronization of communications of departure bus stops. In the final part we give an assessment.

Keywords: Max-plus algebra, modelling, transfer stop, synchronisation.

1. Introduction to the Max-plus algebra

Max-plus algebra appeared in the field of operational research as a scientific approach to decision-making processes in 1950. Most problems in operations research involves finding of optimum. One of Max-plus algebra operations is that of taking maximum, therefore this tool is a suitable candidate for the mathematical description of the problems in the field of operational research. In operations research problems are usually solved by development of algorithms that lead to optimal solutions.

Max-plus algebra is a mathematical tool in which the arithmetic operation of addition is replaced by determining the maximum, and the multiplication operation is replaced by the addition. Due to nonlinear nature of the maximum operation, Max-plus algebra can be used for solving linear algebra problems of synchronization and it gives also a new approach to solving optimization probléme. This mathematical approach provides an interesting way suitable for modeling discrete event systems (DES) and optimization problems in production and transport. Moreover, there is a strong similarity with the classical linear algebra, allowing for example taking into account the sparsity patterns of linear equations and efficient computation of eigenvectors and eigenvalues [1], [2] and [3].

2. Synchronization of public transport lines in the Max-plus algebra

This part of the paper will be focused on modeling the timetable of bus routes in public transport of Prostějov city. We need to determine the times of departure of bus connection synchronized lines shown in figure 1. That is, to ensure the possibility of crossing passage between lines L1 and L2 at bus stop Nemocnice and crossing passage between lines L2 and L3 at the stop Lázně.

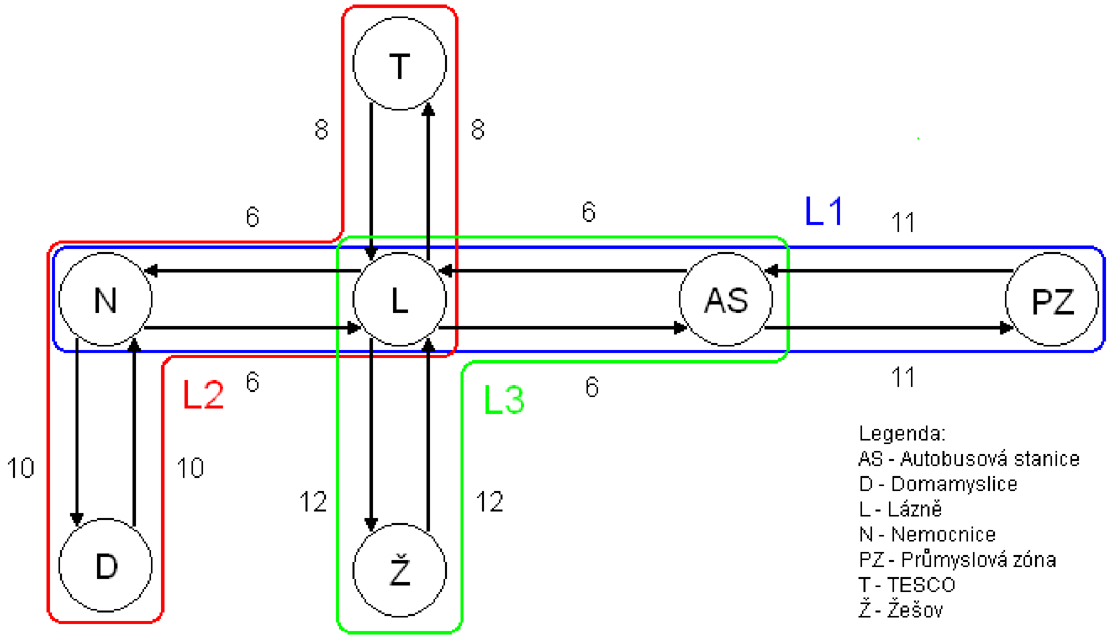

Fig. 1. Fragment of public transport network Prostějov.

2.1. Mathematical model of synchronized public transport lines

The synchronization of public transport lines were modelled using Max-plus algebra equations. We write down the equation for each bus stop so that for every departure from the stops, the arrivals of vehicles from neighbouring bus stops were taken into account.

Let us clarify the notation for symbols used in modelling:

$x_{ij}(k)$ - *k*-th synchronized departure from the *i*- stop in direction to the *j*-th stop (variable quantity) $i \in \{A, B, ..., E\}$, $j \in \{A, B, ..., E\}$,

t_{ij} - travel time between *i*-th and *j*-th stop (constant parameter) $i \in \{A, B, ..., E\}$, $j \in \{A, B, ..., E\}$,

$i_l(k)$ - interval on the line *l* at the k-th synchronized departure (constant).

Mathematical model for guarranted synchronization of public transport lines

$$x_{AS-L}(k+1) = \max\left(x_{AS-L}(k) + i_3, x_{Z-L}(k) + t_{Z-AS}\right). \quad (1)$$

$$x_{D-N}(k+1) = \max\left(x_{D-N}(k) + i_2, x_{T-L}(k) + t_{T-D}\right). \quad (2)$$

$$x_{N-D}(k+1) = \max\left(x_{N-D}(k) + i_2, x_{PZ-AS}(k) + t_{PZ-N}, x_{T-L}(k) + t_{T-N}\right). \quad (1)$$

$$x_{N-L}(k+1) = \max\left(x_{D-N}(k) + t_{D-N}, x_{N-L}(k) + i_1, x_{PZ-AS}(k) + t_{PZ-N}\right). \quad (4)$$

$$x_{L-AS}(k+1) = \max\left(x_{L-AS}(k) + i_3, x_{T-L}(k) + t_{T-L}, x_{Z-L}(k) + t_{Z-L}\right). \quad (5)$$

$$x_{L-T}(k+1) = \max\left(x_{AS-L}(k) + t_{AS-L}, x_{D-N}(k) + t_{D-L}, x_{L-T}(k) + i_2\right). \quad (6)$$

$$x_{PZ-AS}(k+1) = \max\left(x_{N-L}(k) + t_{N-PZ}, x_{PZ-AS}(k) + i_1\right). \quad (7)$$

$$x_{T-L}(k+1) = \max\left(x_{D-N}(k) + t_{D-T}, x_{T-L}(k) + i_2\right). \quad (8)$$

$$x_{Z-L}(k+1) = \max\left(x_{AS-L}(k) + t_{AS-Z}, x_{Z-L}(k) + i_3\right). \quad (9)$$

2.2. Characteristics of input data

The selected part of the transportation network of public transport in Prostějov consists of three lines, which are always served by one vehicle. On each line there are defined regular time intervals of bus arrivals (tab. 1).

Number of line	Time interval on line *l* [min]
Line 1	56
Line 2	58
Line 3	46

Tab. 1. Regular time intervals for lines

2.3. Computing of departure times of bus connections from the stops

By substituting the values of the input data parameters to the Max-plus algebra equations (1) - (9), we can obtain the matrix *A* (10).

Next we computed the eigenvalue and corresponding eigenvector for the matrix *A*. Eigenvector was used for determination of initial departures from the stops. Using computed eigenvalue, we can determine the time period, after which the departures will be repeated.

Using eigenvalue we can also determine each of successive departures from the stops, thus we can obtain the time values for departures between initial departures and repeated initial-like departures.

$$A = \begin{array}{c} \\ ASL \\ DN \\ ND \\ NL \\ LAS \\ LT \\ PZAS \\ TL \\ ZL \end{array} \begin{array}{c} \begin{array}{ccccccccc} NL & PZAS & DN & LT & ND & TL & ASL & LAS & ZL \end{array} \\ \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 46 & 0 & 18 \\ 0 & 0 & 58 & 0 & 0 & 24 & 0 & 0 & 0 \\ 0 & 23 & 0 & 0 & 58 & 14 & 0 & 0 & 0 \\ 56 & 23 & 10 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 8 & 0 & 46 & 12 \\ 0 & 0 & 16 & 58 & 0 & 0 & 6 & 0 & 0 \\ 23 & 56 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 24 & 0 & 0 & 58 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 18 & 0 & 46 \end{pmatrix} \end{array} \qquad (10)$$

The values obtained for synchronized departures from stops, listed in tab. 2 can be interpreted as a departure times of vehicles from individual bus stops. The lowest value of the initial departure 572 may be transformed to the departure time from the vehicle stop Žešov at 5:00 am and the values of subsequent departures from stop Žešov (626, 681, …) can be interpreted for example as the following departure times of vehicles from stop Žešov (5:54, 6:49, …).

Synchronized departures from the i-th stop in the direction to the j-th stop within the computed periodicity time [min]														
AS-L	600	654	709	763	818	872	927	981	1036	1090	1145	1199	1254	1308
D-N	607	661	716	770	825	879	934	988	1043	1097	1152	1206	1261	1315
N-D	603	658	712	767	821	876	930	985	1039	1094	1148	1203	1257	1312
N-L	601	656	710	765	819	874	928	983	1037	1092	1146	1201	1255	1310
L-AS	600	654	709	763	818	872	927	981	1036	1090	1145	1199	1254	1308
L-T	605	659	714	768	823	877	932	986	1041	1095	1150	1204	1259	1313
PZ-AS	608	663	717	772	826	881	935	990	1044	1099	1153	1208	1262	1317
T-L	608	663	717	772	826	881	935	990	1044	1099	1153	1208	1262	1317
Z-L	572	626	681	735	790	844	899	953	1008	1062	1117	1171	1226	1280

AS-L	1363	1417	1472	1526	1581	1635	1690	1744	1799	1853	1908	1962	2017	2071
D-N	1370	1424	1479	1533	1588	1642	1697	1751	1806	1860	1915	1969	2024	2078
N-D	1366	1421	1475	1530	1584	1639	1693	1748	1802	1857	1911	1966	2020	2075
N-L	1364	1419	1473	1528	1582	1637	1691	1746	1800	1855	1909	1964	2018	2073
L-AS	1363	1417	1472	1526	1581	1635	1690	1744	1799	1853	1908	1962	2017	2071
L-T	1368	1422	1477	1531	1586	1640	1695	1749	1804	1858	1913	1967	2022	2076
PZ-AS	1371	1426	1480	1535	1589	1644	1698	1753	1807	1862	1916	1971	2025	2080
T-L	1371	1426	1480	1535	1589	1644	1698	1753	1807	1862	1916	1971	2025	2080
Z-L	1335	1389	1444	1498	1553	1607	1662	1716	1771	1825	1880	1934	1989	2043
AS-L	2126	2180	2235	2289	2344	2398	2453	2507	2562	2616	2671	2725	2780	2834
D-N	2133	2187	2242	2296	2351	2405	2460	2514	2569	2623	2678	2732	2787	2841
N-D	2129	2184	2238	2293	2347	2402	2456	2511	2565	2620	2674	2729	2783	2838
N-L	2127	2182	2236	2291	2345	2400	2509	2563	2563	2618	2672	2727	2781	2836
L-AS	2126	2180	2235	2289	2344	2398	2453	2507	2562	2616	2671	2725	2780	2834
L-T	2131	2185	2240	2294	2349	2403	2458	2512	2567	2621	2676	2730	2785	2839
PZ-AS	2134	2189	2243	2298	2352	2407	2461	2516	2570	2625	2679	2734	2788	2843
T-L	2134	2189	2243	2298	2352	2407	2461	2516	2570	2625	2679	2734	2788	2843
Z-L	2098	2152	2207	2261	2316	2370	2425	2479	2534	2588	2643	2697	2752	2806
AS-L	2889	2943	2998	3052	3107	3161	3216	3270	3325	3379	3434	3488	3543	3597
D-N	2896	2950	3005	3059	3114	3168	3223	3277	3332	3386	3441	3495	3550	3604
N-D	2892	2947	3001	3056	3110	3165	3219	3274	3328	3383	3437	3492	3546	3601
N-L	2890	2945	2999	3054	3108	3163	3217	3272	3326	3381	3435	3490	3544	3599
L-AS	2889	2943	2998	3052	3107	3161	3216	3270	3325	3379	3434	3488	3543	3597
L-T	2894	2948	3003	3057	3112	3166	3221	3275	3330	3384	3439	3493	3548	3602
PZ-AS	2897	2952	3006	3061	3115	3170	3224	3279	3333	3388	3442	3497	3551	3606
T-L	2897	2952	3006	3061	3115	3170	3224	3279	3333	3388	3442	3497	3551	3606
Z-L	2861	2915	2970	3024	3079	3133	3188	3242	3297	3351	3406	3460	3515	3569

Tab. 2. Synchronized departures from public transport stops.

3. Conclusion

In the article we have investigated the possibilities of Max-plus algebra for modeling of synchronization of departures of bus connections for selected lines in public transport in Prostějov city. Max-plus algebra is a promising approach for solving of optimization problems. For the determination of the departure times of bus connections from selected stops (those times beeing periodical, so we need to compute them only for one such time period) we used the Open Source programming system Scilab, designed for numerical computations [5].

For verification of the output obtained from the comprehensive mathematical models the suitable tools can be e.g. time-dependent Petri nets, which can be used by traffic engineers for the visualization and detailed analysis of critical events [4].

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Evaluation of Costs of Service and Repair of Cars In The Polish Mail Company

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Abstract. Economic effectiveness of car use in a transport company is one of the many measures used in the evaluation of transportation services. It is influenced by many diverse factors, which include the technical condition of the means of transport, intensity of vehicle use, transport rates, costs of maintenance materials, personnel costs and costs of repairs and services, as well as taxes and administration fees. A detailed analysis of the effect of the individual factors on the level of profit gained from transport services allows evaluation of the economic effectiveness of a given transport company. The costs of vehicle repairs are one of the factors that influence the profit gained from transportation services. Additionally, an analysis of repair costs may be instrumental in planning and taking decisions related to the company's transport activities such as purchase of a new means of transport, specification of the transport rate, route assignment, etc. The present paper discusses the results of statistical analyses of data concerning the costs of repair of delivery trucks used by the Polish Mail company in Lublin.

Keywords: Economic effectiveness of car use, car repair costs, car service costs, statistical analyses.

1. Introduction

Economic effectiveness of car use in a transport company is one of the numerous measures used in the evaluation of transportation services. It is influenced by many diverse factors, which include the technical condition of the means of transport, intensity of vehicle use, transport rates, costs of maintenance materials, personnel costs and costs of repairs and services, as well as taxes and administration fees [1, 3, 6, 7].

A detailed analysis of the effects of the individual factors, including vehicle repair costs, on the level of profit gained from transportation services allows evaluation of the economic effectiveness of a given transport company. Additionally, an analysis of repair costs may be instrumental in planning and taking decisions related to the company's transport activities such as purchase of a new means of transport, specification of the transport rate, route assignment, etc. [4, 5].

The present paper discusses the results of statistical analyses of data related to the costs of repair of delivery vans used by the Polish Mail company in Lublin.

2. Material

Statistical analyses were carried out using data collected for179 vehicles operated in 2009 by the Polish Mail delivery office in Lublin. The population of the transport vehicles tested was diversified with respect to type and make. Because of this, the study population was divided into three groups characterized by different load space volumes.

Group I consisted of 47 passenger vehicles with small load space volumes (e.g., the Fiat Seicento) The cars in this group ran between post boxes and were used to deliver mail in the city of Lublin and area.

Group II comprised 85 delivery vans with medium load space volumes (e.g., the Lublin III) They moved mail between post offices in the city of Lublin and the former Lublin voivodeship.

In group III, there were 47 vehicles with large load space volumes (e.g., the Iveco Stralis). They carried postal packets between logistics centres of the Polish Mail outside the former Lublin voivodeship.

3. Results of statistical analyses of costs of repairs of the test vehicles

Auto repair costs, during one year of car operation, included costs of replacement of parts and units and change of fluids (lubricating oil, brake fluid, etc.) They did not comprise the personnel costs of staff members of the repair station of the Polish Mail company. It should be noted that the parts and units which were replaced most often were bulbs (2555), gaskets (350), tyres (226), oil (217), fuel (192), air filters (105) and air conditioning filters (47).

Information related to vehicle repair costs, provided by the Polish Mail in Lublin, was analysed statistically [2]. For this purpose, STATISTICA® computer software was used. Results for the entire study population and the individual groups of vehicles are shown in Tab. 1.

Group	Mean	Median	Min. value	Max. value	Standard deviation	Standard error
	[PLN]	[PLN]	[PLN]	[PLN]	[PLN]	[PLN]
Group I	1694.25	1551.27	48.76	4875.72	1158.18	168.94
Group II	3264.24	2372.45	5.34	11771.18	2893.29	313.82
Group III	3832.93	2427.37	38.92	15246.44	3839.07	559.99
Groups I, II i III	3001.33	2077.82	5.34	15246.44	2961.86	221.38

Tab. 1. Location and dispersion parameters of yearly vehicle repair costs in the investigated transport company.

When analysing the results of calculations of the basic statistical parameters, shown in Tab. 1, attention was paid to the differences among the values of mean yearly repair costs in the three investigated groups of vehicles. To test whether the observed differences were statistically significant, an analysis of variance was carried out.

The first step of this analysis was to estimate whether the empirical data obtained could be approximated by the normal distribution. As it follows from Fig. 1, the histograms of yearly costs of repair of vehicles from groups II and III were not fitted by the normal distribution. This finding was supported by the chi-squared χ^2 test, at the level of significance $\alpha = 0.05$, in which the following results were obtained: $\chi^2 = 52.038$ ($p < 0.001$) for group II and $\chi^2 = 35.419$ ($p < 0.001$) for group III.

Bartlett's **B**-test, employed due to the unequal number of results in the analysed groups, showed that the variances within the individual groups were not homogeneous. The value of the test statistic was **B** = 54.082 at the level of significance $p = 0.000$.

The results related to heterogeneity of variances and type of distribution showed that classical analysis of variance could not be used for mean values of yearly vehicle repair costs. Accordingly, a non-parametric method of analysis of variance, the Kruskal-Wallis test **KW**, was used for further calculations. The value of the Kruskal-Wallis statistic was **KW** = 8.294 at the level of significance $p = 0.0158$. This result pointed to significant differences in mean yearly vehicle repair costs among the three studied groups of vehicles. Fig. 1 shows categorised box plots of yearly repair costs for the individual groups of vehicles.

Further analyses were carried out to test whether the month (as a grouping factor) had a significant effect on the observed mean values of monthly vehicle repair costs in the individual groups and the entire population of vehicles. Calculations using the chi-squared χ^2 test demonstrated that the distributions of monthly intensities of use of vehicles in the individual groups were consistent with the normal distribution. However, for the entire population of vehicles, it was found that the monthly distributions of repair costs could not be approximated by the normal distribution. Also, homogeneity of variances was tested using Bartlett's **B**-test. The results are shown in Tab. 2.

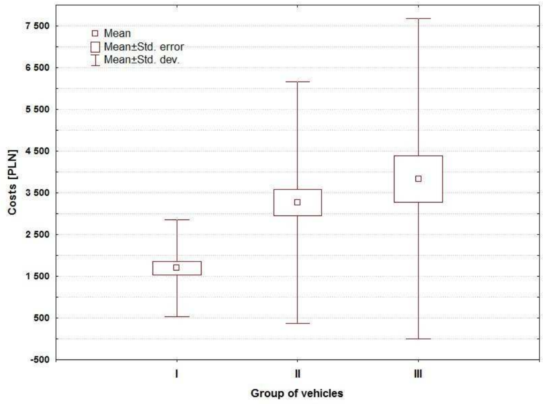

Fig. 1. A categorised box plot for the independent factor – group of vehicles, and the dependent variable – yearly vehicle repair costs.

Group	**B**-statistic	*p*-value
I	93.82	0.000
II	150.90	0.000
II	138.31	0.000
I, II and III	265.15	0.000

Tab. 2. Results of Bartlett's test of homogeneity of variances for repair costs, with the month of operation as a grouping factor.

The results shown in Tab. 2, concerning the homogeneity of variances for monthly repair costs in the individual groups and the entire population of vehicles, indicated that the classical method of analysis of variance could not be applied. That is why the non-parametric method of analysis of variance was applied again using the Kruskal-Wallis test **KW**. The results are shown in Tab. 3.

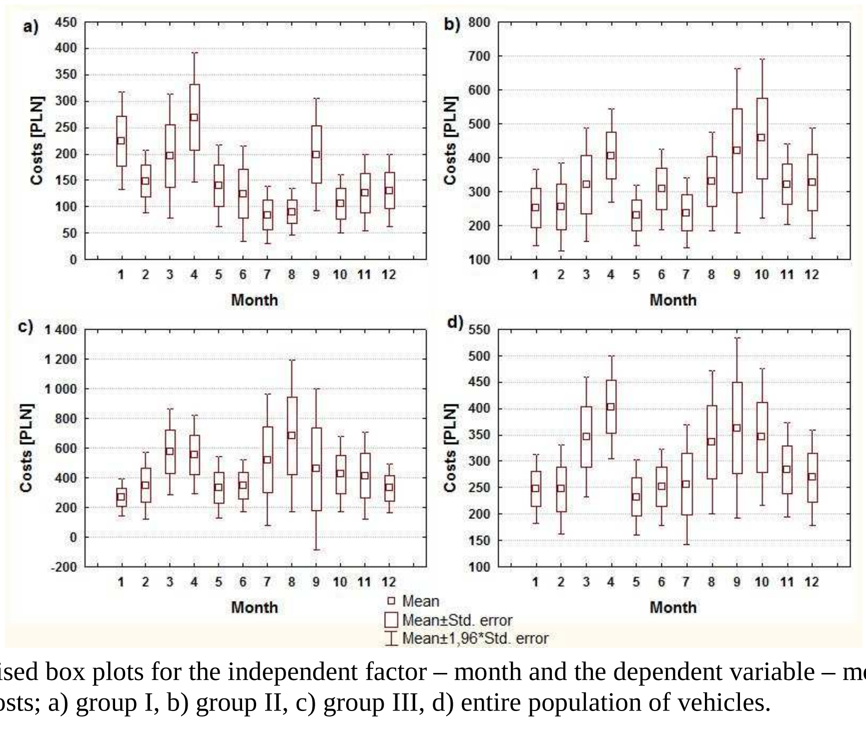

Fig. 2. Categorised box plots for the independent factor – month and the dependent variable – monthly vehicle repair costs; a) group I, b) group II, c) group III, d) entire population of vehicles.

Group	**KW**-statistic	*p*-value
I	23.770	0.0137
II	19.741	0.0490
II	10.408	0.4912
I, II and III	26.844	0.0049

Tab. 3. Results of analysis of variance for the grouping factor – month of operation of the test vehicles.

Based on the results presented in Tab. 3, it was concluded that the month of operation had a significant effect on the monthly mean value of observed repair costs for the entire population and for vehicle groups I and II. No significant difference in these values was observed for vehicle group III, though. Fig. 2 shows categorised box plots of monthly repair costs for the individual groups and the entire population of vehicles.

An analysis of the plots in Fig. 2 revealed a high variability of the values of monthly vehicle repair costs in the individual groups. In group I, the differences totalled 31%, in group II as much as 50%, and in group III only 25%.

4. Conclusion

The results of the statistical analyses of the vehicle repair cost data obtained from the Polish Mail company in Lublin demonstrate that

1. The adopted criterion of division of the population of vehicles into three groups according to load space volume is accurate. This is evidenced by the significant differences in mean values of yearly and monthly repair costs among the individual groups.
2. It was observed that the mean values of yearly repair costs of vehicles in group III were 1.2 times higher compared to the vehicles in group II and 2.2 times higher compared to the vehicles in group I.
3. The month of operation has a significant effect on observed mean vehicle repair costs. Higher vehicle operation costs are observed in months in which there is an increased demand for transportation services, e.g., pre-holiday periods.

It should be noted that because the analyses were conducted for data related to the process of vehicle operation spanning one calendar year, it cannot be unequivocally determined whether the analysed values of vehicle repair costs would be repeatable in different years. To confirm this relationship, analyses should be carried out for data covering at least a few years of vehicle operation. The authors hope to explore this issue in their future research.

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'EFB' Electronic Flight Bag INTEGRATION

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Abstract. Electronic Flight Bag (EFB) will become part of any aircraft cockpit in future. It will reduce pilot's workload and ensure safety enhancement. Airline customers like to expand EFB operations, also to enable ground flight operations to have real-time access to the flight-deck installed EFB systems. Interlinking should be done wired (Ethernet) and wireless (WLAN). None was done before and the major task was testing accuracy and resistance of installed electronic communication equipment for interference with newly added devices aboard the aircraft. Outcome of these tests showed by reason of extensive reviews, that WLAN devices itself will not harm installed electronics of aircrafts. Laptop, Personal Digital Assistants (PDAs), computer-parts of EFBs might influence lower VHF Bands. Therefore special measurement procedures have to been established.

Keywords: electronic flight bag, (W-)LAN aboard an aircraft, preventive maintenance, real-time access to the flight deck

1. Introduction

Electronic Flight Bag (EFB) will become part of any aircraft cockpit regardless of type, whether of those single-engine small general aviation aircraft or those large multi-engine commercial airliners like Airbus or Boeing, to reduce pilot's workload and ensure safety enhancement.

This researchtopic is about integration and application of EFB systems in the airplane's cockpit. It is a guide through the comprehensive interlinking procedure of installing & integrating wireless local area networks (WLAN interface) into the existing avionics and adding Buyer's Furnished Equipment (BFE) which is a device purchased by the buyer/airline and given to the aircraft manufacturer to be installed before taking delivery of the aircraft.

New development of standards has also been established, as none of the kind existed before. To this end basic principles have been set up, to aim and provide guidance materials for aviation authorities worldwide, how to deal in future with this issue.

Further, a fusion of technologies is considered to allow theusage of telephone aboard an aircraft (2G/3G GSM/UMTS telephones) and to offer passengers multi-media services on their own PDAs/PCs as well.

The hardware components needed were linked, to be operated both wired (Ethernet) and wireless (WLAN) in accordance to IEEE 802.xx standards.

For airline operators, special EFB solutions have been evaluated. Ground-flight operation departments were enabled real-time access to the flight deck via satellite communication systems and maintenance departments concurrency data exchange for preventive maintenance actions.

EFB main objectives for airlines are:

- Flight Crew access to emerging electronic flight operations data, general purpose computing and communications,
- Replacement of many of today's paper documents,
- A range of implementations spanning Portable electronic devices up to installed certified integrated systems,
- Consistent with Flight Deck Philosophy,
- Realtime data processing,
- Future expandable for FANS (Future-Air-Navigation-System),
- Physical constraints for Retro-fit and Production,
- Environmental Qualification considerations,
- Crew Interfaces (crew resource management),
- Changes in crew's workload

Airline's potential EFB applications are:

- *Flight Operations*
  - Weather
  - Flight manuals
  - Navigational charts
  - Cabin surveillance
  - Surface moving maps
- *Maintenance*
  - Minimum Equipment Lists
  - Problem reporting
  - Flight data downloads
- *Passengers*
  - Passenger rebooking
  - Buy-on-board programs
  - TV & Radio
  - Movies
  - Email & Internet browsing

A positive side effect is, the in-flight-entertainment system aboard an aircraft is expanded to offer passengers uninterrupted high-speed access via (W)LAN to the ground based world-wide-web while travelling at cruising altitude of 51.000ft / 15.545m & with a speed of Mach 0,92 / 960km/h or 520kt.

Important here was testing accuracy and resistance of installed electronic communication equipment and avionics for interference with the newly added devices aboard the aircraft. In the same way, safety measures had been provided if parameters were not kept.

2. Current Status Definition and history of Electronic Flight Bag's (EFB)

First of all, anybody asks: "WHAT IS AN ELECTRONIC FLIGHT BAG?" An electronic flight bag is an electronic version of a pilot's "flight bag". What then is a "flight bag"?

Simply stated, it is a physical device that carries the printed documentation pilots must have available to them during the course of the flight, such as flight manuals, operation manuals and approach plates. This "bag" can range from a navigation briefcase used in large aircraft, to a smaller, soft sided publications bag used in fighter aircraft, to even a saddle bag that is laid across the glare shield. In some fighters, the pockets of the g-suit are used to hold many of the publications - not the preferred placement for a safe ejection.

Having an electronic display replace the paper documents currently in use not only saves space and weight, but it also offers operational advantages. An electronic flight bag can become the ultimate situational awareness (SA) multiplier. As a high quality display, it can not only present words to the pilot, but pictures and graphics.

On some larger aircraft, the majority of the publications are permanently stored onboard. Weight can differs for example, from 60 lb/28 kg by a standard LTU Airbus 320 Pilot's Paper Flight bag up to a combat transporter like the MC-130H which has a Technical Order (TO) library onboard that weights 270 lb / 122 kg.

Figure 1: A320 with its traditional paper pilot's flight bag on the flight deck behind the Copilot seat

Figure 2: MC-130 with the 270 lb / 122 kg Library cases carried onboard

The Volpe National Transportation Systems Center (VOLPE Center), a human factors research branch of the Department of Transportation, defines an EFB as: "an electronic information management device for use by pilots in performing flight management tasks. It typically consists of a screen and controls in a self-contained unit that is relatively small, weighing only a few pounds at most. EFBs can store and display large amounts of data. Some existing EFBs run proprietary operating systems, but most are compatible with the Microsoft Windows operating system."

This definition is tailored more toward General Aviation (GA) aircraft and represents an entry level EFB. GA is a driving force in the development and usage of paper substitutes, mainly due to the weight savings. The saved weight can be more useful used in fuel aboard or passengers with their luggage carried in the aircraft.

Due to certification and safety oversight responsibilities, the Federal Aviation Administration (FAA) also has become involved in the certification of these devices.

In the FAA's Advisory Circular No: 120-76A EFB, electronic flight bags are defined as "Electronic computing and/or communications equipment or systems used to display a variety of aviation data or perform a variety of aviation functions. In the past some of these functions were traditionally accomplished using paper references.

The scope of EFB functionality may include datalink connectivity. EFBs may be portable electronic devices or installed systems. The physical EFB display may use various technologies, formats and forms of communication."

This definition is broader in scope than the VOLPE Center's definition and expands into two very important areas.

It includes installed devices which could be both more sophisticated and complex and it introduces datalink connectivity, a feature of EFBs that will undoubtedly prove to be very useful.

From the dawn of aviation, most of the information a pilot references in flight has been on paper. With the tremendous improvements in both computing and display technology, there is no reason why some of the paper products, if not all, cannot be replaced by an electronic version. It is difficult to determine exactly where the idea of an EFB first originated.

As GPS became more common and inexpensive, GA aircraft have had several moving map type devices (e.g. Apollo MX20) available to them. As these devices became more sophisticated, many began incorporating additional features into them. For example, some are also integrated with the aircraft's VHF (very high frequency) radio transmitter/receiver. Others display weather information. Within the last several years, these devices have incorporated electronic approach plates and airfield diagrams. This development occurred after Jeppesen, the worldwide provider to commercial aviation of instrument approach plates (IAPs) and navigational charts, made their products available in an electronic format. With this advance, these simple EFBs were able to begin replacing of the paper in cockpits.

The next group of aviators to take advantage of this new technology was the business jet operators. Due to a lesser degree of FAA regulation compared to major commercial airlines and the FAA's omission in the Federal Aviation Regulations (FARs) requiring approach charts to be in a paper form, these business jet operators were able to integrate EFBs into their cockpits.

Fractional jet operator, Flight Options, was one of the first to outfit their entire fleet of 88 business jets with EFBs in the summer of 2000.

According to Jim Miller, Flight Options vice president, "the FAA really didn't know what to do about electronic charts…no one had seriously addressed electronic flight bags at that point. When Flight Options unilaterally said it was going to remove paper charts from its airplanes and use electronic flight bags, people finally began thinking about it."

This move effectively forced the FAA's hand and caused the development of the FAA's Advisory Circular entitled AC 120-EFB, Guidelines for the Certification, Airworthiness, and Operational Approval of Electronic Flight Bag Computing Devices.

The Flight Options pilots are very happy with their EFBs and, according to Miller, by placing 2 EFBs in each cockpit, they have been able to achieve a mean time between failure (MTBF) for their EFBs of about 20,000 hours.

Even large aircraft not initially included in the charter category have taken advantage of EFBs. Boeing delivers today most of their aircraft such as the 737, the BBJ (Boeing Business 737 Jet variant), 777 and others single or multi aisle aircrafts with a system called Boeing Laptop Tool (BLT) as standard equipment in the purchase price.

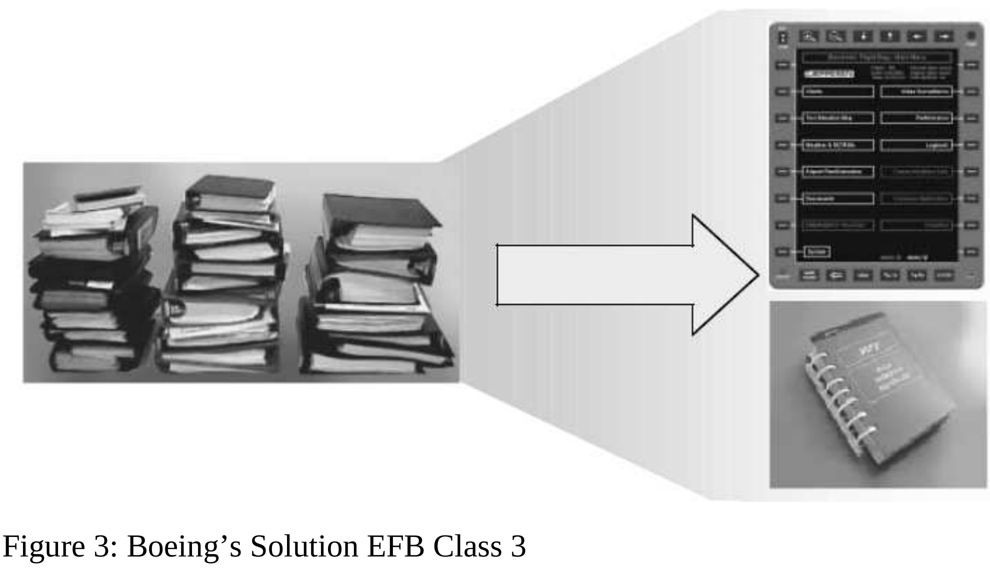

Figure 3: Boeing's Solution EFB Class 3

This Laptop Tool has digital reference sources ranging from the flight and operations manuals, to minimum equipment lists (MELs) and dispatch deviation guides as well as the flight crew training manuals. In addition to reference materials, the BLT incorporates a powerful takeoff performance calculator allowing the operator to maximize payload. It also included Jeppesen's

“FliteDeck”, “FliteStar” and “JeppView” software for displaying electronic approach plates and enroute charts.

Business jet companies are taking full advantage of the tremendous capabilities of electronic flight bags. Major commercial companies have also investigated the advantages of electronic computing devices in the cockpit.

3. Electromagnetic interference & compatibility of EFB transmitting devices to Aircraft Radio Systems

A testing campaigns were conducted at a laboratory in the past be several researchers. Newly now an extensive field testing at an airline site on multiple wireless local area network (WLAN) devices had been performed, using the main three wireless standards for spurious radiated emissions to determine their threat to aircraft radio navigation systems.

The measurement process, data and analysis are provided for EFB installed devices tested using IEEE 802.11a, IEEE 802.11b and Bluetooth as well as data from portable laptops/tablet PCs and PDAs (grouping known as PEDs).

A comparison was made between wireless LAN devices and portable electronic devices.

Spurious radiated emissions were investigated in the radio frequency bands for the following aircraft systems, for simplification same bands are used in real aircraft environment testing as before setup by the laboratory evaluatuions:

- Very High Frequency (VHF) Communication (VHF-COMM),
- VHF Omnidirectional Range (VHF-VOR),
- Instrument Landing System Localizer and Glideslope (ILS/GS),
- Air Traffic Control Radar Beacon System (TXPR/SSR-Transponder),
- Traffic Collision Avoidance System (TCAS),
- Microwave Landing System (MLS) and
- Global Positioning System (GPS).

Since several of the contiguous navigation systems were grouped under one encompassing measurement frequency band, there were five measurement frequency bands where spurious radiated emissions data were collected for the PEDs and WLAN devices. The detailed laboratory report also provides a comparison between emissions data and regulatory emission limits.

4. EMI & EMC EFBs Test Setup; Electromagnetic interference & compatibility of EFBs test setup and measurement methodology

Mode-stirring in a reverberation chamber (RC) was selected in the former testing because it produces repeatable measurements and reduces test time as compared to other methods. Explanations of instrumentation, chamber setup, and spectrum analyzer parameters for obtaining practical measurements are discussed in detail within those tests and nowadays performed trials it was possible to reproduce within the aircrafts / airframes similar results.

RC’s produce radiated emission measurements in terms of total radiated power (TRP) rather than electric field strengths as generated in a semi-anechoic chamber (SAC).

The RC method when compared to a SAC method, is advantageous because the orientation of the device-under-test (DUT) is not considered; thus, the number of tests is considerably reduced.

Another advantage to conducting tests in a RC and the method does not suffer from measurement uncertainty caused by multipath affects, RCs exercise several methods to produce a statistically uniform, isotropic, randomly polarized field.

When the metallic stirrer rotates continuously in time, this is referred to as mode-stirring. Rotation by fixed steps for one rotation is referred to as mode-tuning. In mode-tuning, at each new stirrer position, a small time interval is allotted for DUT response time as in susceptibility or test receiver's response time for emission measurements.

DUT hardware has been selected at the field tests by LTU-Airline and mainly by the US based affiliate airline, because they already focused on a COTS-laptop system which was evaluated for EFB purpose. LTU-Airline added some other devices to have more equipment to select later their EFB favorite.

Test receivers used in this study have suitable response times to accommodate mode-stirring. This is preferable for emission measurements because numerous samples at each frequency are achieved per stirrer rotation.

Emission measurements taken from the receive antenna are corrected for chamber loss to obtain the power radiated by a test article inside the chamber. Maximum received power measurements are completed after one stirrer rotation. Radiated power from the DUT is determined by using the maximum receive power equation obtained from Equation Eq.1.

$$P_{TotRad} = \frac{P_{MaxRec} * \eta_{Tx}}{CLF*IL} \qquad \text{(Eq. 1)}$$

where

PTotRad	radiated power from the DUT within the measurement bandwidth
PMaxRec	maximum receive power over one continuous stirrer rotation within the measurement bandwidth
η Tx	transmit antenna efficiency factor used in chamber calibration; unity is assumed for antennas used
CLF	chamber loading factor (includes the DUT and the test operator)
IL	empty chamber insertion loss determined during chamber calibration that equals PMaxRec / PInput where the input power is supplied by a transmit antenna into the chamber

The equation specified above is an overview for performing emission measurements in a RC according to IEC standards. Measurements conducted during this research effort can be simplified to the following practical equations 2 and 3.

In Eq. 2, measuring the chamber loss (LChmbr) incorporates both chamber loading factor and insertion loss, eliminating the need to measure CLF and IL separately.

CLF correction is applied only in cases where the DUT and personnel do not cause the measured field uniformity in the chamber during calibration to exceed the ± 3 dB uncertainty tolerance.

Therefore the DUT and DUT operator can be present in the chamber during calibration, especially when the measurement is taken at one-location rather than averaging measurements taken at multiple locations.

CF = (PXmit (dBm) – PSAMeas (dBm))
= LChmbr (dB) + LRecCable (dB) + LXmitCable (dB) (Eq. 2)

where

CF	Calibration Factor of the chamber (dB)
LChmbr (dB)	chamber loss (dB), also expressed as –10log10(CLF*IL)

LRecCable (dB)	receive cable loss (dB)
LXmitCable (dB)	transmit cable loss (dB)
PXmit (dBm)	power transmitted from source (dBm)
PSAMeas (dBm)	maximum receive power measured at the spectrum analyzer (dBm) over one stirrer rotation

In order to isolate the spectrums analyzer (SA) measured radiated power from the DUT, losses from the transmit cable and calibration factor are mathematically removed from the PSAMeas in Eq. 3.

PTotRad (dBm) = PSAMeas (dBm) - LXmitCable (dB) + CF (Eq. 3)

Power entered the receive antenna and propagated through the receive path into the spectrum analyzer (SA), where the maximum power was recorded. The SA is able to capture maximum power levels across a measurement frequency band due to connections between the SA and tracking source synchronizing frequency sweeps, both calibration data are included in Eq. 2 & is further applied in Eq. 3.

Dwell time ensures that an adequate number of sweeps have been recorded by the SA to update the maximum power levels of the measurement trace over the frequency band.

5. Summary of Maximum WLAN Emissions

Laboratory tests shows WLAN devices and EFBs, laptop/tablets/PDAs are well below the FCC spurious emission limit. Whereas, WLAN devices are considerably lower than the RTCA/DO-160 limits, except in the case of Band 105-140 MHz, where 802.11a meets the limit within tenths of a dB.

In Band 105-140 MHz and Band 960-1250 MHz, EFBs/laptop/tablets/PDAs exceed the RTCA/DO-160 Category M limits. So far WLAN devices’ emissions are lower than EFB, laptop/tablets/PDAs except in Band 5020-5100MHz.

The recorded test and research data shows that integrated WLAN devices should not compromise the integrity of aircraft radio systems any more than those emissions from EFBs, laptop/tablets/PDAs. These were also check within airframe on-site testing.

Note that this is only a first order comparison, since directivity is not yet accounted for in the emission measurements.

Maximum spurious emission measurements conducted on a group of WLAN devices are not any higher than the maximum spurious emissions from tested PEDs in the considered aircraft communication and navigation bands.

The MLS band was the exception where WLAN devices emission levels were higher than PEDs emissions. Since there is a large safety margin in Band 5020-5100 MHz, WLAN devices are not a concern. Tested integrated WLAN device emissions remained lower than FCC and RTCA/DO-16 Category M limits. Although EFBs, laptop/tablets/PDAs emissions can be higher than RTCA/DO-160 Category M limits, they are lower than their intended FCC spurious emission limit.

Further laboratory and field tests should be conducted using the 802.11a device standard, besides its standard net bit rate of 54 Mbit/s within its 5 GHz frequency band versus the 802.11b with its 11 Mbit/s net rate in the 2.4 GHz band, the public domain counts positively for the 802.11b. Further tests should also focus on 802.11g and 802.11n which might become series equipment for EFB interface modems, laptops and tablet PCs.

6. Conclusion

Any of the tested WLAN devices do not harm found, installed avionics and electronics. The accuracy and resistance of installed electronic communication equipment against interference is proven, certainly only in the tested aircraft environment.

Laboratory tests showed that 802.11a emissions are even lower than 802.11b emissions. Bluetooth emissions are similar close to 802.11b values. In this tested combination individual care must be taken after any installation within the VHF band.

At these days airlines with its Electronic Flight Bag EFB flight-deck operations are entrepreneurs, but it is to assume that soon modified Cabin Entertainment Systems for passenger’s use will follow.

Technique develops constantly; further researches on (W)-LANs, Wireless- and Wired/Ethernet-Local-Area-Networks for onboard aircraft operations are necessary and will focus on posting new standards for certification and operation.

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Charging for External Costs

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Abstract: Everything, what people do, bears costs and transport is not in this regard the exception. Some costs are easily identifiable and clearly associated with transport. Other costs we do not usually realize and they are included into the transport price only partly or not at all. These costs may have on the local level only a small effect, but in the aggregate for the whole mankind their cumulative effect is significant. It is possible to include among them the costs associated with impacts on human health and the environment, the costs associated with traffic accidents and congestions. In connection with these costs we talk about so-called externalities, which are not in most cases reimbursed by their real originators.

Keywords: Externalities, external costs, marginal costs, Coase theorem, Pigouvian tax, internalization of external costs.

1. Introduction

Transportation has become a necessity for human life. Personal mobility and transport of goods is still cheaper and faster. This fact contributes positively to the development of industry dynamics and the economy as well. It also develops the cohesion of society, but the current rate of transport development will become unsustainable in the future. Already nowadays there are congested areas and transport heavily pollutes the environment.

Rapid development of transport affects not only economically developed countries, but the problem is occurring in large cities in less developed countries as well. One of reasons for the rapid development of transport is the inability to internalize the external costs which arise in connection with transport.

2. Externalities

Externalities are part of the subject of economic theory since the 19th century. The externalities are studied especially in the theory of welfare. Welfare economics determines that the economic activity of any group or an individual using limited resource can not be beneficial, if it unfavorably affects the benefit of other groups or individuals [1].

Although this concept has been known and used in economy for a long time, there is not the complete consensus among experts about the exact definition and interpretation of externalities.

According to Macmillan (1994), we can call externalities variously. We can use terms: external effects, external positive and negative savings, spillovers effects or neighborhood effects. Žák (2002) states that: "Externality is a result of economic activity, which their originator can not (fully) usurp (if profit), or from which it can not (fully) recover (if costs)." [2] [3].

In general, externalities are the case of the failure of allocation function of the market. They include all effects arising from the activities of one entity that is transmitted to other entities, without the originator compensates the delegated costs.

2.1. Category of externalities

It is possible to distinguish positive externalities (external benefits) if the activity of one entity gives a positive effect and the increase of benefits to other parties without counter value. On the other side we distinguish the negative externalities (external costs) if the activity of one entity causes the adverse effects and costs in other parties.

Negative externalities often occur in the transport sector. The European Commission (2008) states that the external costs of transport are borne by society and are they are not taken into account by transport users. External costs contain the difference between social costs and private costs. Social costs reflect all costs that occur due to transport and private (or internal costs) represent the costs, which the user of transport pays [4].

Other division by Buchanan and Stubblebine (1962) divides the pecuniary externalities and technology ones. Pecuniary external effects are the result of the general interdependence of economic activities and their action is indirect. Technological externalities are linked to dependence of organizations and their activities and their action is direct [5].

Jilkova (2003) divides the partial externalities, which affect only one or a limited number of entities and global externalities, which may be so large that consumption of a single economic goods does not affect consumption of the economic goods by another entity. The global externalities can include the damage of the environment [6].

3. Justification of charge for external costs

The existence of external costs causes the disruption of the proper functioning of the market mechanism and the failure of allocation function of a market. In the case that there are external costs on the market that are not included in the price of goods or services, then there exists the overconsumption. The solution of the problem of overconsumption and the rapid pace of transport growth is the inclusion of external costs to costs of their actual originators. If the user has to bear the real costs associated with the usage of transport services, then transportation will be used more rationally.

The solution, however, has its pitfalls. The user will consider the ratio of social costs and the utility of a particular mode of transport. If the mode of transport is irreplaceable for users, then it will continue to use although the price is higher. It may also be a situation in which the transport modes, for which users are willing to pay a higher price, retain and those transport modes, where users are not willing to pay higher costs, disappear [7].

3.1. Practical solution

In the case of the failure of the market and in the case of the excludability of external costs, the user pays only the marginal private costs. Marginal private costs are usually lower than the marginal social costs. It is an effort by suitably chosen charges to increase the private marginal costs on the border of the marginal social costs and to achieve the point of optimum quality of service. This solution is called internalisation of external costs and it is connected to the government activities and to economic or environmental policy.

Chosen charges should match marginal external costs, i.e. costs that a user transmits to other entities. These costs, increasing the costs already borne by a user and they will have an effect to his decisions and modal choice. Among the marginal external costs we can include costs of transport congestion, infrastructure costs, environmental costs and costs arising from accidents [7].

4. Internalization of external costs

Macmillan (1994) defines internalization as: "Measures that forces economic actors to take into consideration certain externalities, usually with the malicious character. Output of economic goods, which causes the externality, is reduced to an optimum level. Externality, therefore, is not suppressed, but it matches the level where the cost of reducing an additional unit becomes greater than the associated revenues."[2].

Desired state can be achieved in various ways. Here there are mentioned three:

- Coase approach,
- Pigou approach,
- The polluters and sufferers are bringing to the one ownership (external costs are changing to internal costs).

4.1. Coase theorem

Coase theorem is presented by the thesis of efficiency and the thesis of invariance. Thesis of efficiency states that participation at the increase of welfare, which is realized by achieving maximum efficiency through negotiation is the incentive to achieve the maximum. Thesis of invariance states that all bodies which are interconnected by an externality can participate in it.

Coase theorem is the market method of addressing the existence of market externalities through bargaining without government intervention. In this case the internalization is practiced by the negotiation between the polluter and his sufferer.

The limit of internalization solution is: a prerequisite of clearly defined property rights and distribution rights - a clear definition of the responsibilities and obligations of polluters and patience of sufferers.

The validity of the theorem is very limited and they are raised critical concerns against it [6].

4.2. Pigouvian tax

Pigouvian tax, unlike Coase theorem, implies government intervention to address externalities and works with the theory of optimal taxation. To solve adverse impacts of negative externalities it is proposed a tax and to solve adverse impacts of positive externalities it is proposed compensation in the form of subsidy.

The amount of tax or subsidy is set to match the external effects. This intervention increases (decreases) the marginal private cost to the level of marginal social costs (see Fig. 1).

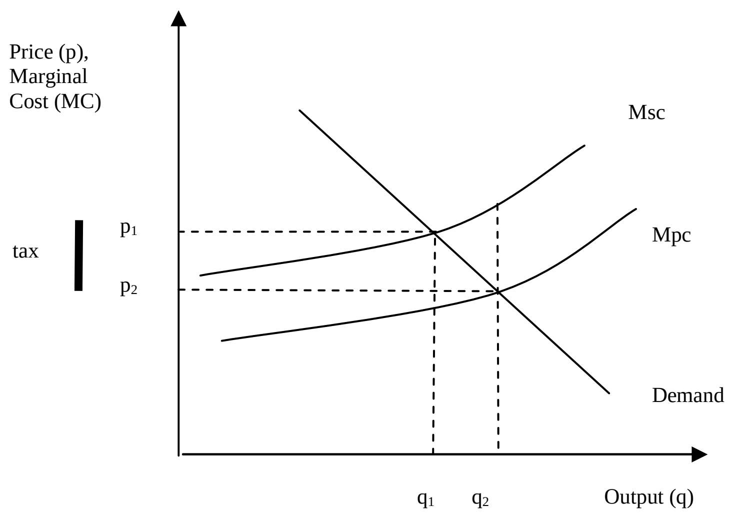

Fig. 1. The effect of a Pigouvian tax

Such taxes are motivation set for transport users to take into account not only the private costs, but also social costs. Pigouvian taxes are taxes theoretically ideal, but their implementation is difficult in the real world. Restriction for Piguovian access is the need to constantly recalculate the tax (subsidy), which is not fixed but varies according to economic activity and conditions of the organizations that cause externalities [6].

5. Conclusion

The issue of externalities and their internalization is a complex problem. On one side, there is demand of human society for transport and the question of mobitily and on the other side it is distortion of the transport market and severe damages on human health and the environment.

Economists examine the theoretical basis of the internalisation of external costs for many years and the target of this article was to show the basic conceptions of the Pigou and the Coase. These two British economists brought important knowledge to research of possibilities for internalization of external costs into the market economy.

The Coase theorem would be the suitable solution in the case of the sufferer is able to abstract the existing damage with lower costs than its polluter. Through this concept we could reach the optimal point even with the saving of total costs. However, in the case of transport externalities (noise, smog, vibration etc.), which influence huge number of subjects and has only restricted possibility to change the current situation, the cost for addressing are too high.

The Pigouvian tax, based on the governmental intervention, seems to be suitable for its motivation part (if we dismiss administration costs), because the polluter is through the increase or decrease of its total costs (imposing of a tax or gaining of a subsidy) motivated to the choice of balanced solution of externalities problems in connection to its activity and the whole society. That is the reason why nowadays conceptions come from the Pigouvian tax, even if it is connected with the external impact into the functioning of the market and into the level of total taxation of transport users.

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Diagnosing Early Stages of Changes in the Valve Clearance in 4-cylinder SI Engine

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Abstract. The paper presents test results, whose aim is diagnosing of valve clearance increase, slightly deviating from the nominal values, in a SI engine. Acceleration of the engine vibration was measured in laboratory tests of the engine, in which clearance of intake and exhaust valves was increased. On the basis of recorded signals, an analysis was made using Wavelet time-frequency decomposition.

Keywords: Diagnostics, Combustion engine, Valve clearance.

1. Introduction

Combustion engines, during their use time, change their valve clearance value. This has an adverse effect on the engine valve timing, and therefore on the change of the opening time of the intake and exhaust valves. Consequently, the process of charge exchange in the cylinders is disrupted, resulting in increased fuel consumption, not achieving the engine full power and uneven work. In addition, the increased clearance in the timing system evokes the engine vibration and noise. The studies of this phenomenon are presented, among others in [1, 2] and in [3-5] the authors dealt with the impact of valve burn on engine work and generated vibration. In combustion engines valve clearance value can vary, mainly due to the system components wear. For systems which require control and regulation of valve clearance by the user, the manufacturers recommend manual controls using for example a feeler gauge and then the adjustment a valve clearance by changing the settings of the adjustment screws or replacing regulator boards. A much more difficult problem arises when using the hydraulic tappet of valve, which will automatically regulate the valve clearance. Their malfunction is manifested in the form of acoustic symptoms such as a metallic sound, which are difficult to detect both manually as well as using a stethoscope [2].

For the non-invasive inspection of the engine valve clearance, and finding the location of the damaged valve can be used vibroacoustic methods of measurement and analysis signal of a vibration and a sound of the engine. Studies of this type are presented, among others in [3-5], where the significantly increased valve clearance associated with damage to the hydraulic tappet of valve of gasoline and diesel engines was detected.

Diagnosing a small increase in engine valve clearance is a difficult research problem. Clearance of this type occurs in engines in case of slight wear of valve, or, if there is damage to the hydraulic tappet of valve. The paper presents preliminary results of diagnostic possibility to detect overstandard-sized valve clearance, slightly deviating from the nominal values. Internal combustion engine with camshaft mounted in the engine block was selected for testing.

2. The object of research, the method of measurement and analysis of the study

The subject of the study was a four-cylinder engine of a passenger car, a Ford Ka, with a spark ignition and cylinder capacity of 1,3 dm^3. This engine is equipped with an eight-valve head and a camshaft located in the engine block (timing OHV). The test head engine with the disassembled valve cover and the possible places of the valve clearance there can decompose is shown on fig. 1.

a) b)

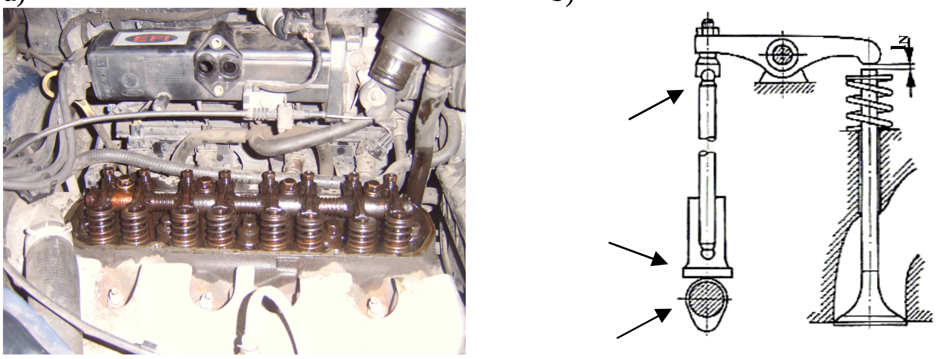


Fig.1. a) The test engine with the disassembled valve cover,
b) Engine valve mechanism with the selected locations of the possible occurrence of valve clearance

For the test engine, the values of the opening and delayed closing time of the valves [3] are respectively: α_d = 18°, β_d = 38°, α_w = 45°, β_w = 7°. During the experiment, there was assumed the change in value of valve clearance - the exhaust and intake valves - increasing their value from the nominal clearance value. Adopted in this case the valve clearance values are shown in table1.

Valve	Test 1	Test 2	Test 3	Test 4	Test 5
Intake	0,2 mm	0,2 mm	0,2 mm	0,25 mm	0,3 mm
Exhaust	0,5 mm	0,55 mm	0,6 mm	0,5 mm	0,5 mm
	Nominal clearance				

Table 1. Valve clearance values used in the research.

To diagnose valve clearance there was used a measuring system consisting of:

1. Two piezoelectric transducers.
2. An optical sensor, which recorded the reference signal of crankshaft position.
3. National Instrument Data Acquisition Card NI 4472.
4. A computer with LabView 8.6 software.

During the tests, the vibrations of the drive unit in two different directions were recorded: in the direction of movement of the piston, and transverse to the direction of movement of the piston.

The position of optical sensor and vibration acceleration measurement system diagram is given on figure 2.

a) b)

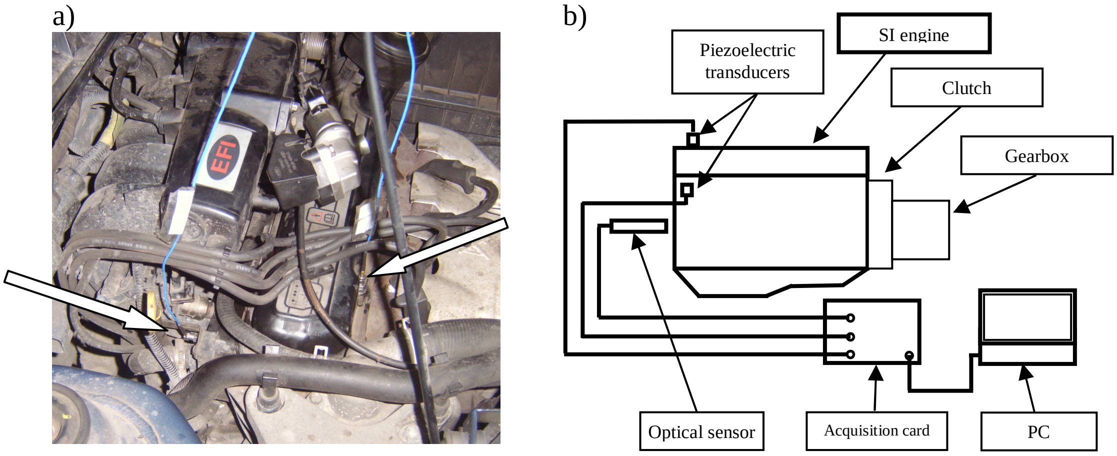


Fig. 2. a) The location of vibration acceleration transducers on the test engine.
b) Diagram of measurement system

Vibration signals were recorded at a frequency of 25 kHz. Matlab-Simulink Signal Processing software was used for processing. Continuous wavelet transform was used to process the signals, which allows obtain components of the signal in time-frequency space. The result of wavelet transform is the decomposition of the test signal in relation to the family of wavelets $\Psi_{a,b}$. For the function $f(t) \in L^2$ defined by the scale parameter "a" and at the moment "b", continuous wavelet transform is [6]:

$$Wf(a,b) = (f, \Psi_{a,b}) = \int_{-\infty}^{\infty} f(t) \frac{1}{\sqrt{a}} \Psi^* \left(\frac{t-b}{a} \right) dt$$

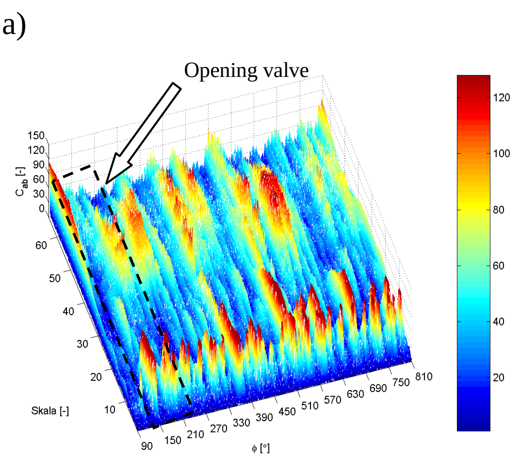
where:

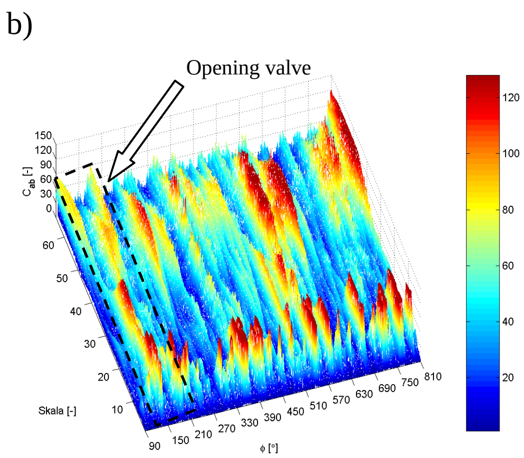
Wf(a,b) – wavelet coefficient; f (t) - test signal; Ψ- the base function (wavelet);
a - scale parameter; b - displacement parameter.

The recorded vibration signals have been pre-processed to select the wavelet and the range of frequencies. As a result of the calculations Morlet wavelet was selected at the frequency scale 2-66, which enabled to obtain satisfactory effects of local changes in the amplitude of wavelet decomposition as a result of increased valve clearance.

The preliminary measurements suggest that the most sensitive to change of valve clearance are vibrations recorded in the direction of the movement of the piston. On the other hand, much less sensitive to the change in valve clearance were the results of measurements of vibration in the transverse direction to the movement of the piston.

The following figures present some of the most representative time-frequency distributions obtained during the measurements. On the diagrams, there are marked some selected areas of the crankshaft rotation angle change, in which there is an increase of vibration amplitude during opening or closing proper valves.





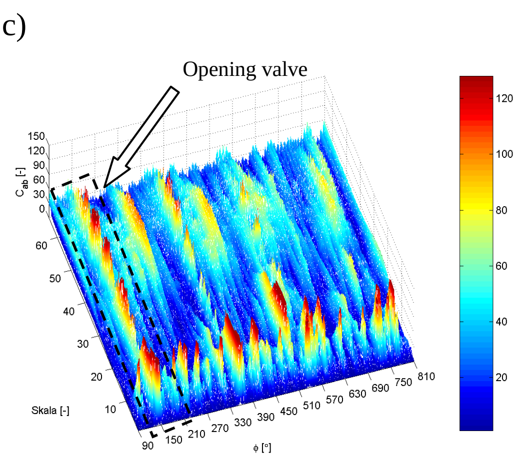
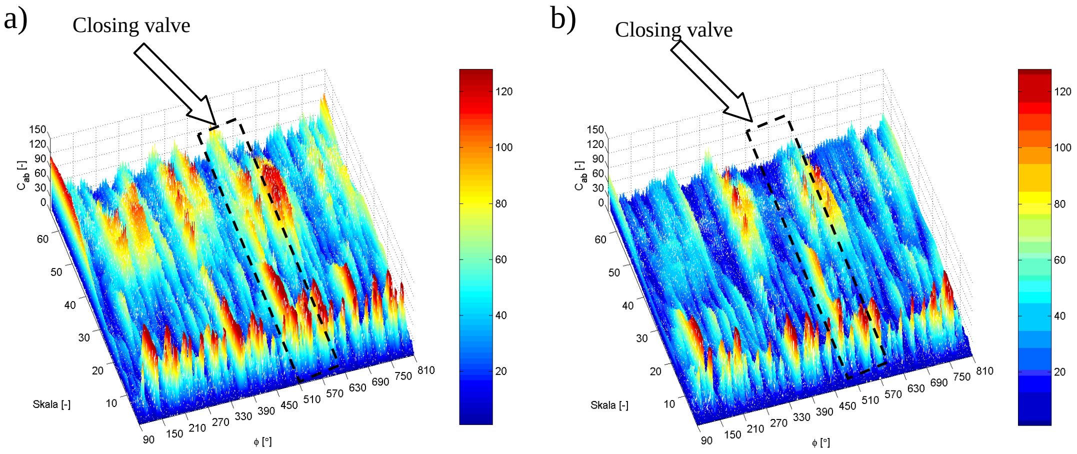


Fig. 3. Time-frequency decomposition of engine vibration signal recorded for valve clearance:
a) intake 0,2 mm, exhaust 0,5 mm;
b) intake 0,2 mm, exhaust 0,55 mm;
c) intake 0,2 mm, exhaust 0,6 mm



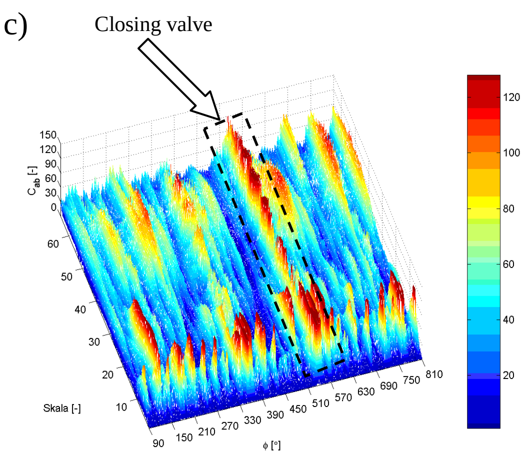


Fig. 4. Time-frequency decomposition of engine vibration signal recorded for valve clearance:
a) intake 0,2 mm, exhaust 0,5 mm;
b) intake 0,25 mm, exhaust 0,5 mm;
c) intake 0,3 mm, exhaust 0,5 mm

3. Conclusion

The paper presents the problem diagnosis of early over normative states of valve clearance. It was proved that the used, in these studies, methods of measurement and analysis of vibration allows the efficient detection of valve clearance.

The diagnosing by vibroacoustic methods in chosen for the tests engine was difficult due to the location of the camshaft. In this case, the total valve clearance is the sum of several combinations clearance of the timing components. Despite this fact, the presented method of diagnosis has been proved successful.

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Water Transport in the Context of Tourism Development

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Abstract. Sustainable tourist traffic cannot do without the solutions in the area of sustainable transport, friendly to the environment and at the same time socially accessible. High quality transport infrastructure and appropriate communication connections are the necessary conditions for the growth of sustainable tourist traffic and the subsequent economic expansion of the specific region. The appropriate incorporation of water tourism – tourist, recreational and sport sailing – into the infrastructure of the region (into the system of the transport services offered) as an active tool in fulfilling leisure time activities of its inhabitants, it is possible to achieve a rise in the interest of visitors in this region and at the same time create the preconditions for the development of its social-economic activities.

Keywords: water transport, tourism, transport services

1. Introduction

Tourism in the twentieth century became an important social and economic phenomenon. According to the World Tourism Organization (WTO) the development of tourism will affect several trends in the beginning of the 21st century, which may include the use of new information technologies in supply and distribution of product orientation for image destinations - tourism centers - as a prerequisite to increase their attractiveness and appeal, not least the increasing preference of tourists focused on convenience, simplification and accelerate the process of travel, ie quality and availability of target sites. Tourism in this sense presents the industry which has a cross-cutting nature and its implementation is directly involved in a number of other sectors, including transport that occupies a key position. Projected growth in tourism of about 2.5% a year is not only determined by the growth of income and educational levels but also the right of traffic, increase range of leisure and lifestyle changes.

By examining the interaction between the development of tourism and regional development is necessary to analyze particularly the external tourism environment - economic (purchasing power, cost of living, economic growth, unemployment, business conditions, access to credit, foreign investment, etc..) social (range of holidays and free time) technological and environmental - and in relation to competition. An important factor affecting the economic development is the technological environment, whereas in terms of tourism is primarily about the development of transport , including consecutive infrastructure.

Another prerequisite for tourism development is the consideration of environmental aspects (ecological environment) by respecting the criteria and conditions for sustainable development.

To create this synergy effect - ie mutual connection and conditionality between improving the state of transport service, accessibility of the region and its services not only assists traffic as a whole, but also its various modes. In this sense, and with the respect to the need for attractive of the region through the development of leisure activities came to the fore right the waterway transport. The waterway transport can participate on a meaningful and active use of leisure time for the visitors / tourists through the development of tourism (cruises, wood-raft cruise), recreation and sport trip (rafting, canoeing, water rodeo, etc..) concluded on water surfaces (lakes, dams) and on navigable natural /canalised waterways (river, derivative channel).

2. The importance of transport for tourism

From the perspective of the European Union, the transport sees as the main tourism industry, which contributes to the quality of tourism services and ensuring the availability of destinations. Relationship between transport and tourism is their mutual relationship, because of the fact that the development of various forms and types the tourism gives rise to the new forms of transport, upgrading existing and building new transport network, and not least the production of vehicles taking into account the requirements of tourists. If the tourism is put at the forefront in the economic policy, so it should be note that it is not enough have good housing facilities, but it is necessary to create a high quality transport infrastructure.

The transport has an important role in the development of domestic and foreign tourism. The transport is one of the conditions for creation and development of tourism and is an integral part of complex services meeting the needs of tourists. Its quality affects the decision the customers about visit destinations and form part of the overall travel experience. The tourism consists of three phases: travel - vacation - travel. Two of these phases are associated with the movement and a single phase with the residents. The travelling is in tourism theory called physical (dynamic) phase. Less analyzed site of the traffic is local transport that directly serves to the tourists. In this context the movement of tourists by vehicles can not be in the place of residence. We do not mean only a universal resources (taxi, bus), but also the specific resources linking the function of delivering customer services in place to target the function of experience - horseback riding, sleigh rides, historic railway or cruise on a cruise ship and so on.

The tourism is divided in terms of the traffic to move, ie movement and residence:

- the transfer the tourist from his place of residence, home environment,
- to the place of recreation, recreational space - the environment, and back to the place of residence,
- movement in the center of tourism, for example. cultural - cognitive tourism,
- stay within the recreation area – the tourism center.

The above breakdown shows that the basic role of transport in tourism is the movement of tourists. Another challenge the transport is providing the complex services to meet the needs of passengers. Transport has to save their time in favor the tourism, expand availability of travel options and distant countries and make attractive areas for tourism participants.

The tourism in relation to transport acts as a carrier for demand for transport services. The tourism expects from the transport satisfaction their needs, always with the same purpose. The transportation needs we consider essential, without their satisfaction we can’t talk about tourism.

The transport infrastructure is one of the key components of public infrastructure influencing the development of tourism. We currently note the inconvenient traffic - technical condition of the regional transport infrastructure, decline the quality and quantity of public transport and its worn-out fleet.

Accelerating the improvement of transport infrastructure as a key precondition for the development of tourism in all regions throughout the country is a priority for the Government in the tourism development strategy until 2013.

Between 2005 to 2013 the Ministry of Transport, Posts and Telecommunications, in cooperation with county authorities and the Association of Towns and Villages, set the objective of upgrading and expansion of road, motorway, speed rail, water and air networks, support and enhancement of public transport, while respecting interests of nature and thereby facilitate access of visitors to the tourist regions of Slovakia in various forms transport. Creating conditions for regular system support for building the cycling routes (local, regional and international) and cycling infrastructure.

Permanently harmonize schedules different types of public transport and make those improvements combined transport.

2.1. The water transport in Slovakia and the tourism

The Slovak Republic is an inland country. It has many rivers and smaller streams, canals, water reservoirs, lakes, ponds and flooded mining pits, which are suitable, among other uses for sports and recreation. This is one of the most natural ways of relaxation and regeneration in the natural environment, sports use from the amateur to top level and also for tourism development in a various individual and organized forms of tourism.

In order to allow a greater degree than is the case now, to exploit the significant potential that sport and pleasure craft provides in Slovakia for the tourism is necessary general support. And not only with the friendly legal framework, creating the necessary technical and suitable organizational conditions but in particular processing and adoption of a missing societal approach to its development. This concept is to use water for recreation and sport boat for tourism development as needed, such as. generally supported its use in the form of snow in winter.

Water tourism offers many unique experiences and unique atmosphere that attracts a wide age range of its devotees. Although Slovakia has a natural potential to offer rich water flows on which it is possible perform activities , canalization and adapt their infrastructure for such activities is insufficient (camping, shops, jetties, etc.)

Create a program, which would partially replace the structural elements of the defunct system will not be easy. One possible way is cooperation the villages located near rivers, which are suitable for water-tourist activities. Through them is still possible to mobilize an existing base of water-sport activities fans. Holders of single concept have to be a central authority which ensure its enforcement the practice (Ministry of Economy, SACR).

Water transport from the perspective of tourism in the SR plays a minimal role, although the Danube is an international waterway, which connects SR with the whole of Europe. Tourists currently use mainly regular connection between Bratislava and Vienna, the other connections (in Hungary) have irregular nature of the recreational traffic. Water transport in relation to tourism has mainly regional character.

For the recreational cruise is currently in the use water flows mainly in western and eastern Slovakia as the Danube and its tributaries Morava, Vah, Hron, an arm the Small Danube and to a lesser extent, Nitra and Ipeľ. In the north of Slovakia is it the river Orava, Kysuca, Bela, Poprad and Dunajec in particular. In the east is the river Bodrog, Hornád, Laborec Latorica lesser extent Ondava and Topľa.

In addition to the waterways in Slovakia there are many water areas, respectively. water tanks suitable also for recreation and recreation. At present recreational cruise carried on Orava Dam on the river Orava, Zemplínska Šírava on Laborec, on the water reservoir above Hrušov Gabčíkovo on the Danube, also on the water surface Nosice, Selice and SĺňAva. For recreation use tourists in Slovakia as well as large dams Domaša, Sunny Lake Senec, Ružín on Hornád and VD Kráľova.

Waterways and water areas in Slovak Republic allow access to all forms and activities in the recreation and sport sailing with regard to local conditions and legislative arrangements for the waterway. The activities can be divided into the organized recreational cruise, individual recreational cruise and sports sailing. Each of these activities requires specific conditions for their positive development. Basic of them are common for all species. In addition to appropriate legislation, we talk about the ensure the access to water and enter into the water, suitable berths and space parking and small boats, basic marking of waterways and navigational barriers.

The current status the sport's and recreation's sailing in Slovakia and its possible share on the domestic tourism dont used opportunities for its development offer the mentioned existing lakes and waterways and favorable natural conditions. Development of individual and organized recreational cruise is essentially random, without a more severe regional or national concept. In this context, are not designed even the necessary uniform regulations and normatives for sett up the recreational cruise operations in relation to other uses of waterways and water areas for the tourism or for the environmental protection. In the official materials about the tourism in Slovakia are missed detailed information about the locations and opportunities for use the services and about the operation of the recreational cruise own or leased vessels.

Different types of water sports, possibly with exception vertex successful water slalom, are marginalized both national and local support and fight at least to maintain their current options. The water tourism is almost completely out of focus and nobody create for it almost any new conditions and possibilities. For example, on the river Hron, was in the last 30 years built about 10 hydroelectric plants, without a device for overcome the drop by vessels (slip or a lock for the small vessels). There is the same situation on the rest usable waterways in the territory of Slovakia.

Insufficient number of places for the mooring recreational boats in the Slovak section of the Danube, with limited opportunities for their lifting and lowering with almost complete absence of the necessary refueling stations for the fuel can hardly be compared with a fully equipped municipal and local ports and harbors for the recreational boats on the Danube in the Austria.

Beautiful, but unused is the Danube branch system in the area Gabčíkovo on the Slovak territory without any facilities for recreation sailing. The situation on the Hungarian side is totally different - docks, boat rentals, parks and other infrastructure.

similar proportion of the waterway, which wanted Baťa connect Baťovany , current Partizánske, with the Danube with, we also have in Slovakia on the river Nitra. With existing locks in the Jelšovce and Nitra (with identical parameters as objects on the Bata canal), could be established about 25 km long recreational waterway directly connected with the county and exhibition city Nitra.

As one of the a few positive efforts can be mentioned at the Government Office to develop a single strategy the use of Gabčíkovo for the tourism and recreation, of course, in the the context of the international context for the development of the Danube area. This activity could be an incentive for the creation of a similar concept of addressing in sporting or recreational sailing in other sections of the Danube and gradually also on other waterways in Slovakia.

3. Conclusion

The use of waterways and water areas for relaxation, regeneration and sports activities is the right of citizens of the Slovak Republic and a very interesting offer for the visitors. Therefore have to be running recreation's and sport's sailing seen as a service and an opportunity the equal on other forms of tourism in Slovakia. It deserves still greater efforts for all of us about improving its current conditions and general support for its further development.

The using of the waterways is dependent primarily on the quality of transport infrastructure. One of the basic conditions for the development of recreational cruise are facilities on the waterways to allow boats enter on the water.

Development of the recreation's and the sport's sailing is not possible without appropriate ports, marinas and the local landing pontoons allowing long term and short-term parking of recreational boats. Part of the equipment beyond the landing port quays and the pontoons, with the possibility of approved connection to the service stations, waste transfer and the use of social and the refreshment facilities at least a minimal extent.

Important also is the base marking of waterways, navigation marked obstacles, placing information boards with names of cities in terms of typical orientation and with the information about services and the attractions nearby.

For further development of the recreational cruise as an important part of tourism and for the Improving the supply for the domestic and foreign visitors for their use, is necessary to focus attention and to develop the most activity on the return of passenger cruise ships on the water areas of large water reservoirs and the appropriate sections of rivers.

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[10]OPV-2009/1.2/01-SORO *Podpora inovatívnych foriem vzdelávania na vysokých školách a rozvoj ľudských zdrojov vo výskume a vývoji „Flexibilné a atraktívne štúdium na Žilinskej univerzite pre potreby trhu práce a vedomostnej spoločnosti“*, doc. Ing. J. Sosedová, PhD.

UNIVERSITY OF ŽILINA

FACULTY OF OPERATION AND ECONOMICS OF TRANSPORT AND COMMUNICATIONS

DEPARTMENT OF ROAD AND URBAN TRANSPORT

ABOUT DRUT

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Thence the department convert from some changes, however till now its authentic profile stay basically unchanged. The department provides the objectives of profiles disciplines namely technology of road and urban transport, transportation engineering, road communications, dynamics of road vehicles, technology of materials handling, road vehicles, bussiness enterprise in road transport, forwarding agency, public transport, diagnostics, transport planning, maintance and repairs of road vehicles and etc.
The dapartment is well known with the activities of safety in road transport. Here was founded the Institut of judicial ingeneering, it is unique specialised institution for education of judicial experts in transport of Slovak republic. In present time is an independent institute of theUniversity of Zilina.

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The structure of department organisation

Section of Transportation engineering and Transport techniques

Section of Transport technology and Logistics

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Use Two-dimensional Scanner to Capture Points of Space.

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Abstract. The purpose of this article is to present the first practical experiences of authors with the laser measurement system LD-OEM1000 by SICK AG. The paper contains examples of the first experiments, used to show how the equipment in question works and describes initial processed raw data captured during communication with the laser scanner. Further it describes experimental measurement and structure of data packets sent via the Ethernet interface, as well as explains meaning of the particular words contained in transmitted packets.

Keywords: laser, scanner, packet, captured, two-dimensional.

1. Introduction

Utilization of a laser beam can be found in many sectors of industry. There are many different ways to use lasers for measuring the distance of a point object to a laser source. Preferred methods for measuring distance are Phase shift measurement, Triangulation and Time of flight. The last mentioned principle is applied in discussed sensing application. The simplified principle the Time of flight method is to measure the amount of time a light pulse takes to travel to the object and back. The speed of light has a setpoint so it is possible to determine the distance travelled. The setups described in the previous sentences provide distance measurements for a single point. Results from more measurements can by used for calculation of coordinates of the target point. One can repeat this process multiple times, by pointing the laser scanner at different directions. When all these directions lie on a plane, the collected data provides the two- dimensional profile shapes of the target object at that plane [1][2].

2. Laser scanner properties

The used scanner LD-OEM1000 [4] is a two dimensional distance measuring system used mainly in industrial environment. This laser measurement system consists of laser scanner and software processing measured values. The scanner operates with an infrared laser of the class 1 (eye safe). The laser beam cannot be seen by the human eye. The scanner interface outputs the contour data on the recorded surroundings in the form of constant raw data incorporating distance and angle values. The 2D profiles of the surrounding are scanned by the multiple pulsed IR laser beams transmitted via a rotating lens head. The sensor via these extremely short light pulses measures the running time of these pulses to the object and back thereby calculating the distance as well as determining the angle of the pulses sent back. Maximal pulse frequency of the laser diode is 14.4 kHz to produce a maximal head rate of 20 times per second. The scanning range of the scanner is dependent on the reflection of the objects to be detected. Scanning range may by up to 250m.

2.1. Communication interface

Communication with the scanner is possible via several interfaces: RS 232/RS 422, CAN and Ethernet. The CAN interface as well as the serial interfaces RS232 and RS422 are having a lower data transmission rate. We have decided to use Ethernet interface since it has the fastest communication speed, it is possible to output all measured values of a scan in real-time and the communication protocol follows the TCP/IP standard. The Ethernet interface has a data transmission rate of 10 MBaud, it is a peer to peer interface and only half duplex is supported. The transferred data is automatically split up into multiple packets by the Ethernet controller. At the receiving end the packets are automatically collected and put into the correct sequential order [3].

2.2. Experimental measuring

Initial measuring shows how the laser scanner can be applied and proves sensor properties in indoors environment. The measurement attributes are the scanning area 180° (90°-270° polar coordinates), scanning frequency 5Hz, angular resolution 0,125° that is 7200 pulses per second. The original software SOPAS ET by manufacturer is both used to visualize measured data on-line and configure the equipment off-line. The graphic representation of measured values is based on the primary function that is measurement of the distance.

The first figure shows a simple horizontal scan of a hallway. From the figures it is apparent that some doors are recognized, but if an incident angle is too small, a number of reflection points diminishes. The glass door at the end of the hallway reflects a laser beam too, that is very important finding for the next research.

Fig.1. Space of the hallway scanned by sensor and graphic representation of measured values.

The second figure shows the same hallway, but there are now two barriers in the area. The graphic interpretation determinates that a back of the chair is approximately 3m far from the scanner. The angle step was set to 0.125° so it is possible capture a thin object which is a case of the clothes-stand in distance 7,5m. Experimental measurements proved configuration and measurement the distance as the primary function of the scanner. These first steps are important for further activities aiming to proper capturing of data and application-based processing.

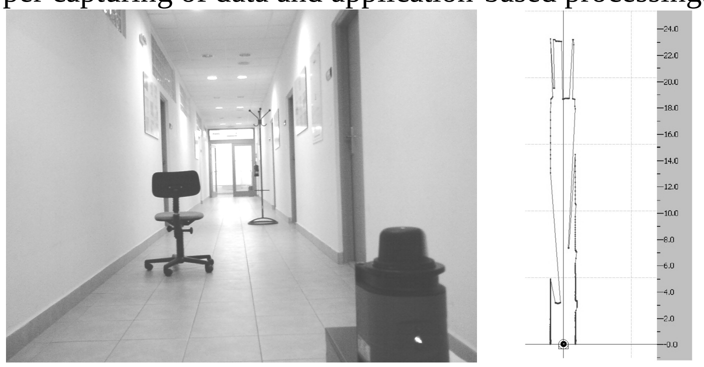

Fig.2. Space of hallway with two barriers and graphic representation of scanned objects.

2.3. Packet capture and analysis

This paragraph describes a structure of one of many packets captured during communication. It was recorded using the network protocol analyzer Wire Shark. The communication protocol follows TCP/IP standard so the packet contains known information like source port, destination port sequence number, acknowledgment number, etc. These bytes in packet are not important, because they do not comprise measured data. There is one part of packet which contains raw data from scanner. This data sent via UPF (user protocol frame) contains a service request comprising service code and data. The structure of the UPF packet in the UPS (User Protocol Service) is given below.

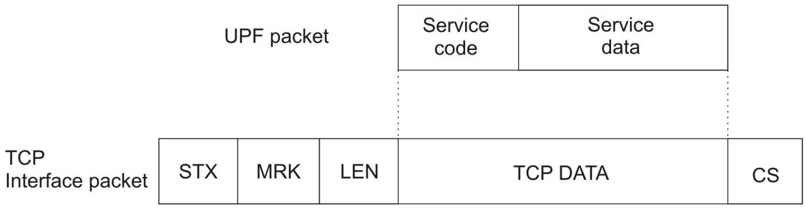

Fig.3. Structure of the UPF packet in the user service protocol [4].

Legend:

STX - (Start of text) is transmitted as a single byte.
MRK - Definition of the transmission format.
LEN - The number of bytes that follow in "Data" is coded as a 32bit integer.
CS - Checksum, is a single byte that is calculated using an exclusive OR.
DATA - Measured value output, contains:

- Profile of the field of view in 2D polar coordinates as hex values.
- Contents of one revolution: include number of the profile emitted, profile counter, sector numbers, angle step, number of points per sector, time stamp for start/end of each sector, value and direction of the distances measured.

Data interpretation can be seen in the actual example of the real packet captured during measurement. One rotation of scanner head corresponds to one scan and one packet with output values. For the maximal scanning area (360°) and the minimal angel step (0.125°) it would be 2880 (360/0,125) pulses per one rotation. For example, the displayed packet was captured for the scanning area 3° (270°-273° polar coordinates) and angular resolution 1° (Fig. 4.). The distance value is represented by a 16-bit binary value with a resolution corresponding to the angle step. The angle is also represented by a 16-bit binary value with a resolution of 1/16°. The hexadecimal numbers are coded as ASCII characters. One WORD consists of 4 characters.

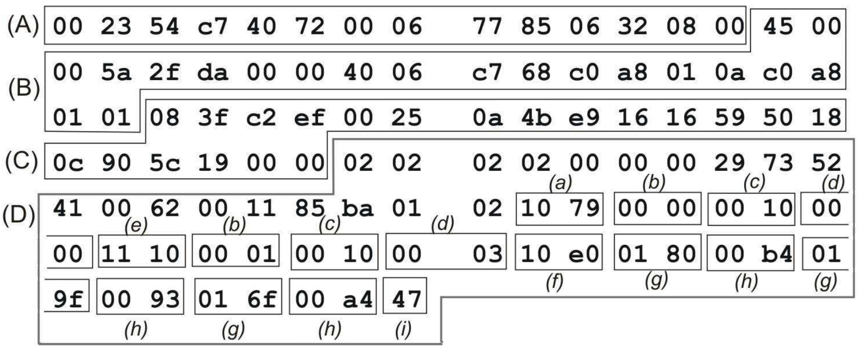

Fig.4. Packet contains measured values.

Legend:

(A) Ethernet II, source and destination MAC address.
(B) Internet Protocol.
(C) Transmission Control Protocol.
(D) TCP data, that mean Interface packet together with UPF.

UPF packet includes Service code and Service data [3]:

(a) Number of the profiles.16-bit counter that counts continuously.
(b) Number of the sector.
(c) Angle step in (*example WORD 0x0010*
first BYTE $00_{HEX} = 00_{DEC}$ - *second BYTE* $10_{HEX} = 16_{DEC}$
resolution of 1/16° so value of the angle step is 1°).

(d) Number of points of the sector.
(e) Time stamp when the sector starts at the first point in.
(f) Start direction of the sector in.
(g) Measured distance *(example WORD 0x019f,*

upper BYTE $01_{HEX} = 01_{DEC}$ - *lower BYTE* $9f_{HEX} = 159_{DEC}$

distance in m + distance in 1/256 $1 + (159x1/256) = 1{,}621m$ *)*

(h) Echo amplitude.
(i) Time stamp of the last point in (ms).

3. Conclusions

Meaning of particular bytes is necessary for additional data processing, especially finding a distance of measured points, angle step, start of direction and number of steps. The laser scanner creates a point cloud, which can by stored as a computer file. This file can be processed by proper software designed for calculation of points coordinates. This program will be created in the program language C++ and will calculate coordinates that locate each point to a two-dimensional space. The third dimension can be assigned, if the scanner starts moving across the plane of scan. Thus accouplement of these coordinates will help to define each point in the three dimensional space. After that we can create a 3D model of the scanned space using only a 2D scanner. This is one of purposes of the doctoral thesis, which plans to design a measurement vehicle used for the intelligent traffic system application.

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Sought Service-Quality during Delays in Railway Transport

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Abstract. This contribution deals with the analysis of customer´s requirements on provided service-quality during delays in railway transport. The analysis covered the situation in the Czech Republic. It summarizes customers´ requirements on provided service in context of guideline 1371/2007/ES. This contribution deals with key questions for quality management, which do not need any extra fees and can be realized direct to improve delivered quality. Analysis is one of the incomes to authors' thesis named Delay from Traffic and Transport Quality.

Keywords: Railway transport, delay, service quality.

1. Introduction

In the last 10 years increase the requirements on quality of railway transport. This influence is caused by bigger mobility and ability of railway system to replace air transport on middle-long distance ways across Europe. Air transport has its own European quality standards in guideline 261/2004/ES, to establish similar rules on railway the new guideline 1371/2007 was passed. This guideline guarantees same quality across Europe in railway international traffic. This guideline is valid for domestic traffic only under the local government approval.

2. Legislation framework

The basic quality guideline ISO 9001 was eked with guideline EN 13816. This guideline defines quality criterions for transport systems (accessibility, availability, information, time, customer care, comfort, security and environmental impact)[1]. According to EN 13816 exists guideline EN 15140, which gives measuring procedure for delivered service-quality´s level in each criterion from EN 13816. The endeavor to be good as air transport brings the need to establish better rights for passengers by rail across Europe. In air transport is valid guideline 261/2004/ES, which establishes common rules on compensation and assistance to passengers in the event of denied boarding and of cancellation or long delay of flights. In railway system had existed only guideline COTIF with its compensation system. Therefore the new guideline 1371/2007/ES was established. It modifies the conditions from 261/2004/ES to rail system conditions.

3. The measurement of customer satisfaction

The measurement of customer satisfaction has tree basic steps (see the paragraphs below).

3.1. Choosing of suitable method of measurement

The customer satisfaction can be measured with several different methods:

- Telephone communication,
- Post (classic, electronic),
- Personal interview,
- Internet,
- The stake of Form.

Author of this contribution have chosen personal interview. This method was chosen thanks to best volume of response and accuracy.

3.2. Measurement

The personal interview was realized at Brno main station during Fridays´ afternoon pick hour in autumn 2010 by the courtesy of CD, a.s. KCOD Brno and New Station Brno Development a.s.. The customers were inquired,

- how often they travel by train,
- what is their journey reason,
- if the reason of delay is important for them,
- which type of CD´s delay announcement they prefer,
- what kind of compensation they welcome.

During the personal interview were the passengers also inquired about train category and acceptable size of delay, but these topics are not part of this contribution.

3.3. Results of measurement

Total number of inquired customers is 603, the results on the most important questions are summarized in this Article. The percentage share of structure of passengers is shown in figures 1-2. Not all of questions from measurement are mentioned in this article.

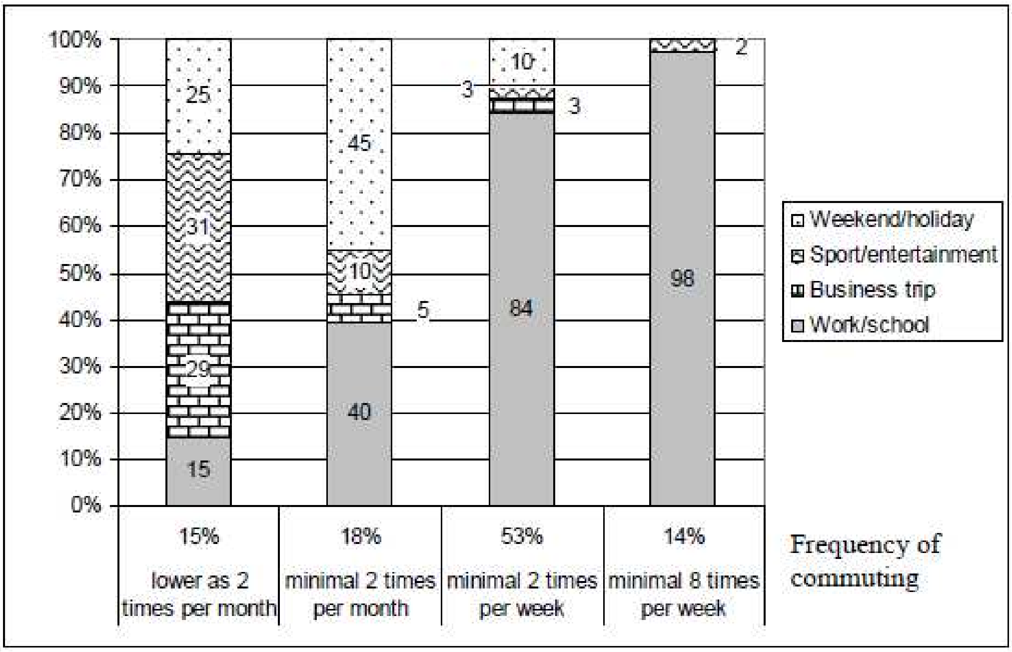

Fig. 1. The percentage of rate and reason of commuting

The minimum range of inquired passengers, that commute more than 8 times per week, is caused by absence of necessity to buy ticket in IDS JMK integrated public transport system. The passengers can go direct to train without waiting at railway station. This fact can be seen in figure 2, where the main volume of passengers goes on longer distance than 150 km.

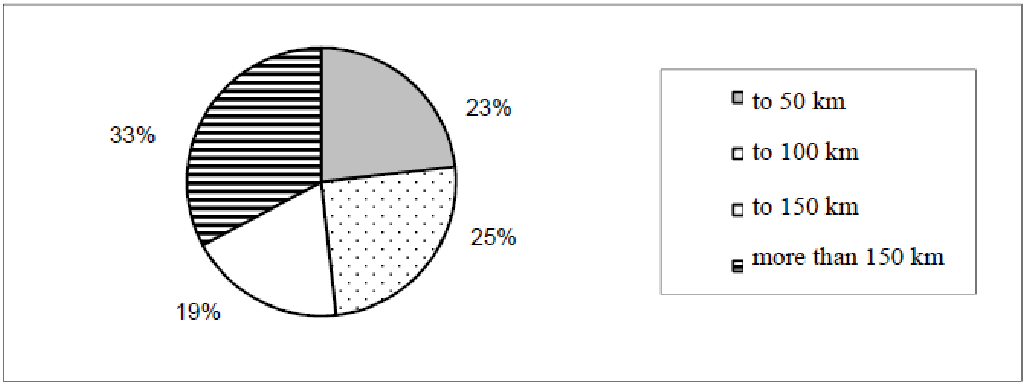

Fig. 2. The percentage of route distance

Key questions for quality management, which do not need any extra fees and can be realized direct to improve delivered quality, are connected with delay announcement, therefore is this contribution focused on these questions:

- Is the reason of delay important for you?
- Which type of delay announcement do you prefer?
- What kind of compensation do you welcome?

Train delay time announcement with 5 minutes tolerance is preferred by 50 % of passenger. Only 32 % of passengers are for exact delay time in announcements. Most of passengers substantiates their answer with the fact, that operator is not able to estimate the exact duration of delay in source of delay. The accuracy of the delay duration finds the rest (18 %) of passengers unimportant.

Results of the question about delay reason announcement are very close. The reason of train delay would like to know 51 % of passengers. For 41 % of passengers is the reason uninteresting. The passengers would like to know the real reason (not only technical or traffic difficulties), but in the case of accident with injure of somebody they prefer only common reason “incident on track”.

The last question of the personal interview was focused on delay compensation. The passengers could choose, what is the best compensation way. The guideline 1371/2007/ES establish the financial compensation with different level for passengers, who are touched by 60 or 120 minutes delay [2].

The measurement shown, that 46 % of passengers is for financial compensation, they are followed by 37 % of passengers, who would welcome the discount for the next ticket.

For full overview on this question is necessary to mention, that 10 % of passengers would like to gain refreshment and 7 % is satisfied with the current system[1].

4. Comparison between passengers of different quality trains

The Czech Railways give opportunity to travel by trains with high offered service-quality. In the conditions of the Czech Republic it should be trains of categories EC, IC, EN and SC. The standards of EC/IC trains are changing, therefore the targeted group of passengers is SC clients (thereinafter SC-passenger). Unfortunately there were found no passengers, who travelled only with SC trains during the measurement.

But there are two groups of passengers, which use SC trains in combination with another train category. Total range of those passengers is 30. The results of the questions about reasons of commuting are shown in fig. 3.

[1] The guideline 1371/2007/ES is not valid in the Czech Republic, but the Czech Railways have their own compensation system for passengers of EC and SC trains [3].

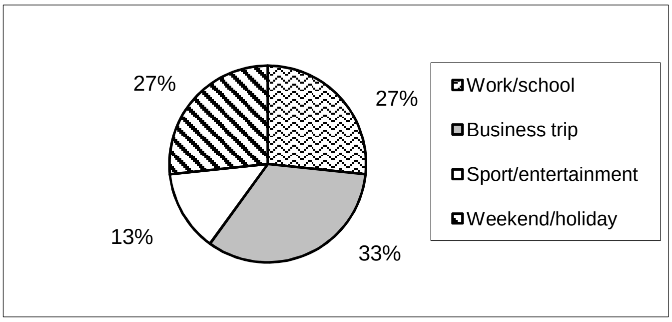

Fig. 3. The percentage of reasons of commuting by trains with high level of services distance

Announcement about delay time with 5 minutes tolerance is preferred by 73 % of SC-passengers. Only 20 % of SC-passengers are for exact delay time in announcements and for 7 % is the way of announcement unimportant.

The reason of train delay would like to know 47 % of SC-passengers. For 53 % of them is the reason uninteresting.

The best way of delay compensation for 47 % of SC-passengers is the financial compensation, they are followed by 20 % of passengers, that would like to have refreshment and 20 % are satisfied with the current system. Only 13 % of SC-passengers would welcome the discount for the next ticket.

This result is not surprise. The most of SC-passengers use train less than 2 times per month (53 %), and the main reason for travel is business trip (33 %). People with low frequency of traveling by train do not want to wait for new ride to use the gained discount for next ticket, as well as the members of business trip do not solve financial compensation, when their employer pay them the ride.

5. Conclusion

The analysis of results of measurement confirms that financial compensation docked in 1371/2007/ES is correct. Passengers prefer the financial compensation. The concrete form of information about size of delay time is on operator´s decision. Information about reason of train delay is important for daily commuters. The passengers would like to know the real reason of delay (not only technical or traffic difficulties). In the case of accident with injure they prefer only common reason e.g. "Incident on track".

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Correvit vs. XL Meter™ Pro–comparison of Braking Deceleration Procedure

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Abstract. This contribution deals with problems of braking the automobile, specifically of category M1. It was carried out the measurement of braking deceleration of the vehicle Citroën C6 by Correvit system and decelograph XL Meter™ Pro. The aim of article is to perform comparison of braking deceleration between these two devices and enquire its lines running. To accomplish the tests, it has been used airport in the Rosina near Žilina. There are published results of performed measurements and its evaluations in the last part of this paper.

Keywords: braking deceleration, Correvit, XL Meter™ Pro, divergence.

1. Introduction

Intensive vehicle braking is usually an essential and defensive driver reaction in order to avoid an accident. Indeed, detection of the values reached during the intense vehicle deceleration is being one of the determining factors in accident action explication. [2]

2. Test vehicle and measurement devices

As a test vehicle was used a car Citroën C6 3.0 i V6 BVA from the laboratories of the Department of Road and Urban Transport, PEDaS Faculty of the University of Žilina. The vehicle was loaded with two attempts persons (a driver, passenger who serve measuring device). Tires had dimension 245/45/R18 100 W. Tread depth for front tires are front 5,1 mm and rear 6,9 mm.

Fig. 1. The vehicle Citroën C6

Correvit Corssys Datron (Fig. 2). This device consists of 4 main parts – microwave sensor (heart of the system), braking sensor, processor and control panel. The microwave sensor consists of sensor head and sensor electronics and accommodates additional connections, such as an interface for flow-measurement systems (for consumption tests), or trigger inputs for light barriers or brake switches, providing exceptional testing power and flexibility. The unit senses the relative movement between itself and the test surface using a planar antenna, which projects two radar beams at 45° angles. Upon striking the test surface, the beams are reflected back to the sensor antenna. The resulting double frequency (equal to the difference of sent and received frequencies) is directly speed-proportional. The two-beam planar system increases accuracy by automatically compensating for mounting and pitch-angle errors. The gained signal is converted to the desired dimension via an onboard RISC processor and then sent to the corresponding outputs. Featuring an effective operating range of 300 mm to 1200 mm, the Microstar Sensor can be used in applications demanding larger standoff distances without loss of accuracy. [5, 1]

When used with the CeCalWin Pro 1.09.001 Software, the Microstar Sensor functions as a complete data acquisition and evaluation system. The software functions enable test parameters and definitions to be permanently saved, along with online displays and evaluations, e.g. charts and plots. All measured signals can be saved and evaluated off-line. Data obtained directly from external memory, evaluation units are stored in the program CeCallWin Pro ADF format. With this software, the data are exported to TXT format, which then are imported into Excel software. [4] These data are clearly established in tabular form with the required parameters and it is possible to use them for future work. Data which were exported to the XLS file were: time, distance, speed, acceleration, respectively deceleration (each 0,005 seconds).

Decelograf – Inventure XL Meter™ Pro (Fig. 2.) fasten to front window by using sucking disc from inside. The measure axis must be parallel to the drive direction and controls are located in operator hand reach. After the switch on and automatic system control mode starts system calibration. There is displayed current value of deceleration. In the case of vehicle stay on horizontal extent the display should show 0 $m.s^{-2}$. Inaccuracy correction of alignment is providing by manipulation. Automatic detection of stagnant, horizontal position is available. There are recorded braking deceleration data 40 s after switch application. [3, 6] After the measurement performance display shows average value of (MFDD – Mean Fully Development Deceleration), braking distance (s_0), initial velocity (v_0) and intensive braking time (t_{br}). The records are loaded in permanent memory and they are available only after the switch off. Three last measurements are available recover from memory. There are used XL Vision™ software for reading, editing and transforming recorded data from XL Meter™ Pro.

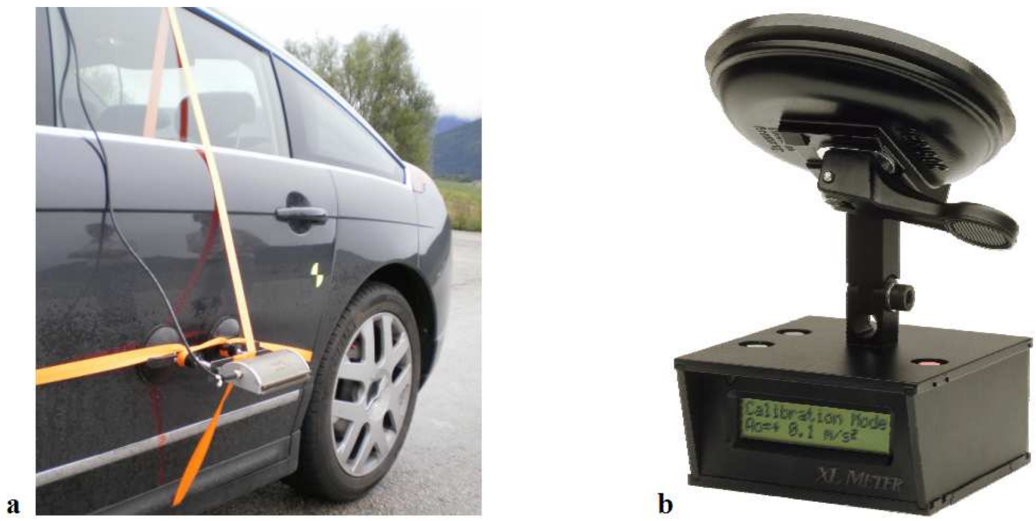

Fig. 2. Correvit (a) and XL Meter™ Pro (b)

3. Experimental conditions and methods

Experiments are carried out 22. 9. 2010 at the airport in the village of Rosina in Žilina. The surface conditions – dry roadway, asphalt adhesion factor estimated in range 0,85 - 0,95. Ambient temperature of air is 19ºC. Variability of measure caused by the road gradient is estimated at 2 %. Devices were installed on Citroën C6 – data frequency of both devices is 200Hz. With the activation of the speed limiter fitted to a vehicle was achieved, the vehicle did not exceed the speed. In about half of departure runway the passenger has activated device and record of data began. At the time of consistent desired speed of the vehicle the driver rapidly depress the service brake pedal. Vehicle is being equipped by ABS system. Braking was done to stop the vehicle till zero speed. All required data were recorded on the memory of the evaluation and available in a complete dataset complete data file. In this state, when the vehicle was completely at rest, the measuring deactivated itself. After a short pause the next measurements were repeated.

4. Results and Data comparison

Using by Software Analysing processing were data synchronized and transformed to Microsoft Excel. There are shown lines of deceleration process of real measurement in graphic mode saved by Correvit and XL Meter Pro on fig. 3. The deceleration section of process is limited by brown dashed line (starting array of negative attributes) and black dot and dash line (ending of negative attributes) on the figure.

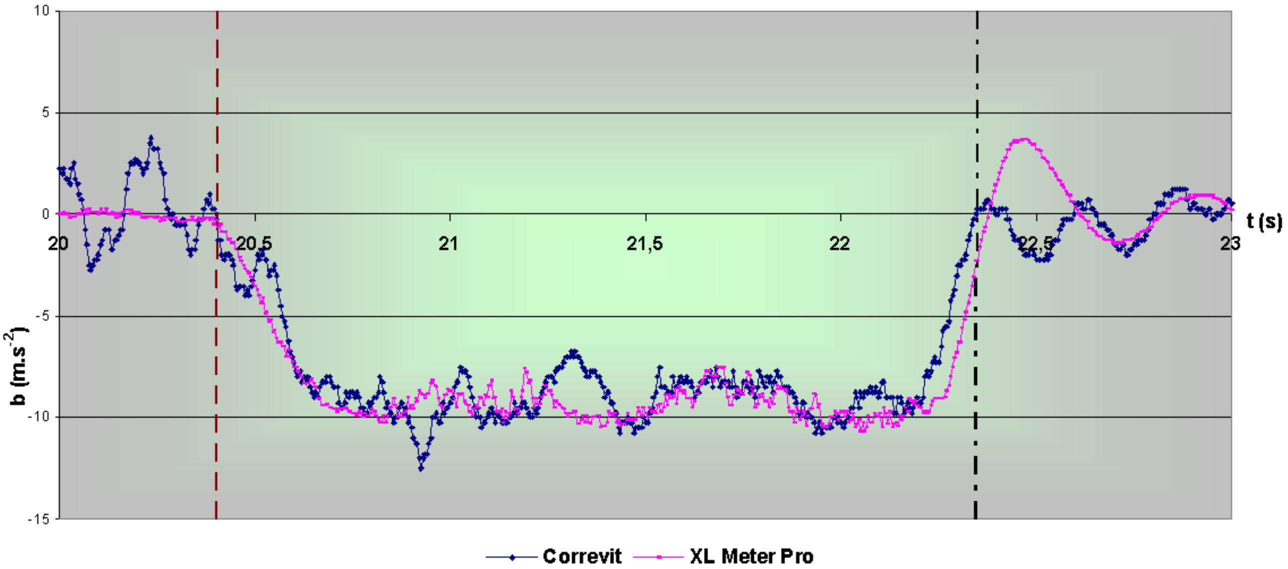

Fig. 3. Deceleration process obtain by using measuring devices

Results of full braking deceleration measurement are:

Reached values

- maximum braking deceleration Correvit: 12,5 m.s^{-2}
- maximum braking deceleration XL Meter^{TM} Pro: 10,7 m.s^{-2}
- minimum braking deceleration Correvit: 0 m.s^{-2}
- minimum braking deceleration XL Meter^{TM} Pro: 0,3 m.s^{-2}

Counted values

- average magnitude braking deceleration Correvit: 8,13 m.s^{-2}
- average magnitude braking deceleration XL Meter^{TM} Pro: 8,626 m.s^{-2}

- standard deviation of braking deceleration Correvit: 2,4
- standard deviation of braking deceleration XL Meter^{TM} Pro: 2,1
- standard deviation/average of braking deceleration Correvit: 0,295
- standard deviation/average of braking deceleration XL Meter^{TM} Pro: 0,24

5. Conclusion

The mentioned braking deceleration measurement is evaluated on seven exams. The value of density data per 1 second is 200. The medial braking process passed in average 1,95 s. That means that comparison results were made from 390 records without of any interpolation.

Correvit is appropriate for scientific measurement requiring high level of precisions. Because of acquisition costs not anticipated application in standard practise conditions. Mentioned comparison gives information about characteristic of devices. According to reached results Correvit is more sensitive device as XL Meter^{TM} Pro (0,295 > 0,24 comparison of variation coefficient shows in Chapter 4). In the case of searching maximum value of braking deceleration (b) Correvit measure 14,4 % higher value compared with XL Meter^{TM} Pro and for this purpose is preferable.

XL Meter^{TM} Pro is preferable device for normal using because of small size, easy installation and fully complies with for professional measurement of braking deceleration.

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Unification of the Rules Related to the Initial Qualification and Periodic Training of Drivers in the European Union

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Abstract. The paper describes initial qualification and periodic training of drivers who carry out freight and passengers in the European Union. This article also shows the differences in implementation of the Directive 2003/59/EC of The European Parliament and of the Council of 15 July 2003 on the initial qualification and periodic training of drivers of certain road vehicles for the carriage of goods or passengers in EU in Member States. It also represents an analysis of these differences in Member States and about results of theme. These differences cause problems in carrying out of driver`s profession and because of that there is also the proposal for this problem solution.

Keywords: Initial qualification, periodic training, drivers, Directive 2003/59/EC

1. Introduction

Sufficient theoretical knowledge and practical experience of drivers are necessary conditions for drivers, who carry out freight or passengers. This knowledge and experience are also very important for quality and safety road transport. To achieve these targets, it is very important to adopt the same rules of the driver education and training in the all EU countries.

For the purpose of unification in the field of education and training of drivers, improving road safety and the safety of drivers and because of ensuring equal conditions of competition, it was adopted the Directive 2003/59/EC of The European Parliament and of the Council of 15 July 2003 on the initial qualification and periodic training of drivers of certain road vehicles for the carriage of goods or passengers in EU. Member States had to adopt this directive into their law before 10 September 2006. According to this Directive, initial qualification and periodic training are intended to the road transport drivers who use vehicles for which is required driving licence of category **C1, C1 + E, C, C + E** acquired after 10 September 2009 or driving licence of category **D1, D1 + E, D, D + E** acquired after 10 September 2008 or a driving licence recognised as equivalent.

2. Initial qualification and periodic training

Driver`s **initial qualification** is a level of knowledge and practical skills of driver, who carry out freight or passengers and it is certificated by certificate of professional competence - CPC. Acquired knowledge and skills have to be updated regularly by **periodic training**. Periodic training must be organised according to the targets of this directive with attention on road safety and rationalisation of fuel consumption.

Given the differences between systems and practices in trainings in certain Member States before the adoption of this Directive, Member States could choose between several options how to get initial qualification and periodic training. These options ensure fluent and easy implementation of the Directive provisions in Member States. The choice of the option depends on certain Member States and their competent authorities. Results of these choices are different conditions of systems and practices in initial qualification and periodic training in Member States.

2.1. Initial qualification

According to this Directive the system of initial qualification can be realized in 2 options – option combining course attendance and test or option involving only tests. In the case of the first one – combining course attendance and test, there are two types of initial qualification course:

- Initial qualification
- Accelerated initial qualification

Initial qualification course	**Non-accelerated**	**Accelerated**
Duration of initial qualification	280 hours	140 hours
Minimum number of driving hours	20 from 280	10 from 140
Maximum number of driving hours on special terrain or on a top-of-the-range simulator	8 from 20	4 from 10
Duration of qualification for drivers who broaden or modify their activities in order to carry passengers, or vice versa	70	35
Number of driving hours for drivers who broaden or modify their activities in order to carry passengers, or vice versa	5	2,5

Tab. 1. Duration of initial qualification course and its distribution

Duration of the initial qualification, accelerated initial qualification course, the minimum qualification and training requirements are listed in the Directive but accurate determination of these requirements depends on the individual definition in every Member State. Duration of the non-accelerated and accelerated initial qualification course is listed in table 1.

But not in all countries that have applied option combining course attendance and test can be chosen the duration of the initial qualification course. For example, in Hungary driver cannot attend an accelerated initial qualification course, while in Germany driver can attend only accelerated initial qualification course.

System of initial qualification	**Member State**
Course attendance and test	Bulgaria, The Czech Republic, Denmark, Estonia, Finland, France, Lithuania, Luxembourg, Poland, Romania, Sweden, Slovakia, Hungary
Only tests	Slovenia, Ireland, Netherlands, Malta, Latvia, Great Britain, Cyprus, Belgium, Austria
Both options	Germany

Tab. 2. System of initial qualification in Member States

Member States which has not chosen the system of course attendance and a test has applied a system of tests. Applied system of initial qualification is listed in table 2.

2.2. Periodic training

According to the Directive 2003/59/EC, every driver who carries out freight or passengers on the basis of CPC must attend periodic training every 5 years. Attending of periodical training is important for drivers to maintain their qualification which is necessary for their profession. Duration of periodic training must be **35 hours at least 7 hours in one period**. This is the only regulation of periodic training. Any other distribution and organisation of the periodic training like the organisation of initial qualification is the responsibility of Member States. Ending periodic training by doing a test and using a top-of-the-range simulator in periodic training depends on decision of every Member State too.

It is clearly, that Member States have a big freedom in organisation of periodic training as well as initial qualification and this freedom causes big differences between Member States in this field.

In some state it is required only theoretical periodic training, but in another must be attended also the practical part.

Theoretical and practical part of periodic training is required in Denmark, France, Hungary, Luxembourg, the Netherlands, and Slovakia, while in Finland, Germany, Ireland and Poland is only theoretical training sufficient.

State	Course organizing
Slovakia	One course every 5 years
The Czech Republic	7 hours every year within 5 years
Estonia	35 hours on one occasion
Great Britain	Without regulation
France	35 hours may be split in two blocks or on one occasion

Tab. 3. Organizing of periodic training

Periodic training can be attended in every Member State by another way. Some states required attending of periodical training at once, another in two or more parts. Examples of organizing periodic training in some Member States are listed in the table 3.

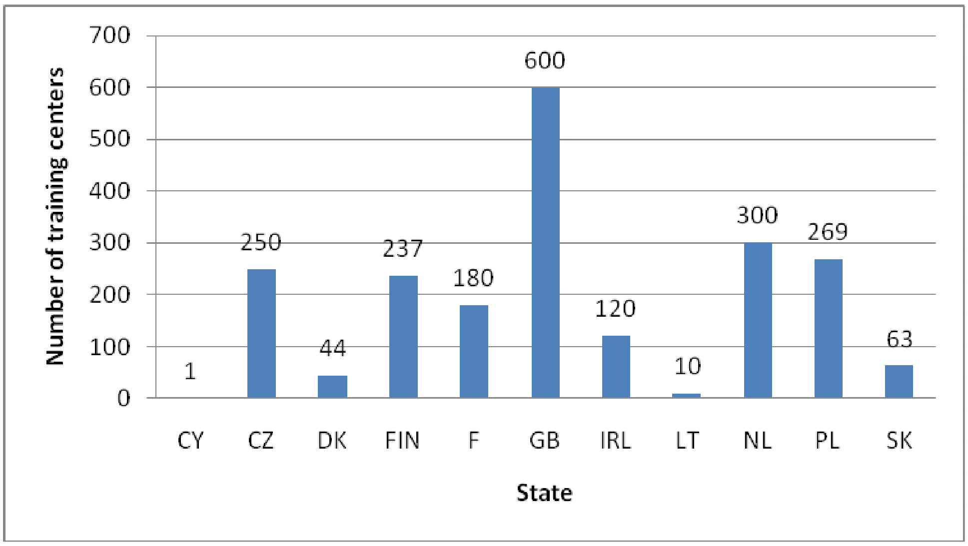

Fig. 1. Number of authorized training centres in selected Member States

Organization of periodic training as well as initial qualification must be organized by only training centres which have been approved by the competent authorities of the Member States. Because of the appointment of training centres and setting of their criteria is responsibility of Member States there is also different number of training centres in Member States. While in Cyprus is only one authorized training centre - The Cyprus Productivity Centre, in Great Britain can be periodic training and initial qualification attended in 600 authorized training centres. Number of authorized training centres in selected Member States is shown in figure 1.

3. Conclusion

Target of the Directive 2003/59/EC – unification of initial qualification and periodic training conditions on the base of information above can be considered as complied only partially.

Because of many differences in systems of initial qualification and periodic training of drivers between the Member States some Member States (The Czech Republic, Finland, France, Hungary, Latvia, Poland, Sweden) do not recognize attending of initial qualification or periodic training in another Member State.

This problem can be solved by European Union measures, for example:

- uniform conditions for training centres in all Member States

- uniform content and range of periodic training in all Member States
- uniform rules for doing and successful passing tests of initial qualification
- precise determination of the technical requirements for top-of-the-range simulators in all Member States

Problem in systems of initial qualification and periodic training should be solved by communication between competent authorities of the Member States, progressive harmonization of rules, setting harmonized criteria for training centres etc. or for uniform conditions of initial qualification and periodic training in all Member States it should be very useful to issue EU regulation. This regulation would be equally applicable in all EU Member States.

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Identification of Black Spots in the Slovak Republic

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Abstract. This article is aimed at identification black spots in the Slovak Republic is determined according to the Slovak Road Administration and the European Road Assessment Programme. Shall indicate the traffic accident statistics of black spots of the two organizations and highlights the differences in their evaluations based on different principles. The basic objective is to increase the safety of the roads and trying to reach the competent authorities in the Slovak Republic to the allocation of financial resources to bear in mind that may prevent needless extinction of life set of practical measures applied directly in black spots.

Keywords: Traffic accidents, black spots, roads.

1. Introduction

Road safety is related to the level of technical condition of the road, as well as the organization of traffic on it. The Slovak Republic joined the European Union committed itself that it meets its standards, or try on their achievement. One of the main requirements was the reduction of traffic accidents on roads, thus eliminating black spots.

Thanks to the entry into the European Union Slovak transport corridors were included in the trans-European transport networks. It is the highway and expressways. At the present time but they have very little. Although the number of cars is constantly increasing, their construction is suspended on some sections. The black spots are not located just in opposing ways, thus we can say that if they completed a highway and expressways, the black spots could be extinguished.

2. Identification of black spots

In the Slovak Republic of black spots down the Slovak Road Administration and European Road Assessment Programme. They are two different organizations have different results of the final evaluation, because each has different criteria for identifying black spots.

In the year 2009 compared to 2008 accident rate decreased significantly by up to 56%. Is it even possible? Yes it is, but unfortunately for us it is not building the transport infrastructure. Police of the Slovak Republic started from this year recorded an accident, only if physical damage is likely to exceed € 3990. In the event that physical damage has exceeded a certain value and were not injured or killed persons shall be considered in our statistics, only the harmful event. Nevertheless, can´t be denied that fell serious consequences of traffic accidents - deaths in 2009 compared to 2008 up to 38% and serious injuries by up to 22%, probably as a result of active operation of the traffic police. In 2010 compared to 2009 but no such significant decrease occurred. Detailed in Tab. 1.

Slovak Republic thanks to this indicator has moved above the European tables. Finally, it should be noted that comparisons of major causes of road accidents with other countries is not so objectively, because for us killed person is a person who has died in a car accident or its consequences, no later than 24 hours after the accident and, in some countries this timeframe to 30 days.

	2008	2009	2010
Killed	558	347	345
Badly injured	1806	1408	1207

Tab. 1. Serious consequences of accidents

2.1 Identification of black spots under European Road Assessment Programme

European Road Assessment Programme is an international nonprofit organization based in Brussels, whose members are motoring organizations, national and regional road transport authorities and independent experts in the field of road safety. In Slovakia, a risk analysis carried out by international protocols evaluating the European Road Assessment Programme Autoturist Slovak Club, which cooperates in implementing the program with the Department of the Traffic Police Office of the Slovak Republic and by the Geomatika s r. o., which is the technical partner. Slovak Autoturist club it represents the Slovak Republic since 2005. European Road Assessment Programme evaluate the safety of a particular road depending on the extent to which participants can protect against accident deaths and serious injuries. Making use of its two-tier system of evaluation and their own methodology.

Two-tier rating system:

I. grade: Protocol RRM (Road Risk Mapping) assesses the safety of road infrastructure on the basis of statistical data on traffic accidents and traffic density (individual and collective risk). The output is a map of the degree of risk, divided into five color bands (Tab.2.). These maps can be variably compiled according to different criteria: for passenger motor vehicles, pedestrians, cyclists, motorcyclists, age groups and the impact of alcohol.

II. grade: a follow-up to the first protocol, RPS (Road Protection Score), a physical inspection of road infrastructure, which corrects the results of protocol RRM, and accurately identifies the risk attributes of roads. The output is a comprehensive security assessment road map of risk which includes both protocols and the resulting level of road safety rating system of stars from 1 to 5 The final report also includes specific design measures for specific locations and economic analysis of their return. Thus, the basic philosophy is to evaluate the level of road safety in Europe under a single methodology, mark them, analyzing and designing highly efficient, low cost, and in particular the immediate solutions to remedy security deficiencies.

The degree of risk	Margin (coefficient European Road Assessment Programme) *	Color map	Number of sections	% representation
low	0,00 -8,43		7	3,5
lower middle	8,44 - 34,60		27	13,5
mean	34,61 - 59,53		18	9,0
upper secondary	59,54 - 101,08		49	25,0
high	101,9 and above		97	49,0

*European Road Assessment Programme coefficient is calculated according to specific methodology, which allows an individual to compare the risk of road infrastructure in different countries. Is the number of deaths and severe injuries to the road section of about 25 km, taking into account traffic volume.

Tab. 2. The rate of accident risk

Methodology European Road Assessment Programme:

- focuses only on traffic accidents with serious consequences
- uses a three-year reporting period,

- continuously monitor sections of up to 30 km,
- is applicable to level III. roads class,
- is an internationally comparable.

Studied road network includes:

- highways,
- expressways,
- roads I. class,
- selected busy roads II. class.

European Road Assessment Programme presents the risk of traffic accidents are most concentrated on the opposing road I. and II. classes, which have a high risk. These roads are not by managers or owners prehliadnuteľné mainly because they are often in the shadow of larger projects - new projects with long-term perspective.

From 2006 to 2010 were processed 3 maps risk by protocol RRM (rated network 5000 km). The latest risk map EuroRAP contains hazardous roads where there is a likelihood of an accident with serious consequences. This map is understandable for the layman, and training for motorists. Despite promising measures are there still appear the same sections on which level of risk did not decrease.

Order	**Number of road**	**Title field**	**Section Length**	**Killed people**	**Injured people**	**Traffic intensity***	**coefficient European Road Assessment Programme**	**The degree of risk**
1	74	Snina Ubľa	30,9 km	3	13	1 740	272,21	
2	68	Ľubotín Sabinov	24,4 km	7	23	4 437	253,29	
3	77	Spišská Belá Stará Ľubovňa	25,6 km	5	29	4 792	252,99	
4	572	Hubice Kútniky	23,3 km	9	24	5 457	236,90	
5	517	Pov. Bystrica Rajec	24,6 km	3	23	4 151	232,15	

*Traffic intensity reflects the average number of vehicles per day pass the segment

Tab. 3 Black spots under European Road Assessment Programme for 2007 - 2009

2.1. Identification of black spots according to the Slovak Road Administration

Slovak Road Administration is a budgetary organization established on 1.1.1996 by the Ministry of Transport, Posts and Telecommunications of the Slovak Republic. Black spots by means of two criteria, namely the number of road accidents and by the consequences to health and property. Besides this it also has a completely different methodology for their assessment, which aims to:

- monitoring of all traffic accidents - even without injured casualties, because the black spots may also be paradoxical way, which is the methodology European Road Assessment Programme safe, since it did not die within three years or one person. The same principle works the other hand, when high-risk dough according to the European Road Assessment Programme is not, in the Slovak Road Administration critical because of the mathematical-statistical point of view the total number of accidents on it do not exceed a critical threshold,
- uses the annual reporting period,
- black spots is the location on the road with a maximum length of 500 m,
- follows the path to levels II. class,

- monitors accidents only of mathematical-statistical point of view, as black spots and then evaluate it, as it has been some accidents,
- not internationally comparable.

Recurring black spots in terms of the consequences of accidents on the road I. and II. classes in Slovakia in 2009:

- Route number: II/500,
- Route number: I/11 Location: Čadca,
- Route number: I/50 Location: Rožňava,
- Route number: I/77 Location: Stará Ľubovňa.

3. Conclusion

Road transport is still increasing. Efforts to improve safety on roads is an issue, but the means of ensuring a minimum. European Road Assessment Programme the Slovak Road Administration, the visible black spots, trying to inform the public about them. Too bad that does not actively working with bodies having an impact on the elimination of identified black spots, because unless the team starts to do something, this statistic is actually useless.

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Failure and Failure Detection Effects on the Safety of a Safety-Relevant Control System

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Abstract. Safety-relevant control system (SRCS) has to perform its specified control functions with a certain level of safety. Redundancy is often used to cope with problems that arise from contradictory requirements on high safety and reliability of the high demand SRCS. Many quantitative methods can be employed to quantify the effects of various system parameters on the safety of a SRCS. In order to obtain relevant measures, adequate approach and method must be used. Chosen method need to be used with respect to its mathematical foundations and assumptions. Given correct input parameters, only then valid measures can be obtained. The topic of this paper is focused on most important parameters of redundant systems, which includes failure rate, diagnostic coverage coefficient and time to restoration. Properties and problems related to these parameters are contemplated in the paper and case study focused on their impacts on safety is performed.

Keywords: safety analysis, quantitative model, failure rate, recovery.

1. Introduction

System safety is an ability of a system to mitigate failure consequences. Safety as a quantitative measure is defined through the probability of the system being in non-dangerous state. Both definitions are valid only in a certain time period and if specific conditions apply [1].

The safety of the safety-relevant function is expressed by the means of the safety integrity level (SIL). The minimal SIL needed to achieve required safety level is achieved through the risk reduction, based on technical and/or organizational measures. Certain qualitative and quantitative requirements are related to the every SIL. Quantitative requirements are met by achieving the required average probability of hazardous failure (for low demand mode systems) or hazardous failure rate (for high demand / continuous operation mode systems).

2. Quantitative safety analysis

The result of the quantitative safety analysis is determination of a probability of hazardous failure $p_H(t)$ or a hazardous failure rate $\lambda_H(t)$ of a SRCS (or a safety-related function failure), in the dependence on time and SRCS's safety-affecting factors [1]. Those factors include component failure rate (random hardware failures), diagnostic coverage coefficient, a time to detection of a failure and time to restoration [2].

Other properties of the SRCS that affect its safety are redundancy, various failure detection mechanisms, preventive (scheduled) and corrective (unscheduled) maintenance [3].

2.1. Failures

The categorisation of failures and their outcomes is rather complex [4]. From the quantitative analysis point of view is important to consider quantifiable set of random hardware failures. Random failures are described by the means of failure rate:

$$\lambda(t) = g(t) \quad (1)$$

The failure rate is often constant in time, so a random time to failure is an exponentially distributed random variable with a cumulative distribution function $P[T < t] = 1 - e^{-\lambda.t}$. Probability that the failure will occur before time t_{max} could be estimated by:

$$F_T(t_{max}) = 1 - e^{-\lambda.t_{max}} = \lambda.t_{max} + \sum_{k=2}^{n} (-1)^{k-1}.\frac{(\lambda.t_{max})^k}{k!} \cong \lambda.t_{max} . \qquad (2)$$

Approximation (2) is valid only on assumption $\lambda.t_{max} < 10^{-2}$ [5], which limits the maximum analysis or simulation time. This approximation also should be avoided if there is a need for maximum accuracy.

The set of failures comprises of at least two subsets – the subset of safe failures with the rate λ_S and the subset of hazardous failures with the rate λ_H. For total failure rate we could state

$$\lambda = \lambda_S + \lambda_H. \qquad (3)$$

Since it is very complicated to determine valid λ_S and λ_H measures ([3], [6]), pessimistic assumption that all failures are possibly dangerous is accepted (therefore $\lambda = \lambda_H$). According to [1], single failure must not cause failure of safety-related function, with probability less or equal tolerable probability (tolerable probability of hazard depends on SIL).Given this requirement, it is absolutely necessary to avoid common cause failures.

2.2. Time to detection and time to restoration

If there is a failure in the SRCS, then it will be detected and negated in time t_δ which is

$$t_\delta = t_O + t_N. \qquad (4)$$

t_O is the maximum time needed to detect a failure and t_N is time needed to negate its consequences. Inverse value of t_δ is a constant failure detection rate δ. Failure is usually negated by disconnecting the failed unit in a very short time, which means that $t_N \ll t_O$ and therefore t_N is often neglected in computation.

Non-operational state affects availability as well as safety of the redundant SRCS. Mean down time of the SRCS with a mean time to recovery is needed to assess effects of non-operational state on safety. Recovery and maintenance is often deterministic and this fact must be considered in stochastic mathematical model [7], however the recovery effects are beyond scope of this paper.

3. Stochastic mathematical model

Fast and simple safety analysis can be performed by the means of Continuous time Markov Chain (CTMC) [8]. More complicated Stochastic Petri nets (SPN), on the other hand, have the same modelling power as the CTMC, but can implement not only exponential random variables, but also general as well as deterministic delays into the model. The safety analysis comprises of two basic steps in both CTMC and SPN: identification of the state space of the SRCS (model creation) and valid determination of the SRCS's parameters that have impact on safety. The state space contains:

- initial failure free state (safe state);
- operational state with a failure (only in redundant systems – safe state);
- failed dangerous state;
- safe state after a failure has been detected and negated.

If the automatic restoration after a failure is not assumed, then the Fig. 1 shows the model of the 2-channel redundant SRCS that serves safety analysis.

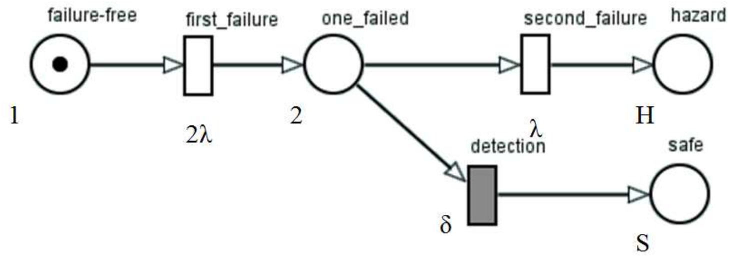

Fig. 1. The SPN model of the general 2-o-o-2 system with a detection mechanism.

3.1. Assumptions of the analysis

Let us assume that the SRCS comprises of two identical independent channels. Given system borders the single channel failure rate λ can be assessed for every channel. The simplified 2-o-o-2 system was chosen as a case study. If the system borders were different, the same analysis could have been performed on another subsystem (e.g. sensor subsystem). Further assumption is that the SRCS has ideal detection mechanism (all failures are detected until certain time) with failure detection rate δ. Detection mechanism is modelled through the gray "detection" transition in the Fig. 1. Three different approaches have been explored in the case study:

- no detection mechanism – $\delta = 0$ (for comparison purposes only);
- exponentially distributed random delay before failure detection with mean time $t_\delta = 4380$ h;
- deterministic delay 4380 h before failure detection

The hazardous state (the H state in the Fig. 1) occurs if both channels fail in a short time interval – the second channel fails before the failure of the first channel have been detected (since simultaneous failure of both channels is mathematically impossible).

4. Analysis and results

Time dependent $p_H(t)$ can be obtained by an analytical or numerical analysis of the SPN pictured on Fig. 1. Plots on the Fig. 2 show time dependent probability distribution of the system states ($p_x(t)$ is the probability of the system being in the state x, $x \in \{1,2,H,S\}$). The analysis has been performed three times, according to three different approaches to failure detection. If the time to detection is exponentially distributed random variable, then the effects of detection are significant even in time $t \ll 4380$ h (as shows Fig. 2 and Fig. 3).

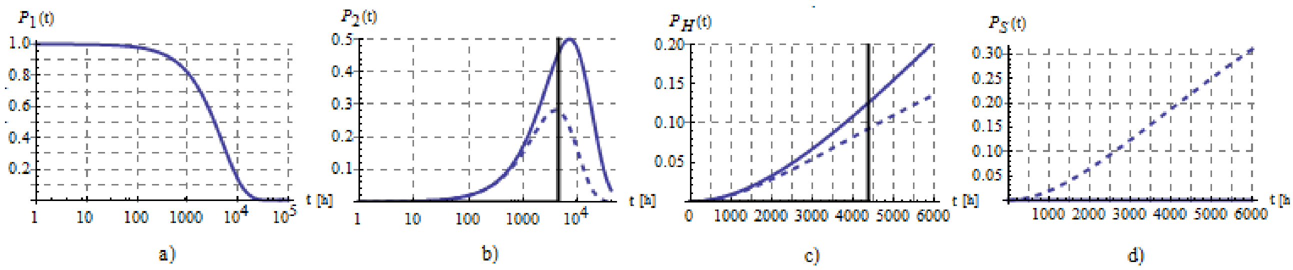

Fig. 2. The probability distribution of the 2-o-o-2 system for $\lambda = 10^{-4}h^{-1}$ if the failure detection rate is 0 – solid line, or exponentially distributed with rate $\delta = 4380^{-1}h^{-1}$– dashed line.

Values of the $p_H(t)$ decrease with an increasing δ (i.e. shortening time to detection), on the other hand the negative effect of detection on the availability should be considered, because as the δ increases, the probability of the system being in the S state increase as well (Fig. 2 d)). It can be concluded, that if the system do not possess detection mechanisms ($\delta = 0$), then the preventive maintenance should occur in time before the value of p_2 (Fig. 2 b)) reaches its peak.

Fig. 3 compares the exponential and deterministic delay to detect a failure. It suggests that deterministic delay is similar to infinite delay to failure detection, in the contrary to the exponential delay, which behaves in favour of higher safety. The conclusion is that deterministic delay in real system cannot be replaced by an exponential one in the model, as it can completely distort the results of a safety analysis.

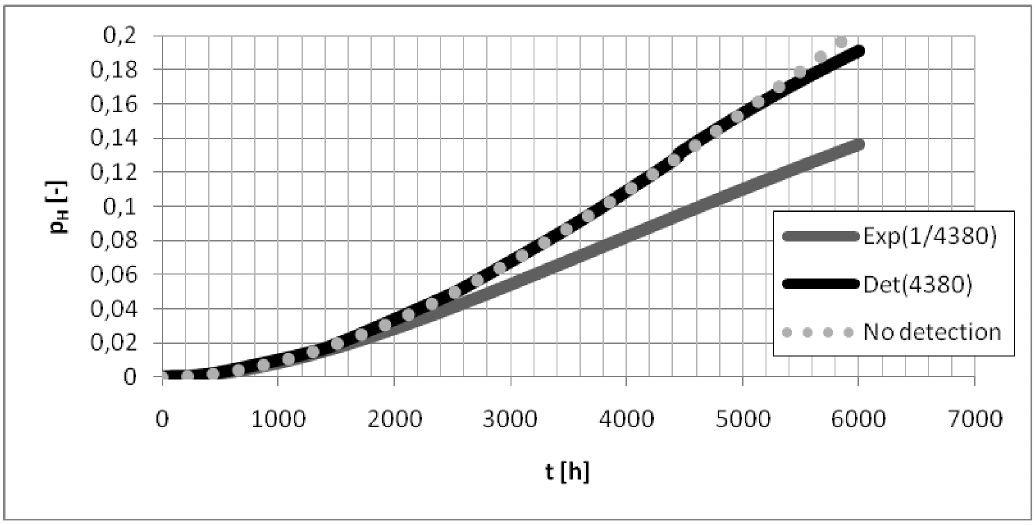

Fig. 3. Comparison of the exponential and deterministic model of detection mechanisms.

5. Conclusion

All safety-affecting factors need to be correctly quantified prior to the safety analysis - especially factors (e.g. detection mechanisms) that has significant effects on the safety and could be mathematically described in more ways. Given the results of the case study analysis, the incorrect implementation of the detection into the mathematical model could render the analysis results invalid. Another factor that deserves further research and should be paid attention to is the system recovery, which could also be modelled by the means of the SPN.

Acknowledgement

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Creating a Robust Plan Using CPM Method and Simulation

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Abstract. The paper discusses the method of robust plan construction in transport systems using computer simulation and CPM method on the flowchart. A strategy for creating the flowchart with all needed resources is presented and explained in detail. This strategy combines known methods with computer simulation and allows creating an executable robust plan.

Keywords: Planning, scheduling, CPM method, uncertainty, simulation, robustness.

1. Introduction

Nowadays in planning processes of transport systems a robustness is used. Robust plan is a plan, whose quality and performance is not reduced during real execution due to already known uncertainties. The robustness is a property of the plan that is used for the comparison of two plans regarding their resistance against changing conditions.

For the description of train or another transport elements behavior in simulation models the flowchart is used very often. Train behavior is described as proceeding of activities. For example the simulation tool Villon uses this kind of technology train description. Because every train has it's own flowchart that describes technology it isn't direct possible to use methods that are used for optimization of activities on the flowchart. There is an advance described in other chapters that allows making a complete flowchart of rail transport service. On this flowchart it is possible to make a plan with required measure of robustness using standard methods (for example CPM - Critical Path Method) and simulating methods.

2. Creating the flowchart

Suppose, every train that arrives in to the simulation model has its own technology described by flowchart. In this flowchart the arcs between nodes introduce the activities that should be made on the train (for example train arriving in the input track, train moving under the crane, train unloading, train loading). The technology described in this way is clear for the program user and allows making the whole simulation model. Every arc has defined resources needed for its making. Personnel, tracks, locomotives, cranes or anything else is considered to be a resource.

Disadvantage of this process is, that there isn't available a complete flowchart of all train working. If it's possible to get this kind of flowchart the optimization of rail working using the existing methods for the flowchart would be allowed. The flowchart can be successfully used for the optimization of activities in which the time consequence is known. This visual presentation of activities and moving of resources between is also suitable for "manual" tuning of the plan. The rail working flowchart has to fulfill requires:

- Acyclic connected digraph that extends the amount of used methods for example CPM
- It has to contain activities of resource moving and use the limited amount of resources

The scheduling problem can be characterized as follows: given are the set of tasks $J = \{J_1, J_2, ..., J_k\}$, and the set of different types of resources $R = \{R_{11}, R_{1m}, R_{21}, ..., R_{nm}\}$, where n is a count of different types of resources and m is a count of a resource type. Every task J represents a single operation that must be executed with the utilization of specified resources. One task may to require a different types and amounts of resources. Resources could be e.g. a group of workers, vehicles, some amount of energy, fuel, raw materials, etc. Activities using the same resources have to be executed sequentially.

Acyclic connected graph of the whole simulation can be reached if we take one fictive starting node at the beginning and one finishing node at the end of the graph. Partial flowcharts of trains are joined into one flowchart by connecting to the starting and finishing node. Duration of the arc that joins the starting node of the chart with the partial chart equals the time of train arriving into the simulation model. The figure one shows making a flowchart for all trains in the simulation model (TA_n – train arrival, TD_n – train departure, SN – starting node, FN – finishing node).

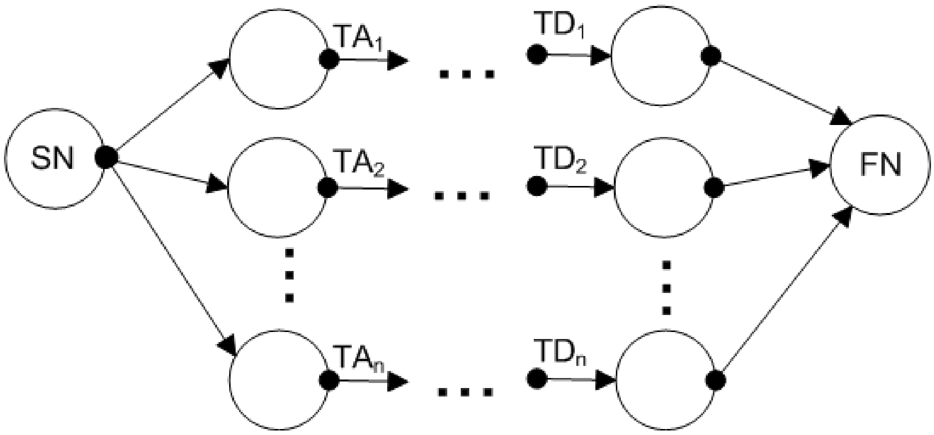

Fig. 1. Final flowchart for all trains in simulation model

The problem of this flowchart is, that it doesn’t contain moving of resources and the need of resources for individual activities. To incorporate required resources into the flowchart an absolutely new method was elaborated. The method will assure proper allocation of resources and at the same time the condition on digraph will be met, which allows us to use CPM.

We have sequence of arcs (jobs from the set J), that will be sequently given to concrete resource. In the chapter 2.1 the possible ways how to reach this kind of sequence will be published. Another arcs will be sequently added into the flowchart, they will present moving of the resource. The figure 2 shows the procedure. Activity A_1 and activity B_3 require the same resource. Only one piece of this resource is available, so the resource must be given to arcs sequently. The sequence of assigning is on A_1, B_3 and that‘s why the end of arc A_1 connects the arc B_3 with a new activity. This new activity in flowchart secures, that the resource will be given to activity A_1 for the first and then to activity B_3. If we know the time needed for moving the resource the length of the arc equals to the time needed for moving the resource. The procedure has secured the sequence of assigning resources is hold, but in some situations the condition for the acyclic digraph won‘t be secured. There are two problem situations that can by adding arcs happen.

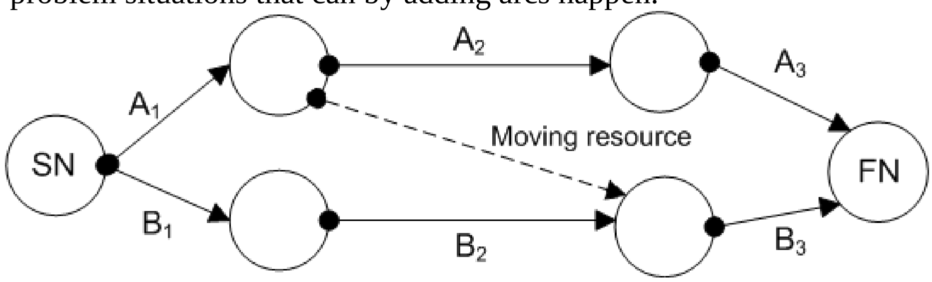

Fig. 2. Addition a new activity of moving resource into the graph

The situation on the figure 3 shows that a resource is given to the arc A_1 for the first and then to the arc B_1. It is not possible to solve the situation by addition another fictive arc. The flowchart won’t be acyclic. The situation can be solved by addition another node. The arc B_1 is divided into two parts. The first part represents the waiting time for assign a needed resource. The second part represents the activity B_1. This method secure sequent assigning of resources to arc A_1 and B_1 and final flowchart is acyclic.

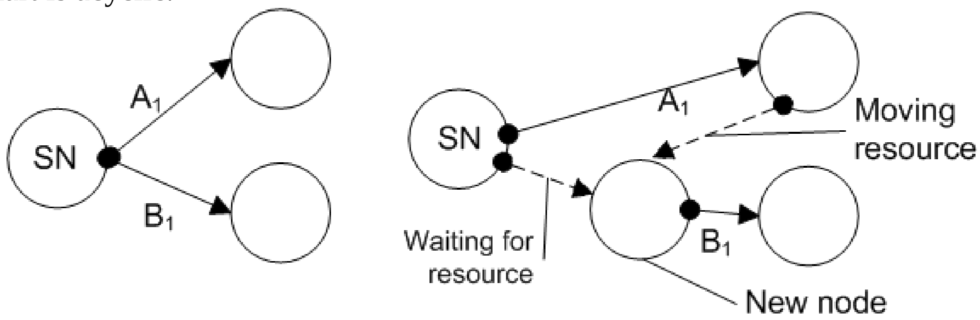

Fig. 3. Two arcs with one starting node require the same resource

The situation on the figure 4 shows that a resource is given to the arc A_1 for the first and then to the arc B_1. It is not possible to solve the situation by addition another fictive arc. The flowchart won't be acyclic. The situation can be solved by addition another node. The arc A_1 is divided into two parts. The first part represents the activity A_1. The second part represents waiting time for the end of the arc B_1. The final flowchart is acyclic.

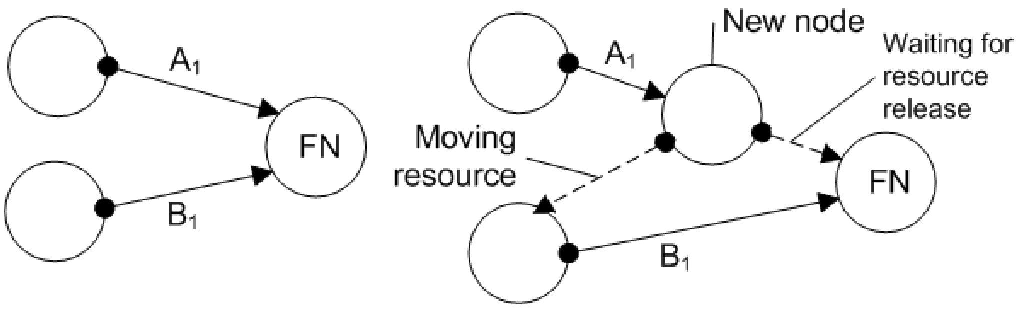

Fig. 4. Two arcs with one ending node require the same resource

With this method it is possible to make one common flowchart of single train flowcharts. It will contain all times of waiting for needed resources.

2.1. Creating a sequence of resource assigning

The described method in previous part for assigning resources allows to make only one acyclic digraph. With the method CPM on this digraph the duration of the whole plan can be reached. The sequence of resources to single activities will be hold. But until now the problem in which sequence the resource will be assigned to single activities, hasn't still been solved. For every concrete resource it is needed to specify in which sequence it will be assign to single arcs. On this sequence depends its utilization and also the effectivity of the whole system.

We can use following heuristic method. With the utilization of CPM (without taking required resources into consideration) we will compute the times when the activity can earliest begin and when it must finish. Consequently the sequence of allocation to individual arcs will be determined for each resource. To determine the sequence, we suggest utilizing the time of the earliest possible beginning of the arc execution. Using the latest necessary finish time of the arc did not produce satisfying results in the praxis. Of course, there exist also other more sophisticated methods that can be used for the determination of the sequence (tabu search, genetic algorithm).

3. Using simulation for increasing the robustness

Determining the robustness of the plan is an important part of planning in transport. The requirements on plan robustness are usually set already by the creation of the plan; however the need for robustness can later be increased. The robustness is a property of the plan that is used for the comparison of two plans regarding their resistance against changing conditions. The problem of increasing the robustness of a plan lies in the necessity to measure the robustness of the plan and also in the need for a method to integrate techniques for obtaining a robust plan into known process. It's necessary to notice that more flexible plan does not have to be also more robust. For example, suppose that plan P_1 is more flexible than P_2; if P_1 will have two critical paths and P_2 only one, the chance of plan P_1 failure is bigger than that of plan P_2 – so the plan P_2 is more robust. An investigation of the sensitivity and parametrical optimization are part of the verification of plan's correctness.

It's possible to use the flowchart for making the plan more robust. For some activities the finish time is fixed. It is needed to hold the finish time (train departure, end of unloading). According to many simulation runs it is possible to calculate missing of finish times. With the simulation can be acquired the informations about the duration of activities, that were unknown or they weren't enough estimated. After addition these informations into the flowchart it is possible to optimize the sequence of assigning resources to single arcs again. After every change of sequence of assigning resources it is possible to calculate with the CPM method the falling down on the duration of activities and missing of some activities. If it's clear that, after calculation the CPM method the activity will miss too long this solution cannot be applied. Using this method it is possible to verify very quickly a lot of potential sequences of assigning resources. Admissible sequences are verified using the simulation and can be later made better. So the phase of testing using the computer simulation can be changed by the optimizing phase using the CPM method.

4. Conclusion

Mainly due to the complexity and stochastic character, planning of transport systems is a challenging task. The method of construction and optimization of the robust plan described here represents only one of the possibilities, how to create required plan, that will be usable under real conditions. The described method connects many advanced methods and allows creating an executable robust plan.

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Device to Study of Seatbelts Safety at Low Speeds Impacts

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Abstract. The paper presents the device to examine the safety of the seatbelts at low speed collisions. The project aims at observing and measuring the delay which affects the driver or passenger when the impact velocity is 20 km/h [2], [3], [4]. The device of this type is characterized by the fact that the acceleration of a wheeled driver seat is inertial [1], [5]. There is used an inclined plane which allows the driver seat to accelerate. Final speed we want to get, can be adjusted by changing the inclination angle of the plane, or by changing the length of the downhill track.

Keywords: passive safety, impacts, collisions.

1. Introduction

The number of accidents in Poland since 2001 has remained roughly constant. The number of deaths on Polish roads every year is approximately 5500 - 6000 [6] and it is still rising. Compared to previous years the number of deaths rose by almost 7%. According to the objectives of the European Union and the National Program GAMBIT, the number of fatal accidents should decrease by half over 10 years [7]. According to the European Union's guidelines, a goal was to be implemented in 2001-2010, while according to the Polish program GAMBIT - in the years 2003-2013.

2. Design of the device and the concept of research that will be performed on it

Figure 1 shows a side view of the device. The basis is formed from the closed sections connected by crosspieces and equipped with the bracket on which the carrying raceway on trunnion pin is mounted rotary. The other top of the carrying raceway is supported on a bracket. A side view of the carrying raceway has a profile consists of two straight sections connected by a curvature (4). The bracket has several openings which allow to support the carrying raceway at different heights. The wheeled driver seat is placed on the carrying raceway which is formed from the closed profiles with a rectangular section and connected with crosspieces. The wheeled driver seat is made up of a platform mounted to the sleeves, which were mounted on wheels. The platform is attached to the bumper. To the sleeves are attached connectors and mandrels with wheels mounted on them. Wheels secure the wheeled driver seat from falling off the track. Wheels as well as protective wheels are equipped with a flange which keeps the driver seat in the track. It is attached the frame to the platform through the component. To the frame it is mounted plate and seat. The component makes possible to set the seat against the drive lane. So it is possible to compare the impact of the wheeled driver seat with the impact at various angles of the seat to the drive lane. The frame is equipped with handles, designed for mounting 2 and 3-point seatbelts, and brackets for fixing 5-point safety seatbelts. The frame has a mechanism to maintain the plate cooperating with an electromagnetic armature (3) fastened to the winch (2) installed on the frame. The hook is attached to the mechanism. Furthermore, the device is equipped with a brake system and wheels which allow to move easily the whole device. The device has been measured and equipped with the necessary measuring equipment (1).

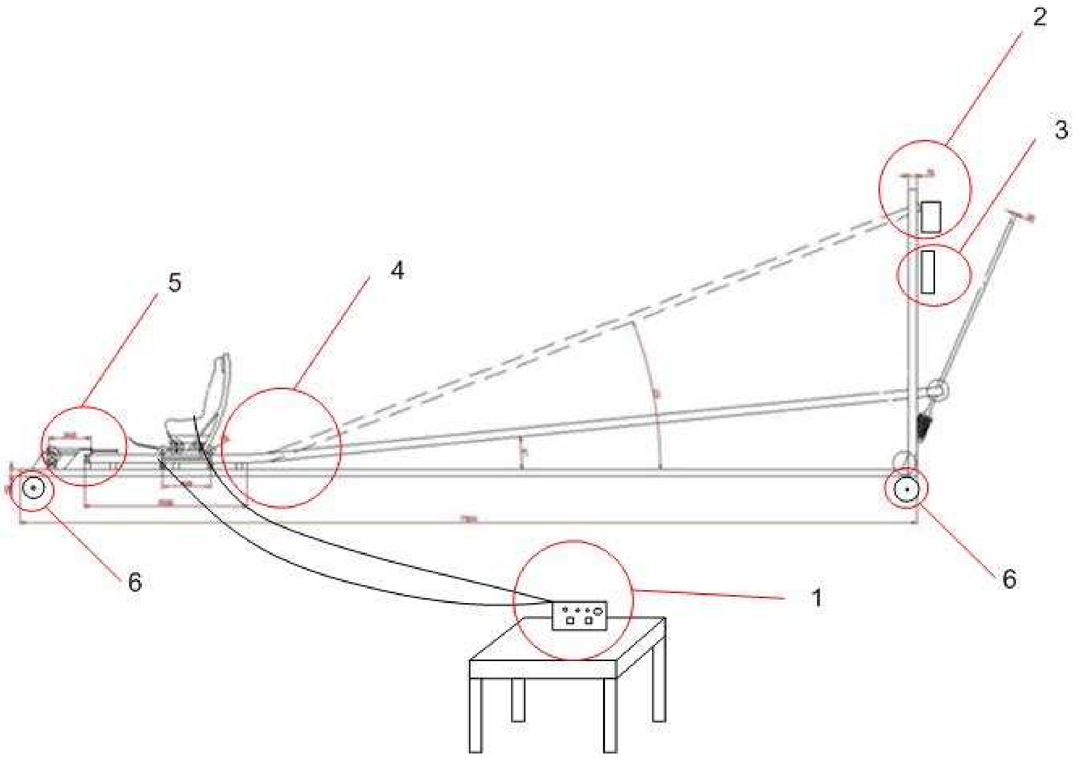

Fig. 1. The device scheme.

The described above device has already been made and it has been used for preliminary tests. Figure 2 shows a picture from the test.

Fig. 2. Tests on the square of the Kielce University of Technology.

As previously established maximum impact velocity is 20 km / h.

3. Conclusion

Another part of the work will be carried out various tests, such as:

- analysis of the influence process of the seatbelt tension and alignment and analysis of the influence of the position of sitting person on the head movement during an impact test:
- analysis of the friction process that occurs between the seatbelt and the investigated person and the relationship between them.

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The Perspective of the Váh River Route and its Potential Uses

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Abstract. Slovakia lies on the intersection of transport corridors both in the direction North – South and East-West. Therefore it is very important to pay attention to creating conditions for the development of water transport. The potential uses of Vah river route as an alternative to the highway network, relocating some of its transport currents to the waterway, as a recreational, sport and water-resources area will be very significant after its completion. Even though the priorities in transport infrastructure in Slovakia are towards the road transport (especially highway) network, it is essential to start up the processes of development alternative carriage infrastructure.

Keywords: Váh river route, Agency for Water Transport Development, infrastructure.

1. Introduction

Transport is amongst the most important factors influencing the economical development of Slovakia and will continue to be also in the future. Slovakia due to its position in the Central Europe, is a connection between the Black Sea and western river ports via the river Danube. Váh, Danube´s tributary becomes a part of this connection.

The river Váh, by its course creates a natural North-South river route. Therefore the significance of this waterway is in reinforcing the North-South transport corridor and creating a unique connection between Danube and the navigable waterways of North and Eastern Europe. Connection of this nature does not yet exist in central European region. The Permanent committee for inland waterway transport under the European economic committee of the UN in Geneva, designated in 1995 the Váh river route as a part of the future international routes and it was assigned the international identification code of E81 with the recommended gabarites of international waterway class VIa up to the town of Sereď and Va up to Žilina. Two years later, as part of the III. Paneuropean Conference of Ministers of Transport in Helsinki, at which the routes of the European transport corridors were defined, there was also a European agreement on Main Inland Waterways of International Importance (AGN) with the river Váh being part of it. The navigability of Váh is the sole responsibility of Slovak Republic and the prolonging of Danube waterway inlands is in the competence of the corresponding governmental bodies of SR.

There have been multiple studies focusing on the possibilities of using Váh river for energy purposes, irrigation, industry, protection of cities and property or navigation. In case of navigation, navigability comes into question. The issue of Váh navigability has been a focus of numerous studies and projects. In 2001 a marketing survey showed that the Váh river route could be used by Slovak merchandising subjects to transport 2,3-2,7 million tones of goods every year between 2001-2010. The project of building this river route is known under the title "Váh river route".

Some of the options of how to use the potential of Váh river route include not only commercial, but also tourist and sport-recreational sailing.

2. Contemporary use of Váh and its waterway

There is a general assumption about the potential uses of Váh river in the transport area – based on the greater volumes of transferred goods in its direction, and also in the energy area – in connection with the anticipated growth of electricity consumption in the future.

The construction Váh river dams began in the 1930s, the main motivation being energy resources, but also area protection and navigability. The first dam to become operational was the power plant in Ladce in 1936.

In 1995, the hydroenergetical potential of Slovakia covered 19% of energy consumption in Slovakia, and the Váh cascade was responsible for 8%. On the installed overall electrical output of all the power plants in the Slovak electrification system, water power plants participated with 33%, Váh river dams alone with 25%.

In a simplified statement it is possible to say that all power plants on river Váh were built and are used as maximum or semi-maximum demand plants. The management of these plants has gradually become automatic, run by the energy dispatching centre in Žilina in way so that the whole cascade works as a single source of energy.

Despite these positive indicators, from navigation point of view, the whole reality of energy use of the river stands against the partial usage of navigations in the specific sections – due to the shifting water level which depends on the through flow and waves originated by the power plant onset.

In the present, level of using the river for navigation and water transport is very low. Navigation is only possible under restricted conditions between the estuary of Váh into Danube and the water dam of Kráľová, depending on the through flow, which in turn depends on the regime of the dam itself. In the first section, from Komárno to Sereď, navigation is possible for the VIa class of ship formations, in the remaining sections for the class Va.

Public use of river Váh is mainly based on the protection against floods, but it also has an effect on other areas of life. Under the term public we understand "beneficial" for the general public.

Areas of public use and benefits:

- Water resources – safety and protection dikes/dams, drainage and anti-leaking precautions,
- Transport – reconstruction of bridges, transport connections to ports,
- Agricultural – irrigation,
- Tourist – sport and recreational sailing.

3. Legislative framework for the Váh river route

The Slovak government, through its ministry of transport, post offices and telecommunications has in its resolution n. 469 from the 21. 6. 2000 approved the Conception of development of water transport in the Slovak republic. This document also contains a plan of constructing the Váh river route, because in the international context of Slovak republic, this route is of a strategic importance, and its realization is being prepared since the half of the 20th century. Two years later the government of Slovak republic, in the resolution n. 463 from 9th of May 2002 has approved the proposal of the project of Váh river route and its connection to the Odra river. This was not yet a detailed technical project for construction purposes; its goal was to create a stable concept of building the water way by constructing additional water dams, finishing the existing ones and other objects for navigational purposes. It also aimed to state the basic parameters and especially the direction / location of the routes for the water connection between Váh and other water ways in Poland and Czech Republic. Approval of this intention created the basic preconditions for the Slovak government to enter negotiations with its Polish and Czech counterparts, about the realization of connecting the waterway of Váh with the waterways of participating countries.

Amongst the Slovak, Czech and Polish navigation and water resources specialists, the proposed route for the planned water connection included Váh and Odra and it would pass through the territory of Slovak republic, in the Kysuce region, in Czech republic the Ostrava agglomeration and in Poland the region of Upper Silesia.

4. Real perspectives of Váh river route

The vision of constructing Váh river route is an idea of public service and even idealistic. The plans, projects and government resolutions that are concerned with the water route are unspecific and only real on paper so far. Construction of river dams, navigations service objects and objects for public use cannot even be called as "stagnating" because they were not yet even started. Marketing surveys done in 2001 are incomparable with the real goods transport on the Váh river route, not to mention that its potential has grown rapidly with the arrival of foreign investors to the region in the last few years.

The attractiveness of water transport in comparison with other forms of carriage is currently on the bottom of the list of priorities of the competent authorities. The evidence of this was also an ongoing struggle in clarifying responsibilities among the two ministries involved – Ministry of Agriculture and the Ministry of Transport, Post offices and Telecommunications, during the process of completing the Váh river route project proposal. Competences were long unclear about who is to participate in talks with the Czech and Polish partners about the realization of the connection between Váh and Odra waterways. Only after few rounds of these talks were finished the ministers agreed that both are to participate with the minister of agriculture to be the designated coordinator. They also agreed on creating a special working group that would fulfill the tasks necessary after they are approved by the government. This working group would consist of member from both ministries and it would prepare all documents necessary for the talks and also coordinate these talks.

Based on the law n. 575/2001 Z.z. about the organization of government procedure and organization of central public management in accordance with the former guidelines, the Ministry of transport, post offices and telecommunications (current Ministry of transport, construction and regional development) is the central governmental body for inland sailing and ports and the Ministry of the environment (since 2004, water section) is the body responsible for water resources, flooding protection and the rational use of water resources. This means that the issue of navigability in the Váh river route was until the end of 2010 in the competence of the Ministry for the environment. By the law n. 556/2010 Z. z., by which the law n. 338/2000 Z. z. about the inland sailing is updated, the **Agency for Development of Water Transport** was established on 1st of January 2011. This organization is to focus mainly on preparations for the realization of construction and modernization of waterways, its components and other objects necessary for waterways operation. In 2011, 3,6 million Euros will be allocated for the functioning of the Agency from the state budget. In the years of 2012 and 2013, 5,2 Euros will be allocated.

The Agency is supposed to be helping the development of not only ports, but also waterways and their links to other forms of transport. Its first conceptual framework though, is oriented mainly towards Danube. Váh river route is a background topic if topic at all. According to the minister of transport Mr. Ján Figeľ, the conceptual framework estimates a growth in cargo traffic on Danube by at least 5,5% in the upcoming 5 years, and as much as 11% between 2016 and 2020, aiming to make the most out of Danube´s potential and to relieve the ground transport. It is questionable whether the Váh river route construction will move forward after the establishment of this Agency, or situation remains the same as in the past several years.

The realistic vision for navigability and further construction of Váh river route is not optimistic. Connecting water transport into the intermodal transport in Slovakia is minimal. The already planned public terminals of intermodal transport in Žilina, Košice, Bratislava and Leopoldov, which are to represent the network of public terminals of intermodal transport fulfilling the requirements defined by the AGTC agreement, including high quality railway and road connection to the basic transport grid do not take into consideration the potential use of Váh river route.

5. Conclusion

Priorities in area of transport are clearly defined in Slovakia. Completion of the D1 highway is clearly a priority and right to be so, but it is also very important not to neglect completely other areas of transport, including the water transport. The potential of Váh river route is publicly well known and its navigability all the way up to Žilina and subsequent use would help to redirect some of the traffic from the extremely strained road transport to more ecological Váh waterway. The reality unfortunately points to the fact that the completion of its construction is a matter of distant future. This pessimistic view was further supported after the talks of Prime Minister Iveta Radičová with the head of the EU Commission José Manuel Barroso in March 2011, where they agreed on the relocation of resources from Operations Program of Transport with the exception of railways and relocation of idle resources from other operation programs. It would be naive to think that this relocation of resources would avoid the water transport. In terms of finishing the D1 Highway this probably is a positive message.

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The Public Transport Quality Measurement

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Abstract. In the present time, the important issue is related to the improvement of public transport quality. The public transport quality measurement is not so simple as it seems on first sight. STN EN 13 816 defines some processes of quality service measurement, but its application is serious. This paper deals with chosen areas in increasing of public transport quality with concerning on temperature measurement inside the vehicle.

Keywords: quality, public transport, temperature, quality criterion

1. Introduction

The increasing of public transport quality is very important issue at this time. Why is important to increase the public transport quality? The reason is keep the passenger in public transport and convince the potential passenger to don't use the individual car to work, but to use the qualitative public transport. From this point it is important to know the expectation of passenger, because the passenger is the person who still evaluate the quality of providing service and he/she requires the constantly improvement of such services. The quality improvement relates mainly with the satisfaction of passenger and with the quality of providing services.

2. The overview of legislation related to Public transport.

In the area of quality the norm „STN EN 13816 Transport. Logistic and services. Public transport. Definitions, goals and measurements of the service of quality" has been published:

1. applicability – the range of service provided in particular area, time, space, frequency and transport system,
2. accessibility – access to public transport system including the connection with other transport systems,
3. information – systematic providing of information about public transport system which make easier the planning and realization of travel,
4. time – the main time factors on planning and realization of travel,
5. customer care – service elements which are established in order to achieved the harmony between the standard service and requirement of single customer,
6. comfort – service elements which are established in order to allow the comfort and relax during the travelling with public transport,
7. safety – the feeling of personal safety acquired from the actual safety measures and from the activities serving for the reason in order to keep these measures by passengers,
8. environmental affect – affecting on the environment resulting from the providing public transport services.

The requirements and recommendation of norm STN EN 13816 are based on following principle (Figure 1).

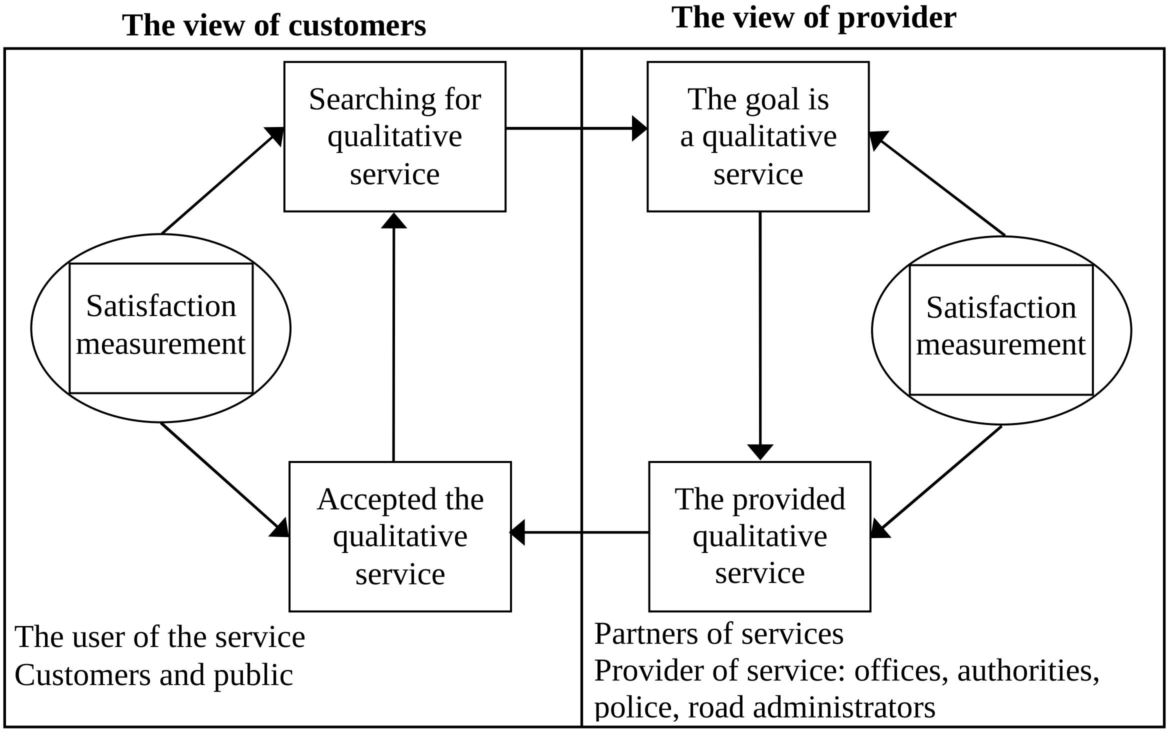

Fig. 1 Loop of quality of service [1]

The norm STN EN 13816 defines the quality service in public transport. It defines the expected service quality which is represented by the level of quality that is required (explicit or implicit) by customers.

The norm also defines the targeted quality of service, which is the level that the provider of services tries to provide to the customer.

The output of these processes is the provided quality of service. It is a level of service which is achieved in daily practise. The provided quality is measured from the view of customer.

The appreciated service of quality is a level of quality perceived and appreciated by customer.

The gap between the provided and appreciated quality depends on customer knowledges and his/her personal and mediated experiences with services and on affect of personal assumption or environment.

The gap between the provided and appreciated quality can be called as a level of customer satisfaction. [1]

In this paper I have focused on chosen criterion of quality from norm STN EN 13816, as the “comfort of passenger” and especially on a possibility of measurement and the influence of temperature in transport vehicle of public transport. In the norm the quality criterions are included in 3 levels and I have focused on criterion:

6. Comfort

	6.3 Comfort of travelling	6.3.1 during ride
		6.3.2 beginning/finishing ride
		6.3.3 External factors

The problematic of Public transport measurement is stated in norm „STN EN 15140 Public transport. Basic requirements and recommendations for systems of measurement of providing the services of quality“. It contains the basic requirements and recommendation on systems on measurements the public transport quality measurement within STN EN 13816. The norm STN EN 15140 states the quality measurement has to be work out during the service.

The measurements can be realized by controllers or they can be realized with the help of technical tools. They can be continuous or in form of random sampling. [2]

I have applied the technical measurement on the chosen criterion of quality.

3. The measurement of chosen criterion quality

The measurements have been realized in regional bus lines during various days in months April and June 2010. The bus lines where the temperature measurements have been realized had length from 3 to kilometres. The measurements have been realized in buses of mark Irisbus Iveco type Crossway which are conditioned.

For the purpose of measurement the meteorological station Irox model PRO-X USB with 4 sensors has been used. The professional meteorological station is shown in Figure 2.

Fig. 2 The Meteo station Irox PRO-X USB with sensors

The sensors have been situated under the seats of bus. Their location under the seat has been chosen for the reason of securing the sensors (anti-theft reason), because the measurement has been realized during full operation. The location of sensors shows the Figure 3.

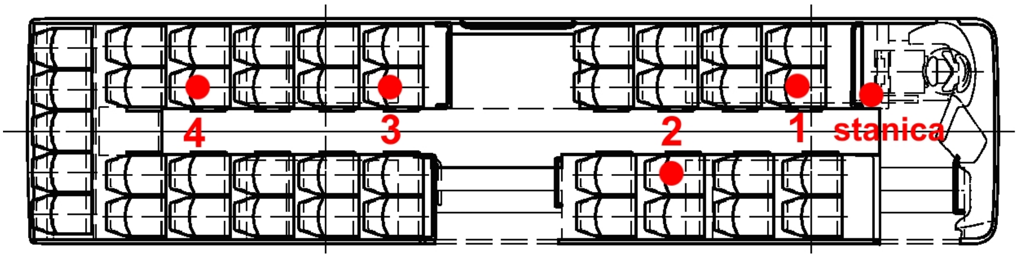

Fig. 3 The location of sensors in bus Irisbus Iveco type Crossway [5]

The range of temperature shows Figure 4 on one line on the 17th April 2010. The duration of travel has been form 7:15 to 7:35. On this line is 14 stops and the length is 13 km. The figure also shows the temperatures 5 minutes before beginning of operation of the line. The temperatures measured with sensors Nr. 2 and 3 are more or less same. The temperature measured with sensor Nr. 1 is the lowest because it was located close the front door. It is caused by the fact that the front door have been open on each stop therefore there was the highest miss of warmth. With the sensor Nr.4 has been measured the highest temperatures because it was situated under the seat where is situated the engine of the bus, where the engine heat was presented. This fact has the influence on temperature of area in rear part of bus and mainly the area under the seat where the sensor has been situated. The outside temperature varied from 1,4°C to 2,6°C. The data about outside temperature have been received from the professional meteorological station Dolný Hričov from Slovak Hydrometeorological Institute.

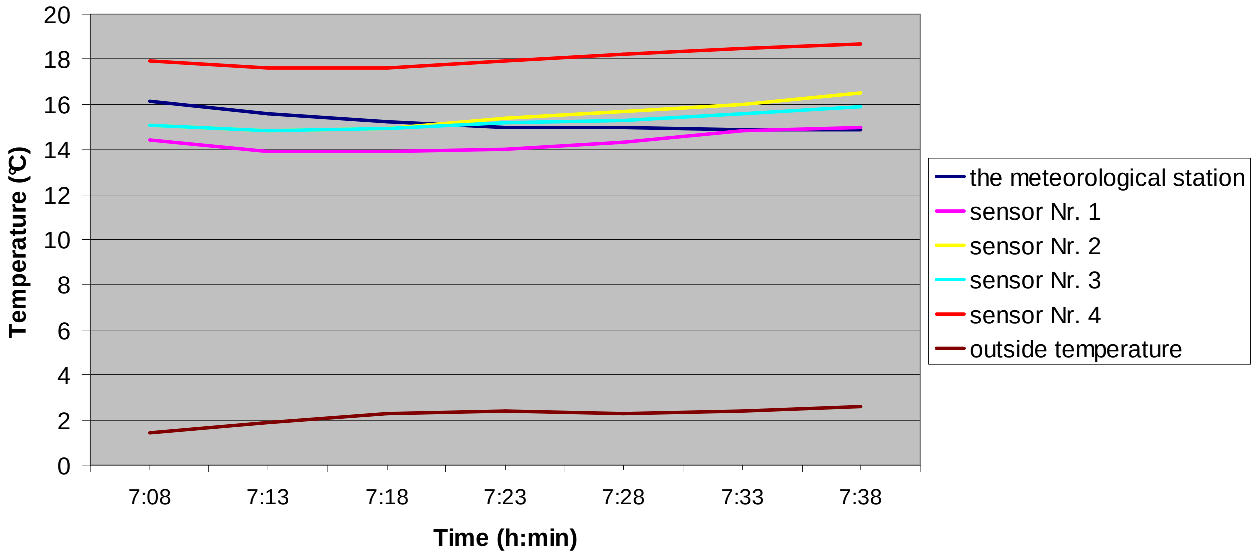

Fig. 4 The variation of temperatures on the line on the 17.4.2010 in time from 7:15 – 7:35 (source: author)

From the reason of location of sensors under the seats the measured temperature can be a little bit different from real temperature which is perceived by passengers.

Very important is also the set up of conditioning. The temperature difference between the outside and inside environment should not be higher than 5 respectively 7 degrees.

I have found out important to notice that on the temperature in the bus also affects the change of passengers, boarding and alighting of passengers and also the density of stops. Mainly in winter time these factors play an important role in affecting the temperature inside the bus, especially close the front door.

4. Conclusion

In the process of statement of quality for passenger is necessary to come out from the priority of orientation on passenger that means, we know her/his needs, requirements, wishes and behaviour. This knowledges is necessary to implement in to processes of providing the qualitative services. The satisfaction of passenger can be achieved only then when his/her expectations are completed. Therefore it is very important to know what the passenger expects because he/she is the right person who permanent evaluates the quality of providing services and she/he still requires the improvement of such kind of services.

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An Analysis of Present Servicing System of Motor Vehicles in Poland

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Abstract: In the article a present servicing system of motor vehicles in Polish condition is discussed. A considerable increase in the number of marks and models of motor vehicle causes an essential change the current system of motor vehicles service. In Poland function different types of repair and service shops, in particular authorized, independent and net shops. In all net service workshops so-called fast-fit and specialist shops, for instance Bosh Service, are distinguished. The analysis carried out in the paper shows that the current servicing system diverges from the systems described in the technical literature.

Keywords: Operation of the vehicle, an authorized repair shop, independent shop, the age structure of vehicles, the choice of the workshop.

1. Introduction

As a result of constitutional and economic transformation in Poland over the last several years the system for servicing and repairing vehicles has changed. In the past, the system consisted of servicing and repairing nearly identical vehicles, largely homogeneous in terms of makes regardless of their models. Currently, in the processes of exploitation are involved vehicles with a very large variation of not only makes but also models. On the market for vehicles there are more than a hundred makes of vehicles. A make has got often about thirty different models of motor vehicles. In addition, the vehicle market, compared with the EU, is negative because of the age of vehicles operating in Poland. The average age of vehicles operating in the EU is 8 years and 6 months whereas in Poland the car age is 14.3 years [1]. In connection with the use of vehicles for longer time, there is a greater diversity of age structure of vehicles in the system of servicing and repairing. Together with the increase in the time of exploitation increases the diversity of the age of motor vehicles. In the Polish system maintenance and repair workshops we can distinguish authorized and independent workshops. The division of these workshops is shown in Figure 1.

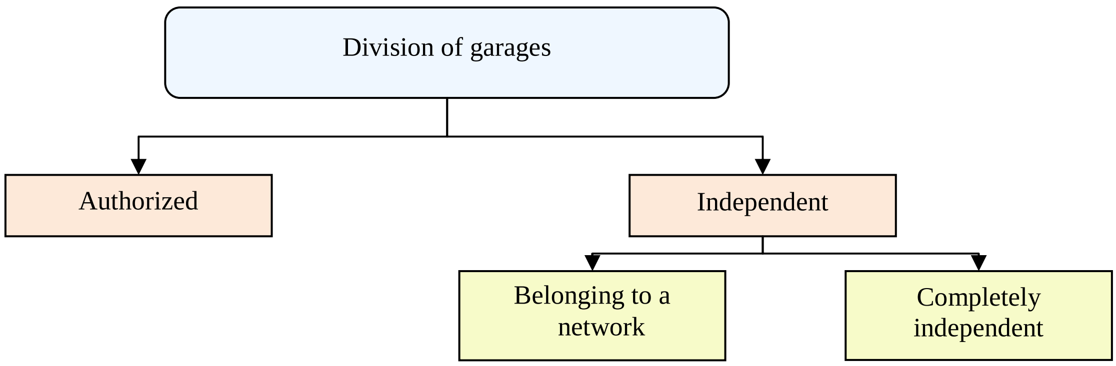

Fig. 1. The division of garages in Poland

In addition, workshops are divided into separate workshops belonging to the network and fully independent. The former ones can be further divided into a fast-fit and a specialist one, such as Bosch Service.

2. Own questionnaire investigations

The study was conducted on a group of 836 people who are clients of independent stations and of 121 people who are clients of licensed stations. The investigation was carried out using a research tool in the form of questionnaire. The following questions are used in the questionnaire:

1. Please specify the age of the vehicle?

0-5 years	6-10 years	11-15 years	Above 15 years

2. In what kind of workshop do you repair your vehicle?

Authorized Workshop	Unauthorized Workshop

3. Why have you chosen that workshop? ……………………………………………………………..

The questions were built on the basis of generally accepted principles of designing a questionnaire form for such a type of research [2, 3].

2.1. The study of the impact of the age on the choice of vehicle workshop

The aim of the study was to determine the relationship between the age and the choice of vehicle garage. Determining the age structure of vehicles serviced and repaired at various garages was based on customers' feedback on these workshops by using the authorized and independent workshops. Questions Nos. 1 and 2 permitted a respondent to specify which workshop has carried out the repair. In addition, they defined the age group in which their vehicle was.

Age of vehicles	Authorized Service Stations	Independent service stations
	% Automotive Repair	
0 – 5 years	31,40	6,70
6 – 10 years	50,41	36,12
11 – 15 years	17,36	30,38
above 15 years	0,83	26,79

Tab. 1. Dependence of the workshop selection on the age of vehicles in the opinion of customers.

Results from these survey show that the vehicle age significantly affects the choice of the workshop. Older vehicles tend to be repaired in unauthorized workshops. Authorized workshops are chosen by customers whose car is relatively shortly exploited.

2.2. Justification of the choice of the workshop by the client

The aim of this study was to analyze the reasons for selecting garage customers of each group of workshops. The choice was based on the customer's own opinion. The results concerning the priorities of the choice of a given workshop are presented in Table 2. This table contains the distribution of answers given by respondents. The way of questioning, i.e., by giving open questions, causes that not only the distribution of responses differs these workshops but also their contents.

Preferences of the choice of independent workshops	% reply	Preferences of the choice of authorized workshops	% reply
Price	34,64%	Warranty	38,64%
Good location	19,38%	High quality service	17,05%
High quality service	9,90%	Expertise	11,36%
A mechanic who is a friend	9,48%	High quality manual	6,82%
Good service	7,84%	Competency of workers	3,41%
Good opinion	5,98%	Implementation schedule	2,27%
The cost of spare parts	3,71%	Location	6,82%
Workshop recommended by a friend	2,47%	Age of vehicle	3,41%
Age of vehicle	2,27%	Costs	2,27%
Expertise	2,06%	Recommendation by friends	2,27%
Work in this workshop	1,24%	A mechanic who is friend	1,14%
Time frame	0,62%	Habit	1,14%
Honesty	0,21%	Opinion on an internet forum	1,14%
Family Workshop	0,21%	An approval from the news	1,14%
		The requirements on the manufacturer's claim	1,14%

Tab. 2. List of preference of choice of a workshop

The open question survey on the selection of workshop, which was given to the customers, the price was given as the main reason of the choice of an independent garage. In the case of the choice of an authorized workshop the decision was influenced first of all by the guarantee given to the customer while purchasing a new vehicle.

From the analysis of the customer feedback, who are clients of independent and authorized workshops, two groups with different needs may be distinguished. Customers expect from independent repair workshops that the repair is cheap and of relative quality. Also, they expect that the workshop is closely located. They are mainly customers from small urbanized areas, with vehicles more advanced in years, whose decision concerning the selection of the workshop is dictated by the cost of repair. Customers of authorized workshops, apart from demanding the maintenance of the guarantee of the vehicle manufacturer, as a priority of choice of the workshop put the quality of service, staff professionalism and service quality. These factors are not important for the clients of independent workshops. It can be stated unequivocally that the customers of authorized workshops are a group of customers with greater social wealth whose vehicles are shortly exploited, 0 - 7 years. Therefore, the quality of service is required at higher levels. The customer of the authorized workshop is interested in an efficient repair. They are not often interested in what is the cause of damage. On the contrary, the customer of the independent garage identify themselves with the cause of damage.

3. Conclusion

From the analysis of age structure and the preferences of customers' choice of specific groups of service stations it was found that:

- Authorized service stations mainly deal with vehicles that are less advanced in years, between 0 - 7 years, than independent outlets.
- Customers of independent workshops put in the first place the price, then the location and the quality of service whereas the customers of authorized workshops put the high quality of service.
- Choice of a particular service station clearly divides respondents into two groups of different social status.

Summary

The paper presents a system servicing - repair operating now in Poland and the exact impact of age of the vehicle on the choice of a particular group of a car repair shop. Furthermore, it examines the basic rationale of the choice of workshops from the perspective of their customers.

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An Analysis of the Intensity of Vehicle Use Using the Example of the Polish Mail Company

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Abstract. Intensity of vehicle use is one of the most important parameters of vehicle operation. The intensity of use affects vehicle life, the costs and the profits from transportation services and other parameters of car operation. It is expressed as the number of kilometers traveled by a car within a specified period of time (day, month, or year). For that reason, analysis of data associated with the intensity of vehicle use may be instrumental in the evaluation of a given transport firm. The paper presents and discusses the results of statistical analyses of data related to the intensity of use of delivery trucks in the Polish Mail company in Lublin.

Keywords: Vehicle operation, intensity of use, statistical analyses.

1. Introduction

There are many indices that can be used to evaluate and compare transportation systems of transport companies. These indices include profit from transportation services, mass of cargo transported and costs of personnel, fuel, lubricating oil, repairs, etc. One of the most important of those parameters is the intensity of vehicle use. It is expressed as the number of kilometres travelled by a car within a specified period of time (day, month or year). The intensity of use plays an important role because it affects many other factors and indices, such as vehicle life, the costs and the profits from transportation services, drivers' working time and other parameters of car operation [2, 3, 4, 5, 6].

For that reason, it seems that a detailed analysis of data related to intensity of vehicle use is vital and instrumental in the evaluation of a given transportation system. The paper presents and discusses results of statistical analyses of data concerning the intensity of use of delivery vans operated by Poczta Polska (the Polish Mail company) in Lublin.

2. Material

Statistical analyses were carried out using data collected for 179 vehicles operated in 2009 by the Polish Mail delivery office in Lublin. The population of the transport vehicles tested was diversified with respect to type and make. Because of this, the study population was divided into three groups characterised by different load space volumes.

Group I consisted of 47 passenger vehicles with small load space volumes (e.g., the Fiat Seicento). The cars in this group ran between post boxes and were used to deliver mail in the city of Lublin and area.

Group II comprised 85 delivery vans with medium load space volumes (e.g., the Lublin III). They moved mail between post offices in the city of Lublin and the former Lublin voivodeship.

In group III, there were 47 vehicles with large load space volumes (e.g., the Iveco Stralis). They carried postal packets between logistics centres of the Polish Mail outside the former Lublin voivodeship.

3. Results of statistical analyses of vehicle mileage rates

Vehicle mileage rate data provided by the Polish Mail in Lublin were analysed statistically using STATISTICA® software. Results for the entire study population and the individual groups of vehicles are shown in Tab. 1.

Group	Mean	Median	Min. value	Max. value	Standard deviation	Standard error
	[km/year]	[km/year]	[km/year]	[km/year]	[km/year]	[km/year]
Group I	14437	12144	1248	46511	8432	1230
Group II	34762	35315	67	97707	17716	1922
Group III	83597	87771	3515	164244	48239	7036
Groups I, II i III	42248	30316	67	164244	38082	2846

Tab. 1. Location and dispersion parameters of yearly intensity of vehicle use.

An analysis of the results of calculations of the statistical parameters shown in Tab. 1 indicated differences in mean yearly intensities of use among the individual groups of vehicles. To test whether the observed differences were statistically significant, an analysis of variance was carried out.

Tests were performed to see whether the classical assumptions of the analysis of variance were met [1]. The first step was to estimate whether the empirical data could be approximated by the normal distribution. An analysis using the chi-squared χ^2 test showed that the data in question, related to intensity of vehicle use, could not be approximated by the normal distribution. Additionally, heterogeneity of variances was observed in the individual groups of vehicles. Due to the unequal number of results in the analysed groups, Bartlett's **B**-test was used. The value of the test statistic was $\mathbf{B} = 134.48$ at the level of significance $p = 0.000$.

Because the assumptions of normal distribution of the analysed variable and heterogeneity of variances were not satisfied, classical analysis of variance could not be used for the observed values of yearly intensity of vehicle use. Accordingly, further calculations were carried out using the Kruskal-Wallis test **KW**, which is a non-parametric method of analysis of variance. The calculations demonstrated that the value of the Kruskal-Wallis statistic was $\mathbf{KW} = 80.145$ at the level of significance $p = 0.000$. This result pointed to significant differences in mean yearly intensities of vehicle use among the individual groups.

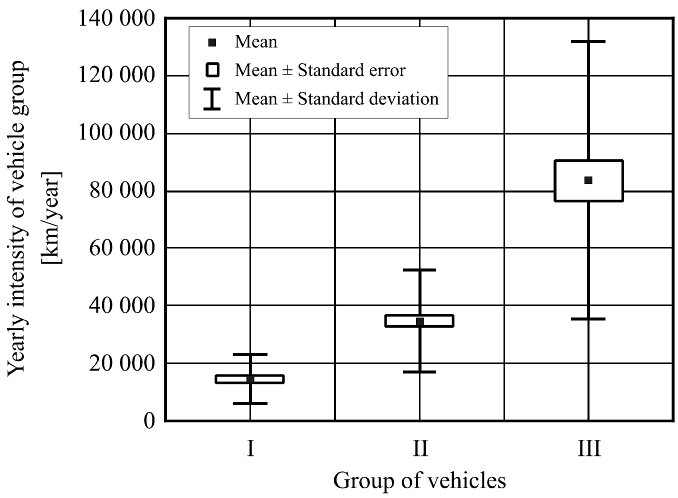

Fig. 1. A categorised box plot for the independent factor – group of vehicles, and the dependent variable – yearly intensity of vehicle use.

Fig. 1 shows a categorised box plot for yearly intensity of vehicle use as a function of group of vehicles. The observed differences in mean yearly intensity of vehicle use among the groups of vehicles follow primarily from the character and range of transportation activities performed.

Further analyses were carried out to test whether the month (as a grouping factor) had a significant effect on the value of the monthly intensity of vehicle use in the particular groups. Calculations using the chi squared χ^2 test demonstrated that the distributions of monthly intensities of use of vehicles in the individual groups were consistent with the normal distribution. Also, homogeneity of variances was tested using Bartlett's **B**-test. The results are shown in Tab. 2.

Group	**B**-statistic	*p*-value
I	6.803	0.814
II	5.120	0.925
II	4.561	0.950

Tab. 2. Results of Bartlett's test of homogeneity of variances for the intensity of vehicle use with the month of operation as a grouping factor.

The results shown in Tab. 2, concerning the homogeneity of variances for monthly intensity of vehicle use in the individual groups for the variable – month, indicate that the classical method of analysis of variance is applicable. Results of calculations carried out using Fisher's **F**-test are shown in Tab. 3.

Group	**F**-statistic	*p*-value
I	1.567	0.104
II	1.392	0.170
II	1.698	0.071

Tab. 3. Results of analysis of variance for the grouping factor – month of operation of the test vehicles.

Based on the results presented in Tab. 3, it can be stated that the month of operation has no significant influence on the intensity of vehicle use observed in that month. This is confirmed by the categorised box plots shown in Fig. 2, illustrating the monthly intensities of vehicle use in the particular groups.

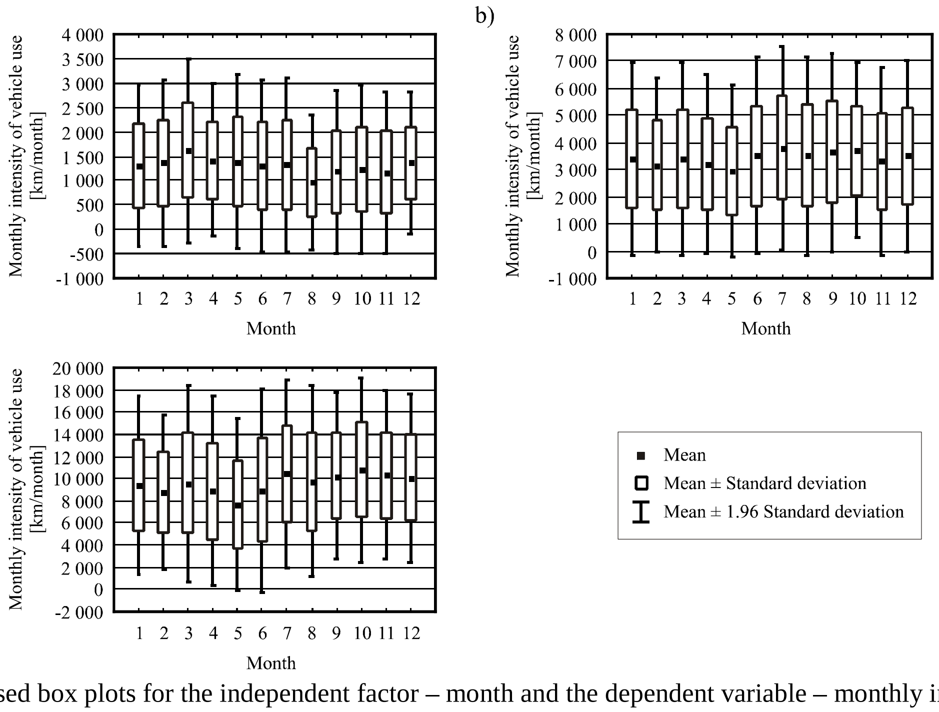

Fig. 2. Categorised box plots for the independent factor – month and the dependent variable – monthly intensity of vehicle use; a) group I, b) group II and c) group III.

4. Conclusion

The results of the discussed statistical analyses of data related to the intensity of use of delivery vans operated by the Polish Mail company in Lublin show that

1. The division of the population of vehicles into three groups according to the criterion of load space volume is accurate. This is evidenced by the significant differences among the individual groups in yearly and monthly intensities of vehicle use.
2. In group II, the values of mean yearly intensity of vehicle use were nearly 2.5 times higher than the values observed in group I. A similar proportion obtained for intensities of vehicle use of group III relative to group II.
3. The month of operation does not have a significant effect on the observed mean values of monthly intensity of vehicle use in the individual groups.

Finally, because the analyses were conducted for data related to the process of vehicle operation spanning one year, it cannot be unequivocally determined whether the analysed intensities of vehicle use would be repeatable in different years. To establish this, calculations should be carried out for data covering at least a few years of vehicle operation in a given transport company. The authors hope to explore this issue in their future research.

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Minimalization of Passangers Waiting Time by Vehicle Schedule Adjustment

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Abstract. The optimization task of the design of some distribution systems can be modeled by nonlinear expressions. In this paper we solve a problem with a nonlinear objective function of the mathematical model. The complication consists in finding an exact solution of the nonlinear problem. In the paper an approach based on piecewise linearization of the nonlinear objective function is used. It is necessary to estimate the accuracy of this linearization and its dependence on the size of the problem. The associated results are reported in the concluding part of this paper.

Keywords: nonlinear, quadratic function, linear approximation, estimate of accuracy of solution.

1. Introduction

The bus link coordination is a complicated job both in the terms of its mathematical formulation and the terms of methods of solution. Especially in this paper, the chosen criterion is the total waiting time of passenger-minutes in regard of unit of time. Unfortunately this criterion leads to a nonlinear model. In the problem n arrivals of vehicles at a stop in the designate period is considered.

Let t_i be arrival time of vehicle i at the stop. The earliest possible arrival time of the vehicle i is denoted as a_i, and this time may be postponed until the time $a_i + c_i$ is reached, where c_i is the maximum possible shift of arrival at the stop. It is necessary to find such time positions of the individual arrivals so that the total passengers waiting time is minimal.

Arrival time's t_0 and t_n are fixed. The aim is to shift times t_i for $i = 1,\ldots, n-1$, so that the overall waiting time of passengers in passenger-minutes is minimal. Figure 1 shows how the waiting time depends on the arrival locations in the time period $< t_0, t_n >$. The grey area represents the total waiting time of passenger's comming at the stop in a given period and waiting for a bus.

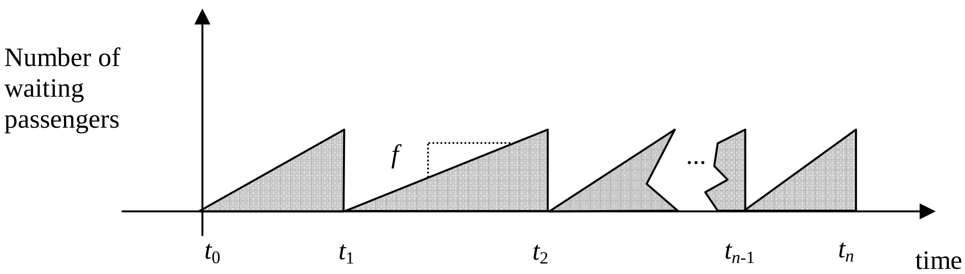

Fig. 1. Time of waiting in period $<t_0, t_n>$.

Total waiting time of passengers in a period $< t_0, t_n >$ can be expressed as:

$$\frac{1}{2} f \sum_{i=1}^{n} (t_i - t_{i-1})^2 = \frac{1}{2} f \sum_{i=1}^{n} v_i^2 \qquad (1)$$

where we introduce a variable $v_i = t_i - t_{i-1}$, which represents the length of time interval between two succeeding arrivals t_{i-1} and t_i for $i = 1,..., n$ with supposition that passengers arrive at the stop equally, uniformly with intensity f. Due to the variables v_i, $i = 1,…, n$ the objective function (1) is nonlinear.

Original approaches were designed in [1], where criterion of the max-min type and the shortest interval between the neighboring arrivals was maximized. That approach was used in [5], [6] with numerical experiments on real data. In this paper we show the possibility of linearization of the objective function (1) what leads to a linear programming model, which can be exactly solved [3]. A disadvantage of this approach is a considerable increase of the number of variables in the model and a lower accuracy of the solution comparing with criterion (1).

1.1. Mathematical model of the linearized model

We introduce variable x_i for shift of the arrival time t_i from the earliest possible arrival time a_i for $i = 1,..., n - 1$. Then a mathematical model of the problem will be as follows:

Minimize $$\frac{1}{2} f \sum_{i=1}^{n} \sum_{j=1}^{m(i)} q_{ij} z_{ij} \qquad (2)$$

Subject to
$$x_1 + a_1 - t_0 = v_1 \qquad (3)$$
$$x_i + a_i - x_{i-1} - a_{i-1} = v_i \quad \text{for } i = 2,.., n-1 \qquad (4)$$
$$t_n - x_{n-1} - a_{n-1} = v_n \qquad (5)$$
$$\sum_{j=1}^{m(i)} z_{ij} = v_i \quad \text{for } i = 1,.., n \qquad (6)$$
$$v_i \ge 0 \quad \text{for } i = 1,.., n \qquad (7)$$
$$x_i \ge (c_i + s_i) y_i \quad \text{for } i = 1,.., n-1 \qquad (8)$$
$$x_i \le c_i + (r_i - c_i) y_i \quad \text{for } i = 1,.., n-1 \qquad (9)$$
$$x_i \ge 0 \quad \text{for } i = 1,.., n-1 \qquad (10)$$
$$z_{ij} \ge 0 \quad \text{for } i = 1,.., n-1,\ j = 1,.., m(i) \qquad (11)$$
$$z_{ij} \le d \quad \text{for } i = 1,.., n-1,\ j = 1,.., m(i) \qquad (12)$$
$$y_i \in \{0, 1\} \quad \text{for } i = 1,.., n-1 \qquad (13)$$

Conditions (3) – (5) determine the gap between two consecutive arrivals as the relation between the values of the variables v_i and x_i.

We will approximate the quadratic nonlinear function (1) by a piecewise linear function (2) by introducing new variables z_{ij} for $j = 1,…, m(i)$ and for each $i = 1,…, n$, where $m(i)$ introduces the number of dividing intervals where we will approximate the quadratic function by linear function. The conditions (6) determine the relation between the values of the variables z_{ij} and v_i.

The real problems should obey some traffic regulation rules as the necessary technological pause for drivers or servicing pause. From this follows that the arrival time shift due to the corresponding time of the earliest arrival is limited by input nonnegative constants s_i and r_i for $i = 1,…, n - 1$. There is necessary to introduce zero-one variables y_i to the model to ensure conditions (8) – (9) that either $x_i \in <0, c_i>$ or $x_i \in <c_i + s_i, r_i>$ depending on the value of y_i. For $y_i = 0$ these conditions ensure that the variables x_i will be nonnegative and less than the maximum permissible value of shift c_i.

This linearization approach has been analyzed in details in [2]. From those results it follows that the dividing points for linearization of quadratic function for minimizing of maximum deviation of the approximation led to the **regular** distribution of interval with choices length of d. The values input constants and the values output variables in regard of unit of time – minute is minimal $d = 1$ (in minutes). Then coefficients q_{ij} of the function (2) we can model by relation: $q_{ij} = 2j - 1$ for $i = 1,\dots, n, j = 1,\dots, m(i)$.

From difference of objective function (1) by the piecewise linear function (2), we derive the upper bound of the total possible deviation as:

$$\frac{1}{2} f \sum_{i=1}^{n} v_i^2 - \frac{1}{2} f \sum_{i=1}^{n} \sum_{j=1}^{m(i)} q_{ij} z_{ij} \le \frac{1}{8} f n d^2 \qquad (14)$$

The right-hand side (14) gives the dependence of the accuracy of linearization on number of variables z_{ij} of the mathematical model. In this paper we can show that if the number of variables is very big for the real world problem, we must change the length d of dividing intervals to the greater value. We can use $d > 1$ to decreese the number of variables z_{ij}. and coefficients q_{ij} of the function (2) we will model by relation: $q_{ij} = (2j - 1).d$ for $i = 1,\dots, n, j = 1,\dots, m(i)$.

Problem	*(a)*	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h)*
Size of problem *n*	10	9	10	10	9	6	9	11
Value of objective function (1) for *d* = 1	3561	4163	7672.5	9833	6651	11990.5	7990	7425.5
Maximal deviation of value of objective function (1) for *d* = 1 by (14)	1.25	1.13	1.25	1.25	1.13	0.75	1.13	1.38
Value of objective function (1) for *d* = 2	3564	4166	7674.5	9834	6651	11990.5	7990	7426.5
Maximal deviation of value of objective function (1) for *d* = 2 by (14)	5	4.5	5	5	4.5	3	4.5	5.5
Gap of value of objective function (1) between values for *d* = 2 and *d* = 1	3	3	2	1	0	0	0	1
Value of objective function (1) for *d* = 3	3565	4167	7673.5	9833	6651	11990.5	7997	7426.5
Maximal deviation of value of objective function (1) for *d* = 3 by (14)	11.25	10.13	11.25	11.25	10.13	6.75	10.13	12.38
Gap of value of objective function (1) between values for *d* = 3 and *d* = 1	4	4	1	0	0	0	7	1
Value of objective function (1) for *d* = 4	3568	4170	7682.5	9840	6651	11990.5	7996	7434.5
Maximal deviation of value of objective function (1) for *d* = 4 by (14)	20	18	20	20	18	12	18	22
Gap of value of objective function (1) between values for *d* = 4 and *d* = 1	7	7	10	7	0	0	6	9
Value of objective function (1) for *d* = 5	3574	4183	7687.5	9836	6659	11990.5	7999	7433.5
Maximal deviation of value of objective function (1) for *d* = 5 by (14)	31.25	28.13	31.25	31.25	28.13	18.75	28.13	34.38
Gap of value of objective function (1) between values for *d* = 5 and *d* = 1	13	20	15	3	8	0	9	8

Tab. 1. Comparison of results of coordination with the various dividing.

2. Numerical experiments

The first series numerical experiments using the optimization environment XPRESS-IVE is described in [4], [8] and brings results comparable with other possible approaches. The linearization approach proved to be effective for one real problem.

The numerical experiments in this paper were made for 8 real problems labelled as *(a)* the public transport in the area of Frýdek Místek - Dobrá (morning) and *(b)* its back traffic saddle, *(c)* Frýdek Místek - Dobrá (evening) and *(d)* its back traffic saddle, *(e)* Frýdek Místek - Chlebovice (morning) and *(f)* its back traffic saddle, *(g)* Frýdek Místek - Chlebovice (evening) and *(h)* its back traffic saddle.

Output values from the results of the algorithm are the computed values of variables v_i, x_i and the value of the objective function (1). The relevant output data for this paper are shown in Table 1. We describe the dependence of the computed value of objective function (1) in passenger-minutes on the size of problem n and its dependence on dividing intervals with lengths d = 1, 2, 3, 4, 5. The right-hand side of (14) gives the maximum theoretic estimate of accuracy of linearization, in passenger-minutes for all $d > 1$. If the solution for $d = 1$ can be considered as feasible exact solution then the gap of the value of objective function (1) between the computed values of objective function (1) for $d > 1$ and $d = 1$ gives the real estimate of the deviation for minimization of function (1), in passenger-minutes. Table 1 shows that for time intervals $d > 1$, the solutions have no significant increase in differences, compared to the solution with time intervals of the length $d = 1$.

3. Conclusion

The proposed linearization procedure in selected tasks with nonlinear conditions shows the possibility of using exact solutions of linear programming problems and also opens the possibility of applications in various areas of logistics. Further research using the described procedure indicate the extent to which it is possible to increase the accuracy of the final solution of linearized problems at the expense of increasing the number of variables of the mathematical model.

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Problems and Possibilities of Development of Cargo Air Transportation in Poland

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Abstract. There were discussed the specificity of the operation of cargo air transportation in Poland and compared with other countries. There were presented barriers to the development of cargo air transportation in Poland, and suggests opportunities for improvement. Attention was drawn to the essence of the air transport intermodality. There were given the perspective of the development of cargo air transportation in Poland. Based on the analysis found that increasing the role of air transport in freight makes the region attractive, but requires a smooth implementation of a broad program of activities and investment organization.

Keywords: cargo air transportation, possibilities of development

1. Operation of air cargo transport in Poland and comparison with other countries [1]

Cargo air transportation is different from the passenger transportation, because they are under different conditions. The development of this sector is the most reasonable and can generate many benefits for the economy. The share of world regions in the port handling of cargo, for example, in 2009 was as follows [4, 6]: Europe 20.5% , Asia Pacific 35,5%, Middle East 5,5%, Africa 2,1%, North America 31,9% and South America / Caribbean 4,5%.

Transportation of goods by air in Poland is treated as a segment of development, which means that Poland is lagging behind compared to other EU economies. However, there is on the Polish market, a gradual increase in the percentage of cargo air transport, and strengthening the position of regional airports. The freight domestic and international traffic is still dominated by Warsaw-Okręcie airport. The reason for this phenomenon is the activity of the majority of shipping companies in the Warsaw area and its surroundings.

The main player in the "Air Cargo" is owned by LOT, but services for air transport of cargo carriers also offer a smaller size, as Exin and White Eagle Aviation. These companies operate in an environment of strong competition from international companies that offer freight regardless of the passenger. These companies operate in a perfectly organized regional grid companies, often offering complementary services, such as in the inland road transport [1, 2, 4].

Office of Cargo and Mail Polish Airlines LOT was established in 1995 and since then offers the services of the highest standard. It is our goal to develop and consolidate its position in the market of air cargo. Prove the quality of services is the Certificate of Quality System to ISO 9001-2000 issued by Lloyd's Register Quality Assurance [1, 2].

Cargo LOT coverage includes the major urban centers in Europe and the USA and Canada. On the basis of agreements with other airlines and cargo carriers LOT Cargo is able to send goods from all over the world. Cargo LOT offers transport of standard, special and arranges transport on request charter. Charters at its disposal, can carry goods weighing up to 120 tons, and their range is up to 12 000 km [4, 5, 6].

The fleet of Polish Airlines LOT SA, which is also a LOT Cargo fleet, is one of the most modern in the world [6, 8, 9]. At present fleet comprises 51 aircraft, including:
- 15 Boeing a range of 2150-11700 km,

- 22 Embraer a range of 1500-3000 km,
- 14 ATR a range 1200 km.

In 2012, PLL LOT SA company receives the first carrier in Europe, four of the eight ordered Boeing 787 Dreamliners. Range of Boeing 787 will be 15 200 km, and with the latest technology, flight times will be reduced by about an hour.

An important activity of the Cargo LOT company is a regular transport of goods by land, so called. RFS (Road Feeder Service). Transport by car are performed mostly for transport of goods whose weight or type (for example, dangerous materials) can not be boarded on the plane. LOT's offer for such operations includes transportation from Warsaw to the largest airports in Poland, Eastern Europe, Central Europe and to international hubs in Germany and the Netherlands.

In 2008, on board Polish aircraft transported a total of about 46 thousand. tons of cargo, the biggest share was: LOT, SprintAir and Exin. LOT Cargo's share amounted to 24.7 thousand tons of cargo, using the lower baggage compartments of passenger aircraft LOT and Centralwings. Most of cargo transported on transatlantic routes. In Europe, the basic directions were Germany and the UK. A great interest was also a call to Beijing, launched in March 2008, the company mainly LOT Cargo transported mail, industrial products, pharmaceuticals and food.

Aircraft Group SprintAir transported 12,200 tons of cargo in domestic and international traffic, primarily for courier companies UPS, TNT, DHL and FedEx. The company also assured SprintAir daily transportation of mail on behalf of the Polish Post.Exin company (the carrier of the Lublin-Poland) has carried 9,000 tons, the majority of international traffic. Transfers were made to order the world's known courier companies (mainly DHL) and the flights on routes to Germany, Britain, France, Hungary, the Czech Republic and Scandinavia [4].

The share of Warsaw Okręcie airport to handle air cargo market in Poland is around 74%. This is based on the fact that this port handles about half of all air traffic in Poland, has adequate infrastructure, and focuses most specialized shipping companies, professionally prepared to provide comprehensive service different kinds of goods transported by air. Outside Warsaw, should pay attention to the airports of Katowice, Gdansk and Poznan. These ports are achieving even better results as a percentage of Warsaw, but their market shares are still low, mainly due to lack of adequate infrastructure to handle the cargo

Poor condition and slow growth of air cargo sector in Poland had many causes. Here are the basic causes:
- low efficiency of customs procedures,
- high operating costs and charges (fees charged at the Warsaw among the highest in Europe)
- lack of proper linkage Polish airports connections intermodal transport network in Europe, and Polish.

In a global ranking of the largest airports in terms of serviced cargo from European ports the highest position is occupied by the Paris-Ch. De Gaulle (sixth place), followed by Amsterdam (14th place), London-Heathrow (18-place). Warszawa-Okręcie Airport didn’t found at all in this ranking. Among EU airports Warsaw Polish port takes place very long [6].

2. Restrictive barrier development of air transport cargo in Poland

Boeing group forecasts assume that in 20 years freight will grow by 6.4% per year, with 5.1-percent increase in passenger traffic [9]. Cargo transport is treated as an area with development potential [3]. But hindered by the barrier. Here are some of them:
- long procedure for customs clearance of goods,
- a large share of the fleet of small airplanes, not suitable for carriage of cargo,
- the lack of convenient intermodal connections Polish airports Polish transport network and Europe
- poor infrastructure, the airports: a short runway, apron with an area of fairly limited, cargo warehouses with an area of insufficient and inadequate equipment,
- unfavorable conditions for directions to the airport.

- some of the existing airport, surrounded by built-up areas there are possibilities for development
In the case of landing and take off heavy freight aircraft is essential and specific surface runways appropriate length.

Polish airports are equipped with essentially only one or two runways. Most of these airports meet the condition of proper roads. However, in terms of length of runways, only a few airports in Poland, holds the appropriate parameters. An example of this is one of the smallest in Poland, Regional Airport Rzeszów-Jesionek.

Due to the lack of freight on scheduled flights, the specificity of Polish cargo system is RFS (Road Feeder Service), which consists in transporting goods by lorries between Polish and European airports. In this system the cargo shipment weighing over 100 kg are transported by truck to the Warsaw about the status of airline flights. The disadvantage of the system is an extension of time to provide loads of approximately 24-48 hours.

Conditions listed above, organizational and infrastructure create an atmosphere that doesn't encourage investors to locate their operations in Poland.

3. Improvement opportunities of cargo air transport in Poland

That needed expansion and modernization of infrastructure is a priority mode of Polish airports, namely: the construction of new terminals, construction of roads, lanes and the extension of runways, aprons, etc. In addition, airports should have the highest quality equipment for navigation and flight attendant. Analysts foresee a scenario of development of airports in Poland, based on existing civil airports (which will be expanded and modernized) and on an adaptation of inactive military airfields and sports services. Currently in Legnica is developed expansion project and modernization of the former military airport in order to adapt to the needs of civilian and cargo traffic.

Generally, the development of airports may be in the process of implementing the following projects: [2]:
1) adapting existing infrastructure to carry out the current passenger and freight,
2) take the expansion of existing infrastructure, transport after reaching the intensity of equal bandwidth (after exhausting the possibility of operating the existing base infrastructure)
3) adequate land use planning and urban regions, in order to improve the accessibility of airports, with particular emphasis on the construction of transport links and rail car,
4) integrating the network of airports in the national and EU-wide network of intermodal transport

A chance for the development of air transport in the cargo handling activity is enhanced technology sectors, whose activities are based on an integrated supply chain management [9]. Experience shows that in the vicinity of ports of the dynamic growth of cargo traffic created technology parks. One example is Europe's ports and East Midlands Airports Athenas International Airport. This phenomenon also occurred in Poland. For example, near Katowice created technology park in Gdansk develop "silicon valley"in which companies are spread new technologies. High market position of the Katowice International Airport contributes to increased traffic in handling cargo traffic. It is expected that the port can be a major cargo port in southern Poland. Development potential of the airport in Katowice performance stems from the favorable location of terrain, from the viewpoint of the efficiency of the airport: the asset is located near the intersection of A1 and A4 motorways and proximity to railway junctions.

Modernizing and expanding existing airports should also be assumed that the cargo terminal, which is part of a potential multi-modal hub should be able to flow and support a diverse assortment structure loads.

4. Air transport intermodality

Attempts to turn the airports in the EU network of national and inter-modal transport is one of the Polish transport policy. This strategy is consistent with the objectives of the European Commission, for an efficient and effective transport system in keeping with the principles of sustainable development. The experience of Western European countries shows that in the future, there is a significant integration of air transport to rail transport, especially with high-speed train, whose construction is planned in the near term. An example of such a proposed project is to bus linking the city of Wroclaw and Poznan and Warsaw (the planned speed of 350 kmph). Rail transport, particularly transport high-speed train can be an alternative for short or even medium distance air travel. Therefore, the integration of air and rail transport can produce good prospects for the future traffic.

The solution which seems the benefits of air logistics center would be designed in an air cargo terminal, railway freight station. An example of such a solution is located in Frankfurt, which is one of the largest intermodal airports in Europe. Railway Station Cargo (Air Cargo Rail) is located in this port, allows the movement of goods from rail to air.

5. Prospects for development of air freight in Poland

As you know, an opportunity to accelerate the development of regional airports of Poland is to increase the transport of passengers and goods. The following are forecast freight cargo service in selected Polish airports by 2020, according to [2, 5, 7, 8]:

1) Warszawa-Okęcie: 2010: 55,4 thous. tons; 2020: 140,3 thous. tons;
2) Łódź-Lublinek: 2010: 10,0 thous. tons; 2020: 150,0 thous. tons;
3) Rzeszów-Jasionka: 2010: 32,0 thous. tons; 2020: 50,0 thous. tons;
4) Poznań-Ławica: 2010: 11,4 thous. tons; 2020: 33,1 thous. tons;
5) Katowice-Pyrzowice: 2010: 6,9 thous. tons; 2020: 15,3 tys. ton;
6) Kraków-Balice: 2010: 5,7 thous. tons; 2020: 12,3 thous. tons;
7) Gdańsk-Trójmiasto: 2010: 7,6 thous. tons; 2020: 11,1 thous. tons;
8) Wrocław-Strachowice: 2010: 5,7 thous. tons; 2020: 9,3 thous. tons.

Analyzing this prediction Polish carriers and local governments, should take into account the unfavorable weather the International Air Transport IATA, which gave Poland outside the twenties countries in the coming years will witness a significant increase in air freight is supported.

Analysts suggest that segment of the freight service contributes to improving the efficiency of the air carriers who transport freight for the most use of open spaces cargo aircraft. At the same time, airports receive genuine benefits from handling cargo. Regions also offer cargo handling segment become more attractive.

From the foregoing statement that increasing the role of air transport in freight makes the region an attractive but requires effective implementation of a comprehensive program of organizational activities, investment, etc.

6. Conclusion

Polish cargo air transportation didn’t develop a satisfactory pace, but the development of this sector is the most legitimate, because it can generate benefits for the economy. The results of professional studies have shown the possibilities and directions of development and improvement of air transport cargo in Poland.

There were many problems to solve in order to accelerate the development and improvement of air cargo in Poland and at the same time to reduce the gap in this sector in relation to the EU.

The largest Polish airport Warsaw Frederic Chopin (the tonnage of cargo at the level of just 50 thousand. tons in 2009) was not even on the list ranking the largest airports in the world [6]. In the first place this list from the year 2009 the airport is located Memphis Int. (USA) from 3697 thousand tons tonnage.

Polish aviation law and regulations require the harmonization and transparency. The infrastructure of almost all Polish airports needs improvement, modernization and expansion. Therefore is necessary investment in new runways, taxiways, aircraft stands, boards, roads, warehouses, etc. The development of airport infrastructure may be a key investment for cargo transportation in Poland. It is uncertain whether Poland will be among the leaders in Europe in terms of handling air cargo, but it is expected that Polish airports can play an important role in the cargo market growth in some regions of Eastern Europe.

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Save Our Lives: a comprehensive road safety strategy for Central Europe (SOL)

Main goal of the project

Main goal of the SOL project to promote sustainable mobility and increase awareness for safety issues as well as contributing to the achievement of higher quality of living conditions.

Project vision

„A region free of road-crash death and injury, safe for all users in every community“.

Materials and tools produced within SOL will help benefit road safety in the region and can inform and contribute to similar action in other regions of the world.

Project partners

The project SOL shall help to prevent road crashes, deaths and injuries in the Central Europe Space (CEUS). In 12 pilot areas of 7 countries (Poland, Czech Republic, Slovakia, Hungary, Slovenia, Italy and Austria) targeted strategies will be developed implementing effective programmes to build a transnational road safety network.

Funding of the project

SOL also brings significant and needed funding towards an increasingly deadly and common public health issue in the CEUS region and world. SOL is a project cofinanced by the European Programme of Territorial Cooperation "Central Europe".

CENTRAL EUROPE COOPERATING FOR SUCCESS. EUROPEAN UNION EUROPEAN REGIONAL DEVELOPMENT FUND

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Vehicle Scheduling Optimization

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Abstract. The paper deals with the vehicle scheduling problem related to regional public transport. Linear programming methods are used to solve the problem. A mathematical model is created including the constraints and the objective function minimizing costs and the number of vehicles. As the number of transportation links is a major factor affecting the time of solving the model by software and the time of processing the input data, a decomposition of the set of lines into disjoint subsets can be used instead of the "direct" optimization. The decomposition has proven to be a suitable alternative in solving large optimization problems, because a substantial reduction of the computation time was achieved, while the objective function value increased by only about 0.6%. A comparison of the solving techniques is presented in the conclusion.

Keywords: transport, optimization, vehicle scheduling, linear mathematical modeling.

1. Introduction

Grant demands of the public transport have increased substantially in the Czech and Slovak Republic in the last 20 years. It should be an interest of the state to reduce subsidy for the public transport. Carriers should be prepared and intensively search for the savings in their management. Significant savings can be achieved simply by changing an organization of work.

It is appropriate to use linear programming methods for solving the optimization problem of the vehicle scheduling.

In the task of the optimizing the vehicle scheduling there is a goal to propose such a sequence of every single transport link (i.e. train, airplane, bus connection etc.) operations for each vehicle, in order to achieve the minimum or the maximum value of an optimization criteria. It is possible to consider a number of criteria in a theory. Given that the reasons of this problem are largely economic, it seems most appropriate to choose as an optimization criterion one of two: the total costs of operation and number of vehicles. It is, however, two criteria, the minimum would be necessary to look at the same time.

Using a multi-criterion optimization function has many disadvantages, it is appropriate to use the following solution. Choose the costs of transport link operation as an optimization criterion. Depreciation (i.e. the cost of the vehicle) for one planning period, include into costs of the vehicle crossing from the garage to the first stop of the first circuit which operates the vehicle that day. If the vehicle throughout the planning period does not serve any link, it is not necessary to put the vehicle into the fleet carrier, and the objective function is not burdened by a depreciation expense. It is ensured that the given set of transport links will be operated at the lowest costs. It is also expected that the number of deployed vehicles will be minimal.

2. The Mathematical Model

First, it is necessary to define what is about to decide in the vehicle scheduling problem:

- z_{ijk} … bivalent variable modeling the decision of whether the vehicle $i \in I$ may pass between the end stop of the transport links $j \in J$ a $k \in K$.

The variable z_{ijk} is introduced only in those cases for which the introduction is necessary:

- $z_{ijk} \in \{0, 1\}$ for $i\in I$, $j\in J$ a $k\in K$.

The definition above sets can be elaborate as follows:

- *I* … the set of vehicles, which can be deployed on the operation of the transport link,
- *J* … the set of the transport links *j* after which, you can change the default stop of transport link *k* to the time of departure of the link *k*,
- *K* … the set of the transport links *k* to which it is possible to drive after finishing of operating the link *j* in the time of departure of the link *k*.
- *S* … the set of the garages.

The objective function minimizing the costs takes the form (1):

$$\min\ f(z) = \sum_{i\in I}\sum_{j\in J\cup S}\sum_{k\in K\cup S} a_{ijk}\cdot z_{ijk} \qquad (1)$$

- a_{ijk} … total costs of the vehicle operation of the transport link *j* plus the costs of the crossing between the links *j* and *k* plus the costs of vehicle's waiting between the operation of the link *j* and *k*.

It is necessary to specify all the requirements on the mathematical model this includes the following requirements:

- deploying the required type of the vehicle on the link (1a),
- avoid the "return of the vehicle at the time" (1b),
- the correct sequence of the technological activities (ensured by the constraint 2),
- the operating each transport link (3),
- every vehicle exits the garages only once during the planning period (4),
- limiting the length of the shifts and the hours of operation of the vehicle (5).

The simplicity of the model is ensured by the introduction of the variable z_{ijk} only in cases when the declaration is necessary. This declaration also meets some of the above requirements: (1a), (1b). The "return at the time" means a situation where the vehicle after finishing operating link in a given time shall be deployed on operation of the other link with the start time earlier.

The correct sequence of technological operations (vehicle crossing from the garage to stop of the link, operating link, vehicle crossing between the final stop of links, crossing between the final stop of the vehicle and garages) can ensure (2):

$$\sum_{k\in K\cup S} z_{ijk} = \sum_{k\in J\cup S} z_{ikj} \quad for\ \forall i\in I \qquad (2)$$

The operating of each link guarantees (3):

$$\sum_{i\in I}\sum_{k\in K} z_{ijk} = 1 \quad for\ \forall j\in J \qquad (3)$$

The constraint (4) ensure that each vehicle exits from the garages at most once:

$$\sum_{k\in K} z_{ijk} \le 1 \quad for\ \forall i\in I,\ j\in S \qquad (4)$$

It is necessary to define a variable t_{ijk} that in the mathematical model represents the duration time of the transport link *j* plus the transit time from the end of the link *j* to the starting point of link *k* plus waiting to start operating link *k*.

The constraint (5) ensure that the time of the operation of the vehicle *i* will not exceed T_i. If we assume that the driver is over the whole operation "assigned" to the same vehicle, the constraint analogous limits the length of the driver's shifts to T_i.

$$\sum_{j\in J}\sum_{k\in K} t_{ijk}\cdot z_{ijk} \le T_i \quad for\ \forall i\in I \qquad (5)$$

The constraints (5), (6) define the domain of variables:

$$z_{ijk} \in \{0,1\} \quad for\ \forall i, j, k \qquad (6)$$

$$t_{ijk} \in Z_0^+ \quad for\ \forall i, j, k \qquad (7)$$

3. Decomposition of the Set of Transport Links

The number of the transport links is a major factor affecting the computational time and the time of processing the input data. The decomposition set of links to *n* disjoint subsets can be also used to achieve optimum solution. The components of the set of links are given by the time interval. The link is inserted into the subset of links based on time of departure from the default stop. The problem is solved separately for each set of components. Separated links sequences operated by the vehicle are suitably connected to achieve the minimum total costs. This procedure does not guarantee an optimal solution, but it can be assumed that the obtained solution is not far from the optimum.

4. Input Data Analysis

It is necessary to accurately determine the value of all inputs appearing in the mathematical model so as valid results with good predictive value could be achieved. The key is to determine values of the costs coefficients.

It is appropriate to calculate the costs of driving and parking of vehicles in several ways, based on different and mutually independent input data. Among other may be used procedures listed in the tab. 1. The methods of calculation differ primarily by how much of the total costs they take into account.

The computational method	The costs of the driving vehicle	The costs of the parking vehicle	Comments
The determination of the relative costs coefficients [1]	1,0000 $[-]$	0,6755 $[-]$	The calculation takes into account the 100% of the costs of the carrier.
The determination of the costs coefficients of the costing formula [2]	614,75 $[CZK \cdot h^{-1}]$ *(8 years depreciation)*	251,59 $[CZK \cdot h^{-1}]$ *(8 years depr.)*	The calculation takes into account of the costs referred in the costing formula.
	666,12 $[CZK \cdot h^{-1}]$ *(5 years depreciation)*	302,96 $[CZK \cdot h^{-1}]$ *(5 years depr.)*	
The determination of the costs coefficients according to the DPO	1184/1408 $[CZK \cdot h^{-1}]$ *(standard/long bus)*	-	The calculation takes into account all of the costs arising when the vehicle is in motion.

Tab. 1. The summary of the costs associated with the operate links according to different methods of the calculation.

It is appropriate to use in the model only the values referred in the costing formula with a depreciation of vehicles 5 years, because the optimization of the vehicle scheduling can only affects the operating costs. The costs of a vehicle are therefore considered 666 $CZK \cdot h^{-1}$ for vehicle in motion and at the 303 $CZK \cdot h^{-1}$ for the parking vehicle with a driver.

5. Application into the Practice

The proposed approach to the problem was applied to optimize vehicle scheduling in the region, which is defined in the south by the towns of Ostrava, Hlučín, Dolní Benešov, Kravaře and in the north by the border between the Czech Republic and Poland. This is the link, no 70, 72, 281, 282 and 283. All of them are finished at the stop called Přívoz, Muglinovská in the urban district of Ostrava-Přívoz. There are used Xpress - IVE software, which solve the problem by simplex algorithm and branch and bound method. Results are listed in the tab. 2.

	The current state	The optimum solution	The index of the original/ optimal solution	The solution obtained by the decomposition	The index of the original/ decomposition solution
The total calculated costs [CZK]	65 526	62 937	0,960	63 268	0,966
The costs (without the operating links and the depreciation) [CZK]	15 739	13 150	0,836	13 481	0,857
The total time of the vehicles being outside the garage [hours]	131	113	0,863	114	0,870
The number of vehicles [-]	8	8	1,000	8	1,000
The number of drivers [-]	14	13	0,929	13	0,929
The number of crossings between the links [-]	0	5	-	6	-

Tab. 2. The comparison of the current state with decomposition and with optimal solution.

The optimization was performed in a relatively small group of links and yet the implementation of the new vehicle scheduling would bring significant costs reductions.

If the minor timetable changes are accepted, further substantial savings could be achieved by reducing the number of vehicles.

6. Conclusion

The decomposition of the set of links has proven to be the suitable alternative in solving large optimizing problems. When it is achieved a substantial reduction of the computation can be reached. It affects the value of the objective function by only 0.6%.

I believe that using linear programming techniques with powerful computers are the way to the rational organization of public passenger transport, which will leads to its improvement and subsequent revival.

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Aggressive Behavior of Drivers in Slovakia

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Abstract. Exceeding the speed limit, inappropriate gestures, nonobservance of safe distance, this is only a fraction of the aggressive behavior of many drivers that need to be solved in the road traffic. The problem of aggressive driving on the roads is becoming more current. At present the problem of aggressive driver behavior in the Slovak Republic is not semifinished.

Keywords: Driver, safety, aggressiveness, behavior, exceeding the speed limit, anger, questionnaire, traffic situations, respondents.

1. Introduction

The severity stems mainly from a loss and the consequences, which are results of aggressive behavior on the road, in physical, health, social and psychological terms [4]. The number of aggressive drivers on the road increases in connection with the developing transport. Sufficient technical information, however, lack in this department.

For behavior, which is most commonly associated with aggressive driving, is considered:

- speeding (significantly exceed the set limits, much faster driving than which isn´t corresponding to the traffic conditions and others),
- improper passing from one lane to another (without giving a sign to change the direction of driving, without verifying whether it can fulfils transfer act safely),
- disregard of the authorized person, traffic signs and equipment, which dictate to give way line or stop the vehicle,
- non-safe distance,
- inappropriate overtaking (without giving any sign of change the direction of driving, overtaking in the place where it is prohibited by law, driving in the lane reserved for slow vehicles, along the tram belt, along the shoulder and so on),
- unauthorized drive in a designated lane for vehicles with a law of preferred driving (buses lane, emergency vehicles),
- right side overtaking on highway or on way for motor vehicles,
- reducing speed suddenly or stop vehicle as punishment for a vehicle traveling behind,
- aggressive and inappropriate gestures and so on.

On the Fig. 1, there can be seen the share of main causes of traffic fatal accidents in Slovakia [6]. The first place takes the speeding, which is drivers´ expression of aggression and the style of driving and break the basic rules either.

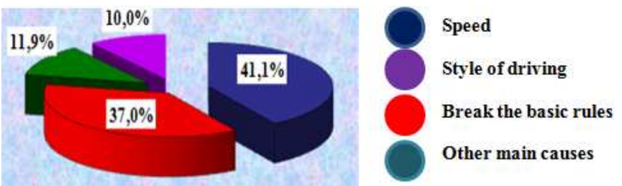

Fig.1. The share of main causes of fatal accidents in Slovakia

If we wanted to examine whether the concept of aggressive, respectively reckless driving can be found in the legislation of Slovak Republic relating to road traffic, it would be futile, as this term is often used in the police and in public, but is not precisely defined.

Aggressive driving on the roads, however, applies to any driver and is not sanctioned in such ranges, so that the drivers thought over that driving and drove with respect to all road users.

2. The Questionnaire of aggressive behavior of drivers in Slovakia [3]

Abroad, the questionnaire is used for the detection of potential aggressive drivers, respectively drivers´ diagnosis of aggressiveness who already had a driving license, have form of survey [2].

This knowledge showed that the survey carried out in Slovakia should be focused on anger, which is the main part and occurs most often by aggressive drivers. This anger should be at least divided (with examples from practice) to 5 scales, which should be precisely defined.

In developing the questionnaire was contacted Slovak Autoturist Club (SATC). On the first page of the questionnaire are 27 situations that commonly occur on Slovak roads. For each of the questions is 5 degreed scale with divisions of anger, which the respondent feels at the concrete traffic situation (degrees - no anger, 1. level of anger, 2. level of anger, 3. level of anger, 4. level of anger). On the other side of the Questionnaire is the classification on the length of perceived anger and on the three most annoyed situations. Moreover, there are additional questions as, for instance, the number of driving years, sex, year of birth, education and district of residence. At the end of side are given explanations, what is meant by other 5-point scale anger.

The Questionnaire was realized from 26.07.2010 to 08.08.2010. The respondents drawn it up electronically and sent to the specified email address. The ongoing questionnaire has been filled out manually either and the respondents were approaching in neighborhood shopping centers, gas stations, as well as nearby the University. Percentages between electronically and manually filled questionnaires were about 55% and 45%.

335 respondents, of who were 203 men and 132 women, were participated to the Questionnaire. Subsequently, respondents were divided into age and gender category. In Fig.2 it can be seen that the numbers of respondents in different age groups are balanced. The only blip can be observed in the age group 60 years and older, which is due to the fact that the majority of these people responded to the survey only in printed form and during the survey it has been concentrating mainly on the age group 25-29 years and 30-39 years, because of police resources, which show, that these drivers cause the most accidents.

The Questionnaire has been treated from different perspectives, but the most important is determining which of the traffic situation is the most annoyed for respondents. From the respondents' answers on various traffic situations was made the average, which determined the respondents´ level of anger.

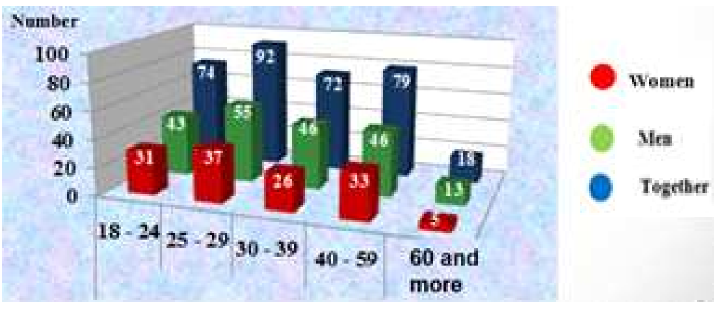

Fig.2. The partition of respondents by age and gender

These averages were divided according to their values. And these averages determine which of these situations the most angry or least moderate are. In Fig.3 it can be seen traffic situations, which are able to "put out" most on the roads.

Traffic situation	Average value
1. Someone is reversing in front of you without looking back	3,27
2. Someone increase the vehicle speed when you are trying overtake him	3,10
3. Someone is pushing on the front of your car after overtaking	3,04
4. Someone is pushing on the back of your car (eg. wants to force the release of the lane)	3,00

Fig.3. The most annoyed traffic situations by average value

The situation of careless reversing angered most respondents, which averaged value was 3,27 and it means "3rd level of anger", which is already inclined to "4th level of anger" according to scale. This situation is classified as passive aggressor on the road, respectively as negligence. In second place fitted in the situation of the increased speed by overtaking by another driver. This situation belongs, however, to the typical aggressive driver´s behavior, which may contribute to serious accidents. Third and fourth place belongs to situations which restrict the driver to which they are applied. Such behavior may cause to the oppressed driver fear, nervousness, which may later result in reciprocation of aggression, but against other participants of road traffic.

Comparing groups of men and groups of women, it is possible to use the median value, which we distributed set of statistics for two equally large parts. Median value was made on depending on sex and age categories and is shown in Fig.4.

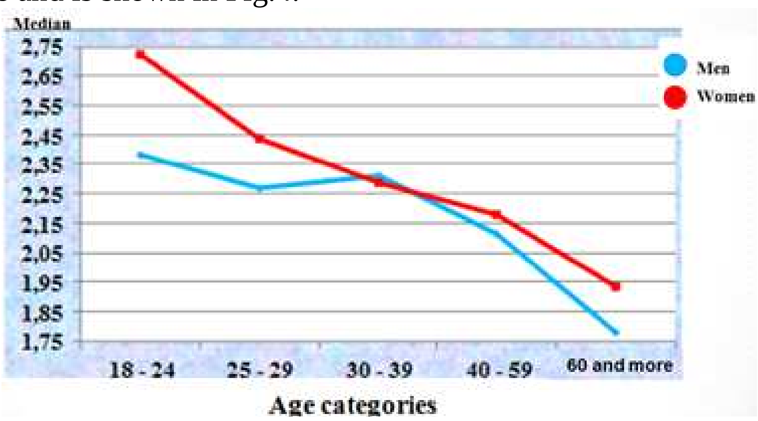

Fig.4. Value of median of average anger classification in dependence on sex and age

From the picture can be deduced that women are more aggressive from samples of 335 respondents, respectively it would be better to define their as more emotional. This condition is not fulfilled only in the age group 30 to 39, in which males are more aggressive. So far, it is proclaimed that men drive more aggressively and the result of the Questionnaire is very surprising. It is also possible to confirm that aggression declines with age, again this is not completely confirmed in the male age group 30-39, which may be due to just more aggressive approach of men to traffic situations on roads, but when you notice women have almost the same median value.

Recent elaboration is from the anger length position and they can be selected from 5 options (only briefly, a while, a longer while, long enough, for a long while – according to the scale of the Questionnaire). The length of women’s anger is divided into specific age categories. The largest number of women (45 women) of different ages indicates (related to the traffic situation from the questionnaire) that they can be angry for “a longer while”. The longer while was defined in the questionnaire within the time period of 10 to 30 minutes inclusive. If it is based on the individual ages, women in age group 25-29 and 40-59 ("while a longer duration of anger") is situated in the number of 14, followed by women in age group 18 to 24 - the number of 12 persons, were the penultimate women´s group 30 to 39 with the number 4 and the last group of women over 60 with a value of 1. In the case of women ages 18 to 24, 25 to 29 and 40 to 59 it was also the highest number of "votes" from all the offered options.

For comparison are introduced the numbers of length of men´s anger and the duration of their anger. Most men identified (with the number 80) that are angry in that traffic situations "a longer while" as well. When it is compared to the numbers of women in response "a long while" and at the same response in the men´s group, we see that men are responsible in the different age groups more proportionately (not taking into account the age group 60 and more). The largest number of responses with the number 28 is for men in the age category 25 - 29,which is followed by men in age category 30 to 39 with 20 responses, then men 18 to 24 years have 19 votes and last (except for age group 60 and above - 0) are men 40 to 59 – number of "votes" 13.

If we think about it, we know that only two seconds of inattention can cause an accident and when it is compared to 10 to 30 minutes duration of anger, during which the driver is more distracted while driving and experiencing negative emotions compared to a peaceful state, which can be classified as inattention, it's worth consideration!

3. Conclusion

Safety is the exemption from accidents and losses on human lives. It also deals with property protection, regulation, management and transport technology development. The analysis of accidents indicates that 95% of transport accidents are caused by human factor failure (wrong determination of situation, participant’s skills/abilities etc.) One of the most frequent errors of drivers is a wrong decision in a critical situation. The decision process is very complicated since the driver has to evaluate the arisen situation correctly within fractions of a second [1].

The questionnaire showed a lot of important data - nervousness and aggression in the road is clearly rising. Drivers should be aware that their own aggression creates problems to themselves, for example currently there are different penalties for the improper execution of gestures, for speeding and begins to address the safe distance from other vehicles in Slovakia. However, many times the fines are not only negligible item for foreign drivers. The essential idea is the awareness of drivers that do not drive on the roads themselves and should also be considerate to other road users.

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The Utilization of DIAL Gas Analyser in the Environmental Flight Laboratory

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Abstract. This paper describes feasibilities of DIAL gas analysers' utilisation in the environmental flight laboratory. Concretely it is focused on the assessment of WVSS-II and AQM FTIR AirSentry's installation on board of an aircraft. AQM FTIR AirSentry is a modification of the Open-path AirSentry FTIR. It is a device primarily designed for usage in ground conditions. One section of the paper is devoted to technical adjustment of the device whilst on board. The paper will also outline the basic principles of LIDAR technology used in gas analysers.

Keywords: Differential absorption LIDAR (DIAL), flight laboratory, gas analyser, light detection and ranging (LIDAR), multi-pass cell, open-path monitoring device.

1. Introduction

The Department of Air Transport at the University of Zilina within the frame of the Centre of Excellence for air transport is currently conducting a project regarding flight laboratory equipment capable for measuring parameters of atmosphere during flight. The aim of this project is to ensure an environmental flight laboratory exists for monitoring airspace above the Slovak republic in the vertical range from ground to FL 100 or to FL 300. Horizontal range should be at least 600 kilometres and the duration of continuous observation should be at least four hours without intermediate landing. The board equipment has to meet requirements for IFR flights. The flight laboratory will be focused on environmental and meteorological observations. It will be equipped by special devices designed for gathering information about atmosphere compounds such as H2O, CO, CO2 and NOx, with aims to monitor other dangerous gases in our environment.

2. The DIAL technology in gas analysers

The newest analysers use DIAL technology (differential absorption LIDAR (light detection and ranging)) for gathering of composition of certain gas. The technique of measurement relies on the unique "fingerprint" absorption spectrum of each molecule. An absorption measurement is made with laser light, at a peak of absorption (lambda-on) and at a trough (lambda-off), giving a differential signal. The differential nature of the signal simplifies the measurement process.

A pulsed laser beam is sent out into the atmosphere (left side of figure 1) and small proportions of the light are backscattered by particles along the beam path to a sensitive detector (right side of figure 1). In this sense dust particles and aerosols are being used as reflectors, albeit rather weak ones. The laser light is in short pulses and time resolution of the backscattered light (along with the speed of light) gives range resolution as in a simple LIDAR.

For concentration measurement the DIAL system relies on a differential return from two closely spaced wavelengths, only one of which is absorbed strongly by the target gas. The size of the differential return signal at different distances along the laser beam path indicates concentration.

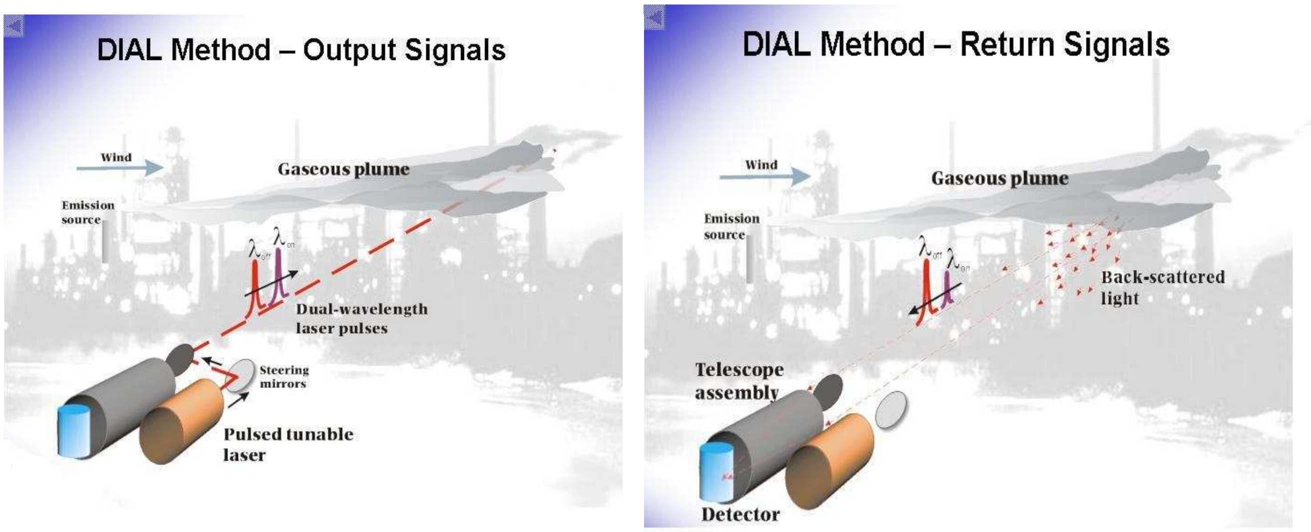

Fig. 1. Principle of DIAL technology [1]

3. WVSS-II

There are many products and solutions regarding measurement of air quality on the world market. However most of them are designed for utilisation in ground conditions such as measurement of air quality in industrial centres. The American company Spectrasensors developed a device capable of gathering information related to the volume of water vapour in all altitudes up to FL 400. This product (shown in figure 2) called WVSS-II (water vapour sensing system) is also based on DIAL technology. Comprehensive system of water vapour monitoring in atmosphere has been used in the USA for two years. It based on cooperation between agencies, airline companies and transmission systems too. The transmission systems are responsible for data gathering from onboard sensors located in airliners.

Fig. 2. WVSS-II [2]

According to this obtained information the American national weather service (NWS) makes out more frequently updated weather forecasts. NWS provides this hot information about weather situation with relevant air traffic centres.

One significant advantage of this device is that it has certification for exploitation in many airliners and in the aircraft of general aviation. Due to its limited rate of measured atmosphere compounds (measurement of water vapour only) it does not meet all requirements for mentioned flight laboratory [3].

4. AQM Sentry FTIR

AQM Sentry FTIR is product of American company CEREXMS which is a leader in real time multi-gas detection systems. Although it is primarily designed for ground exploitation and has no certification for flight laboratory, this device is in compliance with most requirements related to utilisation in the flight laboratory.

This system is based on product called Open-Path AirSentry FTIR which is the most reliable for monitoring industrial facilities, accidental releases, and hazardous waste site emissions. The system monitors from 5 to 1,000 meters and eliminates the need for many single point gas specific sensors, lengthy calibration, and laboratory analysis. The Open-Path AirSentry FTIR in figure 3 shows both the transmitter and receiver are located together in the same housing. The remaining piece of equipment that completes the beampath is a retro-reflector array also shown on the right side of figure 3.

Fig. 3. Open-Path AirSentry FTIR system [4]

It could be noted this system is not usable for flight observations because it is static and requires a retro-reflector for air quality measurement of open space. On the other hand AQM Sentry FTIR (shown in figure 4) is coupled with a multi-pass cell (shown in figure 5) and therefore it is suitable for fixed installation and installation on board aircraft or a mobile van.

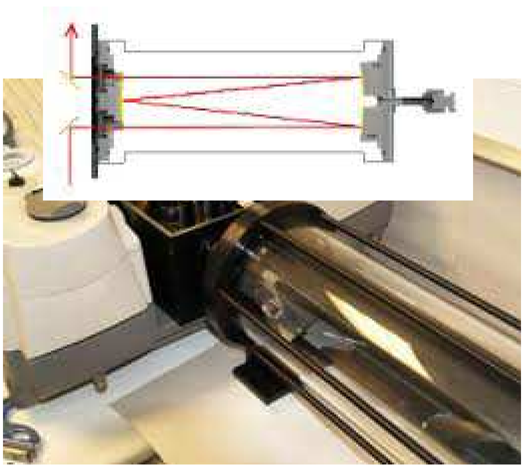

Fig. 4. AQM Sentry FTIR [4] **Fig. 5.** Multi-pass cell [4]

The analyser is provided with a library of nearly 400 compounds. Some of them are shown below as well as the device specifications.

Specifications [3]:

- **Dimensions:** 62.2cm x 47cm x 25.4cm
- **Weight:** 68kg
- **Power:** 4A/2A @ 110/220 VAC
- **Operating Temperature:** 50°C, -40°C

4.1. The proposal of AQM Sentry FTIR installation

The mentioned system could be used on board of aircraft in the following way; the central box with the multi-pass cell will be located in the space for baggage or in the interior. However one of the problems is how to lead air from the outside to the multi-pass cell. Cerexms does not offer necessary accessories therefore utilisation of Spectrasensor`s air sampler with hoses (shown in figure 2) offers a good solution.

During flight the air will flow continuously from the air sampler mounted on the fuselage through hoses to the multi-pass cell where the air composition will be measured by means of a laser beam. The data required will be continuously depicted in real time on the monitor by the operator.

Within the frame of project the air transport department speculates about three aircraft, namely the Diamond DA-42 Twin Star, the Piper Seneca V and the Vulcanair P 68 C. As well as operating as a flight laboratory aeroplane, it will be used for training pilots. The AQM Sentry FTIR is considerably heavy and bulky which proposes a problem for the parallel utilisation of the aircraft during training flights. In this case the capacity of aircraft will decrease as the mass of the device and the operator represents the weight of two pilots. This means that no more than one cadet can be on the training route. Therefore during parallel flights (i. e. carrying out a training flight and observation at the same time) the number of the crew is limited to only two pilots (instructor and cadet).

5. Conclusion

It is possible to say from previous information that AQM Sentry FTIR represents the best solution for environmental flight lab, especially due to its extensive potentialities to measure nearly 400 hundred atmosphere compounds. Due to this advantage, and because of its ability to process data in real time, this device allows for flexible and efficient air quality monitoring at any given altitude. The focus on the protection of our environment means the flexible flight lab has great potential for detection in critically polluted areas. However the issue of FTIR certification for use on board of aircraft remains the greatest problem of this ambitious project.

Acknowledgement

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Analyses of Technology, Which Ensure Preference of Urban Public Transport

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Abstract. This article deals with technology that ensures a preference of public transport vehicles at junctions by light signaling. Junctions must be equipped with devices which enable detection of vehicles before the junction, communication of vehicles with the controller of traffic light equipment and subsequent modification of the signal plan. In the article are mentioned most frequently installed controllers and detectors that provide preference of vehicles and their short description.

Keywords: preference, urban public transport, controller, detector,

1. Introduction

The most favourable kind of transport for urban areas from side of emission, noise, economic, energy, transport, urban and social is, after pedestrian and cycling transport, public transport. Therefore it is necessary to ensure its reliable function and thus attractiveness for passengers through the support of organization of operation in the transport area.

In general, the least affected by outside influences are the road of subsystems, because they don’t come into the contact with another transport, such as metro lines and railway. In contrast, lines of buses and trolley buses are directly dependent on the situation on a route and therefore their operation depends on the permeability of junctions and road communications. For ensure the minimization of the impact of individual transport to public transport, the amount of traffic and construction measures are applied to ensure preference of urban public transport.

2. Technology to ensure preference of urban public transport by light signalling

Preference of urban public transport by light signalling means possibility of a preferred option and extension of the green signal for a vehicle, which come to a junction. It is desirable so that the vehicle can cross through signal controlled junction as far as possible without stopping or at least with minimum delay.

By control of traffic lights equipment is possible achieve a high level of preference of public transport. There are two kind of preference of public transport by traffic lights equipment. Active preference, in which is influenced process of control traffic lights equipment in real-time. It is necessary to ensure the requirements of public transport vehicle. Passive preference is a way of control in which the fixed signal programmes are optimized according to beforehand identified of habitual behaviour of public transport vehicle. It can be a coordinated green waves, which take into account the probabilistic movement of public transport vehicles.

The preference depends on the management of traffic lights equipment, and the best results are achieved with traffic lights equipment, which use detection of vehicles and dynamic management in absolute preference of public transport vehicles.

For the function of system preference on the signal controlled junctions is necessary the junctions equip by controllers and detectors, which ensure the transmission of requirements of public transport vehicles into the traffic lights equipment.

2.1. Controllers

Controller is an electrical device which controls the signalling images of one or more semaphores of traffic signal equipment. Controller is essentially the brain of traffic signal equipment. Hardwar which is installed into the controllers is formed in the recently powerful microprocessor, electrical switching elements and circuits, which including its control, diagnostics, supply and detectors. Controllers are equipped according to complexity of junctions so that meet the requirements of the number of signal groups, detectors, connections to the coordination or to the central level. They are also equipped with memory for records of claims on all detectors. Controllers which enable dynamic traffic control and preference of public transport vehicles have to be equipped with the freely programmable logic. It calls also as control logic.

The control logic is a program into the controller, which directs the length and sequence of phases in the traffic lights equipment. In preference of public transport vehicles have to be preferred the claim of public transport vehicles before the claim other road users in the control logic.

Between the controllers which use in preference of public transport vehicles include for example MTC Mini 3 controller. It can be used to manage smaller junctions and it can be also connect to coordination with other junctions. MTC 300 controller which is designed to manage medium-sized junctions and MTC 3000 controller is used to manage major junctions. Controllers have the software which works in all normal modes i.e. fixed time cycles, dynamic programs with groups to challenge and prolongation of phase, phase control, program blinking yellow, manual control or all- red night. These types of controllers and several others are used to ensure preference of public transport vehicles in the city of Prague.

2.2. Detectors

Detectors are the devices which provide data on traffic flow. They serve for purpose of traffic control or for road traffic surveys. According to the method of obtaining data about vehicles detectors can be divided into contact and contactless detectors.

In preference of urban public transport detectors are the devices that allow detection of public transport vehicles. Detection of vehicles allows determining the presence and location of a vehicle at the junction and transfers the information to the controller of traffic light equipment. There are the information evaluated and subsequently signal plan is changed. Detection of public transport vehicles is necessary especially by the active preference.

On the road there are so. logon and logoff points at which the vehicle is logged and then voted into the system. When vehicles cross this point then may soon begin preferential interference into the management of traffic light equipment. Appropriate time between the first registration of the vehicle and the requirement to meet the claim is in most cases about 30 seconds. Range in which be able to move this time is 20 to 40 seconds. It follows that the open track should be the place logged about 250-500 meters before the stop line.

STOD 1

STOD1 is an infrared detector with optical sensor, which is designed for trolleys with unidirectional traction system. Detection is provided by an infrared optical sensor that works together with other devices of detector in separate isolated system with a safe voltage of 24 V.

Detector is designed for outdoor use in temperatures from -40 to +70 ° C and is constructed to speed 100 km per hour. The sensor can be adapted to the lateral horizontal scanning collector of trolley or to vertical scanning of tram pantograph.

Inductive detector

The inductive detector is the most widely used detector for detection of road vehicles. Its construction is simple and reliable. It is composed of inductive loop, own detector and of analytical unit. The detector works as follows: in the roadway at a depth of about 30 to 60 mm is built a cable wire that creates the induction loop**.** The loop is one of the circuit elements of low-frequency generator, whose frequency varies depending on the presence or absence of the vehicle over the inductive loop.

The advantage of inductive detector is its ability to transfer information and the ability to debugging itself if it is permanently occupied for example by improperly parked vehicle. The disadvantages of this type of detectors include higher costs for troubleshooting, for modifications or the need for debugging of the detector. In the case of using of induction detector is needed ensure quality development of the loop as well as of the roadway because the loop is prone to breakage.

Infrared detectors

They are one of the other possibilities of vehicles detection, which is based on the detection of movement within the radiating angle infrared sensor. Detectors are usually placed on the column or beam of the traffic light equipment or on light poles a few meters over communication and links in the lane before the stop line. They are mainly used where for some reason cannot be put induction loops into the roadway or they can be used as a makeshift solution for emergency situations.

The advantages of these detectors are their low cost, low-cost removal of potential defects as well as their assembly into operation. One of the main disadvantages of these detectors is its uncertainty, since the detector responds to any movement in that lane.

Video Detection

It is used similar as infrared detectors. It works on the following principle: on the picture is a software-defined virtual loops, which the position and shape can be selected arbitrary. The system evaluates the filling of these loops and on the output are generated pulses similar to pulse from the classical loop. When using video-detection in preference of public transport vehicles, the device can evaluate vehicle, which is similar as bus-like vehicle.

Data messages

Using data messages is made possible detection of public transport vehicle, which are equipped with mobile devices to communicate with the controller of traffic light equipment. In this detection method is possible to identify the detected vehicle. Data message can be transmitted from the vehicle to controller deliver a number of ways. We talk about the straight path, thus data message is transmitted to the controller via radio signal. Another way is possible to transfer the message to management control center, where they can add further information and then there may be distributed to controller of traffic light equipment over a wireless network.

This method of detection is an important contribution to the preference of selected vehicles, particularly buses of urban public transport, which is very difficult to detect and to distinguish passive detection methods, such as induction loops.

3. Conclusion

Providing of public transport vehicles preference requires constant monitoring of transport development on individual junctions and consequently changes in the organization of traffic on them. All junctions differ from each other, whether it's the location in the city, number of vehicles which cross through them, or the scope of preference which is necessary ensure and so on. Therefore it is necessary to consider each junction specifically and also to adjust the possibilities of preferences and technology that it ensure. In designing the technology we have to consider options of junction for example location and correct choice of detector and controller at the junction, so that is ensured the transfer of information to the controller and subsequently reliable meet the requirements of public transport vehicles.

The positive impacts of preference of urban public transport aren't only beneficial for passengers if is increased the speed and the reliability of transport. But also for carriers if is reduced the consumption, wear of vehicles, smooth observance of the social legislation and so on.

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Static Zone Adjustment for Approximate Solving of the p-Median Problem

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Abstract. This paper deals with the parameter adjustment of the approximate approach to the p-median problem. If a large instance of the problem is described by a location-allocation model, then the model size often exceeds any acceptable limit for available optimization software. The approximate covering model constitutes a promising approach which enables us to use common optimization software tools. The only payment for it is the loss of accuracy of the solution. But it is very important to realize that the accuracy depends on the model parameter. The main goal of this contribution is to find out a relation between the size of the problem and appropriate value of the parameter.

Keywords: Large p-median problems, covering model, approximate approach, parameter adjustment

1. Introduction

Large instances of the p-median problem and associated solving approaches form a background of many public system design problems where the quality criterion of the design takes into account the average distance between served objects and the source of provided service [1], [2], [3], [4].

The particular location-allocation models are characterized by considerably big number of possible service center locations which must be taken in consideration. The number of serviced objects takes the value of several thousands and the number of possible locations can take this value as well. Concerning the problem size it is obvious that these models constitute such mathematical programming problems which resist to any attempt for fast solution.

On the other hand, large covering problems are easily solvable by common optimization software tools even if they belong to the family of NP-hard problems. The aim of suggested approximate approach is to take the advantage of the covering problem to solve real-sized instances of the p-median problem. This approach is based on the model reformulation reported in [5] which may cause the loss of accuracy. It enables us to solve real-sized instances in admissible time using common optimizations software tools. The accuracy of the approximate covering solution depends on the value of model parameter. The main goal of our survey is to find out how to set the value of mentioned parameter to achieve good accuracy of the solution.

2. The main principle of the approximate covering approach

The p-median problem can be formulated as a task of selection of at most p network nodes so that the sum of network distances from each node to the nearest selected node is minimal. We denote J a set of served customers and the symbol I denotes the set of possible service center locations. The network distance between the possible service location $i \in I$ and the customer $j \in J$ is given by d_{ij}. In the location-allocation model, we are supposed to decide which served object is assigned to which located service center and also where the service centers should be located.

According to [5], the keystone of the approximate approach consists of a relaxation of the assignment of a service center to a customer. This assignment requires introducing the big series of the allocation variables. In the covering approach we try to approximate the distance between a customer and the nearest service center unless the center must be determined. To this purpose, we partition the range <0, max{d_{ij}: $i \in I$, $j \in J$}> of all possible distances of the former location-allocation problem into r+1 zones. The zones are separated by finite ascending sequence of values $D^1, D^2, \dots D^r$, where $0 = D^0 < D^1$ and $D^r < D^m = \max\{d_{ij}: i \in I, j \in J\}$. We introduce a numbering of these zones so that the zone k corresponds to the interval (D^k, D^{k+1}>, the first zone corresponds to the interval (D^1, D^2> and so on till the r-th zone which corresponds to the interval (D^r, D^m>. The width of the k-th interval is denoted by e_k for $k = 0, \dots, r$.

In addition to the zero-one variable y_i, which takes the value of 1 if a facility should be located at place $i \in I$ and which takes the value of 0 otherwise, we introduce auxiliary zero-one variables x_{jk} for $k = 0, \dots, r$. The variable x_{jk} takes the value of 1 if the distance of the customer $j \in J$ from the nearest located center is greater than D^k and it takes the value of 0 otherwise. Then it is obvious that the expression $e_0x_{j1} + e_1x_{j2} + e_2x_{j3} + e_3x_{j4} + \dots + e_{r-1}x_{jr}$ is the lower approximation of d_{ij} and the expression $e_0x_{j0} + e_1x_{j1} + e_2x_{j2} + e_3x_{j3} + \dots + e_rx_{jr}$ is the upper approximation of d_{ij}. It means that if the distance d_{ij} falls to the interval (D^k, D^{k+1}>, it is estimated by its lower bound D^k and the upper bound D^{k+1} respectively with a possible deviation e_k. Similarly to the covering model we introduce a zero-one constant a_{ij}^k for each triple <i, j, k> $\in I \times J \times \{1, \dots, r\}$. The constant a_{ij}^k is equal to 1 if the distance between the served object j and the possible service center location i is less or equal to D^k, i.e. $d_{ij} \le D^k$. Otherwise this constant a_{ij}^k takes the value of 0. Then the associated covering model connected with the upper bound can be formulated as follows:

$$\text{Minimize} \quad \sum_{j \in J} \sum_{k=0}^{r} e_k x_{jk} \tag{1}$$

$$\text{Subject to}: \quad x_{jk} + \sum_{i \in I} a_{ij}^k y_i \ge 1 \quad \text{for } j \in J \text{ and } k = 0, \dots, r \tag{2}$$

$$\sum_{i \in I} y_i \le p \tag{3}$$

$$x_{jk} \ge 0 \quad \text{for } j \in J \text{ and } k = 0, \dots, r \tag{4}$$

$$y_i \in \{0,1\} \quad \text{for } i \in I \tag{5}$$

The objective function (1) gives the upper bound of the sum of the original distances. The constraints (2) ensure that the variables x_{jk} are allowed to take the value of 0 if there is at least one center located in radius D^k from the customer j. The constraint (3) limits the number of located facilities by p. This covering approach is reported in more details in [5].

3. Selection of dividing points

It is clear that only limited number of dividing points can keep the model (1) - (5) in a solvable extent. This restriction impacts a deviation of the approximate solution from the exact one. The only problem is to find the appropriate way of the dividing points selection.

The elements of the distance matrix {d_{ij}} form a finite ordered set of values $d_0 < d_1 < \dots < d_m$ where $D^0 = d_0$ and $D^m = d_m$. Each value d_h is connected with a frequency N_h of its occurrence in the matrix {d_{ij}}. If there are only r different values between d_0 and d_m, we could determine the dividing points $D^1, D^2, \dots, D^r$ so that they would be equal to these values. Then we can obtain the exact solution solving the covering problem described by the model (1) - (5).

Otherwise the distance between a customer and the nearest located center can be only estimated knowing that it belongs to the interval (D^k, D^{k+1}> given by a pair of dividing points.

If we were able to anticipate the frequency n_h of each d_h in the optimal solution, we could minimize the deviation using dividing points obtained by solving the following model:

$$Minimize \quad \sum_{t=1}^{m}\sum_{h=1}^{t}(d_t - d_h)n_h x_{ht} \tag{6}$$

$$Subject\ to: \quad x_{(h-1)t} \le x_{ht} \quad for\ t = 2,...,m\ and\ h = 2,...,t \tag{7}$$

$$\sum_{t=h}^{m} x_{ht} = 1 \tag{8}$$

$$\sum_{t=1}^{m-1} x_{tt} = r \tag{9}$$

$$x_{ht} \ge 0 \quad for\ t = 1,...,m\ and\ h = 1,...,t \tag{10}$$

The decision variable x_{ht} takes the value of 1 if the distance d_h belongs to the interval which ends by the dividing point d_t. The link-up constraints (7) ensure that the distance d_{h-1} can belong to the interval ending with d_t only if each distance between d_{h-1} and d_t belongs to this interval. Constraint (8) assures that each distance d_h belongs to some interval and constraint (9) enables only r dividing points. After the problem (6) - (10) is solved, the nonzero values of x_{tt} indicate the distances which correspond with the optimal dividing points.

Remember that we should be able to anticipate the frequency n_h of each d_h in the optimal solution. The mentioned sequence N_h of occurrence frequencies does not provide us the information, because it reports only on the elements contained in the matrix $\{d_{ij}\}$. Consider, if the parameter $p > 2$, then the biggest value from the *j*-th column will be never included into the optimal solution of the p-median problem. We start here from the hypothesis that the frequency n_h of d_h may be proportional to N_h and to some weight which decreases with increasing value of d_h.

$$n_h = N_h e^{-d^h/T} \tag{11}$$

The symbol T represents a positive parameter and N_h is the mentioned occurrence frequency where only $|I|$ - p + 1 smallest distances of each matrix column are included.

4. Numerical experiments

We have suggested and realized a sequence of numerical experiments to find out the relation between the size of the p-median problem and appropriate value of the parameter T.

All the experiments have been performed on a computer equipped with the Intel Core 2 6700 processor with parameters: 2.66 GHz and 3 GB RAM. As a source of data we used the OR–Lib set of the p-median problem instances [6]. The exact solution was obtained by the universal IP-solver XPRESS-IVE [7] which is used very often to solve various optimization problems [8], [9]. The results of our experiments are given in Tab 1. Each row represents one solved instance of the problem. The size of the p-median instance is defined by $|I|$. The number of possible facility locations is equal to the number of served objects in all the solved instances. The *ObjF* represents the exact objective function value. The computing time in seconds is given by *Time*. The other columns of the table are dedicated to the results of the approximate covering model where the number of dividing points r was set to 20. These covering models were solved with different values of the parameter T = 1, 5, 10, 100, 1000. Since the covering model presents only an approximation of the original one, the objective function value does not have to be the same. The value of the approximate objective function is given by *ApObjF* and the value of corresponding real objective function is given by *ReObjF*. The column *Best T* is used to present the most appropriate value of T. The results show that the higher is the ratio of $|I|$ to p, the higher should be the value of T.

$$T \propto \frac{|I|}{p} \tag{12}$$

File name	|*I*|	*p*	|*I*| / *p*	*Exact solution*		**Approximate covering approach**			
				ObjF	*Time [s]*	*ApObjF*	*ReObjF*	*Time [s]*	*Best T*
pmed21	500	5	100	9380	189,453	10495	9390	83,297	1000
pmed16	400	5	80	8068	79,063	8917	8068	20,485	100
pmed12	300	10	30	6645	28,657	7646	6651	10,297	100
pmed12	300	15	20	5761	17,219	6905	5765	12,390	100
pmed12	300	22	13,636	4963	26,266	5214	4989	7,0	10
pmed8	200	20	10	4459	3,657	5303	4482	1,64	100
pmed12	300	45	6,667	3475	12,203	3692	3485	2,719	10
pmed12	300	54	5,556	3085	12,031	3297	3100	2,515	10
pmed29	600	120	5	3016	78,235	3016	3016	5,172	1
pmed16	400	96	4,167	2367	28,734	2471	2375	2,969	5
pmed16	400	120	3,333	1887	28,437	1887	1887	1,078	1
pmed21	500	200	2,5	1426	56,484	1426	1426	1,594	1
pmed21	500	270	1,852	784	56,781	784	784	1,5	1
pmed40	900	800	1,125	100	261,969	100	100	6,828	1

Tab. 1 Results of numerical experiments

5. Conclusion

The presented results prove that there is a relation between the p-median problem size and the most appropriate value of the parameter *T*. It is obvious that if we consider small value of *p*, then we have to take into account also high values of the distances. So the expected frequency of higher distances must be higher. On the other hand, if the value of *p* is very high, then it is possible to show that the small distances are more frequently used in comparison with the higher ones.

As we have shown, a very satisfactory accuracy of the approximate solution can be achieved by the appropriate selection of the parameter *T*.

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Airport Slots and Historical Precedence

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Abstract. This report discusses the historical precedence in airport slot allocation system. Historical precedence is the first priority for slot allocation. The report describes which airline's slots are appropriate for being historical slots. There is a brief introduction of cooperation between airport coordinators and airlines, and also their responsibilities. There is a description of the system, including the system of communication and technical information swapping through the use of standard messages. There an explanation of exceptions in 80% usage rule, which informs about when airlines should get historical precedence without the utilisation of their operation at least 80% of the scheduling period. This report ends with the list of advantages and disadvantages of the first priority.

Keywords: Historical precedence, airport slot, allocation priority, coordination, airline.

1. Introduction

Slot allocation depends upon a number of priorities and criteria. The first and most important priority is historical precedence. This report will discuss which conditions are compulsory for airlines to obtain desirable airport slots and to retain their dominance for the next period.

2. Conditions for historical precedence

Historical precedence is connected with the previous using of the specific airport slot at the specific coordinated airport. Airport slots are allocated to an airline by a coordinator. The airline will retain precedence over a slot for an "equivalent period", which means summer scheduling in a given year will be the same the following year, this is also applicable to winter. Due to complaints concerning a sizable amount of idle airport slots, allocation priorities have become stricter. Legislation changes have brought about tighter control over allocation of prime airport slots and airlines now need to abide by a 'use it or lose it' rule, which requires the airline to utilise at least 80% of their slots. This means that if the airline does not utilise its slot during the scheduled period, they will lose historical precedence for this slot.

Historic slots have to be confirmed by all parties included, such as airport coordinators and airlines. This is a necessary prerequisite.

There are some principles for the determination of a historical slot; some are defined as follows:

- Airport slots allocated for ad-hoc services are not suitable for obtaining historical precedence. For example slots which were allocated for non-scheduled flights (charter flights) are not going to be historical slots.
- Appropriate slots are those that are allocated by the coordinator and are utilised to 80% or more during the whole scheduled period.
- Historical precedence is also allocated for flights which were requested as series of slots. These flights form into the series with the approximately the same time at the end of the period.

- The deadlines for winter and summer scheduling are the 31st of August and the 31st of January respectively. This the last chance to check the designation of historical slots.

If the airline owns more than one series of slots with the similar or overlapping time periods, it will be calculated historical utilisation for every series particularly. If the flight is operated more than once a week, every such day will be considered as a single series of slots. Time saving techniques throughout the day do not influence historical precedence. Other changes, such as a change in the type of aircraft, number of flight, route or service type also do not affect historical precedence. For this series is calculated 80% usage criteria unless otherwise agreed between coordinator and airline. The coordinator will respect individual cancellation which are executed before the 31st of August and the 31st of January in the calculation. Cancelation of five or more than five consecutive weeks will be reducing period which is suitable for calculation of historical precedence. On the other hand, cancellations of less than five consecutive weeks will not reduce period for historical precedence calculation, because number of cancelations is lower than 20% for whole period. For the calculation of 80% usage are appropriate those flights which operation was not during the entire season, but its start/end have been approximate or the closest to the start/end of the scheduling period.

3. Communication between parties concerned

It is necessary that all parties communicate for the best working of the system, which results in the approval and acknowledgement of all slots. This communication is standardised and has to be subject to conditions. It is the coordinator´s duty is to inform airlines and airports about the allocation and distribution of historical precedence. This communication is executed through SHL messages (Slot Historic and Non-Historic Allocation List Message – standard message used by coordinators to inform airlines of the status of their slots for the historical precedence). SHL messages are standardised messages and they inform users about their historical and non-historical slots.

Feedback from the airline operators is very important. They must confirm the arrival of a SHL report, check the content and consequently inform a coordinator as to whether they agree or disagree with the historical slots. All of the activities need to be sent and followed by the IATA planning calendar before the deadline. In the case that a request is sent after the deadline, it will not incorporated into the calendar. Exception is only given if the problems do not catch up the deadline and start to solve through mediatorial body of IATA that solves conflicts in coordination. In case the case that no SHL report is sent, it is the obligation of the airline operators to request that the coordinator sends the information. The next step in communication is the SCR report (Slot Clearance Request/Reply Message). It is a standardised report used to confirm flights between coordinators and airlines.

The safety of historical slots is guaranteed on the part of the coordinators too. This means, if the historical slot is assigned to airline and the company wants to change the time of the flight or anything else, it will have no influence on historical status. These changes will need to be requested from the coordinator, and if the changes cannot be applied they will be asked if they wish to retain the slot. On the other hand, if the change concerns the time of the historical slot between two or more coordinated airports, the changes need to be negotiated at a Planning conference or exchanged with other companies. This policy prevents the change to be performed only at one airport. It is necessary to note that a change certified by a coordinator cannot be claimed by airlines for previous historical slots. It is necessary to request reports and acknowledgments on all levels of processing that are not sent until the deadline.

4. Legislation exceptions in usage rule

Coordinators should provide feedback to airlines about their historical slot status and if their slots are appropriate for historical status and also coordinators control 80% usage and if there is possibility that percentage of airline using of slot will be lower than 80%, coordinator should inform airlines about that they should lose historical status.

For this 80% rule have been implicated some exceptions. They allow airlines to remain their historical slots even if the utilization has been lower than 80%. All of these exceptions have been accepted as regulation of European Parliament and Committee (of European Community), these regulations have been mandatory in the entire extent for all members countries.

The first regulation was number 894/2002. This regulation have been accepted because of the serious reason, specifically because of terrorist attacks from 11th of September 2001, which have the solid influence on the air transport services provided via airlines. Result of this situation was massive demand decreasing in the processing remaining summer and winter scheduling period for the years 2001 and 2002. Because of these negative influences have not a consequence in loosing of historical precedence of airlines, it was necessary to determinate exactly conditions. These conditions gave exceptions to airlines, it was about allowance of retaining of historical slots and status in spite of these slots have not been used for at least 80% but less than 80%. It was exception for the retaining of historical precedence for the summer scheduling season 2002 and the winter scheduling season 2002/2003 and airlines should retain only the same slots they have in the previous equivalent season.

The next similar regulation was number 1554/2003, which was also arrangement to help airlines, because of decreasing of demand for air transport and avoid massive loses of historical precedence. This time was reason for regulation adoption and bad market situation begging of war in Iraqi on March 2003 and subsequent political progress. There was one another reason and that was outbreak of the Severe Acute Respiratory Syndrome (SARS) which also have seriously affected the air transport operations of air carriers and have triggered a significant reduction in demand in the beginning of the summer scheduling season 2003. Exceptions have been granted for air carriers for the slots for the summer scheduling period 2003.

The last one of the regulations is number 95/93, which have been accepted because of negative impact of the global economic and financial crisis have been seriously affecting the activities of air carriers. It has led to a significant reduction in air traffic over the winter 2008/2009 scheduling period. The summer 2009 scheduling period will also be affected by that economic crisis. For the purpose of Article 10(2), coordinators shall accept that air carriers are entitled to the series of slots for the summer 2010 scheduling period that were allocated to them at the start of the summer 2009 scheduling period in accordance with this Regulation.

5. Conclusion

To summarize first allocation priority is adequate to claim, that this priority is very profitable especially for air carriers with the stable and longstanding tradition at the coordinated airports. All of the regulations and arrangements are accommodating only to airlines with the historical precedence and in the case of need they try to change them to that way that it is also granted airline historical status and also airline satisfaction.

This could be a problem on the other side where are air carriers without historical precedence and they have limited access to coordinated airports and also attractive airports for them. Remembered regulations for exceptions in 80% usage rule are almost always reasons of complains of airlines without historical precedence. Because under the first priority are at the most of airports allocated more than 80% of airport slots. This is reason of lots of arguments about that airport slots allocation system is not fair and historical precedence is too protected.

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Different Approaches to Determine Level Crossing Protection

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Abstract. Some countries of the world use special criteria to determine the measure of impact of different accident-causing factors (i.e. accident mechanisms) on a particular level crossing. Based on quantified value of hazard rate, perhaps even predicted accident consequences, they choose the appropriate level crossing protection. The techniques used by different countries reflect differences between the principal safety management approaches and the nature of the risks of level crossings that are considered within the specific approach at once. In the paper a brief summary of these approaches, their main common features and further specification are dealt. Applying of several specific approaches to risk analysis and consecutive determination of the appropriate degree of level crossing protection on selected Slovak level crossings is presented within the case study. As the conclusion there the achieved results of applying of these methods are confronted and their applicability in Slovak conditions is assessed.

Keywords: Accident, consequences, hazard, level crossing, risk analysis, traffic moment.

1. Introduction

By 2010 register The Slovak Railways (ŽSR) in the area of Slovak Republic the total number of level crossings (LCs) 2220. From these LCs remain 1144 without any active signaling and 1056 LCs are interlocked with a level crossing signalling system [1]. The form of LC protection is determined by decision of ŽSR with cooperation of state administration and traffic police.

In contrast to some countries of the world, in Slovakia there is no universal model according to which the total risk of all Slovak LCs could be calculated and no software tool for these purposes was developed by now. The considered factors that contribute for total risk score on a LC are only traffic moment (the product of rail and road traffic volumes), railway track category, type of the road, sighting factors and local relations, which are also the LC protection determining criteria. Upgrading the present degree of protection is assessed by the number of accident events on the LC and the road traffic volume. These criteria are relatively simple and do not involve many other factors that could contribute to occurrence of an accident.

The main aim of this paper is to prepare a summary of available models to analyze the risk of occurring an accident on a LC that are used by other countries in the world and assessment of possibility of using some in Slovak conditions.

2. General introduction to risk task

Defining the system safety requirements and following safety assessment has to start from a risk analysis [2]. The risk analysis process mostly supposes realization of following steps [3], [4]:

1. Definition of the system. It is necessary to define the system integration in operation conditions, its role in the operation control process, interface between this system and related processes and other conditions if appropriate.
2. Hazard identification. Hazards that could occur for a period of the whole lifecycle are identified.

3. Consequence analysis. This analysis contains an assessment of most probable consequences after hazard supervenes. It is important to identify the consequences separately for every hazard in dependence on a specific operational situation. The consequence of an accident can be a fatality or deadly injured person, damaging the environment or loss of property.
4. Calculation of the total risk. Based on the information about hazard rates and consequences the total risk connected to the analyzed process control is determined.
5. Determining the tolerable hazard rate (THR) according to the risk acceptance criteria. These criteria are ordered by the legislation requirements on national or European standard.

3. Methods to determine level crossing protection

On the present there are 23 different LC risk analysis approaches that have their origin in 12 different countries [5]. Single methods could be classified to four categories according to the type of algorithm used and their complexity:

1. Parameter Gate (PG).
2. Simple Weighted Factor (SWF).
3. Complex Weighted Factor (CWF).
4. Statistically Driven Approach (SDA).

The recent state of their development and area of their usage differs.

3.1. Parameter gate

PG approaches are using simple parameters as decision guides for the selection of appropriate levels of protection. There is no risk prediction by these approaches. The common attribute of these approaches is the considering of traffic moment as a main accident-influencing factor. The type of protection is determined either by the value of traffic moment or by extended traffic volume by other parameters values (e.g. overall LC closure time in 24 hours, number of accidents, maximum line speed, visibility, presence of barriers, etc.) According to the traffic moment value the type of protection in India (approach Train Vehicle Unit) and Russia (approach Rail and Road Intensity Matrix) is assessed. The approaches used in Japan (Closed Road Traffic Indicator, Level Crossing Danger Index), Spain (Crossing Categorizing Criteria) and Sweden (Factors to Determine Crossing Protection) belong to the more complicated PG approaches that consider more accident-influencing factors.

3.2. Simple weighted factor

Building on PG, these models provide some indication of relative risk contribution of each parameter using simple defined weightings. The approaches symbolically combine parameters that are figured in different dimensions with other parameters that have qualitative nature and assign them numeral values according to their impact on accident occurrence. The approaches combine the factors using matrixes (Australian approaches: Risk Based Scoring System, Australian Level Crossing Assessment Model), simple formulas (approach used in New Zealand: Product Assessment), or in form of tables, in which the consequence values are obtained from particular event trees and the probability of collision is estimated according to the product of rail traffic volume and the overall time of passing through the LC area by LC users (Northern Ireland approach: Risk Assessment and Investment Appraisal).

3.3. Complex weighted factor

CWF use more complicated derivation for weightings of parameters than SWF. The typical sign of these approaches is a fact that they combine a huge amount of different parameters (sometimes more than 200) and usually are in the form of single-purposed software tools. Some approaches define the structure of factors relations and causal connections according to different LC and user types. These models provide a lot of output information. Based on specific consequences they compute the risk of a particular LC and compare it with the value of average risk for the specific type of LC. Next kind of output information can be an individual risk and the number of equivalent fatalities per year. Such methods are used in Ireland (Level Crossing Prioritization Tool, Network Wide Risk Model), Spain (Failure Modes and Effects Analysis) and in Great Britain (Automatic Level Crossing Model, All Level Crossings Risk Model). To CWF also belongs a British simulation method Event Window Model that simulates the in- and out-comings of trains and vehicles in stochastic times using Monte Carlo method and estimates human errors impact by HEART analysis (Human Error Analysis and Reliability Assessment).

3.4. Statistically driven approaches

In contrast to other approaches, the SDA models are based around statistical techniques to derive weightings (often empirical power relationships) for parameters. The algorithms of some methods compute predicted number of collisions using binomial distribution of the stochastic variable (collision is supposed as a stochastic feature) and historical accident data. To this category belong Canadian methods Collision Prediction Model a GradeX. A different model (Australia's RAAILc) uses Bayesian Belief Networks to calculate the risk, in which the nodes represent factors that influence the accidents on LCs. Approaches that use filling weighted parameters and historical data in simple formulae are used in New Zealand (Accident Prediction Model) and in USA (Accident Prediction Formula). More complicated SDA modes that contain new technology investment assessment are used in USA (GradeDEC.NET) and in Great Britain (Cost-Benefit Analysis Junction Model).

4. Case study

4.1. Model level crossings properties

For the different methods presentation purposes I determined following input conditions (Tab. 1.):

LC type and its abbreviation / LC parameters	V_D - rail traffic volume (in 7:00 - 18:00) [-]	V_T - rail traffic volume (in 24 hours) [-]	V_R - road traffic volume (in 24 hours) [-]	M_S - max. line speed [km/h]	M_T - number of main tracks [-]	H_P - LC on highway [-]
Automatic half barrier - AHB1	6	10	400	160	1	no
Automatic half barrier - AHB2	12	20	400	160	2	no

Tab. 1. Parameters of the model level crossings AHB1 and AHB2.

4.2. Applying a method from PG category on model level crossings

As an example of usage of a method from PG category I introduce the Indian method Train Vehicle Unit (*TVU*). Numerical value of the parameter *TVU* according to (1) is identical with the value of traffic moment.

$$TVU = V_R \times V_T \,. \tag{1}$$

By applying the formula on the model LCs conditions in Tab. 1 value of *TVU* for the level crossing AHB1 equals to 4000 and for AHB2 it equals to 8000. According to the Indian level crossing protection assessment criteria [5] could AHB1 stay unprotected and AHB2 could be equipped only by manually controlled barriers.

4.3. Applying a method from SWF category on model level crossings

For the purposes of showing an example of using method from the SWF category I present a method that is used in New Zealand – the Product Assessment (*PA*). Value of *PA* is computed according to (2). V_F is view factor (range 1 for crossings with automatic warning to 3 for poor sightings) and H_F is hazard factor (1 for single track, 2 for double track).

$$PA = (2.V_D + V_T) \times V_R \times V_F \times H_F \, . \tag{2}$$

By applying the formula on the model LCs conditions in Tab. 1 value of *PA* for the level crossing AHB1 equals to 48000 and for AHB2 it equals to 192000. According to the criteria [5] could level crossing AHB1 stay equipped only by warning lights and AHB2 has an optimal degree of protection.

4.4. Applying a method from SDA category on model level crossings

As an example of usage of a method from SDA category I present the method Accident Prediction Formula (APF) that is used in USA. Parameter *k* is crossing constant and is 0.00057 for crossings equipped with barriers, H_P is information if the LC is situated on a highway and H_L is the number of highway lanes.

$$APF = k \times V_D \times V_T \times V_R \times M_T \times M_S \times H_P \times H_L \, . \tag{3}$$

After calculation of all the weighted parameters according to [6] and applying the formula on the model LCs conditions is the value of *APF* for the level crossing AHB1 equal 0.02251 and the value of AHB2 is 0.03622, that corresponds to an interval of values, in which is the present degree of protection for both level crossings optimal.

5. Conclusion

By comparing the results of applying different methods on level crossings with the same parameters I draw conclusions that some countries are more tolerant to high values of traffic parameters than others and besides have low degree of level crossing protection. According to reached outputs of all the three applied methods can be in general deduced that for the purposes of Slovak level crossings risk assessment and protection determining is the SDA method the most proper.

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The Risk Analysis for Slovak Road Tunnels

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Abstract: This paper deals with the analysis of technical conditions TP x/xxxx about risk analysis in Slovak road tunnels [1] (onward named technical conditions). The initiative for formation of technical conditions was the creation of unified methodology for analysis of safety risks of road tunnels in terms of the directive of European Parliament and Council 2004/54/EC and consecutive Slovak government regulation no.344/2006. Technical conditions define the minimum safety requirements for tunnels in road system. For a purpose of risk examination there is a risk model designed in technical conditions. The considerable part of technical conditions is concerning the evaluation of results of risk analysis of road tunnels.
Keywords: technical conditions, a road tunnel, a risk analysis, a risk model, event tree,

1. Introduction

After a series of accidents in Alpine tunnels, a group of experts started to engage intensively in the safety of road tunnels. This group analyzed the safety in tunnels and all the related aspects. They identified four categories of aspects (the user, the traffic, the infrastructure and the vehicles) which have impact on the safety and for each of them there were set specific arrangements for the rise of safety. It was a long journey which led to the creation of unified European directive and its starting point was so called White Paper [2] or European Transport Policy to 2010. In it there was emphasized the need to create the unified European directive for harmonization of the minimum degree of facilities and operation of road tunnels. The result was of the directive of European Parliament and Council 2004/54/EC [3] focused on securing the high level of safety for the road users in the tunnels of European road network. It is applied to tunnels with the length of 500 meters and more [4]. European Legislation was implemented in Slovakia in form of Slovak government regulation no.344/2006 [5] from 24th of May 2006. This regulation strictly copies the directive 2004/54/ES and defines the incidence of the road tunnels with the length of 500 meters and more on express highways, motor highways and 1st class roads in the stage of operation, construction or projection. By this regulation, the incidence of regulation is extended and applicable not only on the tunnels in trans-European road network in Slovakia (fig. 1).

The subject of technical conditions is the creation of unified methodology for risk analysis of safety of road tunnels in terms of Slovak government regulation no.344/2006. For a purpose of risk examination there is the risk model designed in technical conditions. The risk model for risk analysis of Slovak road tunnels was elaborated according to Austrian model for risk analysis of tunnels, TuRisMo, presented in RVS 09.03.11 [6]

2. Elaboration and range of applicability of technical conditions

Technical conditions are not replacing any previously issued regulation. Austrian standard RVS 09.03.11, according to which technical conditions were elaborated, evaluated 477 extraordinary events which happened during the years 1999 and 2003 in 470 Austrian tunnels. This solved the problem of lack of statistical data needed for creation of model for risk analysis. Statistical data are needed for reliable estimations of probability of occurrence of the extraordinary event in tunnel. These probabilities are the key for probabilistic approach of qualitative appraisal. Method of qualitative appraisal examines the scenarios of events of system in logical sequence. This results in its main advantages which are transparency, repeatability of procedures and controllability.

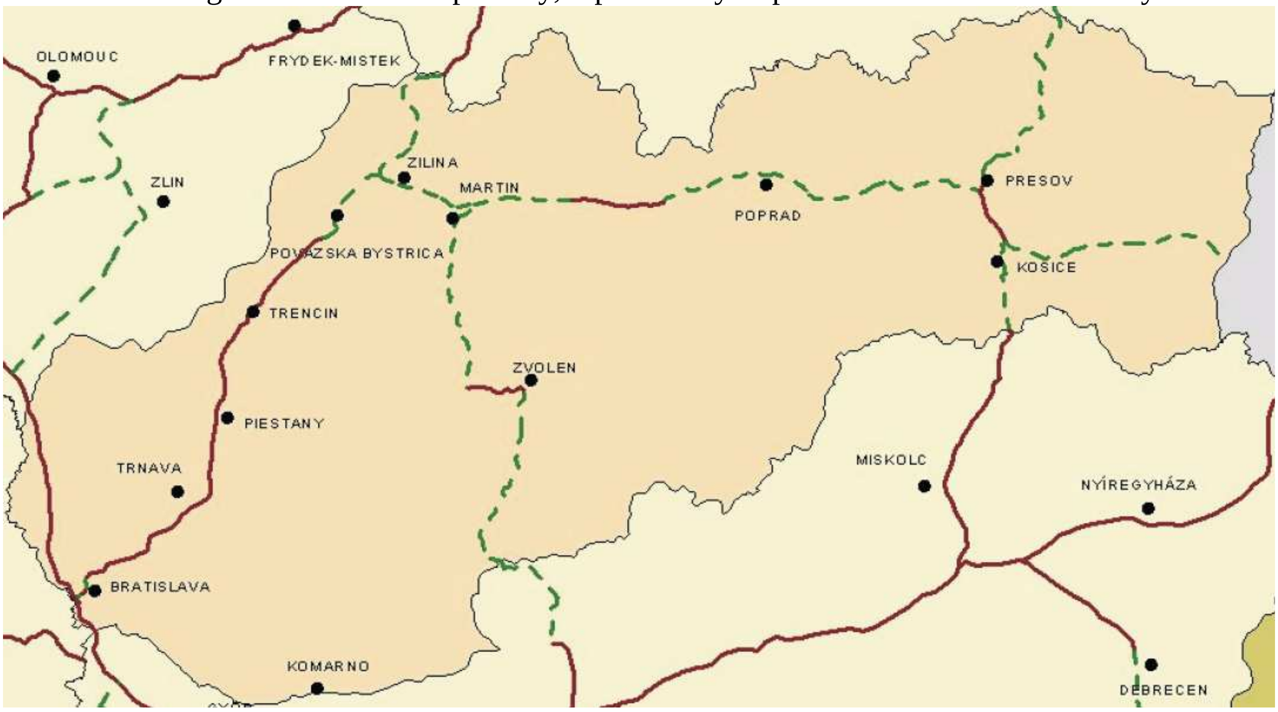

Fig. 1. Trans-European road network in Slovakia

While we think of an accident as a node point between the conditions of formation and consequences, we can graphically illustrate the safety of tunnel complex by the Bow Tie Model. (fig. 2).

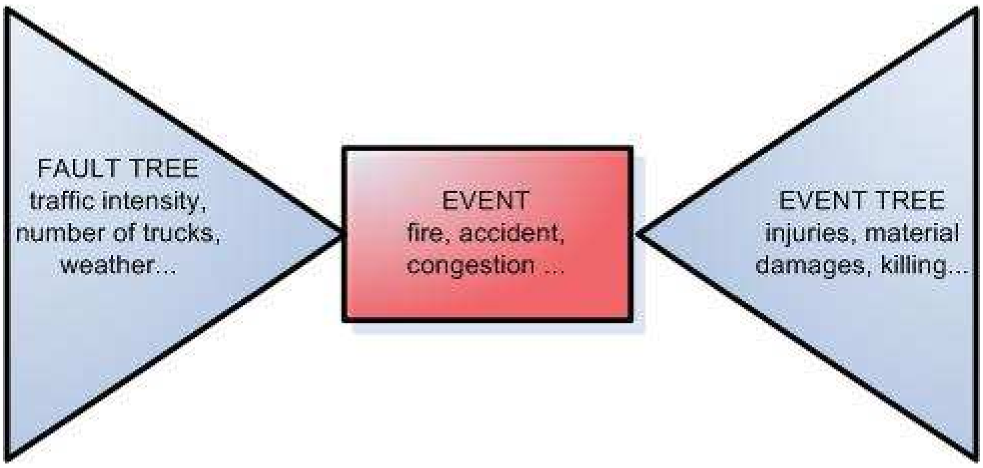

Fig. 2. Bow Tie Model

Both sides of the model contain activities for influencing the events before and after their formation. That means on the left side attention should be given to prevention before the accident, on the other side lessening and elimination of consequences is important.

Austrian directive deals with the question of formation of accidents (fig 2. – left side of Bow Tie Model), but does not handle at all their consequences (fig 2. – right side of Bow Tie Model), or handles only their rough estimates. Especially because of not dealing with the question of consequences of accidents, we could consider this directive as insufficient.

Tunnel risk model serves as methodological base for quantitative determination of risk parameters of road tunnels. The function of tunnel risk model is the creation of unified methodological basis which allows evaluating risk parameters of tunnel in comparison with the reference parameters of other tunnels. As the strategic model and strategy of evaluation are mutually connected, the document contains also suggestions for evaluation of model results.

Realization of quantitative, systematic risk analysis represents only one step in the evaluation of technical safety of road tunnels which include following steps:

-Specific analysis of danger:
Qualitative control of safety with systematic evaluation of all relevant safety-technical parameters of the road tunnel. It serves for identification of specific risk aspects and special characteristics of tunnel and also as a background for stating input data of risk model.

-Evaluation of safety based on safety-technical authoritative Slovak/international directives:
(e.g. 2004/54/ES, Slovak government regulation no. 344/2006 et cetera.) Minimum requirements of national and international standards must be adhered. By means of risk model discrepancies may be quantitatively reviewed in terms of their impact on risk.

-Risk analysis and evaluation of risk:
Quantitative application of risk model and possible realization of next steps of risk analysis for deeper examination of special questions (e.g. transport of dangerous material) including setting potential and additional safety precautions

-Precautionary documentation:
Elaboration of precautionary documentation in terms of requirements of Slovak government regulation no. 344/2006

3. Model of risk analysis

Model of risk analysis and all used parameters refer solely to accidents involving damage to persons. Statistical value of risk for groups of users of tunnel is being determined. Effects of dangerous cargo are examined only with extremely simplified model.

Methodology consists of two following components:

- quantitative analysis of multiplicity
- quantitative analysis of consequences of accidents

With basic risk analysis we may express expected value of risk as multiplication of analysis of multiplicity and analysis of consequences of accidents.

3.1. Analysis of multiplicity

By event tree analysis we can calculate multiplicities for set of defined scenarios of damage. Based on initiatory event which multiplicity was known, several stages of different possible sequences of events which lead to different scenarios of damage were constructed. Scenarios of damage vary in type of event, involved vehicles, caused damage, et cetera.

3.2. Analysis of consequences of accidents

By analysis of consequences of accidents there are estimated consequences of accidents for every scenario of damage:

In accidents with mechanical damage. (without fire and effects of dangerous cargo) based on assessment of accidents in the tunnel with impaired persons, which occurred in the Austrian road tunnels- adaptation level of accidents in Slovak conditions, according to the Slovak statistical data from the period 2000 to 2009.

In accidents with fire are consequences estimated based on model estimation of damage extend. By means of one-dimensional model of smoke spreading can be calculated distribution of temperatures and concentration of harmful substances after fire in tunnel, taking into account ventilation of tunnel. According to a simulation model of evacuation are simulated escape movements of affected users of tunnel within the frame of individual escape, taking into account stopping vehicles, conditions of infrastructure, etc. and they are combined with the results of model of smoke spreading. In the model of damage range there are shown all the factors of influence which affect time sequence of events from the beginning of fire (e.g. fire size, development of fire, ventilation system and its operation, detection and alarming, reactions of effected people, escape movements, distance of emergency exits, mutual delay, etc.)

Accidents, which contain dangerous cargo are taken into consideration only in simplified model.

4. Conclusion

Technical conditions about risk analysis in Slovak road tunnels are not replacing or completing any previously issued regulation in Slovakia. From this point of view, we can consider them an asset. Given the technical conditions were elaborated based on Austrian directive RVS 09.03.11, it would be necessary to examine an adaptation to Slovak circumstances. Here we come to a problem of small set of statistical data of extraordinary events in tunnels, as Slovakia is young country considering the road tunnels.

Technical conditions deal mainly with question of creation of accidents, but practically do not deal with the question of consequences. Also, the model of smoke spreading during the accidents with fire is one-dimensional. Actual standard is two-dimensional model. Risks connected to dangerous cargo are in the model of risk analysis stated only in general form. That is why their examination requires the usage of other methods.

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Supercharge Influence in Engines on Harmful Substances Emission of Vehicles in Real Operating Conditions

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Abstract. The permanent technological progress of construction materials, fuels and lubricating oils results in continuous internal combustion engines evolution. The development of the combustion engines tends towards reducing the toxicity of the exhaust gases, reducing fuel consumption and increasing the power obtained from one dm^3 of the engine displacement. Moreover the reduction of the engine total mass, the assurance of reliability in wide range of operating conditions and extension of durability are expected. Nowadays, because of the menace to the natural environment and to the human beings, the toxic emission reduction is the key issue. One of the possible manners of reducing exhaust gas toxic compounds is the application of supercharging. In the paper results of the comparative test of the exhaust emission are presented. Two engines of similar construction were examined, but the first one was equipped with turbocharger and the second one was a naturally-aspirated engine. Similarly, two combustion engines in comparable vehicles were tested, however one of them was supercharged. Test were made under road operating conditions of the vehicle.

Keywords: emission, supercharged SI engines, supercharged CI engines, road tests.

1. Introduction

Until recently the use of supercharging in gasoline engines was very rare. These were usually designed for propelling sports cars, where the possibly high operational parameters were essential. These engines had a short life, and the issue of toxic compound emissions was not considered. The present development of combustion engines is implemented with the downsizing idea consisting in decreasing the combustion engine displacement and at the same time maintaining the high operational parameters, i.e. torque and power. This activity is aimed at obtaining higher general engine capacity, with the simultaneous decrease of fuel consumption. The assumed direction of combustion engine development is achieved among others with the use of supercharging systems. The possibility of using supercharging systems in gasoline engines, in particular in those, where turbochargers are used, is tightly connected with the technological and material advancement of the production of those devices. The issues related to the construction and production technology of the turbocharger turbine are particularly important. In the developmental works much attention is paid to this component, because the turbine of the gasoline engine is particularly exposed to high temperatures of exhaust gases.

The supercharging systems in combustion engines with a turbocharger have better results than the systems using other supercharging devices because the power needed to compress the charge comes directly from the exhaust gases issued from the exhaust passage and not from the crankshaft. This fact becomes significant in the case of smaller displacement gasoline engines.

Literature [1, 4, 5] indicates a positive effect of the supercharging of combustion engines on the lowered emissions of the harmful compounds contained in exhaust gases. It applies in particular to self-ignition engines. On the other hand, the effects of supercharging on the gasoline engine and its effects on the emission parameters of the vehicles propelled with gasoline engines in the actual operating conditions have not yet been discussed. The purpose of the test conducted was to determine the effect of the use of supercharging system both in gasoline and combustion engine on the green characteristics of the vehicle in real operating conditions.

2. Testing Methodology

In order to assess the effect of supercharging of the gasoline engine on the emissions of harmful compounds in exhaust gases, the emissions characteristics of two Fiat Bravo vehicles were measured. The tests were conducted on vehicles with the same body, chassis and drive train structures. The vehicles were propelled by gasoline engines with the displacement of 1383 cm^3, equipped with MPI type fuel supply systems and three-way catalytic reactors. The engines of the vehicles under testing differ with the effective horsepower value, which results from the use of a supercharging system with a turbocharger in one of them, called "T-jet”. An internal combustion-engine Ford Fiesta with no supercharging and an internal combustion-engine Ford Idea equipped with turbocharger constituted the other pair of vehicles tested. The characteristics of the vehicles are presented in the table below (Tab.1).

Car Engine	Fiat Bravo Dynamic 1.4 16V	Fiat Bravo Dynamic 1.4 T-Jet 16V	Ford Fiesta 1.8D	Fiat Idea 1.3 JTD
				
Number of cylinders	4	4	4	4
Number of valves per cylinder	4	4	2	4
Displacement	1368 cm^3	1368 cm^3	1753 cm^3	1251 cm^3
Compression ratio	11,0	9,8	21,5	18,0
Maximum power	66 kW	88 kW	44 kW	50 kW
Maximum torque	128 Nm	206 Nm	105 Nm	180 Nm
Fuel supply system	MPI	MPI	The system with a pump distributor	Common Rail
Emission standard	Euro 4	Euro 4	Euro 2	Euro 4
Fuel	Gasoline	Gasoline	Diesel oil	Diesel oil

Tab. 1. Engine specifications of the test vehicles

Emission tests were conducted in road conditions on a determined route, identical for all the vehicles under testing. The route included metropolitan area in the agglomeration of Poznan and led through the streets surrounding the Lake of Malta. When planning the experiment, the variation of urban traffic conditions was considered in order to ensure higher credibility of results. Therefore, the emission measurements in the urban area route were taken in two passages for each of the vehicles tested.

The testing of emission characteristics of the vehicle consisted in measuring the concentration of exhaust emissions (CO, HC, NO_x and CO_2) and fuel consumption, and then the emission of exhaust emissions contained in the exhaust gases was determined on the basis of the mass exhaust gas concentration data. The SEMTECH mobile analyzer of toxicity from SENSORS Inc. was used to measure the concentration of toxic compounds (Fig. 1). To measure the mass exhaust gas flow the mass exhaust gas flow rate probe was used (Fig. 2). The data can be entered into the central unit of the analyzer by sending them directly from the vehicle's diagnostics system and by using the GPS positioning signal [2, 3].

Fig. 1. Mobile exhaust gas analyzer SEMTECH DS.

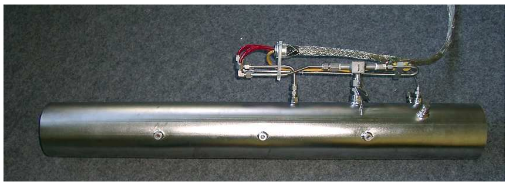

Fig. 2. Mass exhaust gas flow rate probe.

3. Emission test results in real conditions

Using a mobile measurement system of harmful compounds the concentration of CO, HC, NO_x, CO_2 in exhaust gases was measured during the test conducted on a designated route. The data regarding engine operating parameters registered during the passages, obtained from the EOBD central unit allowed for the creation of time density distribution graphs of the parameters measured: emission of carbon dioxides CO_2, carbon monooxide CO, hydrocarbons HC, nitrogen oxides NO_x, for selected vehicles. The performed measurements enabled to determine value of the individual compound emission as well as fuel consumption for comparable road passages (segments). The results for the particular passages are presented in graphs (Fig. 3–6).

Spark ignition engines

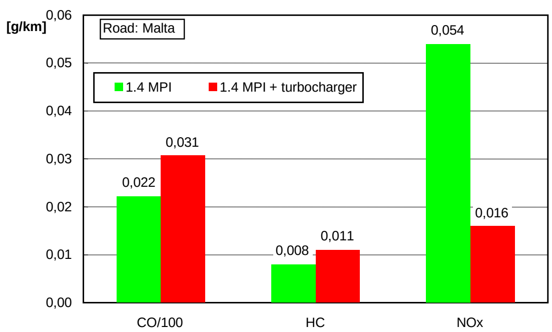

Fig. 3. Exhaust emissions comparison of the real road conditions.

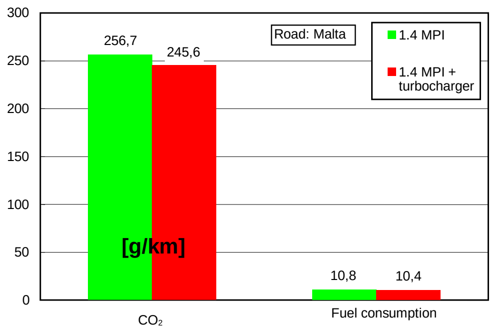

Fig. 5. Comparison of the volume CO_2 of emissions and fuel consumption of the tested engines.

Compression ignition engines

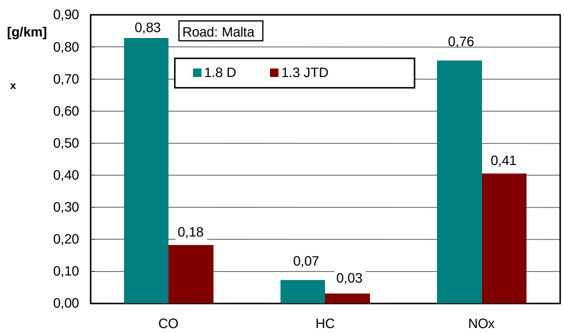

Fig. 4. Exhaust emissions comparison of the real road conditions.

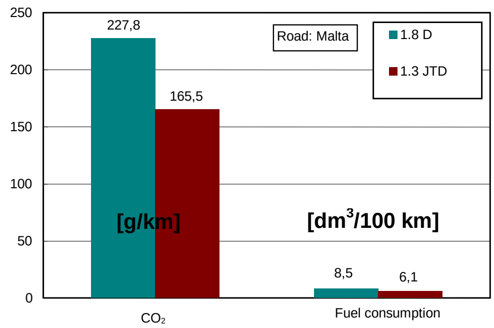

Fig. 6. Comparison of the volume CO_2 of emissions and fuel consumption of the tested engines.

Comparing the total emission values of the particular compounds from the entire passage and fuel consumption (Fig. 3 and Fig. 5), it can be concluded that the supercharged gasoline engine used for propelling the vehicle is characterized by a 40% higher carbon oxide emission, 37% higher hydrocarbons emission, 70% lower nitrogen oxide emission as well as lower emission of carbon dioxide and a lower mileage-related fuel consumption by 4%.

While comparing the total emission values of the particular compounds from the entire passage and the fuel consumption in internal combustion-engine vehicles (Fig.4 and Fig.6), it can be concluded that the combustion engine used for propelling the vehicle is characterized by 79% lower carbon oxide emission, 58% lower hydrocarbons emission, 46% lower nitrogen oxide emission as well as lower emission of carbon dioxide and a lower mileage-related fuel consumption by 28%.

4. Conclusion

Estimation of the supercharge influence in gasoline engine on the operational parameter change and on the ecological properties of the vehicle in real operating conditions can be obtained by examining two similar vehicles of almost identical engine construction but different supercharge system. The obtained results corroborate purposefulness of using supercharging systems. Application of supercharging systems with turbocharger in gasoline engines designed for propelling vehicles contributes to change of the overall characteristic of the engines. These changes enable to shift engine operating points to a low rotational speed range of the engine crankshaft as well as to a higher load range. It results in improvement of an overall engine efficiency which translates to a reduced fuel consumption value and a lower carbon dioxide emission. Availability of the high torque value in a wide speed range of crankshaft makes it possible to load the engine when the rotational speed is low. It is of special significance for city circulation associated with a vehicle frequent moving and acceleration. Moreover the engine exertion results in a higher value of the exhaust system temperature having a beneficial influence on the efficiency of catalyst reactor.

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The Influence of EGR on Exhaust Emissions in a CI DI Engine

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Abstract. The paper presents exhaust emissions variability due to different EGR mass supply to a CI DI engine. Tests were carried out with a one-cylinder research engine AVL 5804 equipped with an electro-magnetic injector produced by Bosch. Additionally, for the purpose of this analysis an EGR system was designed and further applied in the tests.

Keywords: EGR system, direct injection, compression ignition (CI), emissions

1. Introduction

Automotive companies have made great efforts toward producing vehicles with internal combustion engines that emit minimal amounts of toxic compounds so as to ensure more effective exhaust reduction. The EGR (Exhaust Gas Recirculation) system represents one of such means. The EGR system consists of an electronic valve, located in the exhaust manifold through which part of the exhaust escaping from the engine returns to the engine combustion chamber. The application of the EGR system reduces emissions of NO_x and emissions of unburned hydrocarbons HC.

To ensure the proper operation of the exhaust gas recirculation system it is necessary to supply an appropriate exhaust charge that returns to the combustion chamber to take part in the combustion process. The size of the exhaust charge denpends on many factors such as: the engine load, engine speed, temperature, engine coolant, temperature and the air charge ssucked by the intake manifold. On the basis of data gathered from these factors, the EGR valve opens to induce exhaust gas recirculation. CI engines can recirculate up to 50% of exhaust with temperature up to 450 ° C.

2. Teststand

The influence of EGR valve opening parameters on the level of the toxic exhaust emissions was evaluated on the basis of tests. For the purpose of the tests a compression ignition research engine with direct injection was fueled by means of an external Common Rail system [2]. (tab. 1). It is a one-cylinder engine AVL 5804 with a 4-valve cylinder head, 2 camshafts and a separate control system for stabilizing the temperature of the lubricating oil and the cooling liquid.

Tab. 1. Engine characteristics AVL 5804 [1].

Lp.	Quantity	Unit	AVL 5804
1	i	[–]	1
2	$S \times D$	[mm × mm]	90 × 85
3	V_c	[dm^3]	0,5107
4	n_{max}	[rpm]	4200
5	ε	[–]	19,9
6	p_e	[bar]	12,2
7	$N_{e\ max}$	[kW]	16 at 4000 rpm
8	$M_{o\ max}$	[N·m]	56 at 2000 rpm
9	g_e	[g/(kW·h)]	251 at $M_{o\ max}$

The electro-magnetic injector Bosch 0 445 110 131 000 was located centrally in the axis of the cylinder. The engine was coupled with a generator brake. The test apparatus is illustrated in fig.1, whereas fig.2 shows the injector, cylinder head and piston.

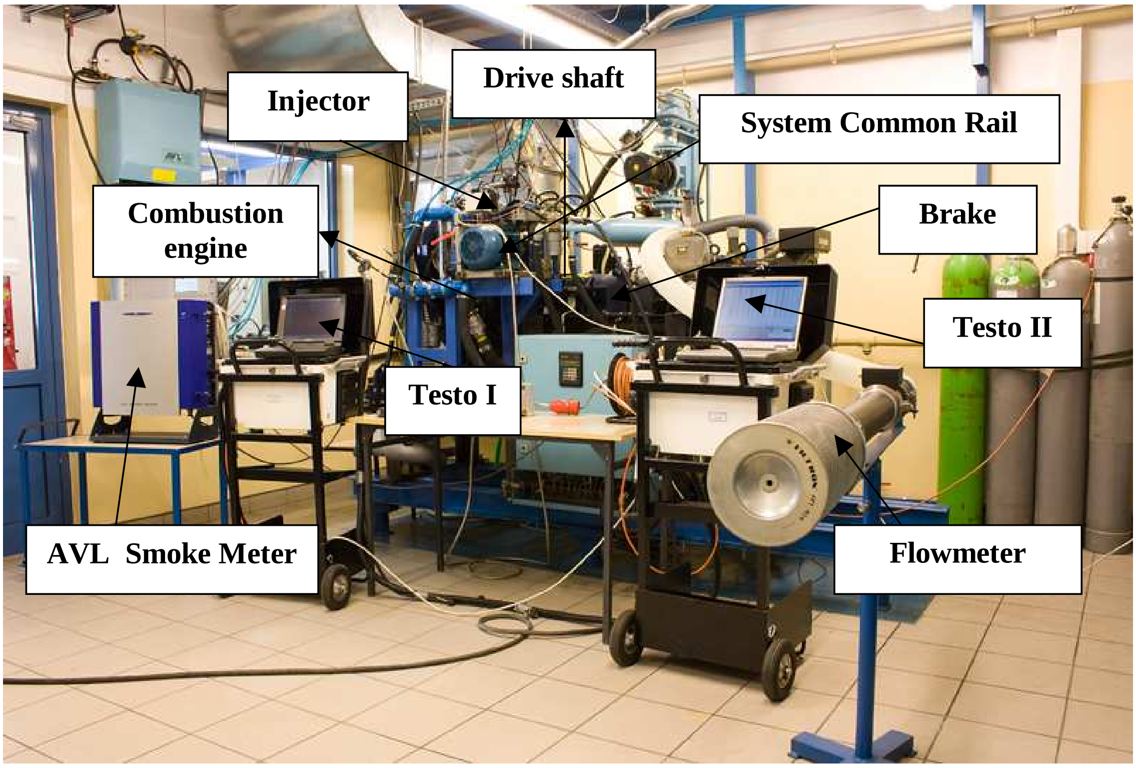

Fig. 1. Teststand

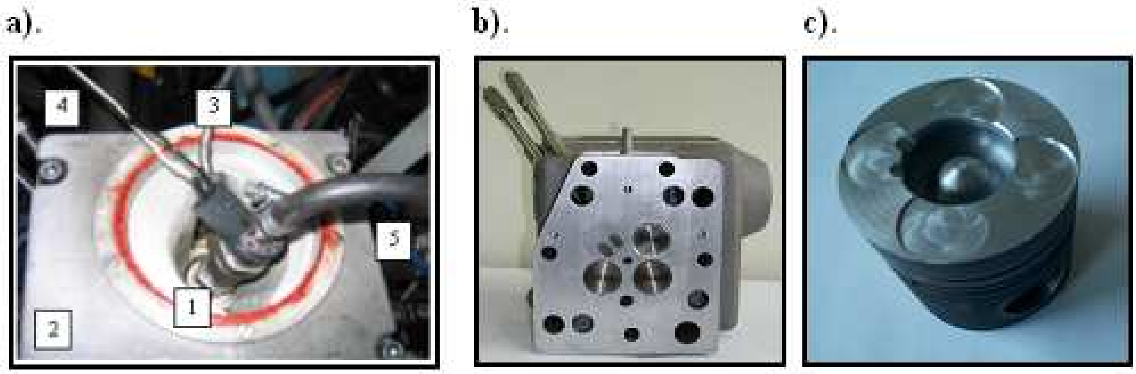

Fig. 2. a). The electro-magnetic injector on the cylinder head: 1 –injector, 2 –valve cover, 3 – injcetion line, 4 – supply lines, 5 – fuel overflow line, **b).** cylinder head, **c).** piston of the research engine AVL 5804 [1].

3. The analysis of the test results

The analysis of the influence of EGR variability on NO_x, CO, HC emissions and FSN is based on tests carried out on a teststand created for the purpose of this research and presented in fig.3. The tests were carried out at engine speed n = 1400 [rpm], constant pressure in the accumulator p=120 [MPa]. During the tests the engine speed increaded from 0 to 20 [Nm], toxic compounds emissions were recorded with measuring apparatus such as Testo I, Testo II and AVL Smoke Meter. The emissions were measured at different EGR valve opening parameters.

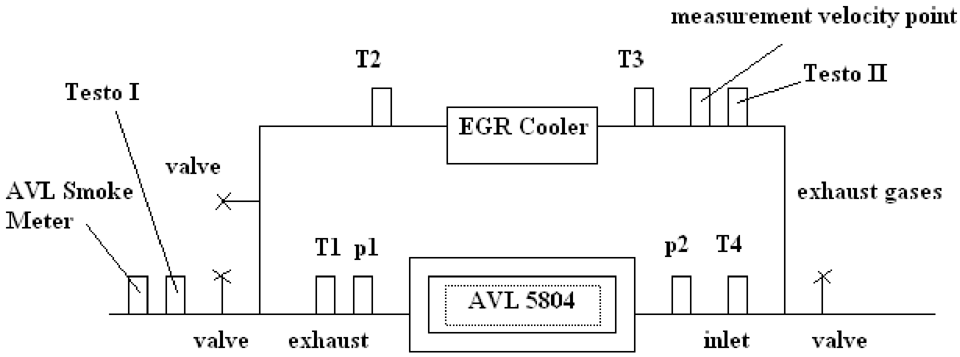

Fig. 3. The EGR system in the teststand.

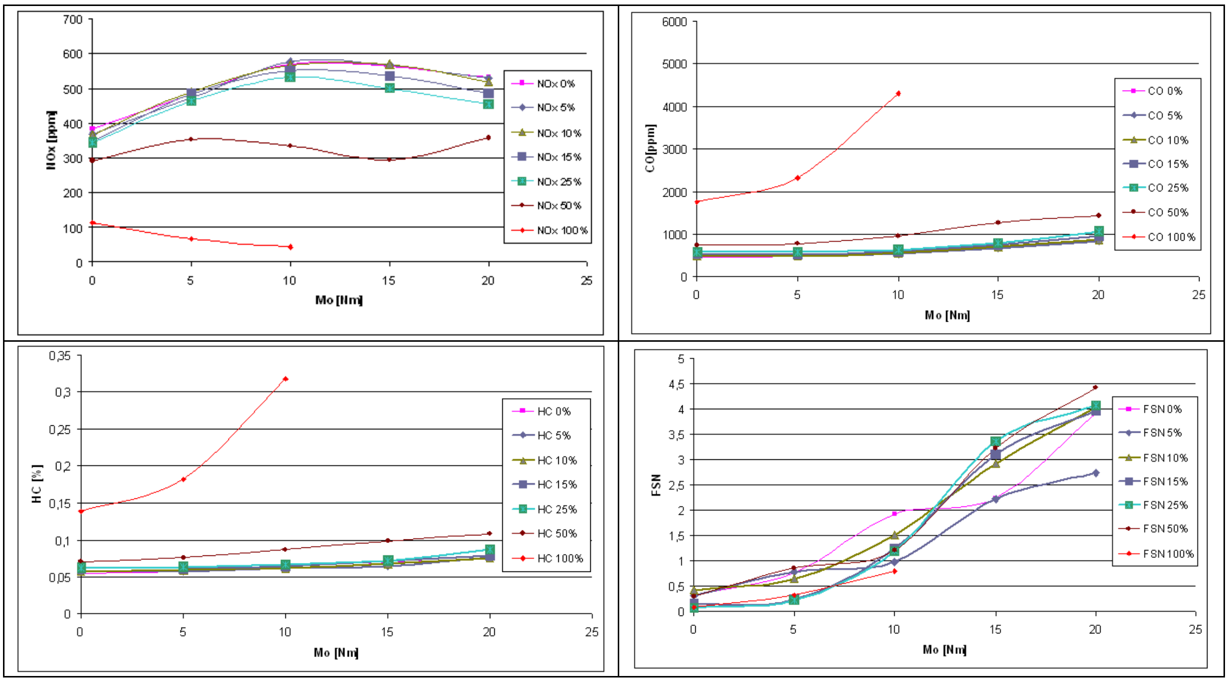

Fig. 4. The influence of EGR variability in valve opening parameters on NO_x, CO, HC, CO_2 emissions and FSN for TESTO I.

In order to evaluate the influence of EGR valve opening parameters on toxic emissions, the results of tests were analyzed. Both emissions and opacity were taken into account. On the basis of the characteristics presented above, it can be concluded that the EGR valve opening parameters exert a great impact on emissions. Whereas NO_x decreased, CO, HC as well as FSN rised. It has to be noted that after the EGR valve opened completely, it was impossible to measure the torque due to a global shortage of oxygen. The influence of EGR valve opening variability on toxic exhaust emissions for Testo I and AVL Smoke Meter was illustrated in fig.4.

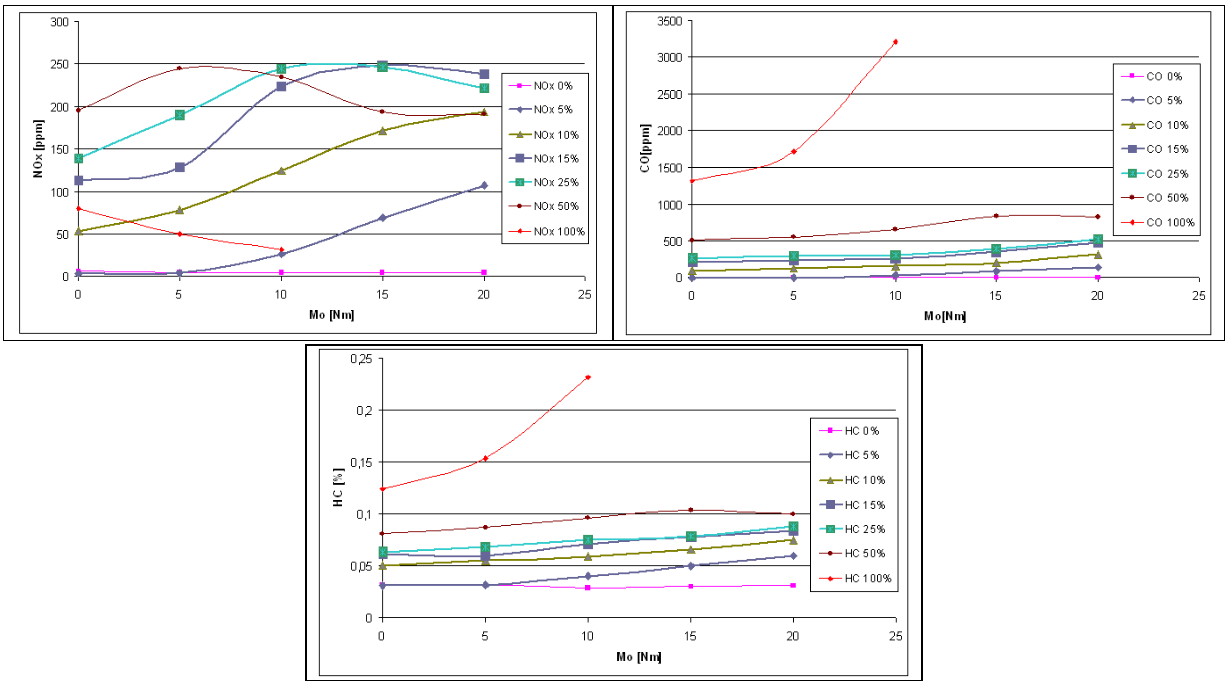

Fig. 5. The influence of EGR valve opening variability on NO_x, CO, HC, CO_2 emissions and FSN for Testo II.

NO_x, CO, HC, CO_2 emissions and FSN characteristics for Testo II are similar to those for Testo I. Although NO_x emissions decreased with wider and wider EGR valve opening, they were significantly lower than in the case of Testo 1. As to CO, HC emissions at the full EGR valve opening, they dramatically rose. Additionally, a global shortage of oxygen was noticed and therefore it was impossible to carry out the tests at the full range of torque. The influence of the EGR valve opening variability on emissions for Testo II is presented in fig.5.

4. Conclusions

The EGR system is applied in engines in order to reduce NO_x emissions by means of lowering the temperature of combustion. The temperature becomes lowered due to the increase of the fuel charge heat capacity. The heat capacity can rise if the air-fuel charge becomes mixed with a volume of additional factor that has higher heat capacity. As the result of dilluting the air-fuel charge with a volume of exhaust, the combustion prolongs and HC, CO emissions a well as FSN rise due to the flame die down on the cylinder walls. In conclusion, the EGR system helps to reduce NO_x emissions at the cost of higher emissions of compounds resulted from the incomplete combustion.

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The Comparison of the On-Road Emission of Carbon Dioxide from Diesel Engines with the Emission Obtained in the NEDC Test

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Abstract. The paper presents differences between the values of carbon dioxide emissions obtained for passenger vehicles in the European homologation procedures and the emission of carbon dioxide obtained in an on-road tests. The paper also shows the results of the on-road fuel consumption tests (a tests performed in the city cycle). The results were compared with the ones obtained in the homologation emission tests (NEDC). The paper compares the results of the on-road tests with the technical specifications provided by the vehicle manufacturers. The calculated emission of carbon dioxide and fuel consumption have been analyzed. The tests were performed under traffic conditions in the city of Poznań. The test objects were vehicles fitted with diesel engines. For the tests the authors used a portable exhaust emission analyzer – SEMTECH-DS by Sensors Inc.

Keywords: road tests, NEDC homologation test, CO_2 emissions, fuel consumption

1. Introduction

Each newly manufactured vehicle has to obtain a homologation certificate in order for the vehicle to be legally operated on the road. One of the criteria taken into account during the homologation tests is its impact on the natural environment. In order for a vehicle to successfully pass the tests it has to fulfill certain standards, set forth by various world organizations responsible for environment protection. In Europe for the vehicle of GVW below 3500 kg a driving test known as NEDC (New European Driving Cycle) applies [1].

Because of a certain procedure of the NEDC performance, which only to a limited extent reflects the regular operating conditions of vehicles, the test results obtained during the measurements may differ from those obtained outside the laboratory i.e. in the on-road tests. Hence, the aim of the tests was to perform on-road measurements and define the differences between the CO_2 emissions and the fuel consumption.

2. Research Objects and Measuring Equipment

Several vehicle models have been tested for exhaust emissions and fuel consumption (different makes and segments; table 1). All vehicles were fitted with diesel engines of the capacity of 1.8–2.4 dm^3. The engines were mostly 4-cylinder in a straight (in-line) configuration operating with 6-speed transmissions. This is currently a frequently applied configuration of the vehicle powertrain in passenger vehicles. The tested vehicles complied with different emission standards (from Euro 2, through the latest Euro 5).

Parameter	D1 car	D2 car	D3 car	D4 car	D5 car
	Ford Fiesta	Opel Vectra	BMW 320d	Toyota Rav4	Alfa Romeo 159
Engine type	CI, 4-cylinder in-line	CI, 4-cylinder in-line	CI, 4-cylinder in-line	CI, 4-cylinder in-line	CI, 5-cylinder in-line
Displacement [cm^3]	1753	1910	1995	2231	2387
Max. power [kW]/[KM] (@ [rpm])	44/60 (3750)	88/120 (3500)	119/163 (4000)	110/150 (3600)	147/200 (2000)
Max. torque [N·m] (@ [rpm])	130 (2200)	280 (2000–2750)	340 (2000)	340 (2000–2800)	400 (2000)
Emission standard	Euro 2	Euro 3	Euro 4	Euro 5	Euro 5
Transmission	manual, 5 gear	manual, 6 gear	manual, 6 gear	manual, 6 gear	automatic, 6 gear
Weight [kg]	1015	1620	1490	1590	1725

Tab. 1. Technical specifications of the vehicles

The emission of carbon dioxide and fuel consumption from the individual vehicles during the on-road tests was obtained through measuring of the individual concentration of the exhaust components during the test-drives in the city of Poznań. The route was designed so as to reflect, to the highest possible extent the average traffic conditions in the city of Poznań. The route was of the distance of 12 km and covered an urban and extra urban road portion (a part of the route was a two lane expressway).

Fig. 1. Example test vehicles with the measuring devices fitted

In order to measure the fuel consumption by individual vehicles a portable exhaust emission analyzer was used (fig. 1). This device – SEMTECH-DS by Sensors Inc. is composed of a set of analyzers (designed for determining of the gas content of exhaust components including CO_2), exhaust mass flow meter (of different diameter depending on the engine capacity exhaust mass flow) and a module enabling the connection of the system to the vehicle OBD (On-Board Diagnostics) and GPS (Global Positioning System) [2].

3. Comparative Analysis of the Test Results

The comparative measurements of the emission of carbon dioxide and fuel consumption were performed several times while repeating the test drives. Each time the fuel consumption was measured (given in dm^3/100 km; fig. 2b) along with carbon dioxide concentration in the exhaust gases. The obtained results of the CO_2 measurement constituted the basis for the calculation of the on-road emission (given in g/km; fig. 2a).

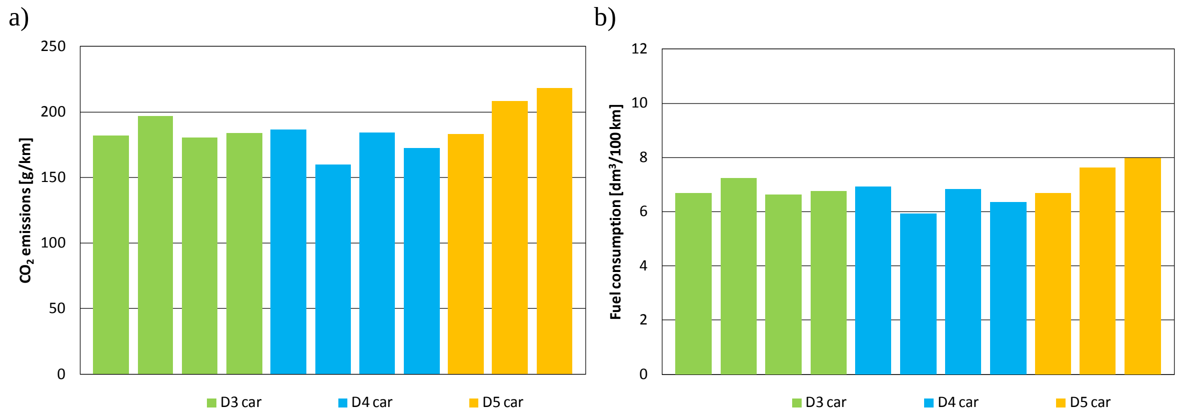

Fig. 2. The test results (for selected vehicles): a) CO_2 emissions, b) fuel consumption

In order to perform the analysis that is the essence of this paper the calculated values of carbon dioxide and fuel consumption were averaged from several test drives on the designated route (fig. 3). Only these averaged values were then compared with the values of these same parameters (CO_2 emissions and fuel consumption) obtained in the homologation procedure (homologation tests).

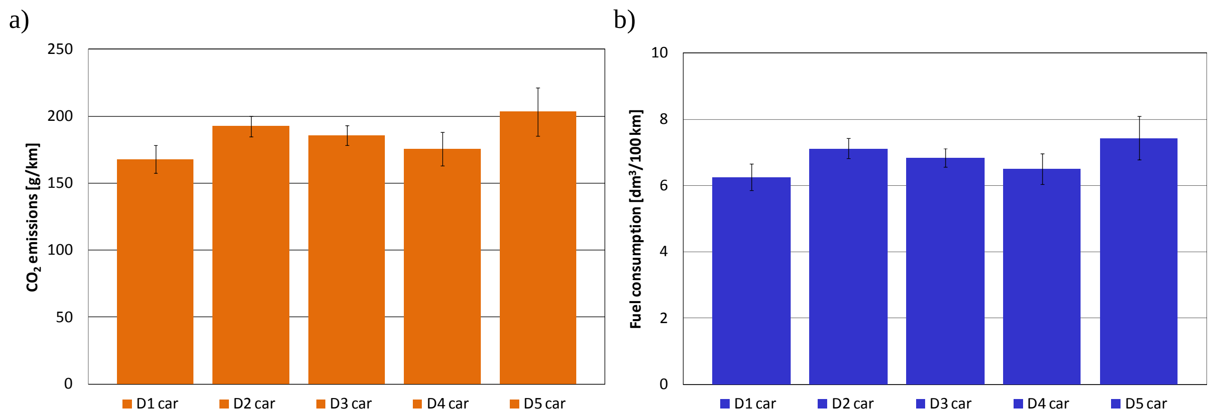

Fig. 3. Averaged values (measurement uncertainty marked): a) CO_2 emissions, b) fuel consumption

The average fuel consumption obtained in the on-road tests was compared with the homologation values for two test cycles of the NEDC test and the whole test (mixed cycle; table 2). The average carbon dioxide emissions from the vehicles (on-road tests) were compared with the values obtained in the whole NEDC test (average value from UDC and EUDC).

Car	**CO_2 emissions**			**Fuel consumption**				
	Catalogue data [g/km]	Measurement results [g/km]	Difference compared with the catalogue data [%]	Catalogue data [dm^3/100 km] extra-urban cycle	urban cycle	mixed cycle	Measurement results [dm^3/100 km]	Difference compared with the mixed cycle [%]
D1	169	168	–0.7	4.9	6.5	5.7	6.3	9.7
D2	195	193	–1.3	4.8	7.5	5.8	7.1	22.8
D3	140	186	32.8	4.4	6.8	5.3	6.8	29.0
D4	159	176	10.5	5.2	7.0	6.5	6.5	0.1
D5	208	203	–2.4	5.4	9.2	6.8	7.4	9.4

Tab. 2. Catalogue data compared with the measurement results

The emission of carbon dioxide from the whole NEDC test measured on the chassis dynamometer and (for the purpose of this paper) under traffic conditions are different (fig. 4a). The greatest differences have been observed for vehicles D3 and D4. The emission of CO_2 from these vehicles – D3 and D4 was greater by approximately 30% and 10% respectively than that given in the technical specifications (obtained in the homologation tests). The emissions of other vehicles (carbon dioxide) measured in the real traffic conditions are similar to those measured in the laboratory conditions.

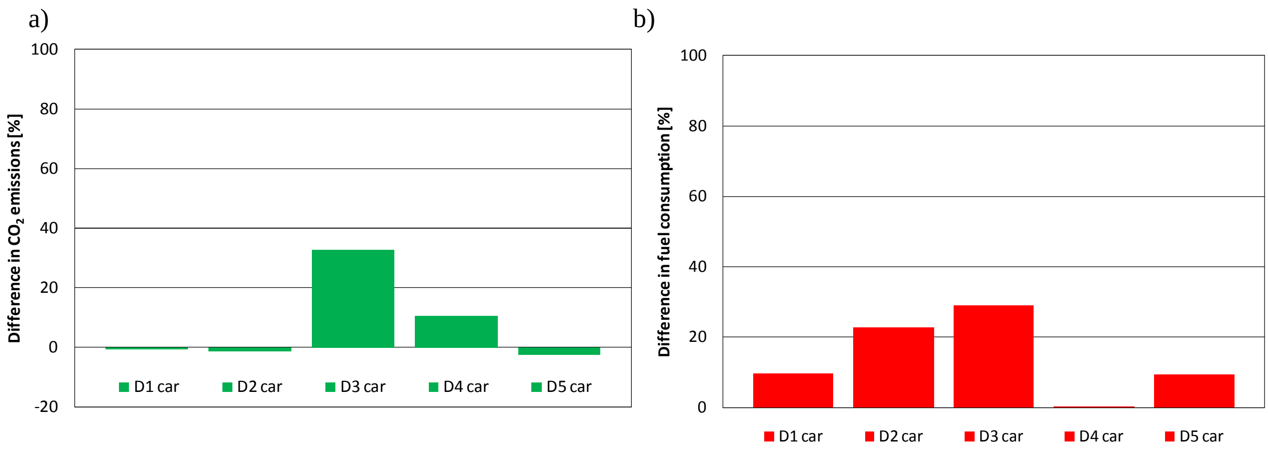

Fig. 4. Percentage difference: a) CO_2 emissions, b) fuel consumption

As for the fuel consumption, for individual vehicles, in most cases, it is much higher under real traffic conditions than it results from the laboratory NEDC tests. The percentage difference for this parameter is within the range of approximately 10% to 30% (fig. 4b).

4. Conclusions

In light of the here presented test results it is justified to state that the values of the emission of carbon dioxide and fuel consumption in the on-road tests are much different from those specified in the technical specifications provided by the manufacturer – as obtained in the homologation tests. This results from different (much more difficult) traffic conditions of the operated vehicles (particularly city driving). During the on-road tests much greater traffic congestion occurred than that estimated in the New European Driving Cycle.

Much more difficult vehicle driving conditions denote a longer time of engine operation under variable states, which largely influences the fuel consumption. This is confirmed by its higher values for individual vehicles under real traffic conditions of characteristics (also dynamically changing characteristics) slightly different than those of NEDC.

Having the above in mind we can state that the costs of operation of a vehicle (those related to the costs of fuel) will, in most cases, be higher than those calculated based on the data provided by the manufacturer. Yet, the homologation data are still helpful – a regular vehicle user can still select a vehicle that suits his individual needs based on the comparative data of vehicles of the same class without the necessity to use a specialized measurement equipment.

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Identification of the Movement of Goods in the Logistics Chain

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Abstract. The thesis deals with one of the basic functions of the logistics information system, and so to monitor the flows of material in the enterprise. This requires effective and coherent identification of items in the production and circulation. The best way to get in the business to ensure a perfect overview of the movement of material, is the use of any of the systems of automatic identification.

Keywords: information flow, automatic identification, barcode, RFID technology

1. Introduction

Logistics ensures the availability of the goods, the delivery of the goods to the right place, at the right time, quantity, quality and at reasonable cost. In the development of logistics chains, i.e. in the coordination, linking and optimization of material flows from the place of production to the place of consumption should be to ensure a wide range of activities. In particular the activities related to the shipment, packaging, material handling, warehousing, customer service and the flow of information. All logistics activities more or less affect the logistics process as a whole.

2. Basic technology of automatic identification systems

Fundamental importance for innovation in information flows consists in identifying the exact product whether raw or semi-finished products ready for sale or consumption and, secondly, in identifying their movements between different points in any one of the logistics chain. For identifying, in industrialised countries used already quite a long time the code systems and automatic identification of the goods.

According to physical principles are divided into of optical systems, radio frequency systems, inductive technology, magnetic technology, voice technologies, biometric technologies.

The most widespread technology currently are optical systems, barcode and radio frequency technologies.

3. Optical technology

Optical technology uses light, the reflection of light sensitive sensors shooting followed by decoding. In the category of optical systems exist several technologies, from which the bar code is in the first place.

3.1. Bar code

The bar code is a unique identification code on the labels of the products, pallets or other elements. It has a standardized form of a combination of vertical lines of varying thickness, the resolution, and free space, that can be read by a scan/scanning using electronic sensors (scanning devices).

Symbol barcode consists of a number of lines and adjacent spaces. Symbolism in which the particular application used, depends on the nature of the data. The most widely used bar code symbologies including:

- EAN-8 ⇒ it used to designate small retail products for which there is not sufficient space for the barcode EAN 13
- EAN-13 ⇒ it is the most commonly used barcode. It is used to indicate the consumer's goods intended for sale to the ultimate consumer. It is also used to describe groups of packages or cardboard packaging.
- UPC-A, UPC-E ⇒ used in North America. As well as codes EAN-8 and EAN-13 is used for marking retail units.
- ITF-14 ⇒ is intended to denote the distribution and transport packaging.
- GS1-128 ⇒ it is used for marking transport units (pallets, crates, containers, etc.). In this type of code we can encode not only digits, but also the characters of the alphabet. Thanks this property we can also enter into a barcode with additional information about the carried unit. For example, the quantity of goods on pallets, weight, production date, batch, etc.
- GS1DataBar ⇒ they are intended to denote the small products, products with variable weight and bulk products. They have been developed specifically for those types of products for which it was not possible to use the codes EAN/UPC but it was necessary to identify them because of the automatic scan feature.

Fig. 1. Bar code ITF-14 (left) and GS1-128 (right).

3.2. Technology RFID

RFID (Radio Frequency Identification) is a contactless identification designed to transmit and store information using electromagnetic waves with frequencies ranging from long waves to microwaves. To store and transmit information used chip, placed on a plastic backing, coupled with a spiral antenna, with which it communicates with its surroundings. Electronic Product Code EPC is number encoded in electronic form and stored in the storage medium - a chip, which consists of 4 parts. The first part is the header, which defines the kind of numbers encoded by the GS1 System. The second part is the EPC Manager - number of the manufacturer of the goods. The third part is the type of product from the producer. The fourth part is serial number, which identifies a specific product and it allows to find all the associated data, e.g. use-by date, the date of filling, etc. Next there is a sensor with antenna and software equipment.

The most often we meet with the deployment of RFID in logistics. This is one of the first areas where the automatic identification was used. Proper handling, storage, packaging and delivery of products to a large extent decide on the success of many companies. RFID helps to track the movement of goods, pallets and containers throughout the distribution chain. Packages may contain RFID chips placed directly in a plastic housing or pressed into the normal self-adhesive labels. The chips contain a number of useful information as product identification for the needs of customers in retail chains, identification of the product for the needs of stock records, date of production, the quantity of goods, etc. [1]

Fig. 2. RFID chip and RFID chip as a self adhesive label.

Depending on the field of application and the tasks to be performed, a distinction is made between more or less high-performance systems. These are characterized as follows [1]:

- Location of the reader:
  - mobile,
  - stationary.
- Transponder construction:
  - smart labels,
  - plastic or glass containers/tubes,
  - card transponder – contactless chip cards,
  - resilient metal transponders,
  - plastic disks.
- Typical frequency ranges/fields of application:
  - low-frequency 125 through 134 KHz (animal identification, vehicle immobilizers, chip cards),
  - high-frequency 13,56 MHz (access systems, container identification, theft surveillance, package, mail and baggage logistics),
  - ultra-high-frequency 433, 868 or 915 MHz (automation, production logistics, goods tracking and identification),
  - microwave 2,45 or 5,8 GHz (tracking/identification of goods, containers and packages, electronic seals, toll systems, fleet management).

4. Comparing the advantages and disadvantages of each technology

Basic and simple comparison of RFID technology and bar code system is shown in Table 1.

Bar codes	RFID
Require direct line of sight for reading	They may be read or overwritten without direct visibility
They can be read only after one	Quantity of "tags " (hundreds) can be read simultaneously
Can not be read if they are soiled or damaged	They are able to work well in a rough and polluted environment
Can not be updated	Electronic information can be re-transcribed
Must be read manually, which brings the possibility of human error	They can be read automatically and so eliminate the possibility of error
Identify only the type of item	Can identify the specificities of the items

Tab. 1. Comparison of RFID technology and bar codes

The main advantages of RFID include high automation and digital collection of information, reduce errors and the possibility of multiple reading. There is no needed direct line of sight for reading and for writing. The medium is durable and variable.

Economic benefit of using RFID is a substantial improvement in the records of movements (such as persons, vehicles, goods, material etc.), further it's minimizing costs for labelling and relabeling, simplify the management and data exchange as well as greater precision in movement and easy inventory.

An advantage of using RFID technology uses also the automotive industry. For each car shall be affixed tag that contains the list of all operations, that the car must be implemented according to specified order. Unlike the central system is thus the process of assembling managed directly on the spot. The central system, however, continue to maintain the overall management and supervision of the process of assembling. To the tag is recorded also the current state assembly. This introduces the possibility of a smooth return of the car on the production line after repair of the problem that it has disposed of it. On the basis of this information, you can track the movement of each piece and backward during the whole process of production.

5. Conclusion

Not only in the retail trade, services, industry but also in the public procurement, production and distribution logistics, extending the scope that offer RFID technology. Offer greater efficiency monitoring and management of supply chains, whether in reducing inventory, optimize processes Just-in-time, in the monitoring of shipments, or in the monitoring of mechanical or weather impacts to the goods during transport.

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Model of an Aircraft Using MATLAB Simulink

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Abstract. This article describes simple mathematical model of an aircraft with its own autopilot, which provides movement along determined trajectory. This model is created in environment MATLAB Simulink.

Keywords: mathematical model, MATLAB Simulink, flight dynamic, body-fixed frame, Euler angles.

1. Introduction

This model is a simple prototype of a model of an aircraft for computer generated forces (CGF) for flight simulator. It is created in environment MATLAB Simulink, which gives many opportunities to the fine-tuning of the whole system.

The requirements to the model were given simply. The model should be able to move with respect to the flight kinematic to the given point and after its achievement it should move to another and so on.

The model consists of two parts. First part of the model manages the whole flight dynamic of the model and the second provides the "piloting" of the model, i.e. autopilot.

2. Flight dynamic model

Let us describe the basic principle of the mathematic model.

The model has got some parameters that determine the flight options of its own. For example maximal speed, maximal angle of inclination, the turning radius and so on. The parameters limited the values of the variables during the all calculations.

The whole model is based on to have the information where the flying object is and where it's directed in every single time step.

First we suppose that the model has got six degrees of freedom, namely the ability to move forward/backward, up/down, left/right (translation in three perpendicular axes) combined with rotation about three perpendicular axes (yaw, pitch, roll – also called Euler angles). In fact it isn't so. The aircraft fly only forward and the flight control is carried only through the Euler angles and its angular velocity.

Let the flying object has the body-fixed coordinate frame.

The flight dynamic equations [1] are given as

$$\begin{aligned} \frac{d\varphi}{dt} &= p + r \cdot \sin\varphi, \\ \frac{d\theta}{dt} &= q \cdot \cos\varphi - r \cdot \sin\varphi, \\ \frac{d\psi}{dt} &= \frac{q \cdot \sin\varphi + r \cdot \cos\varphi}{\cos\theta}. \end{aligned} \quad (1)$$

Where the body-fixed angular velocity is vector $[p,q,r]^T$ and $[\varphi,\theta,\psi]^T$ is the rate of change of the Euler angles vector.

After numerical integration of the system (1) we convert the Euler angles (φ, ψ, υ) to direction cosine matrix – DCM [2], which we multiply by vector of speed of this model. The vector has the form $[v_x, 0, 0]^T$, because it's obvious the way of powering of an aircraft. This vector we consequently integrate numerical and so we get not only actually Euler angles but also actually position of the model $[x, y, z]^T$.

To visualizing the model we use MATLAB Simulink 6DoF Animation block [2], but it's also possible to make own graphical environment.

3. The Guidance System

Now the model is able to move in an environment like an aircraft, but it still does not be able to check points, which it should range. This means that the model has got no "piloting". So in the next part we describe methods of guidance system of the model.

The model calculates in every step the distance of the object to the next checkpoint. If it is less than given value (the value of tolerance) model assess that the object ranges the check point and it's flying to the next one.

If the model is trying to hit the check point, it calculate the vector from the object to the check point and this is a reference angle. The difference between actually direction and reference angle are the reference values which are straight sent to the dynamical model as p and q. The last parameter r is calculated by relationships

$$\rho = \frac{{v_x}^2}{G \cdot \tan\varphi}, \qquad r = \frac{v_x}{\rho}. \tag{2}$$

The whole Guidance System logic is programmed in m-file StrikeTheTarget.m.

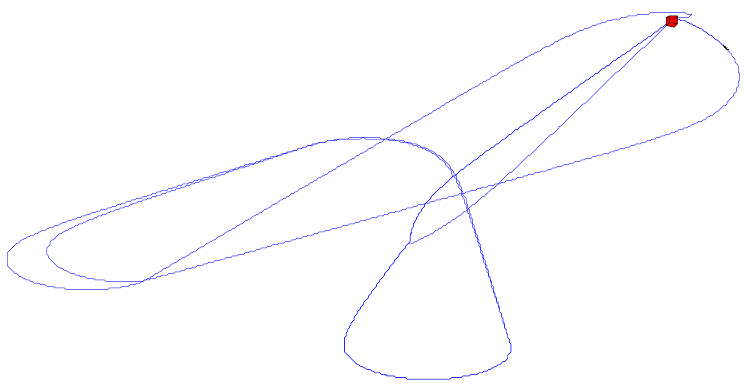

Fig. 1. The whole trajectory of the flying object.

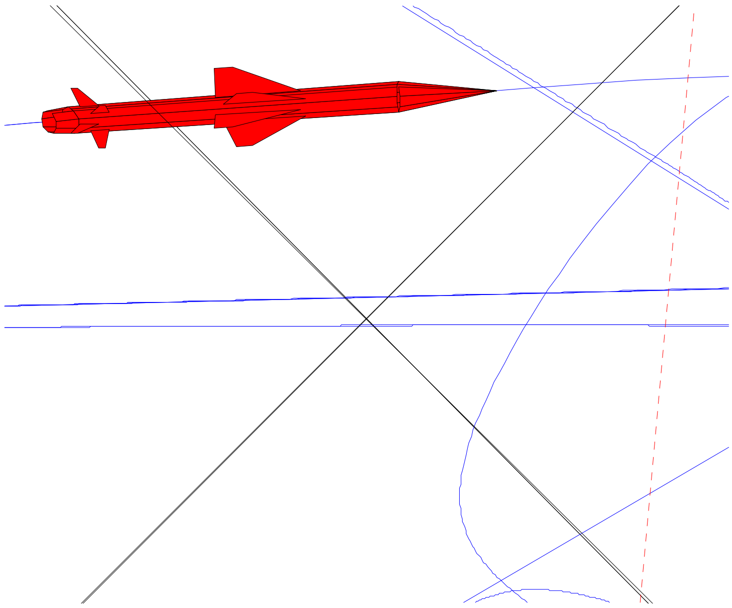

Fig. 2. The maquette of the flying object.

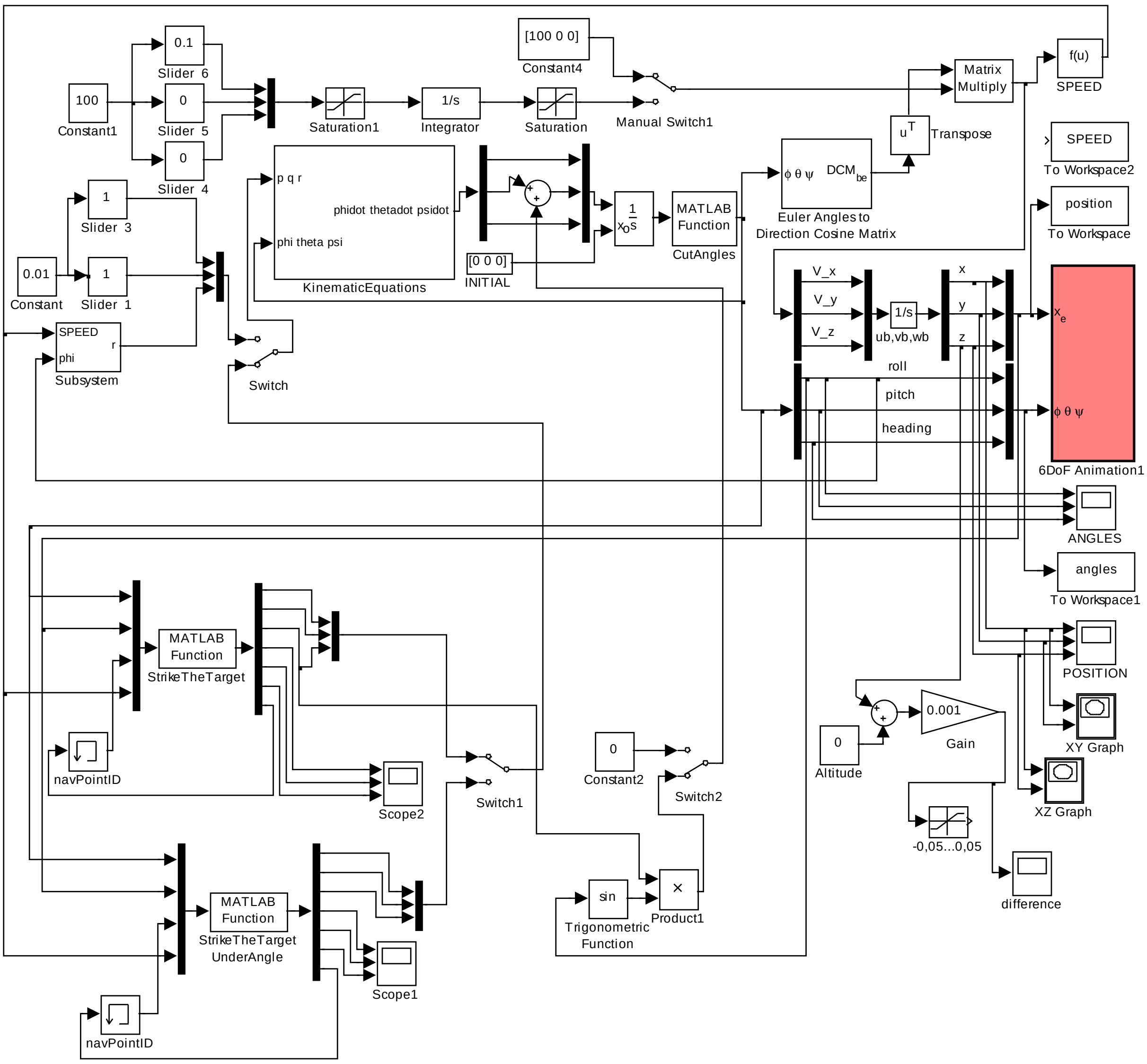

Fig 3. The whole Simulink model.

4. Conclusion

In this article we describe a mathematical model of flying object which is able to move in an environment like aircraft with its own guidance system. The model is based on the assumption that the object has its own body-fixed frame. The guidance system can manage the flying object like autopilot, so it can fly through a given trajectory, which is defined by the points.

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Passenger's Choice of Airport Access Mode and its Environmental Results

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Abstract. This paper deals with the problems of passenger intermodality and its impact on pollution and congestion. It is becoming necessary to determine factors influencing passengers decision making process before journey. This paper contains partial results of the analysis of passengers preferences in intermodal travel.

Keywords: airport access, passenger intermodality, congestion, environment

1. Introduction

The air transport is one of the fastest growing sectors of the world economy and one of the world's most important service industries. It plays major role in world economic activities. Many industrial and commercial activities are dependent on air transport and would not be able to work effectively without it.[1]

Environmental impact of transport modes is a growing issue, especially from the point of view of climate change and air pollution. That is why the air transport industry is facing the effects of increasing environmental pressure. On the other side, continual growth in demand is putting commercial pressures on airports to build new capacities, on airlines to carry more passengers. Environmental issues must be seen as one of the greatest challenges to the future activities of the air transport industry.

Environmental protection is one of the most important issues which airport management and regulators were dealing with. Transportation is the economic sector that is the highest consumer of energy in the European Union. Since 1985, the consumption of energy has increased by 47% compared to 4,4% for the other sectors. The most important categories of environmental costs include the noise, accidents, atmospheric pollution and changes in the climate. Important element in externals costs is congestion and congestion itself increases air pollution and CO_2 emissions. Roads are responsible for about 93% of total external costs in transportation. Rail is responsible for only about 1,6%. Air transportation has also a negative impact on global warming since the emission of gas in high altitude contributes to the green house effects. Airlines are also high energy consumers. For example, if airlines eliminated 10 daily flights, it would cause elimination about 6700tons of CO_2 in the air[2]. Environmental impacts have to be considered at global and local level. Global level means problems such as global warming and ozone depletion. Local level is represented by aircraft noise and airport local air quality.

1.1. The need for transport

The need for transport of air passengers, cargo, visitors and employees from the origin to the airport and from the airport to the destinations has been met in a number of ways- private or public transportation modes. Almost each European airport as well as airports in United States already has bus connection to the city centre. Using rail as an airport access mode choice is also worldwide popular. Public transport is an eco-friendly way to travel to and from the airport, using four times less energy per person transported than the automobile. Despite of this there is still a big portion of travellers using private modes of transport. A high quality rail service can attract people away from cars. Intermodality is one of the ways how to increase catchment area of the airport. It is also a way to offer more city linked services to a given airport. Understanding the passenger needs may help to make airport access more common.

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2. Helpful Hints

People choose the particular travel mode to and from the airport according to the level of attributes which are relevant in making the choice between available transport modes. The purpose of our survey was to determine and analyze passenger travel preferences on different travel modes. We designed the questionnaire of item scales in which individuals implicitly attach weights to a set of attributes that influence their choice. We used an internet survey tool and data were collected online. Passengers were asked to answer question about type of their journey, preferences and personal data useful for better analysis. Our target group was air travelers, rail travelers and, of course, potential travelers. The response rate has been 81 %. Our aim was to obtain information about passenger travel behavior, to understand the ranking of significant factors and compare values among various passenger profiles.

2.1. Questionnaire analyses

We had approximately the same representation of male than female travelers. According to our survey, 10,25% of travelers used airline more than 15 times in last 12 months. As much as 53% of all travelers travel by air on two occasions a year.

The proportion of passengers that have used one of the public transport modes before/after flying is about 50%. Taxi was used by about 20% of travelers. Other passengers used their own car, or were taken by friend or family member. Second part was aimed to identify the most relevant passengers travel preferences.

First question from the second part was aimed to passenger preferences and most important issues in the decision making process. Most important factor was rated number one, and the last one number 8.

ISSUE	RANKING	DISPERSION
Price	2.938	3.434
Service quality	5.125	2.359
Travel time	3.125	3.234
Security issues	4.688	3.84
Number of seats	6.625	4.109
Luggage	5.813	4.152
Number of transfers	4.313	3.215
Connection issues	3.375	5.359

Tab. 1.The most important issues

Most mentioned answer was price, followed by travel time and connection issues. Security issues, luggage and number of transfers were not the most quoted answers. Number of seats was not seen as a major barrier by significant group of respondents.

In the other question, respondents were asked to invest a percentage of ticket prices to improve level of intermodality. 28% of passengers would like to invest to the better customer care, and security. Other important issue is to minimize waiting time. Details can be found in the table below.

ISSUE	RANKING	DISPERSION
Better customer care	5.938	9.809
Security	5.5	7
Waiting time	4.438	4.121
Walking distances	5.5	6.25
Reliability	4	5
Transfers	5.063	7.059
Time spent in vehicle	4.625	2.859
Information services	5.625	6.609
Schedule	4.313	7.59

Tab. 2. How would respondent invest percentage of ticket price

Passengers answers to a question : What would motivate you to use one of the public transport modes rather than automobile on your trip to and from the airport, showed that common ticketing, punctuality/ reliability and improved scheduling are the most important factors from the passengers point of view. Passengers should choose one or more options from the list. According to this, we are able to specify local and global percentage. The local column takes into account only those respondents who chose that option, and therefore the total may not be 100%. Global percentages are calculated with respect to the total number of respondents.

ISSUE	LOCAL	GLOBAL
Reliability	75%	33.33%
Schedule	68.75%	30.56%
Minimum walking distances	62.5%	27.78%
Common ticketing	43.75%	19.44%
Comfort	31.25%	13.89%
In town check in	31.25%	13.89%
Prior check-in	25%	11.11%
Information services	18.75%	8.33%

Tab. 3. Passenger motivation to use public transport

3. Conclusion

Intermodality describes policy objective and a quality of the transport system. In freight transport, intermodality is being promoted with a number of initiatives passenger intermodality has not received the same attention yet. The fundamental importance of passenger intermodality is to provide a seamless journey. Therefore, the increase in passenger transport services, intermodal travel is strongly supported by public transport companies. In our opinion, intermodal travel will become more attractive from the passenger point of view, whereas the individual use of cars will become less attractive due to the increasing congestion of roads.

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Cooperation:

Slovak shipping and navigation companies, Slovak and foreign technical and transport universities

Experiences:

conducting of the EU and national projects

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Experimental Bench for Research of Interaction of Wheel and Rail

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Abstract. Designed and built full-scale test facility, which is based on a pair of friction "wheel-rail." Stand allows you to simulate the real conditions of contact wheels rolling with the rails under the influence of various external factors: the varying degrees of wear surfaces skating vertical load of 30 tons per axle, one- and two-point contact with the rail wheels, the presence of solid and liquid contaminants in the contact area. A distinctive feature of the stand is the ease and convenience of changing working samples of rail. Known about the effects of electric current and magnetic flux on the frictional properties of friction pair "wheel-rail." To detect the possibility of using this effect on the rolling stock test stand equipped with electrical current and magnetic flux in the contact zone.

Keywords: Booth, research, adhesion, pin, wheel, rail, transport.

1. Introduction

Efficiency of rail transport is largely determined by the traction as a locomotive, whose implementation depends on the interaction between the drive wheels of the locomotive to the rails. The largest of adhesion traction engine is defined [1] the known law:

$$F_{\hat{e}\ddot{e}} = G\psi\eta_{\grave{e}}\,, \qquad (1)$$

where ψ - the estimated coefficient adhesion between wheels and rails, reaching the maximum values of 0,3 ... 0,33 for a dry contact; η_u - static coefficient of coupling weight of the locomotive G.

Existing restrictions on the load driving wheels on the rails not to significantly increase the adhesion weight of the locomotive G. As a result, improving the design of the locomotives cartwright recently η_u ratio reached values close to 0,98 [2]. Thus, the main parameter influencing the increase of traction properties of the rolling friction coefficient is ψ, which depends on many internal and external factors, in particular, on the condition of friction surfaces of the locomotive driving wheels and rails.

To increase the coefficient of friction so far proposed a number of technical solutions. One of the first in the on-board were working to clean up tires wheels and rails from surface contamination, which can be mechanical, chemical, electric spark. Among more recent works include the cleaning of the roll surface pressure water, laser and plasma torch. Well-known ways to increase the coefficient of friction by acting on the contact area heated and air-foreign particles of high hardness, in particular quartz sand. Only the last of these methods is widely used on railways in the world. Other methods are characterized by lack of stability, complexity, high cost, etc. At the same time, the use of sand also has its drawbacks, which include a significant influence on the wear of wheels and rails, the pollution of the permanent way, and others. Therefore necessary to develop methods and systems for increasing ψ, based on new principles and provide the necessary state contacts in various operating conditions.

As part of the solution to this problem is proposed to influence the zone of contact wheel and rail electric current and magnetic flux. At the Department of Lokomotiv Bryansk State Technical University (BSTU) were conducted laboratory tests [3] the plane-crystal samples were tie-wheel and rail steel odnosharikovom tribometer, as well as in the experimental setup containing the wheel model as a disk. Typical oscillogram of the process when applying an electric current in the contact zone is shown in Fig. 1. Here the moment of switching current corresponds to point B. The results showed that the tested models wheel and rail by passing a current through their contact may increase the friction coefficient and ψ, respectively, the tangential traction f. more than doubled. In addition, experiments were conducted with the filing of the magnetic flux in the study contact, showed similar results.

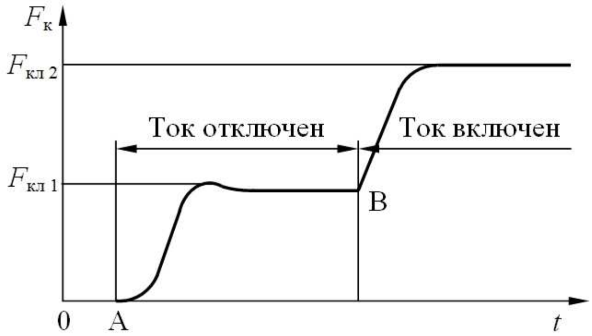

Fig. 1. Oscillogram of the process.

The main drawback of these studies is a significantly difference between the size and shape of spots modeling contacts from re-cial. It can not accurately assess the impact of consideration of external influences on the quality of the locomotive traction.

2. Test bench

To study the traction properties of railway rolling stock on the real contact spot in BSTU been designed and manufactured full-scale stand (Fig. 2), which is based on the tribological system that contains the wheel of the locomotive and the rail segment. A characteristic feature of this stand is that he is makes it possible to conduct studies of traction properties of railway vehicles according to the degree of wear surfaces, riding wheel and rail, as well as the supply to the zone of contact wheel and rail outside influences in the form of electric current and magnetic flux. In addition, the stand provided the formation of spots of the specified contact, whenever possible, the relative position wheel and rail at various conditions of contact for the degree of contamination.

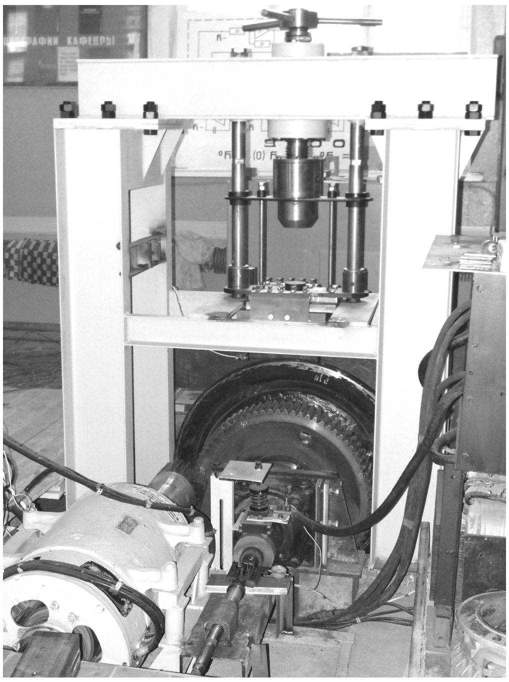

Fig. 2. Test bench.

Stand (Fig. 3) comprises a base 1, which establishes the support 2, 3, 4, 5, 6, and stands 7 and 8. In nests of supports 2, 3, 4, 5 base 1 fixed upper parts 9 and 10, planted on the axle 11-wheel vehicle 12. After the traction gear 13, intermediate shaft 14, mounted in a bearing knot 15 and the sleeve 16 wheels 12 is connected with the motor shaft 17. At the posts 7, 8 through beams 18 and 19 mounted mechanism vertical radial loading wheel containing the screw 20, nut 21, spring 22, bearing plates 23, 24, 25, fixed guide rods 26, 27, and thrust 28, 29. In this case, the screw 20 rests on bearings 30, 31. By supporting plate 25 is mounted roller bearing, operating on the principle of the flat bearing consisting of a fixed 32 and movable 33 rails between which set rollers 34 and sets the fixing of balls 35. Simulator track as a segment of rail 36 rigidly mounted on a movable guide 33 screw terminals 37, 38 and in contact with the wheel 12. In the longitudinal direction of a segment of rail 36 is fixed Diaphragm 39, established the universe on a beam 19 from the opposite direction of the rail segment and connected with them thrust 40.

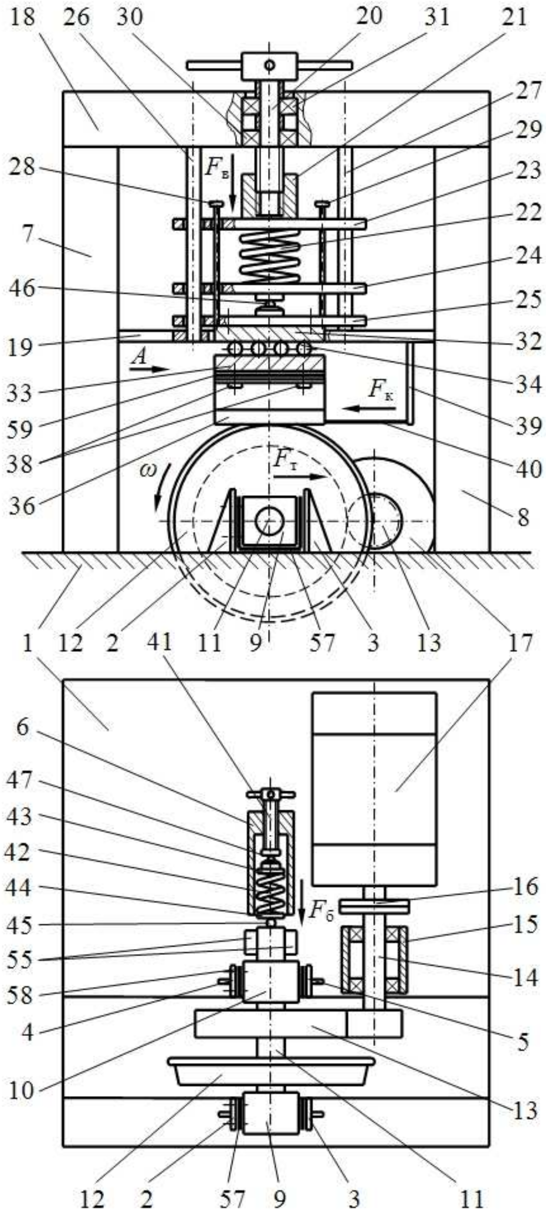

Fig. 3. General form of the test bench.

6 mounted on a support mechanism for the horizontal side-loading wheel, which contains a screw 41, spring 42, bearing cups 43, 44 and ball 45, resting in the end of the axis 11 wheel 12.

Measurement of the force FB vertical radial loading wheel 12 provides mesdozoy (sensor) 46, force F ± horizontal lateral load wheels - mesdozoy 47. In addition, the sensors are mounted on a spring plate 39 for measuring the tangential traction F., as well as on the supports 3 and 5 to measure the traction force FT on the center axis 11.

In order to study the effect of traction on the quality of same-leznodorozhnyh vehicles equipped with a magnetic flux stand magnetic circuit (in Fig. 2 not shown), which is mounted on a segment of rail 36. On the magnetic circuit is an electromagnetic coil connected by wires to a power source.

To study the effect on the quality of rail traction vehicles electric current stand is equipped with a current source, which is a single wire through the sliding contacts (brushes) 55 is connected to the wheel of 12 vehicles, and another wire is connected to a segment of rail 36. In this case, the wheel 12, a segment of rail 36 and sliding contacts 55 are provided with electrical insulation 57, 58, 59 from other elements of stand structure.

It is known [4], the contact wheel and rail can be both the two-nym, and a singleton and has a different location and shape depending on the transverse displacement of the wheelset and the angle of crowding during the movement. This leads to a different division of the contact points on the zone of slip and grip, and hence to different conditions of implementation of the traction qualities. For this reason, the stand provided (Fig. 2) the free movement of wheel 12 in relation to a segment of rail 36, covering all possible cases of contact formation.

In the operation of the running surface of rails and wheels wear out and change their shape, which also affects the contact patch wheel and rail. To simplify the replacement operation of the test samples of rails with varying degrees of wear of the rail segment 36 is located above the wheel 12 and secured with removable clamps 38 on roller bearings. It should be noted that the relatively small size and weight provide certain amenities in the preparation of samples for testing of rails and equipment them with the necessary sensors. On the stand also provides the possibility of replacing the wheel 12 together with the axis 11 by the dismantling of Books 9, 10, set in sockets supports 2 - 5 base 1.

3. Conclusion

Designed stand allows the study of traction qualities of railway vehicles, taking into account the external forces in the gearing of traction gear and wear surfaces, riding wheel and rail under all possible conditions of formation of spots of their contact. It provides opportunity to study the influence on the tribological condition of wheel and rail contacts the magnetic flux and electric current of different sizes and shapes, as well as the surge since the traction motor. In addition, the stand is simplified operation of replacing the test sections of rails, which reduces the time required to prepare an experiment. The stand has a considerable potential for further upgrades and improvements aimed at increasing the range of objectives of the study of processes occurring in contact with the rail wheels of the locomotive.

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Competence Based Pilot Training

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Abstract. Competence based training is rather a new phenomenon in civil aviation pilot training. This method starts to spread into aviation world as a new type of training and license called MPL (multi-crew pilot license). In EACEA´s Atlantis project AV-EDEN the Department of Air Transport works, together with Dowling College, New York, on best practices for aviation education and training. MPL as a new type of training fulfills the category of a best practice for future of aviation training. Because of this, the paper will try to bring closer to the aviation public the history and basics of MPL and competence based training itself.

Keywords: Training, Competence, Multi-crew, Pilot, License

1. Introduction

Competence based training is rather a new phenomenon in civil aviation pilot training. This method was for the first time incorporated in the year 2006 into ICAO Annex 1 - Personnel Licensing, in the 10th edition of this regulation, in the form of multi-crew pilot licence (MPL). ICAO Flight Crew Licensing and Training Panel (FCLTP) realized that the standards set by the Annex 1 in 1948 no longer kept up with new methods of training and new technology available in the field of advanced flight simulation devices. There is some perception that MPL was designed for the purpose of saving time and money spent in the conventional training courses, but "the FCLTP experts who fashioned the programme during the 2002-06 period were unanimously motivated by a desire to improve the safety standards that govern the operation of modern multi-crew civil aircraft. The MPL initiative was not driven by economic factors, although most members of the FCLTP, now disbanded, foresaw that the operations-oriented training approach could also reduce the duration and cost of pilot training."[1]

2. What is MPL?

MPL substitutes conventional training courses for the role of second-in-command pilot in civil aviation. A graduate from this course can act as a co-pilot of an aeroplane required to be operated with a co-pilot. Unlike normal modular and integrated courses, the graduate can´t perform duties of a pilot in single pilot operations. Even after obtaining his airline transport pilot licence later in his career, there is an endorsement for operations only in multi-crew environment. The regulatory requirement set by ICAO Annex 1 in terms of total flight time is 240 hours minimum.

The most fundamental requirement for an MPL course to be approved by the appropriate authority is close partnership between the flight training organisation (FTO) providing the training and an airline that will employ the students after the completion of the course. The MPL normally consists of several stages. At first it is basic flight training on a single engine aircraft with a minimum of 10 solo hours. Afterwards follows a dual multi-engine training and several phases of instrument training in multi-pilot environment, where two trainees cooperate as a pilot flying and pilot monitoring. All this is ended with a normal type rating training. The total flight time to become a co-pilot is essentially the same between the two ab-initio courses available (MPL and integrated ATP). The difference is that in the MPL course a lot of flight hours, usually well above half, are flown on a flight simulation training device (FSTD). Most of these hours are full flight simulator (FFS) hours supplemented with some flight and navigation procedures trainer (FNPT) hours. Emphasis is laid on multi crew cooperation, threat and error management and standard operating procedures (SOPs). The main advantages of MPL are:

- The airline can pick best students to accommodate their needs.
- The airline business culture and SOPs are built in from the beginning.
- Safety and threat and error management culture is integrated in the course.
- The environmental impact is reduced in comparison to other courses.
- The procedural and interpersonal competences of the trainees are taught throughout the entire course.

You can see an example of the much steeper learning curve in comparison to integrated ATPL course on Fig. 1 and Fig. 2:

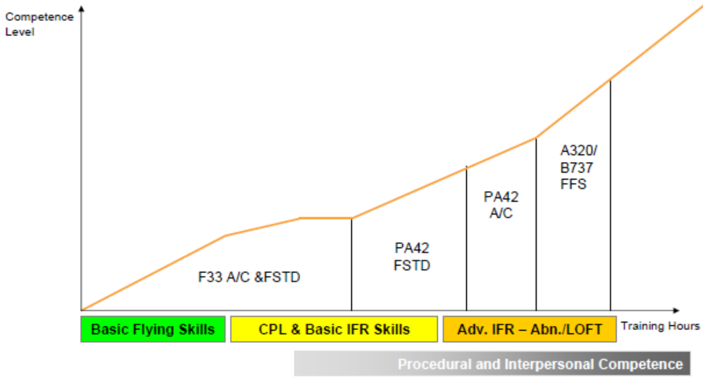

Fig. 1. Integrated ATP course learning curve. [2]

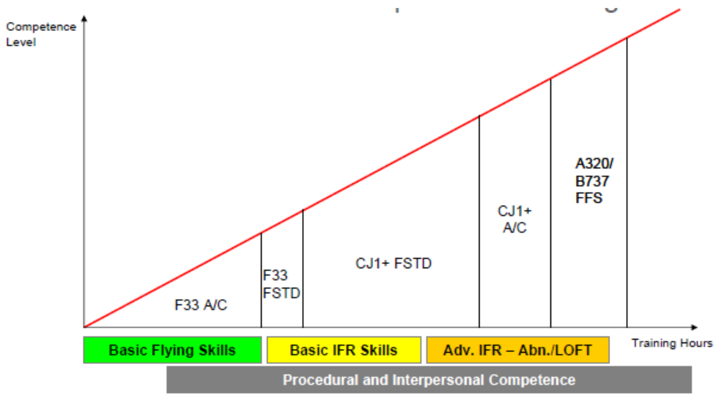

Fig. 2. MPL course learning curve. [2]

As you can see from the figures above, the students in MPL start with multi-engine and multi-crew training much sooner in the training course. In case of Lufthansa they even fly jet aircraft from almost the beginning of the instrument training. This puts more pressure on students to learn in a quickly manner.

3. MPL Around The World

The situation around the world rather differs between states and continents. Generally, Asian and European countries have positive attitude to this new type of training. Some other countries such as Australia or Canada start to implement MPL courses into their national regulations and open first courses. The country that hesitates the most is the United States of America. Not only the long discussion leads nowhere so far, but what is more, there is a new initiative where The House of Representatives passed far-reaching legislation designed to boost the safety of the country's regional air carrier system as a response to a February 2009 crash that killed 50 people near Buffalo. The bill, which passed the House 409 to 11, pushed the Federal Aviation Administration to ensure that all airline pilots obtain airline transport pilot certificates, which require 1,500 hours of flight time. [3] This can in the end lead to total impossibility to implement multi-crew pilot licence in the USA.

Generally much better situation is on the Asian continent, where they appreciate the possibility of more advanced training and recognize the positive impact on safety. What is more, Asian carriers usually tend to invest more into the quality of flight crew training, and thus into safety. Asian civil aviation authorities require from 325 to 355 hours minimum for approval of an MPL course. [4] This is far beyond the 240 hour requirement in the Annex 1 to ICAO convention. In Europe, there are mainly large traditional carriers that like the idea of MPL, because it provides training more suited for their needs. These carriers appreciate the possibility to control the amount and quality of their new hire co-pilots up to three years in advance. Pre-selection is widely used in these companies. Among other companies using MPL training in Europe are Air Berlin and Flybe. In Europe, the minimum of 240 hours is usually sufficient for the course to be approved.

4. The Basics Of Competence Based Training

Competence based training is a training principle known for several decades. This technique moves away from a bottom-up, classroom approach. This entails teaching a candidate until they are deemed competent, rather than relying on prescriptive rules such as counting the number of hours trained. [5] Except MPL which is the first step towards competency based training in aviation, there are also tendencies to implement this method into other trainings, such as PPL, CPL and instrument trainings. “In partnership with industry and academia, the FAA/Industry Training Standards (FITS) program creates scenario-based, learner-focused training materials that encourage practical application of knowledge and skills. The goal is to help pilots of technically advanced aircraft.” [6] These syllabuses are scenario based and are not regulatory requirements. They rather give an alternative opportunity for more efficient and quality training and at the same time fully comply with current FAA regulations. Also on the European side there are similar efforts. Task number FCL.006 (a) in EASA Rulemaking Programme 2011-2014 states: “Extension of competency-based training to all licences and ratings and extension of TEM principle to all licences and ratings.”[7] As we can see, there is a similar goal on both sides of the Atlantic, but the means of achieving this goal are considerably different.

So what exactly is competence based training? “Simply put, competency based training and assessment means that a person is trained and assessed to meet specified standards that define the skills, knowledge and behaviours required to safely and effectively ‘do a job’.” [8] This training must comply with specified standards and should reflect real world activities and situations encountered at the typical workplace. It is focused on the outcome of training, not the duration/extent of training (number of hours flown).

The cornerstone of a competency based training and assessment system is objective assessment of the trainee. The teaching methods may vary between training organisations, but the final result must be that a trainee meets a consistent and appropriate standard. To ensure the quality of the assessment, the standards must be measurable, objective, valid, authentic, sufficient and current. This competency standard includes several stages, namely units, elements, performance criteria, range of variables and underpinning knowledge. This system is of pyramidal construction. A unit consists of a number of elements; an element consists of a number of performance criteria, etc. “A unit of competency represents a discrete job or function that is written as a measure of outcome.” [8] As an example, Land Aeroplane is a Unit. “The unit is subdivided into the elements which detail the various functions that must be carried out to satisfy the Unit Description.” [8] As an example, the elements of unit Land Aeroplane are: Land aeroplane; Land aeroplane in a crosswind; and Perform a mishandled landing procedure. “Each element has a number of performance criteria. The performance criteria are evaluative statements that specify what is to be assessed and the required level of performance. The performance criteria applicable to the element ‘Land aeroplane’ are for example: Identifies and selects aiming point; Selects power to idle prior to touchdown; Flares the aircraft at an appropriate height; Controls ballooning during flare and bouncing after touchdown by adjustment of attitude without the application of power;" [8] Range of variables sets concrete conditions which must be met during the evaluation, such as for example day time, class of aircraft and flight rules used. If these conditions aren´t met, the evaluation or assessment is invalid. The underpinning knowledge comprises specific knowledge, which should be thought by the instructor during lessons and which is specific for the particular unit of competency, such as interpreting windsock indications is underpinning knowledge for Land aeroplane competency. "The assessment process must take into account task skills, management and contingency skills, role skills and transfer skills. For example, instead of just assessing a 30° banked turn against the specified standard, it may be more realistic to observe the candidate performing the manoeuvre during a precautionary search (a contingency) where the turn is used to position the aircraft to observe and assess the landing surface (a role)." [8]

The assessment occurs in several stages. At first it is a formative assessment, which monitors learning process during instruction. The instructor should do this assessment after almost every flight and the student should be aware of his progress in completion of the final standard. The second stage is a diagnostic assessment measures the current trainee's skills, such as the formative assessment, but it has a different purpose. It is used to set the proper strategy to get rid of the student´s learning difficulties and it requires a deeper insight by the instructor to do this job thoroughly. At last but not least, there is a summative assessment, which occurs at the end of training and compares the trainee´s skills to the set competency standards and determines if the instructional objectives were achieved.

5. Conclusion

Competence based training together with its most common incarnation, the MPL, contribute heavily to the aviation safety and quality of pilot training. This is the reason why not only MPL, but also competency based training as a means of pilot training delivery, should be a standard in 21st century pilot training all around the world. It is up to the civil aviation authorities to realize the potential this training offers in terms of pilot training graduates skills and abilities resulting from usage of new, highly sophisticated flight simulation training devices and aircraft with complex systems and avionics. Also it is in the deepest interest of pilot training providers and also carriers to see the potential of reduced risk in terms of number and quality of potential first officers for the same or possibly less money than the conventional pilot training systems could provide.

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The Improvement of Amenities of the Passenger Cars in the Vehicle Gauge RIC

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Abstract. The construction of the carriage body of the passenger car in the vehicle gauge RIC, which provides the improvement of amenities of passenger transportation with help of height increase of the compartment is developed. The height increase is attained due to adoption of depression of floor's surface level on the distance between truck centres. Two modifications of passenger cars' emplacements of first and second classes are proposed. The layout of equipment is done for these emplacements. The strength assessment of the suggested option of carriage body's bearing construction is done on the base of the plate-bar analytical model of FEM.

Keywords: Passenger car, the vehicle gauge RIC, amenities of passenger transportation, strength of bearing construction.

1. Introduction

The railroad passenger cars in the vehicle gauge RIC are used for international transportation in the countries of the European Union. Most of these cars belonging to Russian Railway have been made in the middle of the 20th century by «Waggonbau Ammendorf» company, Germany [1]. There are eleven compartments in these cars. There is a washing stand, a table and three berths in every compartment, which situated on one of separation wall. The disadvantage of such a lay-out is insufficient level of amenities that is caused by an arrangement of three berths on one coast of the compartment the height of which is limited by the vehicle gauge RIC. When there are three passengers in the compartment, the passengers of the first and second berth should be in a seated position when a second berth combined or in a lying position when a second berth put in sleeping position.

The other disadvantage of the lay-out is the small distance between the berths and between the third berth and the car's ceiling. Nowadays Russian Railways set a task to engineer home railroad passenger car in the vehicle gauge RIC for the organization of the international railway passenger transportation. As a part of this task Tver Carriage Works conduct the works to design such a carriage. In this work we offer an original construction of the car body of the new generation passenger car in the vehicle gauge RIC which provides international transportation with higher level of comfort.

2. Suggested carriage body's construction

To exclude the aforementioned disadvantages of the passenger cars which are exploited at present and to raise the level of passengers transportation's comfort we offer to increase the compartments' height which is attained due to adoption of depression of floor's surface level on the distance between truck centres "Fig.1". This change will allow to increase a compartment's height to 2550 mm with saving the rail loading gauge. However these changes will demand considerable revisions in a car lay-out. The passenger compartments take place in the lowered part of a car body on the distance between truck centres. There are sanitary zones, maintenance stuff's zones and car's equipments in console parts of the car. Two variants of a lay-out for the first and the second class cars are developed for an offered design of a car body "Fig. 2, 3".

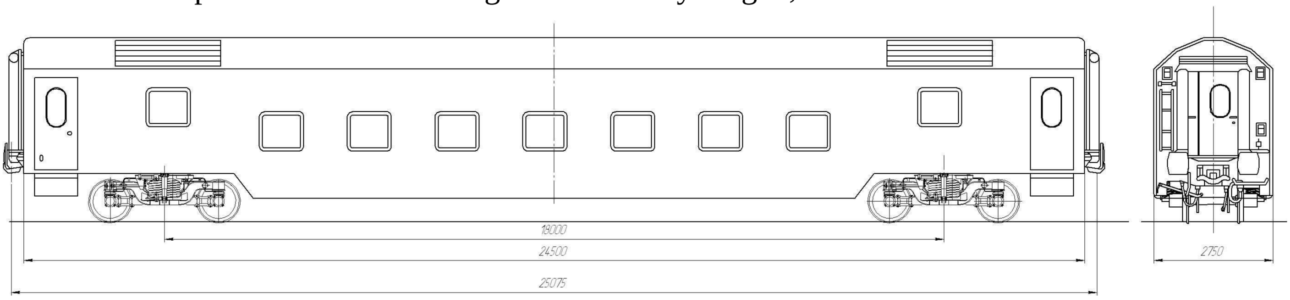

Fig. 1. The car's main plan.

The passenger accommodation in six double compartments is supposed in the car of first class "Fig. 2".

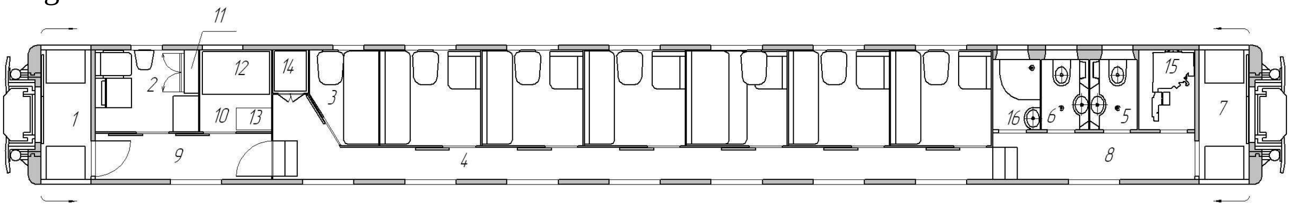

Fig. 2. The first class car's lay-out.

There is a two-sleeping bench, an upper bunk, an armchair, a little table, a wardrobe and the multimedia center in the compartment. There is the lavatory which includes two toilet cabin 6 and a shower cabin 16 in the car's end. The tanks with water and a waste tank take place in the room 15 for maintenance of work of a lavatory. Such position of the lavatory excludes a laying of pipes for water along a car body. There is service compartment 2 with the control center of the car systems in the other car's end. There is the area of electric fixtures which contains a battery bank and a voltage converter near to the service compartment. The high-voltage equipment 14 is located in a conversion zone of the car. The single guard's accommodation 3 settles down in the lowered central portion of a car body. The climatic installation providing individual climate control in the each passenger compartment settles down over a service zone in the console part of the car.

The passenger accommodation in seven 4-berth compartments is provided in the second class car "Fig. 3".

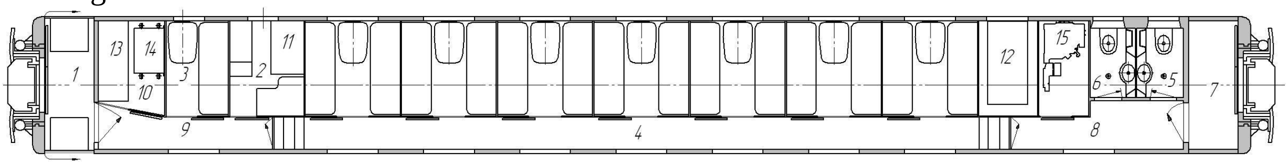

Fig. 3. The second class car's lay-out.

The passenger accommodation on two sleeping bench and two upper bunks which located in two circles on both walls of a compartment is provided. There is a little table, clothes rails, and the multimedia center in the compartment. There is the lavatory which includes two toilet cabin the car's end. The tanks with water and a waste tank take place left of the lavatory. There is the battery bank in the room 12. The maintenance free battery with gel filler and the sure venting system of the battery bank are applied in the car for the safety of the passengers. There is service compartment 2 with the control center of the car systems and the single guard's accommodation 3 in the other car's end. The electrical converter plant is situated in the room 10. The air heating with use of climatic installation is provided in the car. The developed lay-outs of cars conform fully to requirements of sanitary rules of the organization of passenger transportations in Russia [2].

The carriage of first class contains twelve passengers according to two-seat passengers' lay-out in the compartment and eighteen passengers during three-seat passengers' lay-out with allowance for collocation of two people on the double bed (family variant). The carriage of second class provides transportation of twenty-eight passengers.

Proposed variants of heavy equipment's lay-out in the console parts allow to reduce load of bearing construction of carriage body because of transmission of load from equipment's weight to car truck.

Cars' exploitation is performed on the speed car trucks, which don't have swing link, which are made by Tver Carriage Works, design speed is less than or equal to 200 km/h.

3. Description of the finite element model

In this work strength assessment of suggested bearing construction is done on the base of finite-element method to estimate working ability of carriage body's construction. Accomplish this plate-bar finite element model "Fig. 4" was developed in the field of bundled software FEM Siemens PLM Software [3].

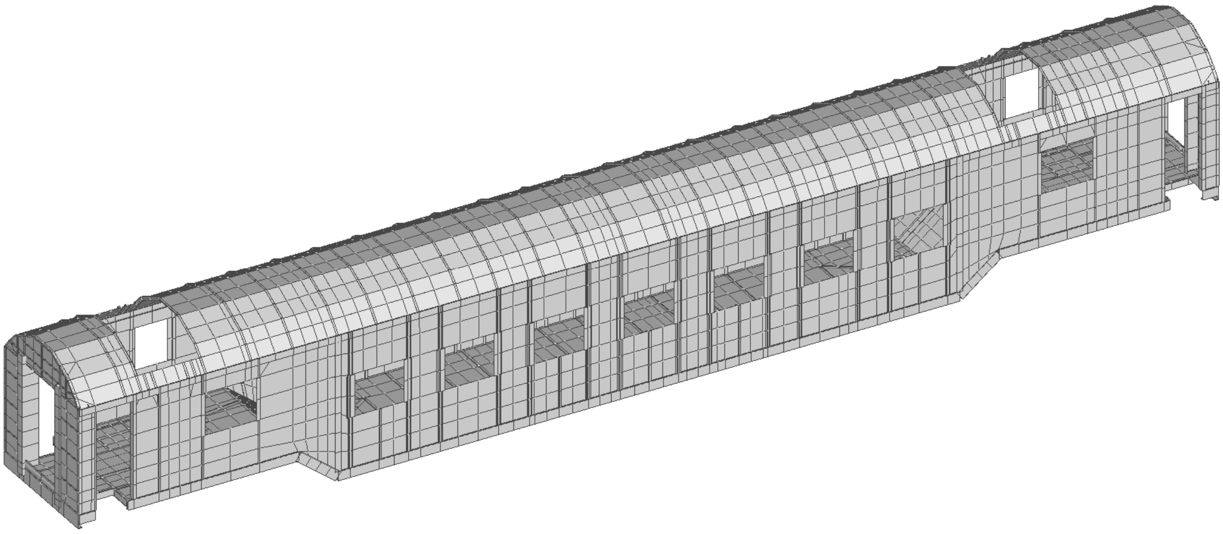

Fig. 4. The finite element model.

Every supporting member of carriage body is shown as canes which has absolutely stiff consoles. The coat of floor, side wall, end wall and roof is made of three or four nodal finite elements. There are 3950 elements in the model. The total number of the degrees of freedom of the finite element model is 28000.

Heavy equipment's lay-out in the carriage body structure was simulated with incorporation of single forces into corresponding nodal points of finite element model. Passengers' and luggage's weight was simulated with incorporation of distributed loads into finite element model's fields which go with its real position.

Static operating loads, which satisfy the requirements of normative documents for cars' engineering and design [4], were adjoined to the car. The estimation was done for the carriage bodies of first and second classes.

4. Conclusion

Accounting results which we got in the form of stress and strain of bearing construction are absolutely suited to the standard requirements. Hereof we can make a conclusion that suggested alternate designs of carriage bodies can be realized in our generation.

The use of designed cars’ constructions allows to improve comfort during passenger transportation and competitive ability of international rail transportations which are carried out by Russian Railways.

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The Impact of Model Complexity on Computation Time and Quality of Intersection Signal Plan

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Abstract. An optimal intersection signal plans minimizes the total waiting time of all vehicles in the intersection. We can simplify mathematical model of the problem by introducing of phases, which gather non-collision flows together. An obstacle in solving this problem is an objective function, which contains a quadratic term. For problem solving by IP solver the objective function have to be linearised. Two approaches to linearization of objective function can be used - linear approximation and rearrangement of the problem to min-max form. In this paper we deal with the impact of this simplification for computational time and quality of the assignment.

Keywords: signal plan, traffic flow, red point, phases, waiting time, linearisation.

1. Introduction

Design of an intersection signal plans has an elaborate role both in terms of its mathematical formulation, and in terms of methods of solution. The principle of solving this problem is to find the time of beginning and end of the green signal for each traffic flow respecting the collision times between flows and minimal given technical time for the green signal.

One of problems with which the signal plan designer can meet, is the existence of phases. A phase gathers non-collision flows together. The general model of the problem solves the design of intersection signal plan without any phase groups. We can simplify the model using the phase groups and reduce the number of constraints and variables.

In model problem development consists in identification quality criteria. One of the criteria may be the total waiting time of all vehicles in vehicle-seconds. This criterion has the disadvantage that it leads to a nonlinear model.

In this paper we focus on how the use of phases can influence the overall waiting time of vehicles in the intersection and the solution time. We will solve both models with and without phases by two methods. First one is linearization of the quadratic objective function based on piecewise linear function, second one is the reformulation of the model based on max-min criterion. We verify the feasibility of the proposed modifications of the model on 13 intersections where the signal design plan for all modes and compare them. For the computational study and comparison of the approaches we use optimization tool XPRESS-IVE [6]. Example of use of IP-solver is in [3][4].

2. Mathematical Model of the Problem with and without Phases

Let the traffic flows entering the intersection constitute a set *I*. Each traffic flow *i* from the set *I* is specified by the intensity f_i. During the red signal vehicles in the flow create the queue and after the beginning of the green signal vehicles leave the intersection with saturated intensity f_i^s. Technical standards set value τ_i for each type of traffic flow. This value is the minimum time for green signal of the flow *i*. [1]

Furthermore, for every two collision flows *i* and *j* we assume the minimum time of delay between the end of the green signal of flow *i* and the beginning of the green signal of flow *j* as m_{ij}. The period of intersection signal plan will be considered as the interval $<0, t_{max}>$.

The total waiting time of the vehicles in the flow *i* during the period $<0, t_{max}>$ where the time t_i^r is the duration of the red signal corresponds to the gray area in Fig 1.

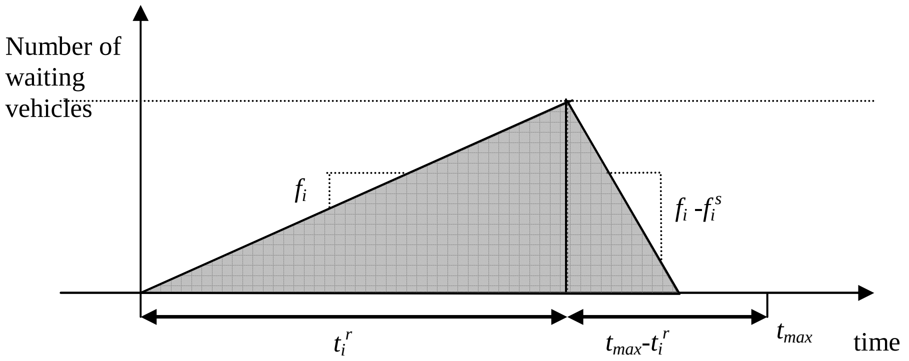

Fig. 1. Waiting time of vehicles in flow *i*: $0.5*(t_i^r)^2 * f_i * f_i^s/(f_i^s - f_i)$

We introduce a variable u_i to model the length of the red signal of the flow *i* and variable x_i and y_i to model the start and end of the green signal of the flow *i*. In the case, where no phase groups are used in the model, we introduce also binary variables z_i, which obtain value 1 when $x_i>y_i$ and value 0 otherwise. We also introduce binary variables w_{ij} for all pairs of collision flows where this variable obtains value 1 when $y_i>x_j$ and value 0 otherwise.

Then the mathematical model can be written in the form *(NoPhase)*:

$$Minimize \sum_{i\in I} 0.5*\left(\frac{f_i * f_i^s}{f_i^s - f_i}\right)*(u_i)^2 \quad (1)$$

$$Subject\ to \quad t_{\max} z_i - y_i + x_i = u_i \quad for \ \ i\in I \quad (2)$$

$$y_i - t_{\max} z_i + x_i \ge \left(\frac{f_i t_{\max}}{f_i^s} + 1\right) \quad for \ \ i \in I \quad (3)$$

$$y_i + t_{\max} z_i - x_i \ge \tau_i \quad for \ \ i\in I \quad (4)$$

$$y_i + (t_{\max}+1) z_i - x_i \le t_{\max} \quad for \ i\in I \quad (5)$$

$$x_j + t_{\max} w_{ij} - y_i \ge m_{ij} \quad for\, i\in I, j\in I, i, j - collision \quad (6)$$

$$x_j + (t_{\max}+1) w_{ij} - y_i \le t_{\max} \quad for\, i\in I, j\in I, i, j - collision \quad (7)$$

$$z_i + z_j + w_{ij} + w_{ji} \le 1 \quad for\, i\in I, j\in I, i, j - collision \quad (8)$$

$$x_i \le t_{\max} \quad for\ i\in I \quad (9)$$

$$y_i \le t_{\max} \quad for\ i\in I \quad (10)$$

$$z_i \in \{0,1\} \quad for\ i\in I \quad (11)$$

$$w_{ij} \in \{0,1\} \quad for\ i\in I, j\in I, i, j - collision \quad (12)$$

$$x_i \in Z^+ \quad for\ i\in I \quad (13)$$

$$y_i \in Z^+ \quad for\ i\in I \quad (14)$$

$$u_i \ge 0 \quad for\ i\in I \quad (15)$$

Quadratic objective function *(1)* models the total waiting time of vehicles crossing the intersection during the period. Conditions (2) are the coupling conditions between the beginning and end of the green signal and duration of the red signal of the flow *i*. Conditions (3) ensure that the flow *i* will have a sufficiently long period of green signal that all vehicles in the flow could leave the intersection.

Conditions (4) ensure that duration of the green signal will be at least as long as the prescribed standard value τ_i. Conditions (6) ensure adequate minimum delay for flows to avoid in collision. The conditions (5) and (7) solve the situations with inverse position of flows *i* and *j*.

We can simplify the model by introducing phases of the set $K = \{F_1, F_2, ..., F_r\}$, where F_k is the set of non-collision traffic flows, ie. traffic flows which vehicles can pass through the intersection simultaneously. [4] This simplification of the model reduces in the number of variables, since variables w_{ij} will not be needed in the model. Also the number of conditions (6) will be reduced, as it will not necessarily control the minimum time of delay between all collision flows, but only between flows in various phases.

The model after rearrangement can be written in the form *(LastPhase)*:

$$Minimize\,(1)$$

$$Subject\,to \quad (2)-(5),(9)-(11),(13)-(15)$$

$$x_j - y_i \geq m_{ij} - t_{\max} \quad for\ k = s+1,..,r-1,\ s = 1,..,r-1,\ i \in F_k,\ j \in F_s,\ i, j - collision \qquad (16)$$

$$x_j - y_i \geq m_{ij} - t_{\max} z_i \quad for\ s = 1..r-1,\ i \in F_r,\ j \in F_s,\ i, j - collision \qquad (17)$$

$$x_j + t_{\max} - y_i \geq m_{ij} - t_{\max}(1 - z_i) \quad for\ s = 1..r-1,\ i \in F_r,\ j \in F_s,\ i, j - collision \qquad (18)$$

3. Solving method

Due to the nonlinearity of the objective function in all models we will use another optimizing criterion. We will use two different approaches.

First approach is to use the linearization, which can be used to replace objective function (1) by linear expressions almost without loss of preciseness. It follows that the quadratic function can be replaced by piecewise linear function without loss of preciseness *(Linearization Method)*[2].

Second one is the max-min solving method and instead of minimizing of total waiting time we will maximize the worst relative proportion of the actual length of green signal required for the current green*(Max-min Method)*[5].

4. Numerical experiments

Verification of the two basic approaches, which were divided to other two sub-approaches, was made on the specific examples of signal design plan for the group of 13 intersections in the city of Ostrava. To perform the computation we used the general optimization software environment XPRESS-IVE. This software system includes the branch-and-cut method and it also enables solving of large linear programming problems. The experiments were performed on a personal computer equipped with Intel Core 2 Duo E6850 with parameters 3 GHz and 3,5 GB RAM.

In the Tab. 1. are results for all approaches and models used in this study. In the column "*Linearization Method*" there are the results for the model linearised by piecewise linear function. In the column "*Max-min Method*" are results for the model in which we maximize the worst relative proportion. In the sub-columns of the basic columns "*Linearization Method*" and "*Max-min Method*" called "*NoPhase*" there are a results for a version of model, in which we don't divide a traffic flows into the phases and the column called "*LastPhase*" there are a results for a version of model in which we use dividing of trafic flows into the phases. The columns called "*W.T.*" give an information about total waiting times of vehicles in the intersection and column "*C.T.*" give an information about length of computing time of the model. The results for a waiting time are for Linearised model without a partitioning traffic flows into the phases in vehicles-seconds and the other results are in percents, which represent an increase of waiting time with regard to the solution obtained by linearization in the "NoPhase" model. The computing time is given in seconds.

Intersection identifier	No. of Traffic Flows	*Linearization Method*				*Max-min Method*			
		NoPhase		**LastPhase**		**NoPhase**		**LastPhase**	
		W.T.	*C.T.*	*W.T.*	*C.T.*	*W.T.*	*C.T.*	*W.T.*	*C.T.*
		[v-s]	*[s]*	*[+ %]*	*[s]*	*[+ %]*	*[s]*	*[+ %]*	*[s]*
1005	17	492	1,00	5	0,05	54	8,70	76	0,02
3006	13	867	1,95	2	0,06	20	2,52	20	0,03
3008	11	195	0,05	0	0,03	37	0,08	44	0,02
4006	20	1252	21,30	1	0,05	26	316,86	37	0,02
4022	19	729	22,33	3	0,08	10	9,75	20	0,03
4089	21	510	2,13	9	0,08	22	21,70	34	0,02
1006	26	1022	0,67	11	0,17	27	0,64	42	0,08
1019	14	569	0,44	0	0,05	17	0,24	52	0,02
2015	8	756	0,09	0	0,05	29	0,20	35	0,03
2070	5	200	0,03	2	0,02	46	0,05	48	0,02
4008 (1)	15	1155	4,33	5	0,06	47	108,91	42	0,05
4008 (2)	15	1403	4,06	4	0,09	35	39,84	45	0,06
4008 (3)	15	2083	8,13	2	0,11	34	154,52	51	0,03

Tab. 1. Results of numerical experiments.

5. Conclusion

Performed experiments shows that usage of linearization method gives better solution than max-min method and usage of “*NoPhase*” model gives better solutions than “*LastPhase*” model. There is one exception from these conclusions, the solution of intersection 4008(1) using max-min method, where “*LastPhase*” model obtains better solution than “*NoPhase*” model. This is caused by the different criterion in objective function in max-min approach, where we want to maximize the worst relative proportion of the actual length of green signal instead of the total waiting time.

When comparing results in terms of calculation time, solving time of “*LastPhase*” model for both methods was lower than one second in all cases. The computational time of “*NoPhase”* model using the linearization method was several of seconds maximally and in the case of max-min method the computation time was several tens of seconds maximally in some cases.

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Level of Implementation of the Digital Tachograph System in European Union in Light of Introduction of Second Generation of Digital Tachograph

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Abstract. Tachograph belongs to On Board Recording Devices. It was initially introduced for the railroads in order to companies could better document irregularities. The inventor of the tachograph was Max Maria von Weber, an administrative official, engineer and author. The Hasler Event Recorder was introduced in the 1920s. Regrettably, the construction of analogue tachograph, an original type of tachograph used in road transport, encouraged to numerous frauds and counterfeits of social rules for drivers. For this reason the European Union has developed an inspection system, based on digital tachograph and chip cards, used for recording the data and identification of the system users. The article is the presentation of the main rules of function of the digital tachograph system, used in road transport in European Union. The document describes main legal rules introducing the digital tachograph system, foremost requirements which must be fulfilled by the producers of digital tachographs in order to get the type approval, possibility of future requirements of digital tachograph, main functions, characteristics of participant of digital tachograph system and their tools of the identification, acting and setting of authorize workshops in Poland and European Union and the accessible methods of check and calibration of digital tachographs and their description, based on Commission Regulation (EC) No 1360/2002 of 13 June 2002, 1266/2009 and Polish law. Furthermore, the dissertation presents current level of implementation of digital tachograph system in EU Member States and in all Europe.

Keywords: calibration, cards, tachonet, control officers, workshop, move sensor.

1. Introduction

The legal basis for the introduction of the digital tachograph system is Council Regulation (EEC) No 2135/98 of 24 September 1998, amending Regulation (EC) No 3821/85 of 20 December 1985 on recording equipment in road transport. Annex 1B of this Regulation contains the technical specification for digital tachographs.

Commission Regulation (EC) No 1360/2002 of 13 June 2002, replacing the Annex 1B, is an actual detailed technical specification for digital tachographs. In accordance with new regulations the inspection system consists of the following elements:

– a digital tachograph VU (*Vehicle Unit*), recording the driver and vehicle operation performance,
– a speed sensor, supplying the vehicle unit with relevant data concerning the vehicle speed and distance travelled,
– chip (data) cards intended for recording the data and identification of the system users.

For the conformity reasons all admitted equipment must fulfil three stages of tests:

– security test – test verifying the fulfilment of all requirements concerning the security, as listed in Annex 10 to the (EC) No 1360 of 13 June 2002,
– functional test – test verifying the requirements concerning the functionality of the equipment; the tests are specified in Annex 9 to the (EC) No 1360/2002 of 13 June 2002,
– interoperability test – test for verifying the abilities of a considered equipment to interoperate with other equipment; such tests are performed by only one laboratory under the

supervision of the European Commission (this task is given to the Joint Research Centre at Ispra); only equipment fulfilling these two tests mentioned above can be admitted to this test.

2. Level of implementation of digital tachograph system

Level of introducing the system of the digital tachograph, leading it, was divided into the following elements:

- issue of digital tachograph's card,
- connect to TACHOnet system,
- approved of digital tachograph workshop,
- trained and equipped control services.

States which do not issue cards in the system of digital tachographs:

- Croatia (January 2010 started to issue cards),
- Serbia,
- Kosovo (the first half of 2009 will begin issuing cards),
- Cyprus.

States which do not connected to the tachonet system

- Denmark,
- Greece,
- Hungary (is in the test phases),
- Portugal,
- Kosovo,
- Serbia,
- Croatia,
- Cyprus.

States, which have not started methods of checking and calibrating digital tachographs:

- Greece (it passed requirements determining functioning of methods of the digital tachograph),
- Malta (it adopted the Italian system, drivers are going to Italy to carry checking and calibrating digital tachographs),
- Kosovo,
- Serbia,
- Croatia,
- Cyprus.

Almost all states accomplished training and equipping of control officers, with the exception of:

- Greece,
- Portugal,
- Romania,
- Serbia,
- Croatia,
- Kosovo,
- Cyprus.

At present they are being led widely snitch works above introducing the system of digital tachograph in such states as Russia, Ukraine or Moldova. Level of implementation of digital tachograophs system is presented in figure 1-5. They present situation of each country and connected do TACHOnet system, number of issued cars (driver, company, workshop, control), number of approval workshop in country of Europe and situation with malfunction, stolen or lost cards.

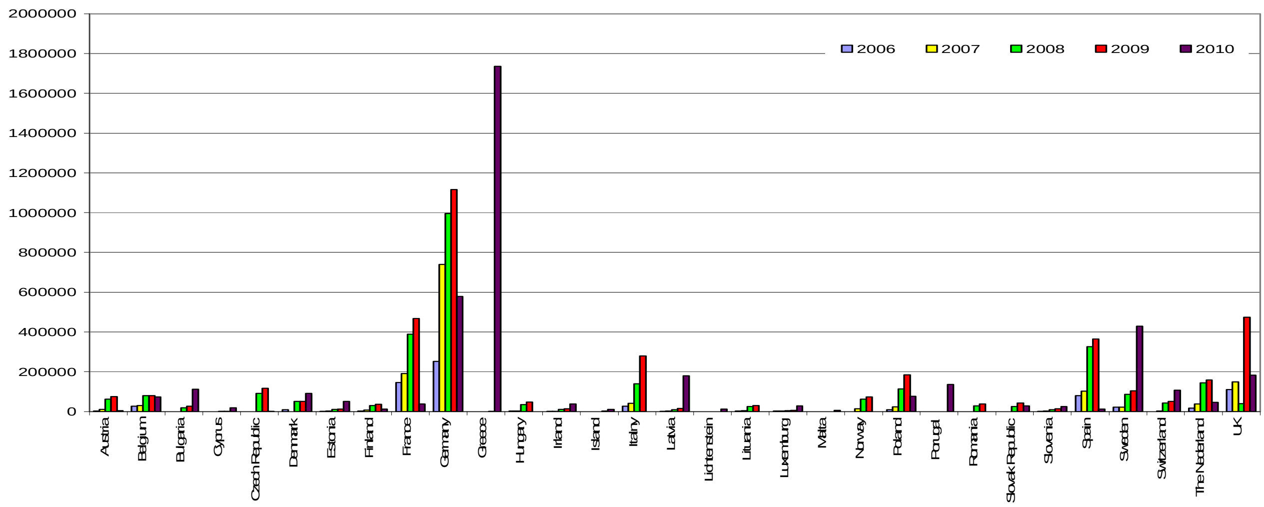

Fig. 1. Number of issued driver cards in Europe in 2006–2010

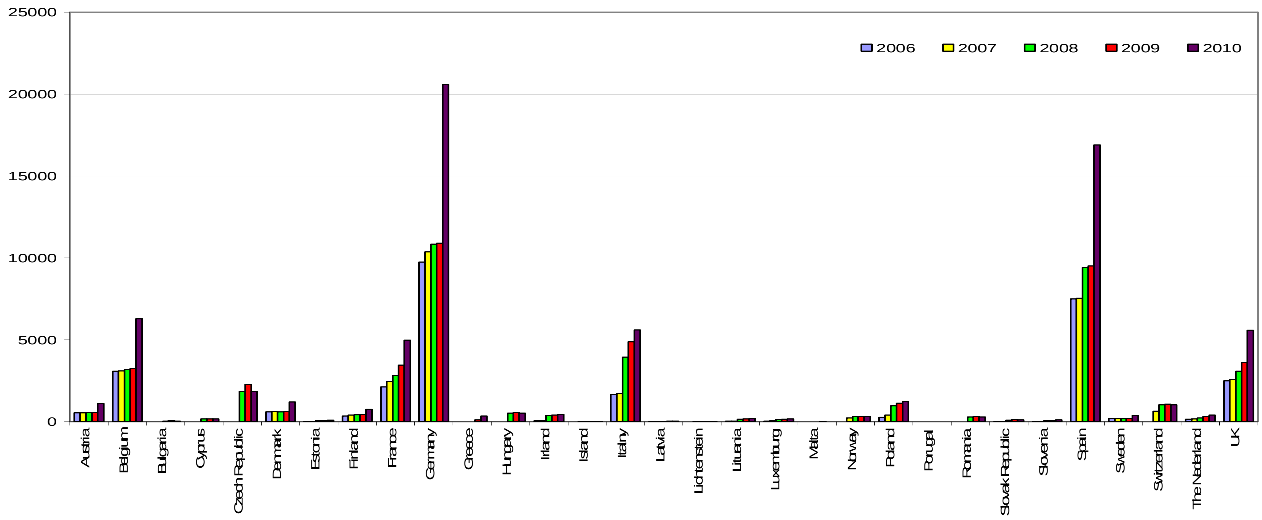

Fig. 2. Number of issued control cards in Europe in 2006–2010

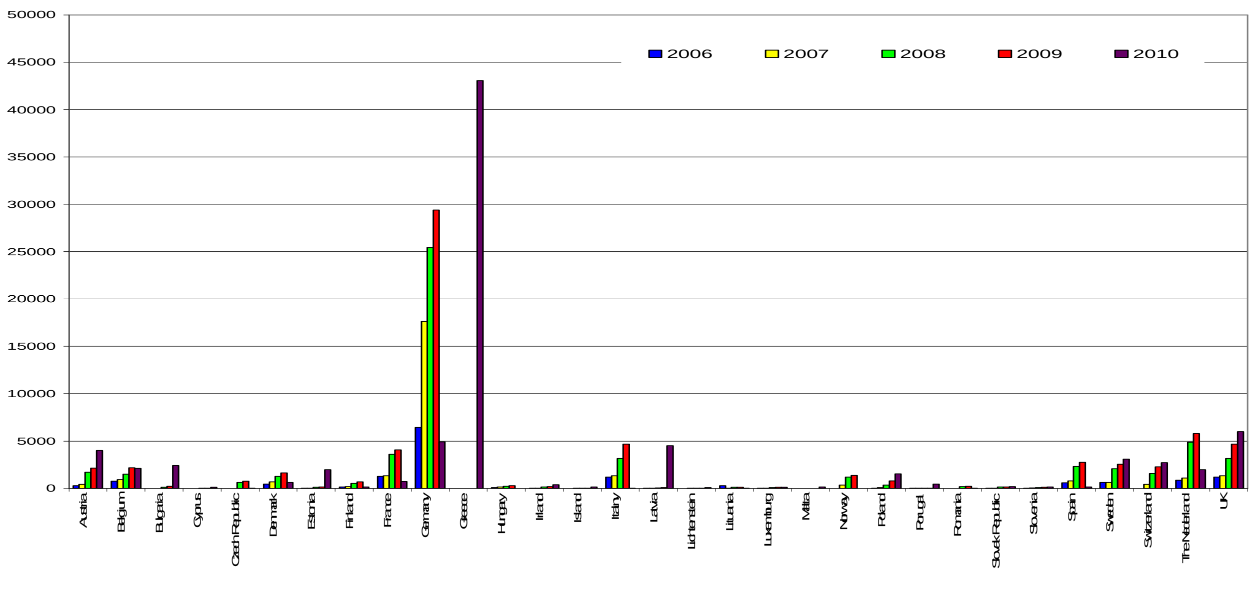

Fig. 3. Number of issued workshop cards in Europe in 2006–2010

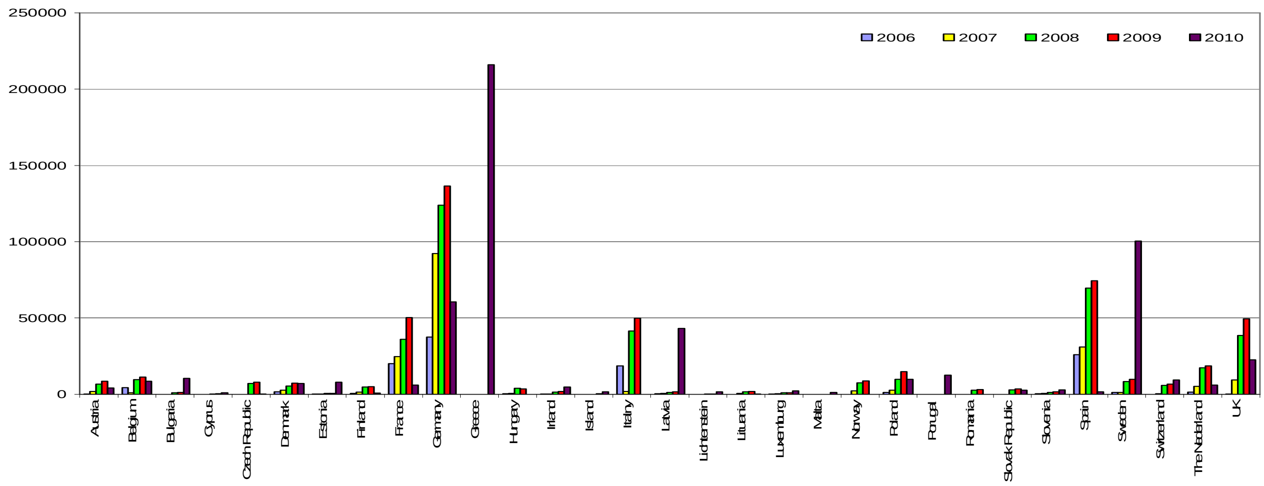

Fig. 4. Number of issued company cards in Europe in 2006–2010

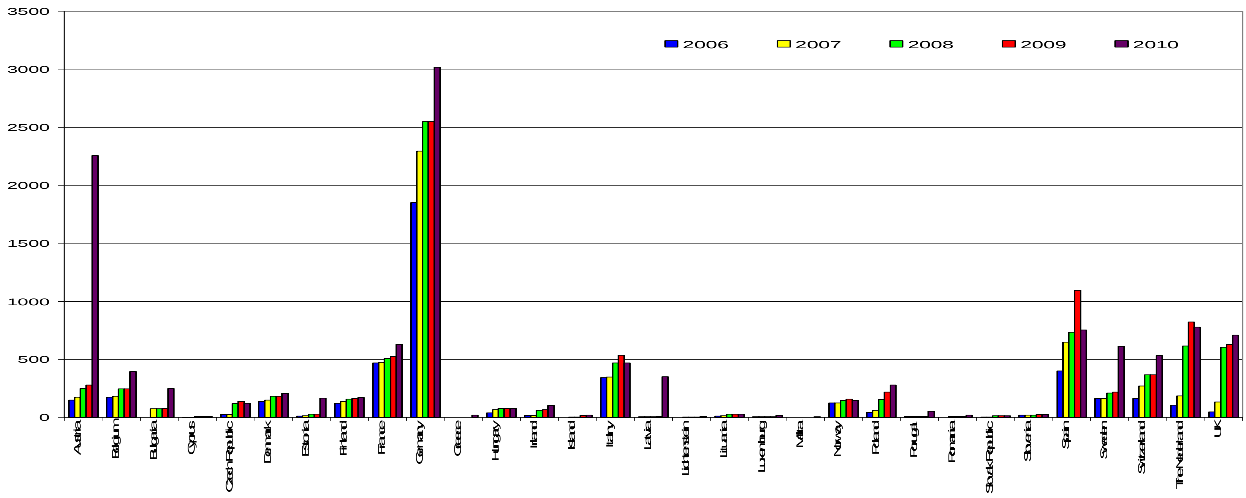

Fig. 5. Number of approved workshops in Europe in 2006–2010

Conclusion

In Europe digital tachograph cards are issued by 32 card issuing authorities. In consecutive years of functiong of digital tachograph system the following number of cards were issued (table 1) and percentage participation of malfunctioned cards were (table 1).

Year	Issued cards	Malfunction cards
2005	233087	0,32%
2006	1278954	0,42%
2007	1666613	0,55%
2008	1443636	0,85%
2009	4002033	0,84
2010	4736122	0,91

Table 1. Number of issued and malfunction cards in 2005 to 2010

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Methods and Tools of the Sequential Supply of Automobile Manufacturers

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Abstract. The paper gives an insight into the sequential supply of automobile manufacturers. It describes the components, that are suitable for supply under the Just-in-sequence and possible methods to deliver these supplies. It also describes the requirements for information systems providing the process of sequencing.

Keywords: Just-in-sequence supplies, sequential impulses, automobile manufacturer.

1. Introduction

During their development the automobile manufacturers have overtaken each other in the offered scale of manufactured vehicles. The situation came to the state where it is virtually possible to assemble a customer specific car. There is a selection of a wide range of colours, engines as well as other elements of interior and exterior vehicle accessories and equipment. For example, according to the manufacturer Škoda, the model Octavia has more than 50 thousand real and more than 8 billion of theoretical assembly variants [5]. Other sources say about over 130 millions of possible modifications for configuration of the Mercedes Benz C-Class [2].

Developments in automotive design have obviously had a huge influence on the development of automotive logistics. The technology Just-in-time (JIT) is not sufficient to enable delivering of operational units or modules produced in the hundreds, even thousands of variants. Therefore, the model of Just-in-sequence (JIS) supplies was developed. Suppliers under JIS regulate its own production plans so as to be able to deliver their products at the right time, in right quantity, at the right place, and in a specific order - the sequence.

2. The Main Reasons for Sequencing and its Benefits

It is obvious that the sequencing of the modules and parts with plenty of production variants such as dashboards means to achieve:

- elimination of capital blocked in stock of a wide range of relatively expensive products,
- reduction of the storage space and associated investments,
- reduction of the material handling,
- minimisation of errors and thus the risk of stopping the assembly line.

Besides products with plenty of modifications, JIS is used in the supply of another product category – bulky components such as exhaust systems and fuel or additional tanks. The reasons are similar to previous product group, but the key reason is to reduce storage space.

3. Methods for Execution of Sequential Supply

In practice, primary input for car production and delivery of car parts under the JIS is information coming from customers, such as automobile dealers and companies. The information is processed by analytical department of the automobile manufacturer and transformed into the production plan [4]. The production plan determines the order of vehicle production. Information about this order goes to the automobile production, as well as to the suppliers of the components. The information for suppliers is generated automatically in the form of sequential impulses, which are also automatically sent usually via electronic data intercharge (EDI).

Sequential impulses define the sequence in which modules should be deliver and are usually sent to the supplier a few days before the final assembly of the car. It is necessary to respect the time required to produce the items ordered and time of the consignment delivering.

It should be noted that after sending sequential impulse, there is still a possibility of error or failure in the welding shop, paint shop or engine shop of car manufacturer. There are two fundamentally different ways of solving this situation by manufacturers:

1. The vehicle is removed from the sequence and returns to the assembly line after solving the error. The sequence of delivered modules is also changed, so the final (changed) impulse is often received by the supplier after vehicle leaves the paint shop. It puts on the supplier high time demands and requirements on correct sequence of shipped modules. It is obvious that a precondition for working of such supply system is a relatively short distance between the supplier and assembly plant (approximately up to 50 km).
2. Another possibility is the application of so called fixed sequentional impulses. The vehicle is also removed from the sequence, but after correction the modul is delivered from the car manufacturer´s safety stock. This means that the original sequential impulses are changeless and therefore there is not so strong pressure on the flexible respond to changes as in the previous possibility. This way, this method helps to increase the range of potential suppliers, while the condition of short distance to assembly plant is not relevant any more.

By the choice of sequential method, automobile manufacturer must compare the cost of the above two alternatives – increasing financial requirements of the supplier associated with the growing demand of supply securing and amount of capital held in manufacturer´s own safety stock.

In view of the common supply operation, it is possible to execute the process of sequencing in two basic forms:

- supplier delivers components under JIT to a location near or within the assembly plant, the components are from this place sequenced to the assembly line,
- supplier delivers pre-sequenced items directly to the assembly line.

In the first case, complex services of third party logistics providers (3PLs) are often used. In addition to transportation they perform the sequential warehouse operation icluding the process of sequencing. After receiving the sequential list from the client, the 3PL repackages the products in the correct order in the special containers, which must be on time and again in the correct order sent to the assembly line. The sequential warehouse may be owned by the car manufacturer or directly by logistics company, which operates it.

In the second case, supplier inserts components to the special containers in accordance with required sequence, and then these containers are also placed to semi-trailer with respect to the order. At defined time the supplier delivers the consignment, stops the semi-trailer vehicle at the concrete place of unloading and assembly line is supplied directly from the semi-trailer. After emptying the trailer, it is filled with empty containers which are delivered back to the supplier. The supplier may also hire a 3PL for all these activities.

4. Information Support for the Process of sequencing

Considering the accuracy that is required for delivery under JIS and revelance of adverse impacts arising from its breach, it is obvious that the whole process of sequencing must be supported by an efficient information system. Interference of human factor means an increase in the risk of errors, and so must be reduced to a minimum. The transfer of the sequential impulses is carried out exclusively by electronic means, either through EDI or by accesing the car manufacturer’s information system (so called in-house sequential suppliers). An important feature, which should be taken into account by the selection of an information system, is its configurability. It is the rate with which the system can be modified to meet the future requirements. Therefore, it is profitable to use systems based on a modular structure that allows individual processes (represented by the modules) to be modified, replaced, relocated or create entirely new processes.

Relatively high demands are placed on the supplier’s information system. The contractor must be able to accept sequential impulses, process them, even check for eventual errors (duplication of sequence numbers, missing sequences, etc.). Information system also automatically gives the impulse for printing of the sequential labels for every component. Each label contains information about particular component and identifies the vehicle, which is a component intended for.

If the suppliers decide to fully synchronize their production with the automobile manufacturer’s assembly, the information system can be also used to control their own sequential assembly. The system can convert incoming sequential impulses to production schedule and shipping schedule automatically. It also automatically generate a packing list and delivery notes which are electronically transmitted back to the car manufacturer. In addition, information system significantly simplifies invoicing for delivered components.

5. Conclusion

JIS technology is already being used for more than 10 years. Currently, the share of components supplied in this mode reaches almost 80% of all imported parts by some car manufacturers. Components, which were initially considered not suitable for JIS, such as parts with few decades of variants or parts from distant suppliers (sometimes further than 800 km), are also successfully sequenced today. There are also trends of widening the range of companies which use JIS supplies within their inbound logistics, particularly among suppliers of automotive manufacturers.

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Controlled Flight into Terrain

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Abstract. This paper speaks about seriousness of aircraft accidents caused by controlled flight into terrain. The first part describes possible situations leading to controlled flight into terrain, their severity and causes of occurrence. Another part of this paper deals with possible precautions to prevent such accidents. As was already mentioned in the paper itself, one of the possible measures for avoiding this type of severe accidents is thorough controlled flights into terrain awareness.

Keywords: Controlled Flight into Terrain, Training, Instrument Approach, Accident

1. Introduction

Accidents have been closely connected to aviation since the very first flight. Although accident or incident is always an unpleasant occasion, we have to accept a fact that both aviation incidents and accidents are and will still be an integral part of air transport. Our goal is to eliminate negative effects leading to such situations. The basic method is to analyse the primary cause of the aviation accidents and define further steps and actions to be taken. These days, a long line of the primary causes exists. Due to the rapid expansion of air transport in almost all spheres, accidents caused by aviation technique are being minimized. The process of improving the aviation technical standards leads to higher and higher complexity of various aviation systems and navigation instruments in particular. This poses more demanding claims on the flight crew. That reveals the human factor related problems that represent the weakest element of the air transport system. Human factor failure is the cause of most of both aviation accidents and incidents. This means that accidents caused by the human factor are increasing linearly. Accidents caused by the human factor amount 75% of all aviation accidents worldwide. So called Controlled Flight into Terrain (CFIT) belongs to a category of the most critical aviation accidents.

2. What is CFIT?

The Controlled Flight into Terrain (CFIT) is a generic term for accidents when an aircraft capable for the particular flight, without any failures, is fully under control and is unintentionally guided to a terrain, water area or an obstacle. This term was created at the end of 1970's by the Boeing engineers who participated in inspections of aviation accidents. Due to their conclusions based on evaluation of particular accidents, the CFIT have caused approximately 9,000 deaths since the introduction of commercial transport. Despite the fact that there are many reasons which could contribute to the CFIT, such as bad weather or generally radio navigational failures, the flying technique is the main reason of the CFIT. Even experienced pilots can easily cause the CFIT due to exhaustion, loss of situation awareness or disorientation. The CFIT are considered as a form of areal disorientation when a position, orientation or appearance of a terrain is incorrectly perceived by a pilot or a flight crew. Of course, risk of aviation accidents connected with the CFIT increases mostly in mountainous terrain during conditions for flights conducted under IFR (Instrument Flight Rules) or during lowered visibility. Such kind of aviation accident has a similar process and conditions. The most frequent place of these accidents is the vicinity of the airport, during a final approach phase or approach. The CFIT can also be connected with a negligible instrument error. In case when a navigation failure occurs but is not detected or is not correctly understood by a pilot, it can lead to the aerial disorientation and the pilot or the flight crew can, despite next information from the correctly working instruments and facilities or even referred to a visual contact, unknowingly continue in the CFIT. This behavioural model can be classified as a "tunnel perception". To be more specific, a crew focuses on information from only one source which can be easily influenced, whereas ignores other available information and sources. Alerting danger in case of the CFIT is that the terrain is noticed in the very last moment when there is no time to react.

A typical example is accident of Flight 801 from 6th August 1997. Korean Air flew from Soul to Agana, Guama. Based on the conclusion of the accident inspection, condition of the aircraft Boeing 747-3B5 was not the cause of the accident as all the instruments, including the navigational ones, were working correctly at time of the accident. It was a night approach for runway 06L in Guama. The Flight 801 was descending 800 feet under the given path when it crashed to the Nimitz Mountain at altitude of 650 feet. The top of the Nimitz Mountain is at altitude of 709 feet. The aircraft subsequently felt to a jungle in the valley where it broke up and flamed out. Totally, 206 passengers and 22 crew members died. Further inspection revealed captain's failure in calculation of the approach and the first officer's insufficient monitoring role. Factors contributing to this fatal accident were also captain's exhaustion and insufficient training of the Korean Air crew.

It is important to depict fact that not only the direct causes of the aviation accidents are executed but also a flight phase. It is generally known that 50% of all accidents occur during approach and landing, this represent only 4% of total flight time. Next 27% of accidents occur during take-off and initial climb, which is only 2% of the total flight time. By a basic calculation is given result that more than ¾ of the total aviation accidents occurs during these relatively short flight phases. The statistics from 2009 shows that during the recent 10 years, by average 34% of all aviation accidents were caused by the CFIT. The statistics from the given graph indicate that a significant part of the CFIT is caused by private pilots in general aviation. Next are commercial pilots and finally trade pilots. [7], [8]

Causes:

- Loss of situation awareness
- Aerial disorientation
- Facility error
- Bad weather conditions
- Non-standard instrument approach

Especially the non-standard approach or deviation from trained procedures can cause a deviation from a designed route and a descend profile. Almost 60% of accidents in this category happen during a non precision approach where there is no strict vertical guidance (horizontal) during approach or flight. Fact is that the non precision approach is one of the most difficult approaches and it also requires a significant knowledge of standards, areal perception, flying skills, and it is not as frequent as precision approaches. [6]

3. Prevention

Prevention against the CFIT is focused into basic spheres. The first sphere is GPWS (Ground Proximity Warning System) equipment. These are systems installed into aircraft and which enable flight crew warning by an acoustic form – a synthetic voice warning against an eventual approach to the terrain. These days, there are many standards according which aircraft with TOM (Take Off

Mass) over 150 000 kg must be equipped with the GPWS. The GPWS installation on aircraft between 5 700 kg and 150 000 kg is mandatory only in case they are certificated to carry more than 30 persons on board. Presently, the GPWS is widely used as an augmentation of GPS with map documentation and also enable visual warning against approaching into terrain. It takes into consideration also the given flight trajectory. [9]

Second sphere is crew training and certification. During this phase, flight crews are provided with a suitable training. After it the crews will be familiar with the danger of the CFIT and they will be also well-prepared for recognizing such situation and will know how to face the areal disorientation. Information about the CFIT is implemented into the whole training process, especially during the IFR training, MCC (Multi Crew Cooperation) and particular line trainings. The studies demonstrate that a risk of the CFIT is much higher during the non precision approach, as mentioned hereinbefore. To the category of non precision approach belong mainly VOR-DME, NDB and NDB-GPS approaches. Despite the fact that the approach process is not dangerous at all, it is important to count with a probability of navigation facility failures. Hence it is not recommended. Operators should emphasise this risk during training to lower probability of neglecting. They should also implement standards for vertical guidance when executing a non standard approach. The operators typically use one of three possible techniques of vertical guidance for the non precision approach. Among these techniques, a CDFA (Continuous Descent Final Approach) is preferred. Whenever possible, the operators should use it to decrease pilots' workload and consequence probability of mistakes. Many contracting states require usage of the CDFA technique or require higher visibility or RVR parameters in case the CDFA is not available. When this technique is used, a pilot keeps a constant rate of descent when the vertical navigation is either calculated or enabled by onboard instruments. Speed of descending is chosen in order to get a constant descending to the point approximately 15 m (50 ft) from the runway threshold where the pilot should flare the aircraft. Descending has to be calculated and performed in order to ensure descending in or above minimum altitude at any point. If no visual references required for landing are available when reaching MDAH (minimum descent altitude/height), the vertical part (climb) of a missed approach procedure is initiated in the MDA/H. This manoeuvre is sufficient to ensure the required minima. The aircraft does not level off when approaching the MDA/H. Any turn must not be initiated before MAPt is reached. It is also necessary to depict that there are only two options for the flight crew while approaching the MDA/H as in the case of precision approach procedures: continue in descending under MDA/H to land with help of particular visual references or to proceed according to missed approach procedures. The CDFA technique eases the final segment of the instrument approach as it includes procedures similar to ones used during precision approach or APV (Approaches with Vertical Guidance). The CDFA technique improves pilot's situation awareness and fully corresponds to criteria of "stabilised approach". Disregarding the fact if aircraft operator accepts the CDFA techniques, the specific training is necessary. [3]

Next important sphere of prevention against CFIT is flight documentation. The flight documentation includes approach, en-route and other map documents. Airlines and pilots must always have actual maps for a given flight. These maps are one of the tools which contribute to the situation awareness and can be used to ensure required safe minimum altitude in the case of loss of situation awareness or emergency. This information is implemented and published in AIPs by particular state organs. Standards are being changed in map documentation, as well. Non precision approach maps are made to be as similar to the precision approach maps as possible. Moreover, non precision approach maps only include procedures for step down approach. Despite the fact that all information published in AIPs are mandatory for all operators and have a legal form, every airline is allowed to implement its own flight documentation based on the published procedures in the AIP. The specific flight documentation can be created by the particular airline or the responsibility for their creation can be shifted to a relevant company. Such an institution can be for example JEPPESEN which has the biggest experience in this sphere and most airlines fly in accordance with its maps. On the other hand, it is important to emphasise that such "improved" maps might be more transparent to some pilots but they have no legal basis. In other words, it means that inspection of any aviation incident or accident is based on information published in AIP and not according to information published in maps created by JEPPESEN.

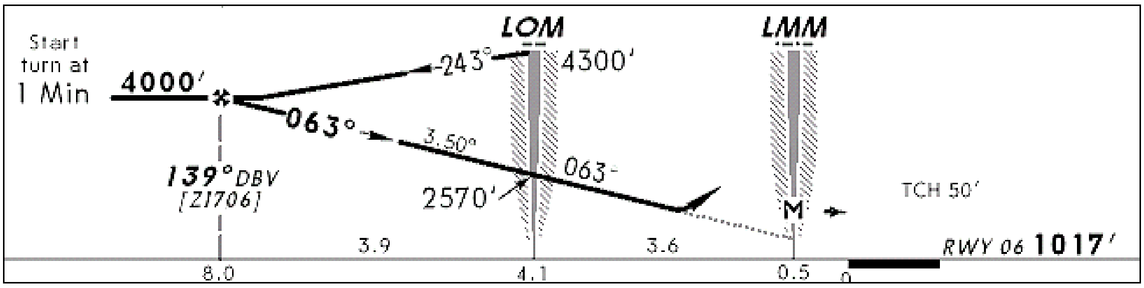

Fig. 1. Instrument Approach NDB – LZZI - Continuous Descent Final Approach. [1]

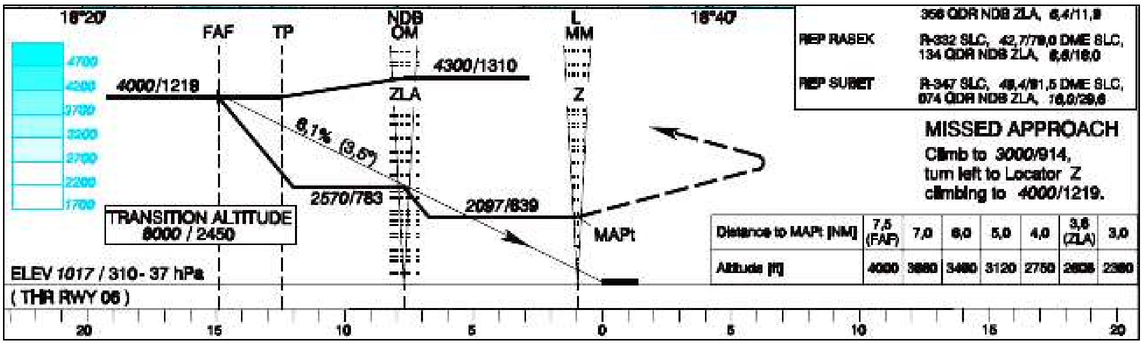

Fig. 2. Instrument Approach NDB – LZZI – AD2-LZZI-7-1. [2]

4. Conclusion

There are more tools preventing from the CFIT occurrence such as ATC training or reduction of maximum daily workload for personnel. Despite all of these methods and tools, being informed about the eventual CFIT risks is still the most efficient one. This can help in early detection of the common signs and take the right action. It is very improbable that era without any incidents or accidents will ever appear in aviation but we can minimise the risk using the defined mitigating steps and actions.

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Formal Specification of Railway Safety System in Event-B

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Abstract. The contribution deals with formal specification of a safety-related control system. There is given a practical example to show how the Event-B method can be use for writing specification of the axle counter system in the area of railway systems. The paper results from survey of the state-of-art inevitable for future work of the author over his PhD. thesis.

Keywords: formal method, Event-B, railway system.

1. Introduction

This paper represents a part survey of knowledge necessary to solving topic of the author's PhD thesis that deals with *Use of formal and semiformal methods in safety-related system assessment.* At first the importance of functional specification is briefly presented from the standardization point of view. The main attention is paid to Event-B formal method suitable for producing functional specification of safety-related control systems with proofs of their consistency. There is given a practical example to show how the Event-B method can be use for writing specification of the axle counter system in the area of railway systems.

2. Functional system specification

During the life span of a system, one of the most delicate steps to be accomplished is translation of needs and requirements into specifications. The drafting of specifications is very important, in particular for safety-related systems. Mistakes made during specification phases are often detectable as late as during the integration tests. If errors remain undetected, they become potential sources of dangerous faults during system operation. Different types of specification languages may be distinguished: specification written by ordinary language, semi-formal specification and formal specification. Generally, natural languages and similar non-formal notations are said to have many disadvantages when used for technical descriptions, it is generally incomplete, incoherent, ambiguous, contradictory and erroneous. Therefore standards for developing safety-related systems (for example in railway industry there are EN 50126, EN 50128, EN 50129) highly recommend formal and semi-formal methods for development of software in a way that is based on mathematics (this includes formal design and formal coding techniques) and their use for writing specifications and for verifying the safety.

3. Example in Event-B formal method

3.1. Event-B method

Event-B [1] is a formal method for building and analyzing a model at system level. Event-B is based on the set theory. Its key features are the support for formal refinement, which allows systems to be described at different levels of abstraction. Event-B models are built using top-down stepwise refinement. After each step a series of Proof Obligations (PO) is generated if necessary. These POs represent properties of the model that need to be satisfied for the refinement, called the concrete model, to preserve the properties defined in the preceding abstract models. This enforces correct-by-construction refinement with properties being preserved from the most abstract down to the most concrete model. Practically it is shown in the next chapters.

3.2. Non-formal specification of axle counter system

Although in this example the formal specification is produced, we have to begin with the non-formal specification of the desired function, in this case for the axle counter system. Important characteristics of the system are marked by identifiers in brackets. Identifiers allow tracing of important characteristics easy in the development process.

(FUN1) Axle Counter is a system determined to detect railway vehicle axels and to evaluate track section occupancy. (EQP1) Each track section is defined by counting points. Counting points are located in every possible input or output place of the track section. (EQP2) Counting points towards the start of the track line are marked as odd points, towards the end of the track line as even points. (FUN2) Counting points detect the axles of the passing train vehicles. The system evaluates number of detected axles presented in a track section. (FUN3) Axles of a train passed through the odd counting point in the odd direction are counted in, and vice versa in the even direction are counted out of the track section. (FUN4) Axles of a train passed through the even counting point in the even direction are counted in, and vice versa in the odd direction are counted out of the track section. (FUN5) Section clear indication will be set only if the number of the axels is zero. (SAF1) After restart the system occupancy of the track section is indicated. Graphical representation is shown in Fig 1.

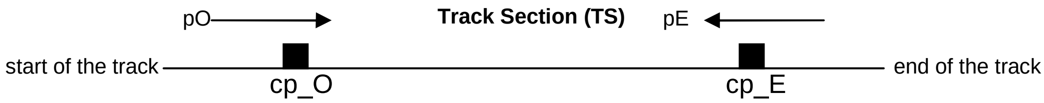

Fig. 1. Graphical representation of the axle counter system.

Track section is bordered by odd counting point (cp_O) and by even counting point (cp_E). Arrows indicate the direction of crossing through counting point in the odd direction (pO) and in the even direction (pE).

3.3. Initial Event-B model

The Event-B model is developed in an incremental manner. It is no purpose to create a model of the system which we want to construct in all its details in one step. We create a series of more and more accurate models of the system with the gradual addition of details (refining), thus approaching a reality. The initial model is usually very abstract. We do not consider all the various pieces of equipment; they will be introduced in subsequent refinements.

The first Event-B model is made up of a single variable *n*, which denotes the actual number of axes in the section. This is simply written as shown in the boxes in Fig. 1. Variable *n* is defined by mean of one condition, which is called the invariant. An invariant is a constraint on the allowed values of the variables which must hold on all reachable states of a model. The invariant (inv0_1) declare that this variable belongs to the set of natural numbers, thus it is not negative. The variable *n* is initialized to 0 at the beginning. At this stage, we can observe two events in the system. They correspond to axis entering the track section or leaving it. An event has a name: here KU_out and KU_in. Event contains an action (statements) which can be read as follows: "*n* becomes equal to *n* + 1". It is important to notice that in writing these actions we are not programming. We are just formally representing what can be observed in discrete evolutions of our system. We are giving a formal representation to our observation.

```
variable: n

inv0_1: n ∈ ℕ

init
  begin
    n:=0
  end

TS_in
  begin
    n:=n+1
  end

TS_out
  begin
    n:=n-1
  end
```

Fig. 2. Representation of initial Event-B model

At this level of abstraction we are not interested in which counting point is affected by axle in which direction of passing through, we model no more demand than FUN2. When the event TS_in occurs, system status is changed in such a manner as mentioned in the action of this event, thus adding one axle to track section (TS). If the event TS_out occurs number of axes in a TS is decremented.

3.4. Proof of consistency of the initial model

After creating a model, we have to perform a proof in order to verify consistency of our initial model. We are required to show that the behaviour of a system is compatible with the properties given by invariant. In our case, to verify consistency means to show, that invariant holds for initial states, and the invariant is preserved by all events. Intuitively, we can see, that action of the event TS_out is not consistent with the invariant inv0_1 in case of $n<1$. This causes, that the invariant preservation proof fails. A failed proof reveals a bug. We create inconsistent specification and we are notified about this by the tool. It is necessary to mention, that invariant preservation is only one of the various Event-B proof obligations, sometimes also called verification conditions. Formal definitions of all proof obligations are given in [1]. Many of the proof obligations in the Event-B are produced automatically by a Rodin Platform tool [2] called a Proof Obligation Generator. This tool static checks texts of the models and decides then what is to be proved. We figure out that proving has the same effect as debugging.

3.5. Improving the initial model

In order to correct the deficiencies we have discovered while carrying out the proof, we have to add guards to our events. These guards denote the necessary conditions for an event to be enabled. More precisely, when an event is enabled, it means that the transition corresponding to the event can take place. Event TS_out after correction is illustrated in Fig.3.

```
TS_out
  when
    n>0
  begin
    n:=n-1
  end
```

Fig. 3. Correct form of TS_out event from the initial model

3.6. First Refinement

A refinement is a more precise model than the initial one; which should not contradict the initial model. In first refinement, we introduce the further details about counting axles in or out of the TS. Counting axles in or out TS depends on which direction are the counting points passed by wheel, as is specified in FUN3 and FUN4 of non-formal specification. Counting point for this level of abstraction may be influenced by passing in an odd direction (pO), in the even direction (pE) or unaffected (pU). It may also be affected incorrectly (pI). This set of information we label as EP and it is introduced into the model. We introduce two new variables, namely cp_O (counting point_Odd) and cp_E (counting point_Even). New variables carry information about how is each counting point passed (take their values from the set of EP). Next we supplement the original events TS_in and TS_out by the conditions which specify under what circumstances it is possible to add axles into the TS. For example TS_in event occurs when the odd counting point is passed in an odd direction (FUN3) or even counting point is passed in the even direction (FUN-4). This is indicated by the first guard condition. Also at the same time none of counting points may be affected incorrectly as is indicated by the second guard condition. After refinement tool turn generates a series of evidence of internal consistency refining model and its compliance with the more abstract (initial) model.

```
set: EP
constants: pO, pE, pU, pI

axm1_1: EP = {pO, pE, pU, pI}

variable: n, cp_O, cp_E

inv1_1: n ∈ ℕ
inv1_2: cp_O ∈ EP
inv1_3: cp_E ∈ EP

init
  begin
    n:=0
    cp_O:=0
    cp_E:=0
  end

KU_in
  when
    cp_O=pO ∨ cp_E=pE
    cp_O≠pI ∧ cp_E≠pI
  begin
    n:=n+1
  end

KU_out
  when
    n>0
    cp_O=pE ∨ cp_E=pO
    cp_O≠pI ∧ cp_E≠pI
  begin
    n:=n-1
  end
```

Fig. 4. Representation of Event-B model after the first refinement.

In a manner outlined in the first refinement, it is necessary to include further details of the functional specification. For example, according to the desired function, the axle counter system is supposed to evaluate track section occupancy (FUN1 and FUN5), not only count number of axles. Due to limited size of the paper the following refinements of our model are not presented. But, practically, the final phase of refinements consists in performing the various hardware or software automatic code generation.

4. Conclusion

Formal methods are one of the ways of increasing confidence in computer systems in area of safety systems. The design and verification of systems based on formal or semiformal methods give a chance to check functional correctness just before creating the system itself. This approach to a system design is in accordance with requirements of the European standards. Simply writing a formal text is insufficient, though, to achieve a specification of high quality. The Event-B method offers the serious way to analyze a system specification, to reason about it and proving it in a mathematically rigorous way that all required properties are satisfied. The modelling language is easy to understand and assumes not so high level of education in formal logic and an appropriate suitable computer tool for industrial use is available.

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Construction of the Planned Intermodal Terminal in the City of Žilina and Effects Resulting from This

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Abstract. The paper deals with the characteristics of certain aspects of intermodal transport, intermodal terminals and logistics parks in the Slovak republic. The purpose of this paper is also to specify the planned intermodal terminal in the city of Žilina, to determine the assumed operational necessity of handling devices in this terminal and presents the effects, which the realization of this project could bring. The main objective of this article is to inform readers about the beneficial effects which may be in the consequence of planned construction of an intermodal terminal in the Žilina region caused.

Keywords: Intermodal transport, Intermodal terminals, Logistics parks, Intermodal transport units.

1. Introduction

Intermodal transport is an energy-effective and also environmentally friendly system concerning the transport of goods in logistics chains of freight transport. In the transportation of goods it effectively uses advantages of different transport modes. Thus intermodal transport reduces the overall burden of environment by harmful emissions and noise. Energy consumption in comparison with direct long-distance road transport is lower and in the case of the use of combined transport block trains either the price for cargo transportation is lower. In terms of transports over long distance intermodal transport has realistic assumptions to become the best quality transport system, mainly for that reason that it minimizes the disadvantages of participating transport modes and at full blast it takes advantages of their strengths.

2. Intermodal terminals and logistics parks in Slovakia

In this section are briefly specified intermodal terminals and follow-up logistics parks in the Slovak republic and here are also their shortcomings.

2.1. Aspects of intermodal terminals in Slovakia at present

An intermodal terminal is generally the place where a change of transport modes during the manipulation with intermodal transport units is made. Nowadays there are in operation eight intermodal terminals in Slovakia. These are: Bratislava - Central freight station, Bratislava Pálenisko port – only trimodal terminal in Slovakia, Žilina, Terminal IT Dobrá, Dunajská Streda II, Sládkovičovo, Košice and Veľká Ida. The main weaknesses of these terminals (except the terminal in Dunajská Streda) are:

- Insufficient length of transshipment line,
- Unsatisfactory handling devices in terms of their number, load capacity, speed of manipulation and possibility to handle with all of intermodal transport units,
- Impossibility to widen the transship centre because of their improper placement,
- Insufficient size of warehouse space in the terminal.

These shortcomings result in the fact that foreign elements of logistics chain do not accept Slovak point of intermodal transport nodes as appropriate locations for initial respectively final consignments transportations of intermodal transport.

2.2. Some aspects of logistics parks in Slovakia at present

Logistics parks are created especially in order to increase quality and efficiency of transport, services and ensuring the organizing of the cargo flow. They can be characterized as an object, where independently transport companies, freight forwarders, warehouse keepers and other entities active in the logistics chain operate. They combine traffic flows and in some cases also different types of freight transport and thus they facilitate the cooperation between individual carriers. Thus they are built in places of major transport node and in places of great economic concentration. The logistics park is an important element that can greatly relieve the already overloaded road transport with the link of various types of freight transport.

The primary specific feature of many logistics parks currently in operation in Slovakia is monomodality. Compared with foreign logistics centers, which use several transport modes, they allow only the connection to roads, but one-sided focus on road transport appears to be a significant disadvantage. In the grounds of these logistics parks the additional building of private railway sidings is often difficult to achieve because of their position in an already built locality.

There are currently in operation about twenty public logistics parks and warehouses with a total usable area of the associated space 20 000 m^2 in Slovakia. The term public means that these parks are built with the financial support from the Slovak republic and also they are open for the general business community. The biggest logistics parks in Slovakia are: Prešov CTPark, Beta - Car Pezinok, Senec Logistics Centre Goodman, ProLogis Park Bratislava, Senec ProLogis, CTPark Trenčín, ProLogis Park Galanta etc.

3. Construction of the planned intermodal terminal in Žilina

The proposed terminal in Žilina will be located between the railway track Žilina - Vrútky and Vodné dielo Žilina, near the unfinished marshalling yard Teplička nad Váhom. Within the designing of the terminal it is assumes that the marshalling yard will already be operational. The terminal will serve to transship intermodal transport units (ITU) between road and rail transport and for their storage. Attraction circuit of the terminal with 80 km range would allow serving the entire Žilina County, northern districts of Trenčín County, Ostrava County in the Czech Republic and southern part of the Katowice Voivodeship in Poland. And also the terminal in Žilina could become the input and connecting terminal for transportations in all directions and in the future it would be a part of a logistics center for the north Slovakia.

Technical specifications of the terminal [2]:

- 2 gantry cranes with crane runway length 750 m, with a lifting capacity to tow of 45 tons,
- 1 additional handling device, which would operate the space beyond the reach of cranes and it would be designed especially for handling with empty ITU´s,
- 5 handling tracks with a minimum length of 750 m, where 4 of them would be operated by cranes,
- ROLA line,
- Deposit areas within the range of cranes 31 587 m^2, to store empty ITU´s 23 817 m^2 and to deposit damaged ITU´s 8 877 m^2,
- Areas for storing swap bodies with a capacity of 33 seats,
- The road for ensuring of mutual access to the mobile front ramps for loading and unloading of road trains in the system ROLA.

Individual elements of the terminal are designed with a sufficient margin with the possibility of their extension. Terminal arrangement also provides the possibility of its extension by the logistics center. The number of handled ITU´s is expected 30 000 per year at the beginning, but this number might be increased up to 70 000 per year later. Expected completion of the terminal construction is in 2012. For the construction of this terminal are allocated total financial resources in amount 41,5 million €, where it is only public resources arising from EU resources and from the state budget of Slovakia in proportion 85%: 15%.

Calculation of expected operational necessity of same type handling devices (gantry cranes) used for the handling with ITU´s in the planned intermodal terminal Žilina is determined by the following equation [3]:

$$Z_c = \frac{N_{LO} * k_{vo} * t_{lo}}{(T - T_p) * \alpha_{pv}} * \left(1 + \frac{r}{100}\right) \tag{1}$$

where:

Z_c	Total number of gantry cranes,
N_{LO}	Average number of incoming and outgoing ITU´s per day, which is determined by the sum of loadings, unloadings and transshipments of incoming and outgoing ITU´s,
k_d	Coefficient of depositing that expresses the share of transshipments through storage area, the direct transshipment has a value of 1 and the loading or unloading has a value of 2,
k_{vo}	Coefficient of ancillary operations of the gantry crane which are not directly related to the transshipment of ITU´s,
t_{lo}	Average duration of one loading operation with ITU (loading, unloading, transshipment), it is dependent on the selected mechanization device,
T	Daily working time,
T_p	Legitimate and necessary technology breaks at work,
α_{pv}	Coefficient of operational use of gantry cranes. It characterizes whether the device actually works all the time during the shift,
r	Reserve for the planned scheduled maintenance and planned repairs of gantry crane, which are determined by producer to ensure the long existence of devices.

Sample calculation:

Value N_{LO} is greatly influenced by the coefficient of depositing, because it essentially multiplies the number actually incoming and outgoing ITU´s. Therefore k_d must be set appropriately, which is different for each category of ITU´s. For the purposes of calculating 1,4 will be the appropriate value (actual values are between 1,4 and 1,6). In determining t_{lo} several factors are operated, which are taken into account. These are speed of handling device in an empty / loaded condition, the distance that must be overcome, the method of handling and stacking. The value 4 minutes is chosen for gantry cranes. Coefficient of ancillary operations k_{vo} = 1,1. Daily working time is on average T = 12 hours (720 minutes) and value T_p is determined on 60 minutes (T - T_p = 660 minutes). Coefficient of operational use α_{pv} = 0,8 and reserve for planned repairs and maintenance is 15 %. In the calculations an average daily number of incoming and outgoing ITU´s 280 pieces will be considered (70 000 ITU´s/year : 250 days = 280 ITU´s/day).

The total number of handled ITU´s per day:

$$N_{LO} = 280 * 1{,}4 = 392 \text{ ITU´s} \tag{2}$$

Calculation of gantry cranes necessity:

$$Z_c = \frac{392 * 1{,}1 * 4}{660 * 0{,}8} * \left(1 + \frac{15}{100}\right) = 3{,}76 = 4 \text{ gantry cranes} \tag{3}$$

The calculation shows that within the expected annual number of handled ITU´s 30 000, the planned number of 2 gantry cranes and 1 additional handling device would be sufficient. However, if the annual number of handled ITU´s were increased on 70 000 pieces, it would be necessary to increase the number of gantry cranes to 4, respectively to 3 and the additional handling device would be also available.

4. Conclusion

The main assumed benefit of building modern intermodal terminals and intermodal logistics parks is expected transfer of transportations parts from the direct road transport to more environmentally-friendly rail and waterways transport. This would bring a relief of road network and also the number of road accidents would be reduced. Developed infrastructure together with logistics parks built near of intermodal terminals also creates better opportunities to use logistics services. Planned intermodal terminal is designed as a bimodal, it means it connects two modes of transport within a single complex. For that reason it is destined to yield the desired effect in the form of acceleration and improvement of transport service of the Žilina County and improvement of logistics processes in companies, which will use services of planned public intermodal terminal in Žilina.

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Technical Standards for Modernization Main Railways in Poland

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Abstract. There were specified tasks for the PKP in the light of provisions of the EU. There were described selected provisions developed by the Ministry of Infrastructure, the technical conditions to be met by the railway facilities in the construction, modernization and maintenance. There were presented Technical Standards developed by the Centre for Scientific and Technical. Document provides detailed technical specifications for the modernization of international importance (assuming a speed of 160 kmph.) in order to adapt to conditions resulting from the EU Directive 2004/50/EC and 2001/16EC and records of the Technical Specifications for Interoperability of the conventional rail (TSI CR).

Keywords: technical standards, main line, modernization

1. Tasks for PKP S.A. in the light of provisions of the EU

PKP S.A. (Polish Railway Lines) consistently implement the provisions of the European Union, as contained in the "European railway master plan for high-speed", adopted in 1990. The plan pointed out the necessity of speeding up work on building high-speed lines in the countries of Central and Eastern Europe. Poland's four rail corridors pass PAN (belonging to the railway network of ten Pan-European corridors) [1]. There were marked with numbers and relationships were:

I. Helsinki-Tallinn-Riga-Warsaw branch of Riga-Gdańsk (velocity 200-250 kmph)
II. Berlin-Warsaw-Minsk-Moscow-New Novgorod (v> 300 kmph)
III. Berlin / Dresden-Wroclaw-Lvov-Kiev (v = 200-250 kmph)
IV. Gdańsk-Warsaw-Katowice-Zilina-Budapest (v = 200-300 kmph).

Transport corridors designated in 1997 at a conference in Helsinki, with the implementation of this plan is expected in 2015. These corridors include 20 thousand km of railway lines, 18 thousand km of road, 38 airports and 48 inland waterways ports [1]. In the corridors I, II, III, IV, on Polish territory operates five international flow of traffic, which is expected to speed: 120, 160, 250, 300 and 300 kmph. These were the following strings [1]:

1) E20: Berlin-Kunowice-Poznan-Warsaw-Moscow-Terespol,
2) E30 Dresden-Zgorzelec-Wroclaw-Krakow-Przemysl-Lviv-Kiev, with a branch C30, / 1 by Nowy Sacz-Muszyna to Presov,
3) E59: Stockholm-Swinoujscie-Poznan-Wroclaw-Opole-bor-Vienna, with a branch C59 / 1 (the Zgorzelec-Zawidów) and C59 / 2 (by Międzylesie) in the direction of Prague,
4) E65: Helsinki-Gdynia-Warszwa-Katowice-Zebrzydowice-Prague,
5) E26: Wrocław-Piotrków Tryb.-Idzikowice-Warsaw-Bialystok-St. Petersburg

Adjustment program of rail lines designed to speed includes time horizons: 2005-2015 and 2015-2030, [1], which provides for the modernization and construction of new railway lines. By 2015, PKP decided to upgrade 1900 km of railway lines and build 330 km of new lines. During the year 2015-2030 is anticipated construction of new lines of high-performance service that allow driving at a velocity v ≥ 300 kmph, were intended solely for passenger traffic. One of these rail lines will be the relationship Kunowice-Poznań-Łódź-Warsaw-Terespol, which is part of the corridor, London-Paris-Berlin-Moscow. In connection with the provisions of the EU and taking into account the need to improve the quality of the services offered Polish Railway Lines and the Ministry of Infrastructure is developing new technical conditions to be met by railway structures in the construction, modernization and maintenance. These conditions are contained in the documents include:

- Id-1 (D-1), 2005, Technical maintenance and rail traffic, lines of classification, and diagnosis of geometric surfaces [2];
- D-2, 2005, the technical conditions for railway engineering structures (bridges, viaducts, culverts, tunnels, footbridges and other) [3];
- Id-3, 2009, Technical maintain the subgrade in the area of technical requirements, drainage, maintenance and repair, inspection and acceptance of works [4];

However, Center for Scientific and Technical had established a Technical Standards, which are detailed technical specifications for the modernization of international importance (assuming a speed of 160 kmph) in order to adapt to conditions resulting from the EU Directive 2004/50/EC and 2001/16EC and records of the Technical Specifications for Interoperability of the conventional rail (TSI CR) [8].

2. Id-1 (D-1) Technical conditions for maintenance of the surface of railway lines [2]

Figure 1 shown a cross section of the track double track line and first on the main straight section [2]. If the min railway was anticipated by the Guidelines for Id-1 (D-1) maximum speed of passenger trains at 200 kmph goods trains at 120 kmph, which was consistent with the recommendations of the UIC.Compensation for completing the requirements as natural environmental decision permits for the implementation of investments [4]

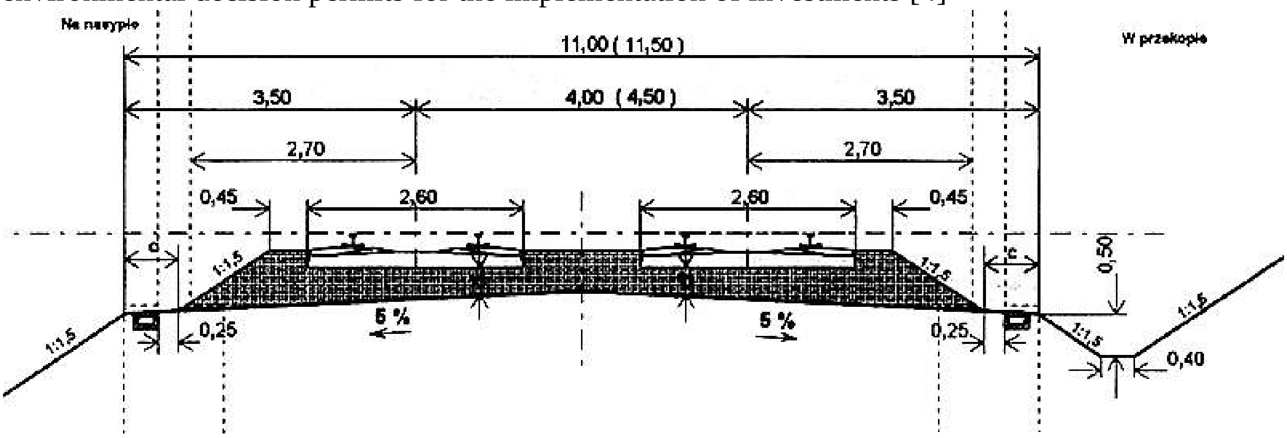

Fig. 1. Cross section of double track main and first class line on a straight stretch [2]

Technical conditions for the maintenance of surface Id-1 (D-1) [2] refer to the standard gauge railway tracks and lay down requirements for the maintenance of surface to ensure safe operating conditions of the technical and exploitation parameters set for the line. Conditions of Id-1 (D-1) contain the main part (eight chapters) information concerning: the technical requirements for the maintenance of surface,, the technical conditions of geometrical track surface diagnostics, track the welfare of non-contact conditions for the exercise of trackwork and safety conditions while maintaining surface . For the main part of the attached 17 annexes, including but not limited to: pavement design standards, pavement design elements, the technical characteristics of the rails; types of sleepers, ballast specifications, operating conditions of the track-contact, traffic signs, pavement condition evaluation criteria, principles of work acceptance procedures.

3. Specific technical conditions for modernization of the international line for velocity v_{max} = 160 kmph [8]

Study carried out by the Centre for Scientific and Technical provides technical norms and standards and detailed requirements for the modernization of railway lines covered by the AGC and AGTC (European Agreement on International Combined Transport Lines and Related Installations) adapted to the velocity v_{max} = 160 km/h [16]. Takes into account circumstances arising from the Directive 2001/16/EC of the European Union and the provisions of the Technical Specifications for Interoperability of Conventional Rail (TSI CR). The content of the paper was divided into modules, including requirements for: superstructure, substructure, gauge, intersections, facilities engineering, enclosed structures, platforms, canopies, screens, sound insulation, smaller sports facilities and bus passenger stations, equipment power supply, control devices signaling, radio communications, systems and devices wired telecommunications, technical diagnostics of vehicles, environmental elements of visual information. Each module ended with a list of related documents. A discussion of selected issues of engineering requirements

The content of the requirements is divided into chapters containing guidelines for:
- construction of bridges, viaducts and culverts railway
- the surface on the object and its approach roads.

Engineering objects may be released to service after refurbishment works when:
- their condition is at least good, which is one in which the technical parameters of the facility are consistent with the design and there is no need to reduce the projected operating conditions (speed, axle load, gauge);
- meet the requirements specified in the relevant technical conditions [D2].

Among the requirements of design deserve special attention:
- new bridges and viaducts should be designed with the bridge plate of closed construction
- in bridges and viaducts new or upgraded shock absorbers should be used with transferring large braking force directly to the wall of the outpost,
- on bridges, viaducts and culverts should be used vibroisolation and drainage systems
- noise barriers installed on civil engineering structures must be firmly attached to the beams or bridges to span load-bearing elements,
- when the modernized railway viaduct bridge or highway is located or the state road, to protect traffic against falling dirt from the bridges, all bridges should be carried out as a sidewalk full of, and barriers to the Solid web site;
- retaining walls along the tracks in excavation should be at a distance of at least 4.0 m from the track,
- on new bridges and viaducts with a length of more than 15 m should be separated sidewalks on both sides missions with a minimum width 0.75 m, protected from the edge of a bay barrier height of 1.10 m;
- supports construction of new bridges and flyovers must be designed solely as a monolithic,
- all structures shall be protected against corrosion in such a way as to the durability of this protection is at least 15 years;
- when designing new bridges and viaducts are recommended span of a mountain ride on the design:

a) slab of reinforced concrete or compressed,
b) with steel concrete girders,
c) slab-beam reinforced concrete or compressed,
d) the composite steel-concrete (steel section in a beam or a box)
e) plate with the steel bed to surface on ballast,

f) for the design of new construction is recommended for multi-span continuous regimes, instead of simply supported.

Among the requirements for the surface on the object and its approach roads are distinguished as follows:

- track on bridges and viaducts with spans spans theoretical $l_t \geq 30$ m should be placed in each bay with bilateral decrease in the longitudinal direction from the center of the span. For buildings with spans spans $l_t < 30$ m from the track can be installed in accordance with the longitudinal profile of the railway line,
- the bridges do not use the classic rail joints. The first contact rail can be placed at a distance of at least 10 m from the rear wall of the bridgehead. The same rule applies just the beginning or end of the track-contact and turnout;
- allows the use of bridges of welded rail joints by electro-resistive or termite welded the requirements specified in the relevant standards, instructions and guidelines,
- compensatory instruments and rails for civil engineering structures to be used in accordance with the principles laid down in the technical conditions,
- in areas adjacent to the use of engineering design to allow for a gradual change in stiffness of the substrate (for example, the transitional board).

4. Interoperability and technical standards for high-speed rail

Interoperability according to directive 96/48/EC of the European Parliament and Council of the EU means the ability of trans-european railway system to enable the safe and uninterrupted movement of trains, ensuring the required size of the performance (speed, etc.) [6]. Interoperability requires that technical and organizational conditions. To specify these conditions, the railway system was divided into subsystems, for which the requirements are included in the technical specifications for interoperability (TSI) [6]. TSIs contain the essential requirements for the subsystems [6]: infrastructure (railway), energy (traction power), traffic control systems (ETCS and GSM-R drive safely control the transmission of track-vehicle), rolling stock, traffic management and telematics applications

The technical specifications for interoperability were appointed to European standards, which were contained details necessary technical standards. Each TSI wre based on the state of the art review of an existing subsystem and indicate the final solution, which can be achieved gradually in a reasonable timeframe. It was noteworthy that for high-speed rail specifications apply to the currently selected which relate to one and the other one: conventional and high speed. This could be the TSIs of safety in tunnels.

Currently, the EU railway managements are working on the gradual development of common methodologies to ensure the safety of railway traffic. These methods were based on the principles laid down in Directive 2004/49/EC on safety in rail transport. Entering this system into practice based on joint ventures, characterized [6]:

- CSI safety indicators (number of accidents, victims, etc.)
- the safety objectives of CST, formulated in relation to the risks
- methods to ensure the safety of the CSM

5. Conclusion

Against the background of the tasks for the Polish Railways Lines in the light of the EU were presented, inter alia, technical standards developed by the Centre for Scientific and Technical. Document provides detailed technical specifications for the modernization of international importance (assuming a speed of 160 kmph) in order to adapt to conditions resulting from the EU

Directive 2004/50/EC and 2001/16EC and records of the Technical Specifications for Interoperability of the conventional rail (TSI CR).

The Polish railway documents increasingly appears to require more speed, which in turn is a measure of modernity [5, 6, 7, 9, 10]. In these Technical Conditions of Id-1 (D-1) introduced a speed of 200 kmph. Velocity ≥ 300 kmph was a challenge in developed in 2005 by the Centre for Scientific and Technical pre-feasibility study for a railway line Wroclaw / Poznan-London-Warsaw [5, 7]. This means that the PKP SA properly treat the provisions of the UIC.

Construction of high-speed railways in Poland must be preceded by the development of an appropriate system standardization, based on legal regulations [6]. In that regard, it is an opportunity to benefit from the experience of EU countries, which for many years exploited the high speed rail. In Poland, the Office has been running for High-Speed Train (BLDP) [6], which is currently preparing the national legislative system (bearing in mind the existing EU ETS) and internal control system for future high-speed rail infrastructure manager. Measurable effect of BLDP operation will be consistent set of requirements for high-speed rail in the Polish conditions [6].

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We support research activities in the Slovak Republic/Projects are co-financed from the EU funds.

Title: Implementation of scientific research knowledge to the Air Transport

Code ITMS: 26220220010

Objectives: The main project objective is to design technological processes with the aim of enhancing operational efficiency and safety of air traffic, which is in line with the global objectives of the Operational Program for Research and Development OPVaV-2008/2.2/01-SORO . The basic objectives include the development of monitoring and evaluation system for condition of the aircraft's power units that will have an impact on flight safety and increase of energy efficiency of the flights in the future. An important part of the project is the creation of favourable conditions for application of knowledge, acquired research and development activities into the educational process of professional staff in the field of transport.

The project is co-financed from EU funds supporting research activities in the Slovak Republic.

The Air Transport Department of the University of Zilina works on this project in cooperation with the Flight Training and Education Centre – the Air School of the University of Zilina.

Title: Centre of excellence for Air Transport

Code ITMS: 26220120065

Objectives: The project is based on defined needs and is elaborated in accordance with the "long-term goals of the state's science policy until 2015, both in the area of technical infrastructure as well as in the field of human resources in science and research, and in the institutional framework. Project objectives are in accordance with the global objective of the Operational Programme for Research and Development OPVaV-2009/2.1/03-SORO, specifically:

- optimization of transportation needs of society, development and implementation of intelligent transport systems,
- planning the future development of transport considering the social, economic and environmental impact.

The project aims at improving the quality of aviation research organisation focusing on the area of infrastructure and planning of the future transport development considering the social, economic and environmental impact.

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Options of Data Using from the Self-diagnostics System

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Abstract. Article discusses the possibility of internal diagnostics devices using for other tasks (eg driving test). The control unit processes information from a variety of sensors in the vehicle, which it needs to its operate. With connecting of suitable technique to the control unit we can monitor these values. In some cases these values can be also recorded and then evaluated. Values from the vehicle control unit and value measured with external device were compared by experimental measurements.

Keywords: On-board diagnostic, diagnostic tools, engine speed.

1. Introduction

On-board diagnostics refers to the systems on the vehicle carrying out some form of self-monitoring. The more complex automobiles become, the greater the number of electronic systems and the more difficult it is to register the actual condition in case of a defect. Many connecting cables and adapters are required to achieve this. Data about the different systems and their working together is needed to allow a system specific diagnosis. Modern electronics with self-diagnosis supports the technician by registering actual values, comparing them with the nominal values, and diagnosing faults that are stored for repair purposes.

2. Self-diagnostic (On-board diagnostic)

The term on board diagnostics refers to the self-diagnosing capabilities that are carried in the computers on the vehicle, and the aids that are provided to make the diagnostic data available to authorized users. Off-board diagnostics is equipment such as scan tools, oscilloscopes and other test equipment. In most cases both types of equipment are required for vehicle repair work. To date (January 2000) there have been two versions of OBD, i.e., OBD I and OBD II. Both apply to the USA, but introduction of similar legislation for Europe is imminent.

2.1. OBD I

This required vehicles produced from 1988 onwards to be equipped with electronically (computer) controlled systems that were capable of monitoring themselves. Any malfunction (defect) that affected exhaust emissions must be displayed on a warning lamp, known as the malfunction indicator lamp (MIL), on the dashboard. The malfunction must be stored in the ECM's memory and it must be readable with the aid of 'on board' facilities, e.g. a flash code on a lamp.

2.2. OBD II

OBD II strengthens the requirements of OBD I on vehicles of model year 1994 and afterwards. OBD II applies to spark-ignition cars and light vans, and from 1996 onwards to diesel-engined vehicles. The main features are that the following emissions related systems must be continuously monitored:

- combustion
- catalytic convertor

- oxygen (lambda) sensors
- secondary air system
- fuel evaporative control system
- exhaust gas recirculation system

3. Tools and equipments

As the complexity of the modern vehicle continues to increase, developments in suitable test equipment must follow. Many mechanical and electronic systems now have ECUs, that contain self-diagnosis circuits.

The test equipment on the market can be subdivided into two main categories:

● hand-held or portable instruments;

● stationary equipment.

Hand-held instruments are commonly used for the control of engine functions like ignition or fuel injection and the request of error codes from the ECUs. Stationary test equipment may be able to cover the whole range of function and performance checks of the engine, gear, brakes, chassis, and exhaust monitoring. Most of the common testers are used for diagnosing engine faults.

Currently, there are many diagnostic systems that are installed using the CD or DVD directly to the PC (usually a laptop). The advantage of these facilities is their possible use in driving tests and recording of different values to the PC and their subsequent evaluation.

3.1. Tools function

In general, diagnostics device contains the following features:

- Read identification- Displays complete identification of control unit, e.g. part number, software/hardware version, manufacturer, etc.
- Read fault codes- Displays all stored and pending fault codes with complete description (e.g. "Rail pressure - too low pressure"). Program supports report printing or copy to clipboard.
- Clear fault codes- This function clears all stored fault codes and other diagnostic information.
- Auto-scan (complete car test)- Detects all ECUs (electronic control units) installed in car and reads all diagnostic fault codes.
- Measured Values- Program displays live data like engine speed, battery voltage, oxygen sensor, coolant temperature, etc. Logging to file is also supported, which allows offline analysis.
- Actuator test- Actuator test activates particular actuator (e.g. turn on fuel pump, lock/unlock wheel, lock/unlock doors, cut off fuel, etc.)
- Programming functions/Adaptation- This feature is of great importance in all vehicles because systems like engine control units, immobilizers, airbags, alarms, body control units, and some others, require you to perform reset or programming procedures after car repair is done, or even configuration after replacing broken control unit.

Measure values is very useful feature of diagnostic tools. For example, the diagnostic program Lexia allows to measure and record 6 parameters. These parameters are divided into vehicle systems. Figure 2 illustrates the engine speed and injection time in the time scale.

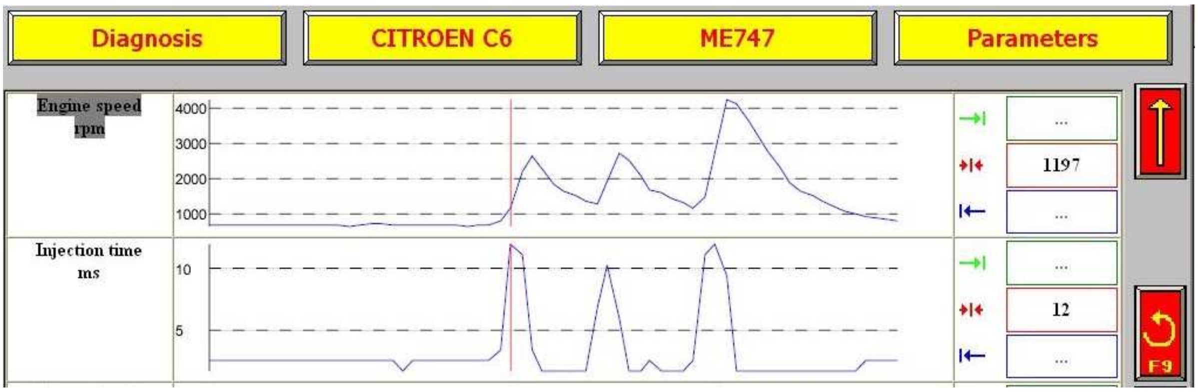

Fig. 1. Diagnostic software Lexia

4. Measuring

For measuring we used diagnostic technique Lexia intended for Citreon and Peugeot. The aim was to compare the speed of the vehicle engine Citroen C6 measured with Lexia and with external engine speed Brain Bee MGT 300 / R. Recording spent 90 seconds and the engine speed was gradually increasing according to Table 1. The table contains the values only range from 40 to 60 seconds because of the large scale of data. Complete graph of engine speed is on the Figure 2.

Time (sec.)	41	42	43	44	45	46	47	48	49	50
Lexia (1/min)	2600	2840	2960	3000	3000	3000	3000	3000	2960	3000
MGT 300 (1/min)	2320	2670	2950	3010	3030	3040	3030	3030	3030	3010
Time (sec.)	51	52	53	54	55	56	57	58	59	60
Lexia (1/min)	3240	3960	4160	3920	4080	4080	4040	4080	4080	4120
MGT 300 (1/min)	3030	3510	4020	4070	4050	4130	4100	4090	4110	4170

Tab. 1. Values of engine speed in range from 40 to 60 second

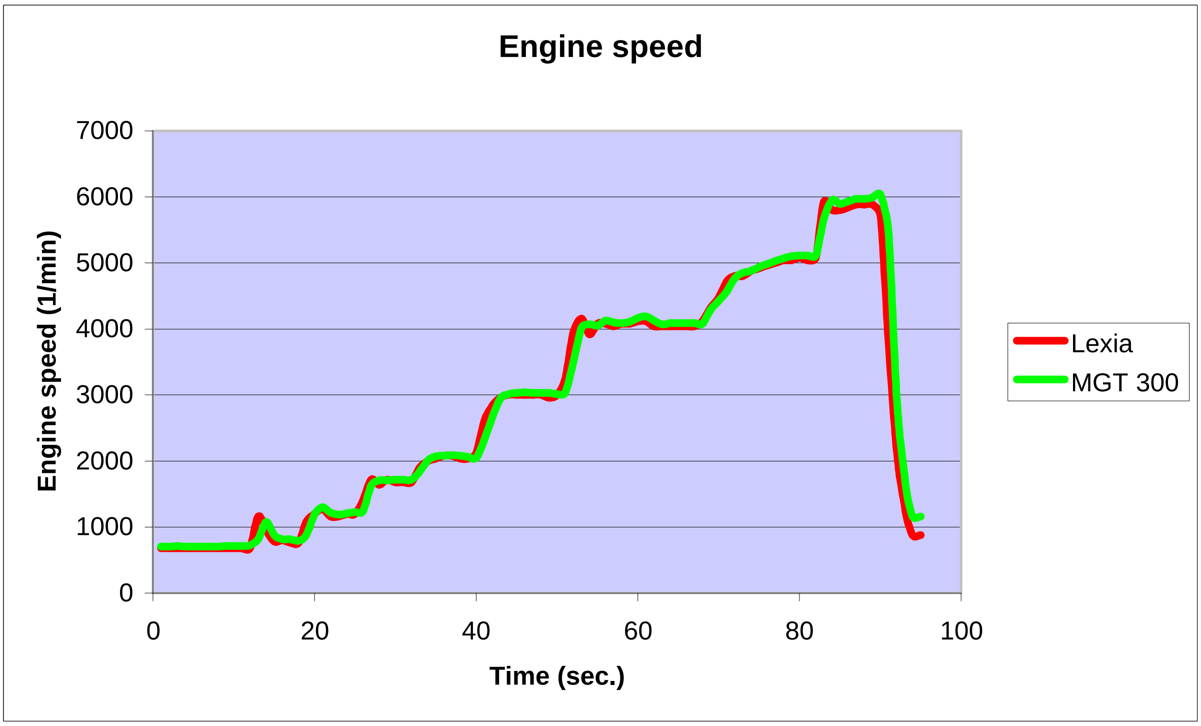

Fig. 2. Engine speed

On the graph we can see that data from Lexia and MGT 300 are almost identical. Small differences are only in the sudden increase or decrease of engine speed. It is caused by different sampling frequency of these two devices. In the steady engine speed, difference is very small.

5. Conclusion

Diagnostic software enables us to read data from the control unit. In the case of software Lexia we can view maximum 6 parameters, which can be recorded and then evaluated. During the driving test can be very useful data from the control unit, eg. on vehicle speed, engine speed and others. They can be used as supplementary or expanding data in tests like:

- measurement of fuel consumption
- measurement of braking deceleration
- measuring the acceleration of the vehicle

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Min-Max Approach for Evacuation Problem Supported by BB-Search

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Abstract. This paper deals with evacuation plan design. The plan is needed for efficient perform of evacuation. Here is shown min-max approach for solving evacuation vehicle assignment problem. This problem comprises a key part of evacuation problem from operational research point of view. Branch and bound method is used for finding integer solution. The paper also deals with improvement which reduces amount of computational time which is required by this method.

Keywords: evacuation plan, vehicle assignment, integer programming, min-max approach, computational time saving.

1. Introduction

In case of emergency when people who are located in any geographical area are endangered by some thread (natural disaster or industrial accident) evacuation must be performed. The evacuation allows us to prevent death toll and to minimize bad consequences of that emergencies. In order to evacuation can be performed it is needed to create an evacuation plan for particular emergency in the shortest time as possible. The time includes time for creating input data and computational time which is needed for solving the problem. One way of solving the evacuation problem is to create linear model which describes the problem. The problem can be subsequently solved by some general optimization software. This kind of informatics decision support systems are often used for solving many types of problem [1] [2] [3] [4] and [5]. But they are not suitable for people who do not have operational research knowledge and are not practical for common using because they require special input data preparation which can consume a lot of time. Other way is to create specialized decision support system given for solving mentioned problem. That system requires specialized algorithm for its completion. The algorithm which we deal with in this paper is based on the min-max approach for solving the evacuation vehicle assignment problem. This problem comprises key part of evacuation problem from operational research point of view. The object of evacuation problem is to minimise total evacuation time.

2. Problem Formulation and Model Building

Let us assume a set J of municipalities which are created by dividing endangered dwelling places into the parts which contain less number of inhabitants. These municipalities can be evacuated independently. Each municipality j has population b_j inhabitants who must be evacuated to the refuge. The refuge is pre-assigned to municipality in advance. Let us also assume a set I of homogenous fleets where each fleet i contains number N_i vehicles and each vehicle has capacity K_i. Symbol t_{ij} denotes the time which a vehicle from fleet i needs to traverse to municipality j and symbol s_j denotes the time which a vehicle needs to traverse between municipality j and the refuge which was pre-assigned to the municipality. Let us denote with symbol q_{ij} number of vehicles from fleet i assigned to municipality j. We require satisfaction of next precondition: if some vehicle is assigned to municipality j then the vehicle can not be assigned to another municipality $j` \in J$, $j \neq j`$. A vehicle assigned to municipality can visit this municipality more than one time (see **Fig. 1**). The objective of the evacuation vehicle assignment problem is to assign appropriate number of vehicles from fleets $i \in I$ to municipalities $j \in J$ so that every inhabitant from all municipalities is saved and the total time of evacuation is minimal. Authors in [3] created complex model which is, however, nonlinear. They showed way how to transform the model to linear one, but the computational time required for solving the problem is still too big.

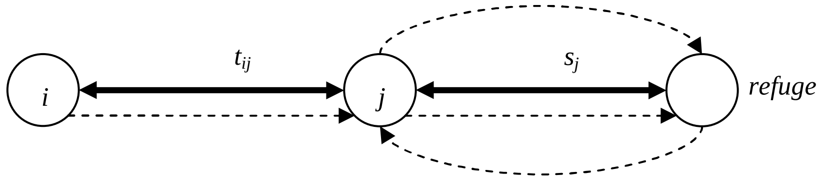

Fig. 1 Route of a vehicle from fleet i with two visits in municipality j

We transform the complex vehicle assignment problem to the reduced problem. In this problem we just try to perform evacuation into the maximal predetermine time which let us denote with symbol T^{max}. Solving of this reduced problem for suitable values of the times T^{max} comprises iterative process [1] [6] [7] for optimal solving of the complex vehicle assignment problem with demanded accuracy. If the maximal evacuation time T^{max} is given we can determine value of coefficient $P_{ij}(T^{max})$ which represents total number of visits for a vehicle from fleet i in municipality j into the time T^{max} accordingly to (1).

$$P_{ij}(T^{\max}) = \max\left\{0;\left\lfloor \left(T^{\max} + s_j - t_{ij}\right)/2s_j \right\rfloor\right\} \quad (1)$$

Vehicle from fleet i is able to evacuate $a_{ij}(T^{max}) = P_{ij}(T^{max})K_i$ inhabitants from municipality j into the time T^{max}. Symbol $a_{ij}(T^{max})$ depends on the time T^{max} but it is convenient to omit the symbol T^{max} and just to write a_{ij}. The objective for the time-constrained reduced problem of vehicle assignment (2)-(4) is to find feasible solution or prove that not exists.

$$\sum_{j\in J} q_{ij} \le N_i \qquad for\ i\in I \quad (2)$$

$$\sum_{i\in I} a_{ij} q_{ij} \ge b_j \qquad for\ j\in J \quad (3)$$

$$q_{ij} \in Z_0^+ \quad for\ i\in I,\ j\in J \quad (4)$$

3. BB-Search for Time-Constraint Feasible Solution

We reformulate the existence problem (2)-(4) to minimization problem (5)-(10) by following way. We introduce fictive municipality r and artificial fleet s and slack variables q_{ir} for $i\in I$ and artificial variables q_{sj} for $j\in J$. Model of the minimization problem is

$$\text{Minimise } \sum_{j\in J} q_{sj} \quad (5)$$

$$\text{Subject to } \sum_{j\in J} q_{ij} + q_{ir} = N_i \quad for\ i\in I \quad (6)$$

$$\sum_{i\in I} a_{ij} q_{ij} + q_{sj} \ge b_j \quad for\ j\in J \quad (7)$$

$$q_{ij} \le S_{ij} \quad for\ i\in I,\ j\in J \quad (8)$$

$$q_{ij} \in Z_0^+ \quad for\ i\in I,\ j\in J \quad (9)$$

$$q_{sj},\ q_{ir} \ge 0 \quad for\ i\in I,\ j\in J\ . \quad (10)$$

Coefficient S_{ij} represents reasonable upper bound of value q_{ij}. The problem (2)-(4) has feasible solution if and only if the problem (5)-(10) has optimal solution with value of the objective function (5) equals to zero.

Let us assume non-integer solution $\{Q_{ij}\}$ of the LP relaxed problem (5)-(10). One of the non-integer value q_{vw} from $\{Q_{ij}\}$ must be chosen for branching. The first branch is formed by integer solutions of (5)-(10) which additionally satisfy (11). Integer solutions of the second branch have to additionally satisfy (12).

$$q_{vw} \leq S_{vw} = \lfloor q_{vw} \rfloor \quad (11)$$

$$q_{vw} \geq R_{vw} = \lceil q_{vw} \rceil \quad (12)$$

As concerns the second branch, the following transformation for pair (v, w) is needed in order to the model (5)-(10) can be applied. The values N_v, b_w and S_{vw} must be reduced according to these formulaes: $N_v := N_v - R_{vw}$, $b_w :=$ max$\{0, b_w - a_{vw}R_{vw}\}$, $S_{vw} := S_{vw} - R_{vw}$.

In the original approach the solving process starts with the "empty" solution where the values q_{ij} are equal to zero for $i \in I$, $j \in J$ and only the values q_{ir} and q_{sj} are equal to value N_i for $i \in I$ and b_j for $j \in J$ respectively. The alternative approach which should save required computational time uses non-integer solution $\{Q_{ij}\}$ which was obtained just before branching. The inheritance of non-integer solution is used only during down progress in the searching tree. But its combination with depth searching tree scheme gives memory undemanding way of compress of computational time which is required for finding a feasible solution.

An initial non-integer solution for the first branch, where the constrain (11) is added to the model (5)-(10), can be created by the following transformation of $\{Q_{ij}\}$:
$q_{vr} := q_{vr} + q_{vw} - S_{vw}$; $q_{sw} := a_{vw}(q_{vw} - S_{vw})$ and $q_{vw} := S_{vw}$.

An initial non-integer solution for the second branch, where the constrain (12) is added to the model (5)-(10), can by created by the following transformation of $\{Q_{ij}\}$:

1. Set $q := R_{vw} - q_{vw}$
2. Set $u := min\{q, q_{vr}\}$; $q := q - u$ and $q_{vr} := q_{vr} - u$
3. While $q > 0$ do
    for $k \in J - \{w\}$ where $a_{vk} > 0$ do
        $u := min\{q, q_{vk}\}$; $q := q - u$; $q_{vk} := q_{vk} - u$ and $q_{sk} := a_{vk}u$.

After reduction of the coefficients N_v, b_w and S_{vw} the value of q_{vw} is set to zero. This transformation can be applied only under assumption that $N_v \geq q$, where q is the value calculated in step 1. In the opposite case the branch has no feasible solution.

4. Numerical Experiments

To verify the suggested way of computational time compression were performed experiments on a personal computer equipped with Intel Pentium 4 with parameters 2.41 GHz and 1 GB RAM. Five instances of evacuation problem formulated on Slovakia transportation network were solved in two series. The computational time needed for finding non-integer solution was measured during the solving process. The instances were solved without inheritance of non-integer solution in the first series and with suggested inheritance of non-integer solution in the second series. The results of performed numerical experiments are presented in **Tab. 1** where *Fleets* means number of fleets, *Munic.* means number of municipalities, *Depth* means depth in searching tree in the branch and bound method where was observed the biggest number of inheritance of non-integer solution. The depth is given by interval *From-To* (root of the tree has depth equals to zero). *Weigh. avg. comp. time* means weighted average computational time required for finding non-integer solution in depth of searching tree which is given by the interval *Depth*. *Percentage comp. time saving* is saving of the computational time given in percents which was achieved by using the principle of inheritance of non-integer solutions.

As can be observed in **Tab. 1**, the suggested way of computational time compression has saved the computational time required for finding non-integer solution. When we consider that the solving process of branch and bound method may explore big number of searching tree nodes and that exploring of a searching tree node requires for finding a non-integer solution, we can obtain considerable computational time saving. Moreover, the suggested way is not memory demanding if it is used with the depth searching tree scheme.

Instance	Fleets	Munic.	Depth		Weigh. avg. comp. time [millisecond]		Percentage comp. time saving [%]
			From	To	Without inheritance	With inheritance	
04	7	16	28	43	0.195	0.088	54.83
08	10	16	25	39	0.117	0.049	57.69
09	10	17	35	54	0.374	0.061	83.77
16	10	24	36	51	0.125	0.061	51.22
19	4	15	21	48	0.047	0.018	62.07

Tab. 1 Results of numerical experiments

5. Conclusion

We have suggested the approach which can be used for solving the evacuation vehicle assignment problem with min-max criterion. Essence of this approach is the iterative process which searches for such vehicle assignment so the total evacuation time is minimal. In every step of the process is searched the time-constrained feasible solution of the reduced problem by branch and bound method. The method searches for a non-integer solution in every searching tree node. We have suggested and tested the approach which uses inheritance of non-integer solution obtained before branching for faster searching for non-integer solution in the descendant branch. This approach seems to be promising way of computational time saving.

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Kia Motors Slovakia Corporation and Logistics Technologies

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Abstract. Nowadays, Kia Motors Slovakia Corporation utilizes three types of logistics technologies: JIT, JIS and combined transportation. Each technology mentioned is specific one. It has its advantages and disadvantages, uses its own technology strategies. Significant factor while choosing the strategy is represented by expenditure on: transportation, storage, order processing, information system and store maintanance.

Keywords: logistics technology, JIT, JIS, combined transportation

1. Introduction

Kia Motors Slovakia Corporation (KMSC) belongs to the corporations employing logistics technology JIT that has not been used in Korea yet. Slovakia has the status of the first country which has adopted mentioned technology. Despite the fact implementing itself was hard enough and required enormous financial investments, management of the corporation agrees it has been profitable. One year represents minimum time necessary to implement JIT, JIS (Just in Sequence) and SAP (planning, finance, employees) technology. Before the JIT technology was implemented, the Kanban technology had been used and is still used nowadays. Kia Motors Slovakia Corporation deals with logistics planning by means of JIT, JIS.

2. Works

JIS realization is based on the sequences, it means, each vehicle goes through automatic scanner- bar code (every bar code is specific and in accordance with it the order is forwarded). When certain number of sequences (1 till 12 segments) is downloaded, automobile is dispatched to import required components. Certain means the number of items which can be delivered in one vehicle. Purchase order is arranged according demand (i.e. in order it was downloading, based on coloured and specific layout). To make this transaction, provider is given about one hour. Provider has to load and deliver demand in required amount and time. Therefore the JIS providers are situated around the factory. Johnson Control (global diversified corporation operating in building and automobile industry) and Pactra Logistics conduct the JIS technology for Kia Motors Slovakia. Contractor carries out everything involving consignation and installation (preparing, loading, distributing, unloading, carrying to assembly line).

Components can be considered as the property of Kia Motors Slovakia since they were installed into certain vehicle. Since the corporation was established, it has never had any difficulties with bar codes.

Kia Motors Slovakia employs so- called CKD components which are distributed by combined transport technology to factory storehouse in advance (import is from other states- the USA, China, Turkey, Korea).

Peugeot company functionates alike principle. It also employs JIT, JIS and Combined Transport technology.

For the respected approach in order to deal with consumer`s demands, there are two ways of production and delivery realization. Its profit should be counted over and considered its conduct and organization expenditure. It is so-called:

- synchronizing and
- emancipatory strategy JIT.

If the provider decides to carry out synchronizing strategy JIT, his function is to produce and dispatch immediately the precise amount in agreed frequency. The results of this strategy are:

- lower expenditure on storage
- higher expenditure on lesser amount production
- higher expenditure on amount transportation.

If the provider chooses emancipatory strategy JIT for production and delivery services, then it produces some amount at once with lesser production expenditure. Provider stores the produced amount in its own place and dispatches it in fractions to the consumer. The process is done in agreed amount and frequency. The results are following:

- higher expenditure on storage
- lesser production expenditure
- provider`s flexibility in case of fluctuation of consumer`s consumption

Based on stated options and revealed facts we can affirm Johnson Control Company employs emancipatory strategy JIT.

2.1. Contributions from implementing technology JIT

Technology JIT usually brings pull system into production process, i.e. to adjust production to pre- known demand. Contributions of JIT system are following:

- considerable supply decrease,
- significant shortening of the material flow period,
- reduction of the space needed in production process,
- productivity enhancement and better level of management,
- marked enhancement of stock turn.

JIT system emplementing in Kia Motors Slovakia Corporation has cut down distribution and transportation expenses. It has also increased provider`s product quality and decreased number of providers and carrying agents.

In Sixt`s and Mačát`s literature [1] it is said that the similar success in implementing technology JIT was reached by Rank Xerox Manufacturing (Nederlands) and Ford Motor Company. Rank Xerox Manufacturing, common company of American firm Xerox Corporation and British one Rank Corporation, which is the biggest part of the Xerox concern outside the USA. It produces and refurbishes copy machines that are distributed all over the world. This company was implementing JIT technology almost entire period of 80s.

Another function of JIT technology was to install automatic operating system and inforamtion processing system. At the same time production procedures were also modified. In consequence of implementing JIT technology and other system changes Rank Xerox has achieved these results:

- provider`s number has been reduced down from 3000 to 30
- 98% of supplies were distributed on time, in which 70% of the material was delivered in one hour from the time when demand was entered
- store supply amount was reduced down from 3-month-cubature to half-month one
- the whole expenses on material were reduced down more than 40%
- most control points for product take over could be closed since quality of delivered material has increased markedly
- percentage of returned material (defective or low-class) was reduced down from 17% to 0,8%

- 40 pre-packing positions could be cancelled because standardized criteria for material packing was used instead.
- costs of delivering material to the company were cut to 40 %
- consignment output on time to the company increased about 28%

2.2. Problems related with implementing of JIT technology

No technology is ideal, therefore JIT technology mentioned has its problematic areas. Among negative consequences and problems in asserting JIT technology belong:

- fact, that especially in our conditions it makes our roads overcrowded by lorries, vans and their capacity is run out quicklier
- negative exhalation effect from exhaust fumes, noise and accidents caused by bigger number of vehicles on the roads , life and health hazard, environmental pollution
- emerging problems when timetable is followed by crossing some borders in heavy traffic of urban concentration

These problems can be summarized into three categories:

- factory production planning
- provider production plans
- provider`s placement

Kia Motors Slovakia Corporation utilizes combined transportation within delivery of CKD (Complete Knock Down) components from Korea to Žilina. The main characteristic feature is long-term delivery.

2.4. Forms of CKD components transportation from Korea

1) Ship Transport

Pusan (Korea)- Koper (Slovenia)- Žilina (Slovakia)- essential capacity of transportation CKD components from Korea to KMSC. Transport time (Pusan- Koper) is 25- 27 days.
Transport of material Koper- Žilina is realized in two ways:

- rail transport (Koper- Žilina or Koper- Dunajská Streda- Žilina),
- road transport (directly Koper- Žilina).

Pusan (Korea)- Bremerhaven (Germany)- Žilina (Slovakia)- extraordinary circumstances only Transport time is approximately 30 days. Material transport from Bremerhaven to Žilina is accomplished either by railway or road. Pusan (Korea)- Hamburg (Germany)- Žilina (Slovakia)- extraordinary circumstances only. Transport time is approximately 30 days. Material transport from Hamburg to Žilina is accomplished again either by railway or road.

2) Air Transport

Seoul, Incheon (Korea)- Vienna (Austria)- Žilina (Slovakia)
- air transport is accomplished in urgent cases, mainly when KMSC production is at risk
Air transport is combined with road transport. The transport change is conducted at Vienna terminals. Transport of material from Vienna to Žilina is accomplished by road transport (trucks). It is carried out by agreement corporations such as Pactra Logistics.

2.5. Costs related with utilization of logistics technology in chosen companies

Logistics with minimal total expenses is such a phase, when the total amount of logistics costs is minimalized as the level of scheduled customer service is achieved. For successful implementing analysis of the commitment cost, relevant data about particular costs have to be available to the management. Management should not establish policy of amount and turn-over of supplies arbitrary, but based on good quality knowledge about maintenance costs, total cost of logistics system and strategy necessary for customer service.

Marketing goal is to allocate resources within marketing mix in a way to minimalize long-term company profitability.

Logistics goal is to minimalize total costs when we reach required level of customer service while i tis stated that total costs= transport costs+ inventory costs+ purchasing services and information systems costs+ quantitative costs+ supply maintenance costs

Transportation costs are represented by activities referring to product transportation. These costs are changeable according to:

- consignment capacity
- consignment weight
- transportation distance
- initial and final destination

Important factor which determines transportation costs is chosen way of transportation.

Inventory costs emerges in store and store away process. They are determined by choice of production capacity and store place. They includes all costs arising from number and store place changes. Most companies use storehouses to achieve the lowest total logistics costs and along with that to quarantee scheduled level of customer service. Therefore we need to consider all commitment costs.

Purchasing services and information system costs comprise group including costs connected with following functions:

- purchasing service
- logistics communication
- demand forecasting

Purchasing costs are related to functions such as : order handover, order entry into system, order processing, delivery notification to carrying agents and customers.

Nowadays a lot of carrying agents invest considerable financial means into improvement of their information systems in order to provide such technologies as: [2]

- EDI (electronic data interchange)
- satellite data interchange
- bar code use and its scanning

Automation and integration of order process is expressed by the fact that it saves time, reduce probability of information delay, help management integrate logistics system and reduce costs (reduce supplies, transportation tariffs...). Communication system is key factor in effort to minimalize total logistics costs.

Quantitative costs have their origin in amounts of purchase or production process. They are costs realted to changes in purchase amount and production. It involves following entries:

- preparation costs
- capacity losses caused by dropout errors
- material manipulation, planning and despatching
- price differences incurred by purchase of various amount
- order costs associated with demand of various amount

It is not possible to look at these costs separately as they can affect other costs. Therefore i tis essential to investigate impact of one type of cost to another ones.

Store maintenance costs have direct impact not only on number of storehouses which the company maintains, but also on other logistics strategies, including store depletion and also customer service costs. JIT implementation in production and business corporations has direct impact on particular logistics sections as well as storage area.

Since store reduction and more flexible logistics systems in JIT systems are emphasised, there are higher requests for storage in means of its efficiency and capacity value. Among these higher requests we can integrate:

JIT insists on higher requests for storage and material manipulation

- *Maximal emphasis on quality*. Store workers have to carry out their tasks consistently in input and output store operations at the level required by customers
- *Reduced amount of production series*. Items are packed in smaller amounts, storage consignments are generally smaller and they are stored in various amounts
- *Elimination of activities which do not add value*. All redundant and inefficient activities in physical motions and product manipulation are identified and consequently eliminated. The result is seen in improved storage organization and increase of effectivity in storage operations.
- *Fast motion / material flow*. JIT stresses low or zero-rated supplies so not the product storage but the function of combination and product transfer prevail.

3. Conclusions

Logistics with minimal total expenses is such a phase, when the total amount of logistics costs is minimalized as the level of scheduled customer service is achieved. For successful implementing analysis of the commitment cost, relevant data about particular costs have to be available to the management. Management should not establish policy of amount and turn-over of supplies arbitrary, but based on good quality knowledge about maintenance costs, total cost of logistics system and strategy necessary for customer service.

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The Tire Unit Costs in the Transport Company

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Abstract. For seamless operation of the company carrier must spend a certain amount of money. They are represented by cost. Important place in a calculation formula of transport company the tire costs have. Minimize these costs can by achieved by appropriate manner of recovery tires, which has the effect of reducing the overall costs and thereby to increase the competitiveness of the transport company.

Keywords: Tire, costs, cutting of, retreading.

1. Introduction

Currently, the road freight due to high competition, the position of the carrier's very difficult to remain on the market. Offer price, based on the market is therefore only possible if the implementation of high performance, which may be fixed costs allocated over the high mileage, or look for possible reserves to reduce costs in all cost components.

In practice today says most of the cost of fuel, or costs for using the road network are significantly higher mainly in domestic traffic. In addition to these cost items that make up the largest share of total costs, can optimize the costs of other cost items, which include the cost of tires.

2. Selection of suitable housing for specific operating activities

In the matter of what kind of activities carried out by individual carriers, would be collected and used tires to their vehicles. In the event that it is a carrier engaged in international road freight transport should choose gowns that have a long lifetime, or less resistance rolling, which is also reflected in lower fuel consumption. Conversely, if we take into account the carrier, which carries regional traffic, implement and freight on the unpaved road, it is preferable for such carrier to use the cheapest tires, because the results is greater likelihood of mechanical damage to the tire than the tire tread wear [2].

Taking into account the life of plastic used on each axle, which is published by the company Matador, Table 1, and these values considered in a model example, where the case of a vehicle carrying road freight transport, we can calculate the cost per kilometer of traveled distance with this vehicle.

Mode of transport	Steering axle [ths km]	Driving axle [ths km]	Trailing axle [ths km]
Haulage	140 – 180	150 – 190	180 – 280
Regional transport	90 – 130	120 – 160	*
Mixed transport	60 – 120	80 – 140	*
Urban transport	80 – 140	*	*

Tab. 1. Lifetime of tires by mode of transport and location of tires (Matador)

3. Model example for the calculation of unit costs

3.1. Buying new tires

Vehicle / axle	Number of tires [pc]	The average price of new tire [€ / tyre]	Average life of the tire [km]
Towing vehicle			
Steering axle	2	384	160 000
Driving axle	4	394	170 000
Semi-trailer			
1. trailing axle	2	366	230 000
2. trailing axle	2	366	230 000
3. trailing axle	2	366	230 000

Tab. 2. Average price and average life of tires (Source: Author)

Vehicle / axle	Number of tires [pc]	The average price of new tire [€ / tyre]	Average life of the tire [km]
Towing vehicle			
Steering axle	2	0,00240	0,00480
Driving axle	4	0,00232	0,00928
Semi-trailer			
1. trailing axle	2	0,00159	0,00318
2. trailing axle	2	0,00159	0,00318
3. trailing axle	2	0,00159	0,00318

Tab. 3. Unit cost of new tires (Source: Author)

3.2. Extension of tire life

With the improving of the life of tires in kilometers, the unit cost of the tire, expressed in euros per kilometer is the lower. Tire life extension is possible by the cutting of, or retreading.

Based on an analysis survey conducted a technical seminar "Current issues in road transport business in 2003" among 8 bus carriers who operate with 1628 buses and 39 freight carriers, with 496 vehicles, it is possible to maintain the following information:

- tires at cutting of, their lifetime is extension approximately about 30%
- for retreading tires we can extend that their lifetime will be extension about 70%.

Despite the claim of several producers of retreaded tires, tire retreading, that amounts to lifetime again as a new tire, the survey results showed that the retreaded tires to reduce tire lifetime by an average of 70%. The survey also found that higher lifetime achieve retreaded tires in the bus transport than in road haulage.

Determination of unit costs in € / km deepen tread

Retreading can also be combined with cutting of, which is deepening the tread, the sidewall of the tire must be REGROOVABLE inscription. If we consider that the network Pneubox tire service is the price of one eruption groove 22,5-inch the tire, € 8,5 and these tires have 4 to 5 slots pruning to, eruption one tire price is € 34 to € 42,5.

As it was mentioned above, the cutting of the carrier can increase lifetime by up to 30%. Tires on the steering axle to which the author probes have 4 grooves that can prune. Price eruption of one such tire is € 34. It follows that a 30% lifetime tire carrier pays only about 8.9% of the price of of a new tire. More than half of the tires on the drive axle to which the author thinking has 5 slots, which can be cut, therefore the calculations it is considered that the slit can be 5 slots and cutting price of one tire is therefore € 42.5. It is clear that in 30% of the life of tire on his tractor driving axle carrier will pay only 10.8% of the price of new tire. Similarly, it is also the trailing axle. Majority of tires, has 4 slots, we are thinking of cutting of the four slots. This cutting the carrier in one tire to pay € 34, which constitutes approximately 9.3% of the price of a new 22.5 "tire.

Axle	30% life of the tire [km]	Price of cutting [€]	The unit cost of a tire [€ / km]	Unit cost of axle [€ / km]
Steering axle	48 000	34	0,00071	0,00142
Driving axle	51 000	42,5	0,00083	0,00332
Trailing axle	69 000	34	0,00049	0,00294

Tab. 4. Unit cost of cutting tires (Source: Author)

Determination of unit costs in € / km for retreading tires

A survey of the Department of road and urban transport in year 2003 between 8 bus service organizations and 39 organizations freight transport, it was found that carriers use retreaded tires to about 90% of their vehicles. In the model example, we can calculate the unit cost of tires per kilometer of distance traveled [1].

ARS company operates approximately 20 years on the Slovak market and one of its activities is also retreading tires. Table 5 shows the prices of retreading tires in the matter from the tread used and the dimensions necessary to calculate for a model example. For comparison, the prices also finished a protectorate, which offers a firm ARS. Prices are current as of August 2010.

Tire size		Price of retreading in € without VAT	
315 / 80 R 22,5		172 ÷ 259	
385 / 65 R 22,5		205 ÷ 251	
Tire size	**Price protector in € without VAT by the type of skeleton**		
	Michelin	**Other**	**Matador, Barum**
315 / 80 R 22,5	275 ÷ 362	263 ÷ 350	215 ÷ 302
385 / 65 R 22,5	305 ÷ 351	276 ÷ 322	244 ÷ 290

Tab. 5. Prices of retreading and the protectorate for specific dimensions (Source: Author)

Table 6 contains a 70 percent lifetime of tires, used on each tractor and trailer axles. It is calculated in the table and the price of one kilometer of distance traveled on a tire and one axle.

Axle	Life of the tire [km]	The average price of retreading [€]	The unit cost of a tire [€ / km]	Unit cost of axles [€ / km]
Steering	112 000	215,5	0,00192	0,00384
Driving	119 000	215,5	0,00181	0,00724
Trailing	161 000	228	0,00142	0,00852

Tab. 6. Unit cost of retreaded tires (Source: Author)

Axle	UC of new tires [€ / km]	UC of cutting [€ / km]	UC of retreading 1. time [€ / km]	UC of retreading 2. time [€ / km]	UC renewed tire [€ / km]
Steering	0,00480	0,00142	0,00384	0,00384	0,00342
Driving	0,00928	0,00332	0,00724	0,00724	0,00655
Trailing	0,00954	0,00294	0,00852	0,00852	0,00752
Σ	0,02362	0,00768	0,0196	0,0196	0,01749

Tab. 7. Overview of unit costs for individual axles and the combination on the new and renewed tires (Source: Author)

The unit cost of each axle and the total for the entire combination of vehicles are shown in Table 7 The table of unit costs (UC) divided into three basic categories. Unit cost of:

- new tires
- cutting tires
- retreaded tires

In the last column of the table are calculated unit cost for renewed tire, thus cutting of and subsequently retrieved retreading [3].

4. Conclusion

The carrier has two options when buying tires:

- always buy new tires
- or use the possibility of renewal tires.

In terms of reducing the tire costs it is more suitable to use the possibility of using the renewal tires, because the unit cost per kilometer with the renewal tires is lower than the unit cost per kilometer with the new tires. The saved costs can be used for partially finance the purchase of the new tires, or it may offers the discounts from the transport.

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Cryptography Protocol Used in EURORADIO System within Railway Applications

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Abstract. The paper deals with safety analysis of safety layer of EURORADIO protocol (EURORADIO SL) used within safety related control system in European train control system. There are cryptoanalysis methods implemented against symmetric block ciphers Data Encryption Standard (DES) and Triple Data Encryption Standard (TDES) mentioned.

Keywords: European train control system, Euroradio protocol, DES, TDES, CBC-MAC, cryptoanalysis methods

1. Introduction

Incompatibility between the interlocking systems within railway transport in Europe can be changed with using ETCS (European Train Control System), which is developed in Europe as part of international project ERTMS (European Rail Traffic Management System) [1]. The aim of ERTMS is to create standardized European system in railway, common for all countries of EU (European Union), which allows transport of trains with ETCS equipment in all European railway lines. EU legislation deals with integration of this system in the European countries. Slovak republic starts with building first layer of ETCS, which is in testing operation. In Slovak railway strategy is also build higher levels of ETCS in the future after corresponding analysis.

2. European Train Control System

According to equipment of track side of ERTMS/ETCS we can differ the three basic application levels L1, L2 a L3 [2]. For ETCS L2 and L3 the necessary part of solution is system GSM-R (Global System for Mobile Communications – Railway), which realizes the radio transmission between stationary and mobile parts of ETCS system via safety cryptography protocol.

In ERTMS/ETCS L2 OBU (On-board unit) in the train and RBC (Radio Block Central) with connection of interlocking equipments change information among each other's using cryptography protocol Euroradio [3]. The protocol presents the safety communication across un-trusted open transmission system GSM-R (Global System Management for Railway). If OBU wants to communicate with given RBC must be able to verify whether the communication with this RBC is valid or no and oppositely. This procedure is based on concrete cryptography techniques, which are implemented in safety layers of Euroradio protocol and used secret keys. It is necessary to underline that these procedures do not offer the tools for cryptography keys generation, distribution and actualization of key, so called KMS (Key Management System).

In the present development of key management system on the principle of off-line and on-line KMS with using symmetric and asymmetric cryptography is in the process in many European countries [4], [5], [6], [7]. Nowdays to suggest the global solution of KMS realization is impossible by reason of using different types of interlocking systems in different counties. On the Fig. 1 is illustrated the basic principle of ERTMS/ETCS L2 system.

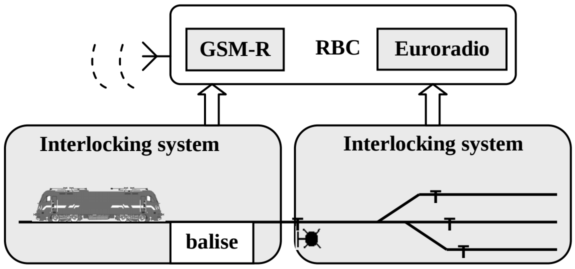

Fig. 1. Principle of ERTMS/ETCS application layer L2.

Information about train position, etc., which it is need to operation of ETCS L2 is obtained from classic station and track interlocking equipment. On the base of this information RBC with using Euroradio and communication network GSM-R transmits the driving authorization.

Euroradio is perspective multiple purpose communication system which will create in the future universal connection of stationary centrals on the track with all mobile units each other and according to requirement between mobile units too. Localizations of Euroradio safety layer within ETCS system is illustrated in the Figure 2.

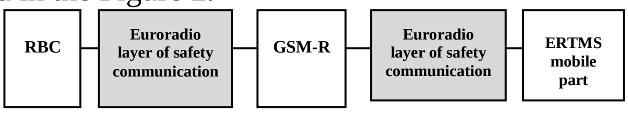

Fig. 2. Location of Euroradio SL within ETCS.

3. Safety layers of EURORADIO protocol

Communication between system components of ETCS is based on layer principle and meets standardized demands for safety-related communication [8]. Additional safety-related layer, added to standard layers of the Open System Interconnection Reference Model (RM OSI) is formed by two sub-layers:

- Euroradio Safety Layer (Euroradio SL) [9];
- Safety Application Interface (SAI) [10].

Within the RM OSI they are integrated above transport layer, having an adaptation layer between them.

Euroradio Safety Layer is responsible for secure data transmission which implies protection against threats such as corruption, masking or inserting a message, establishment and release of secure communication link together with error handling. Among secure procedures of the layer there are procedures ensuring message authentication and integrity during transmission. They are realized with the help of the cryptographic technique MAC (Message Authentication Code) which is a function of the message *M* and the shared key *K*c, when applying operation of ciphering *C*. The formal notation of MAC calculation is:

$$MAC = C_{K_c}(M). \qquad (1)$$

MAC is calculated both at the side of transmitter which adds it to the message being sent, and the side of receiver which verifies coincidence of received and self-calculated authentication codes. If the codes are equivalent it may be assumed the message has not been corrupted (message integrity), and the message has been sent by the original sender because no one else shares the secret key. To increase safety of procedure for MAC calculation in Euroradio Safety Layer the chained mode of Cipher Block Chaining MAC (CBC-MAC) is used together with the algorithm Triple-DES in EDE mode (Encryption – Decryption - Encryption), also known as a Triple Data Encryption Algorithm (TDEA) defined in ANSI X9.52 [11]. Another safety procedure of the Euroradio SL is procedure for peer entity authentication, which also uses the algorithms CBC-MAC and Triple-DES.

A DES key consists of 64 binary digits ("0"s or "1"s) of which 56 bits are randomly generated and used directly by the algorithm. The other 8 bits, which are not used by the algorithm, may be used for error detection. The 8 error detecting bits are set to make the parity of each 8-bit byte of the key odd, i.e., there is an odd number of "1"s in each 8-bit byte. A Triple Data Encryption Algorithm (TDEA) key consists of three DES keys, which are also referred to as a key bundle. Authorized users of encrypted computer data must have the key that was used to encipher the data in order to decrypt it. The cryptographic of the data depends on the security provided for the key used to encipher and decipher the data. The safety of DES or TDES is possible to increase with application one of recommended mode of operation. According norm for railway application [8] is more preferred CBC (Cipher Block Chaining) mode in comparison of ECB (Elecronic Code Book).

The CBC mode is a mode whose encryption process features the combining ("chaining") of the plaintext blocks with the previous cipher text blocks. The CBC mode requires an initialization vector (IV) to combine with the first plaintext block. The IV need not be secret, but it must be unpredictable. The CBC is defined foe encryption and decryption as follows:

$$C_1 = E_K(P_1 \oplus IV), \qquad (2)$$
$$C_j = E_K(P_j \oplus P_{j-1}), for \quad j = 2,...,n.$$

$$P_1 = D_K(C_1 \oplus IV), \qquad (3)$$
$$P_j = D_K(C_j \oplus C_{j-1}), for \quad j = 2,...,n.$$

In CBC encryption, the first input block is formed by exclusive-ORing the first block of the plaintext with the IV. The forward cipher function is applied to the first input block, and the resulting output block is the first block of the cipher ext. This output block is also exclusive - ORed with the second plaintext data block to produce the second input block, and the forward cipher function is applied to produce the second output block. And so on.

In the present several well-known cryptanalysis methods can be used against block cipher in ECB and CBC modes. In this chapter the summarization of three groups of cryptanalytic methods based on cipher text only attack, known plaintext attacks and side channel attacks is mentioned.

4. Cryptoanalysis methods

Most of informations have been published on the cryptoanalysis of DES than any other block cipher. Most practical attack to date is still a brute force approach. There are three attacks known that can break the full sixteen rounds of DES with less complexity than a brute-force search: differential cryptoanalysis (DC), linear cryptoanalysis (LC), and Davies' attack. However, these attacks are theoretical and are not feasible to mount in practice. Differential cryptoanalysis was introduced in the late 1980s by Eli Biham and Adi Shamir. To break the full 16 rounds, differential cryptoanalysis requires 2^{47} chosen plaintexts. Although it is a theoretical breakthrough, this attack is not practical because of both the large data requirements and the difficulty of mounting a chosen plaintext attack. DES was designed to be resistant to DC.

Linear cryptanalysis was discovered by Mitsuru Matsui, and needs 2^{43} known plaintexts. The first experimental cryptoanalysis of DES was successfully achieved in an attack requiring 50 days on 12 HP 9735 workstations. However, this attack is still impractical.

While linear and differential cryptoanalysis are general techniques and can be applied to a number of schemes, Davies' attack is a specialized technique for DES, first suggested by Donald Davies [12] in the eighties, and improved by Biham and Biryukov [13]. The most powerful form of the attack requires 2^{50} known plaintexts, with a computational complexity of 2^{50}, and 51% success rate.

The best attack known on 3-key TDES requires around 2^{32} known plaintexts, 2^{113} steps, 2^{90} single DES encryptions, and 2^{88} memory. This is not currently practical. If the attacker seeks to discover any one of many cryptographic keys, there is a memory efficient attack which will discover one of 2^{28} keys, given a handful of chosen plaintexts per key and around 2^{84} encryption operations.

TDES is slowly disappearing from use, largely replaced by its natural successor, the Advanced Encryption Standard (AES). One large-scale exception is within the electronic payments industry, which still uses 2TDES extensively and continues to develop and promulgate standards based upon it (e.g. EMV(Europay, MasterCard and Visa)). This guarantees that TDES will remain an active cryptographic standard well into the future. TDES suffers from slow performance in software; on modern processors, AES was designed to the high hardware and software performance so it tends to be much faster than TDES.

In addition to linear and differential cryptoanalysis, there is a growing catalog of attacks: truncated differential cryptoanalysis, partial differential cryptoanalysis, integral cryptoanalysis, which contains square and integral attacks, slide attacks, boomerang attacks, the XSL attacks, impossible differential cryptoanalysis and algebraic attacks.

5. Conclusion

TDES with 112 bit key need almost three-times longer attack by brute force on text than DES with 56 bit key according to experimental tests. CBC mode of block ciphers gives slightly higher attack times, which means that they are more reliable than ECB mode of block ciphers. Experiments showing that breaking TDES in CBC mode need most of time, so we can assume that it is most reliable from choosed algorithms.

There are also much more attacks on these ciphers, which are more sophisticated and quicker than brute force attack.

We can decrease amount of risks for example by changing key every possible time. Another option is using AES (Advanced Encrytion Standard). NIST says, that to break AES, we need 324 times more time to break it, than to T-DES. Calculating time for ciphering and deciphering is approximately the same in hardware and software applications so it tends to be much faster than TDES.

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Broadband Access in Maritime and Inland Navigation

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Abstract. Recent inventions and development in the field of information and communication technologies get also into transport processes. Broadband communication technologies were successfully implemented in several modes of transportation. In order to bring future economic growth, the adoption of robust communication infrastructure in transportation is one of the requisitions to be fulfilled. Communications are nowadays important needs for mariners for routine operations and for safety purposes. As a result of several research projects, the EU officially defined the concept of River Information Services (RIS) in 1998. It is defined as a concept of harmonized information services to support traffic and transport management in inland navigation. This concept includes interfaces to other modes of transport. The European Telecommunications Standards Institute (ETSI) is the responsible person for technical standards and reports concerning radio equipment and systems for maritime and inland-navigation in EU.

Keywords: broadband access, data communication, River Information Services, inland navigation, maritime navigation.

1. Introduction

Information and communication technologies during past few years completely changed the scope of international business. Adequate interconnection between fast business flows and the transportation became essential. The effort to bring advantages of information and communication technologies into transport processes is a way to reach new equilibrium.

In the field of communications, new broadband technologies based on copper-wire, fiber-glass and wireless transmission media were designed to address this issue covering all modes of transport. There are important differences in technological needs for transport appliances operating on the ground, in the air or on the water-line. These differences make the technological coherence of transmission technologies very intermittent.

The technological level of communication environment available for mobile transport appliances can indirectly affect balancing of the modal shares of transport systems. Suitable communication infrastructure is one of the pre-requisitions to be fulfilled in order to fully utilize existing infrastructure capacity and to bring further economic growth in the future.

2. Data communication in Water Transportation

Communications are essential needs for mariners for both safety purposes and routine operations. The European Telecommunications Standards Institute (ETSI) is the responsible person for technical standards and reports concerning radio equipment and systems for maritime and inland-navigation in EU.

What concerns the communication solution design itself, a number of international and European requirements have to be taken in account. The cooperation between ETSI, International

Maritime Organization (IMO), European Commission (EC) and several other organizations ensures that the final design would be in accordance with such conventions and regulations.

The International Convention on Safety of Life at Sea (SOLAS) issued by IMO obliges flag states to establish national responsible person to ensure that relevant ships carry specified equipment on board. Flag states are required to carry out type approval of such devices to ensure that it meets the appropriate safety requirements.

The IMO introduced in 1988 the Global Maritime Distress and Safety System (GMDSS) as a part of the SOLAS Convention. The GMDSS is based on propagation of electromagnetic waves - radio communication. It is used to alert search and rescue organizations and ships in the vicinity in the case of an emergency. The GMDSS is mainly used for distress communications, but it also provides some basic general maritime safety information (such as navigational and meteorological warnings and urgent information to ships). Unified frequency bands for maritime communication and for distress/safety services are generally allocated on a global basis by International Telecommunications Union (ITU) Radio Regulations.

The River Information Services Directive (2004/44/EC) was a successful EC initiative to harmonize river traffic information services on inland waterways within the EC. In 1998, based on the results of various research projects the EU officially defined the concept of River Information Services (RIS) as a concept of harmonized information services to support traffic and transport management in inland navigation. This concept also included interfaces to other modes of transport.

The RIS uses information services for optimal planning and management of traffic operations. Further development of RIS requires continuous research to update the concepts and technologies in use. By implementing RIS onto suitable broadband communication infrastructure, traffic safety will be even more improved. Also the environmental protection and security of transport operations will be increased. The waterway users and important administrative authorities will receive direct benefits from such operational improvements by implementation broadband communication capabilities. Water transport will take part in modern logistic systems in Europe in the 21st century.

3. Water Transport in EU Transport System

Maritime and inland waterway transport is reliable, economical, and eco-friendly mode of transport. The aim of River Information Services is to create conditions for further development of the sector. Its future development requires modern concepts, technologies and solutions to be able to adapt to future market needs. The implementation of information and communication technologies in water transport provides an opportunity to reliably transfer containers and other sensitive cargo in just-in-time mode.

Europe has over 30,000 km of canals and rivers that link together hundreds of industrial areas. The backbone of this waterway network is naturally composed of major rivers. Many important canals interconnect smaller industrial centers and towns. A number of ports on the network provide links with other modes of transport.

The way to increase operational efficiency and safety is implementation of communication and information technologies into processes of transport. The information exchange could be in such case easily optimized. Modern logistics requires intensive and reliable information exchange between partners in supply chains.

4. Broadband Solution Design in Water Transport

ETSI constantly monitors development in the field of maritime and inland navigation communication. Based on this, it creates new standards, technical specifications, reports and guides for maritime and inland waterways radio equipment and communication systems. According to international requirements, such documents include equipment and systems for promotion of safety of life, radio communication, location and navigation equipment and the maritime correspondence providing radio access to terrestrial telecommunication networks. ETSI Maritime Electro-Magnetic Compatibility (EMC) standards are also based on the general requirements for navigational and radio equipment found in the International Electrotechnical Commission (IEC) standard IEC 60945. The European Standards for communications equipment fall within the scope of the Marine Equipment Directive and the River Information Services Directive.

5. Conclusion

The technological level of communication environment available for mobile transport appliances can indirectly affect balancing of the modal shares of transport systems. The way to increase operational efficiency and safety is implementation of communication and information technologies into processes of transport. Suitable communication infrastructure is one of the pre-requisitions to be fulfilled in order to fully utilize existing infrastructure capacity and to bring further economic growth in the future.

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Department of the railway transport assigns education of the shaped disciplines in **study field Transport**, with focus on the **Railway transport** (in all forms of study), as well as selected disciplines for other study fields of **Faculty of Operation and Economics of Transport and Communications at University of Zilina**. These disciplines are mainly focused on **technologies, management and economics of traffic-transporting activities of railway transport**.

Department of the railway transport in his own scientific-research activities is mainly focus on organization and operation of technological processes in railway and combined transport, optimization and development of freight and passenger transport, effectiveness of investment projects, processes of railway companies transformation etc. For example:

- cooperation with organizations of transport section on creation of developing projects and legislative norms
- lecture activities in managerial and other professional courses for employees of transport section as well as in the framework of professional movements (conferences, seminars) with monothematic issues
- solving the topical problems of transport practice in the framework of research activities of department

Department is equipped with own modern outlined **traffic laboratory** with the extensive model yard (total length of tracks is 100 m). Except of that, the department provides computer classroom with LAN connected to the internet, in which is assigned education about multimedia and simulative applications for supporting of traffic and transport operation processes.

Web site of department of the railway transport: http://fpedas.utc.sk/~kzd/index.php?lang=english

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Future of the Traditional Post Offices

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Abstract. Post office is a basic structural unit of the postal network. Here the traditional type of post office is described, where a permanent establishment is used for the provision of postal service, and compared with franchises in the postal sector, where various kinds of shops and retail outlets are used to provide partial or complete postal service. The final section deals with alternative approaches addressing the organization and functioning of post offices in the future. The presented models are based on statistical data of Swedish, Slovakian and Slovenian postal operators.

Keywords: Posten AB, post office, postal operator, postal network

1. Introduction

The postal sector is one of the oldest network industries. Postal retail and distribution networks have continued to grow over centuries, driven by factors such as commerce, population growth, nation building and expanding government services.

However, while access to postal services remains a key element of government policies, the nature of the postal business and their networks is changing rapidly. Eroding mail volumes, increasing package volumes and alternative means of communications, usually based on the electronic principles, are in their own way putting strains on the traditional model of the post offices.

We present the summary of several types and possible ways of organizing the post offices.

1.1. Traditional Post Offices

Traditional post office is known for each user who has ever sent postal items. It represents the most common type of organization of postal operations in a particular place, as for example postal network in Slovakia.

Post office is usually a building designed exclusively for the provision of postal services and contact with customers. The size and structure depend on several factors as:

- size of the territory served,
- number of customers related to the catchment area of potential post office,
- population density per square kilometer,
- expected profitability of the installation in the field,
- importance and size of hardware devices,
- size of available space in the proposed area,
- functions and processes to be performed in the post office,
- number of performed operations,
- level of postal network, on which the facility will be located,
- requirements for different specialized services.

For the purpose of the paper we consider the basic level of postal network, involving contact with customers and directly provided services.

The following figure shows the general matrix of the post office structure. The individual components making up the matrix are based on materials of Slovenia Post, but are not significantly different from Slovakia Post.

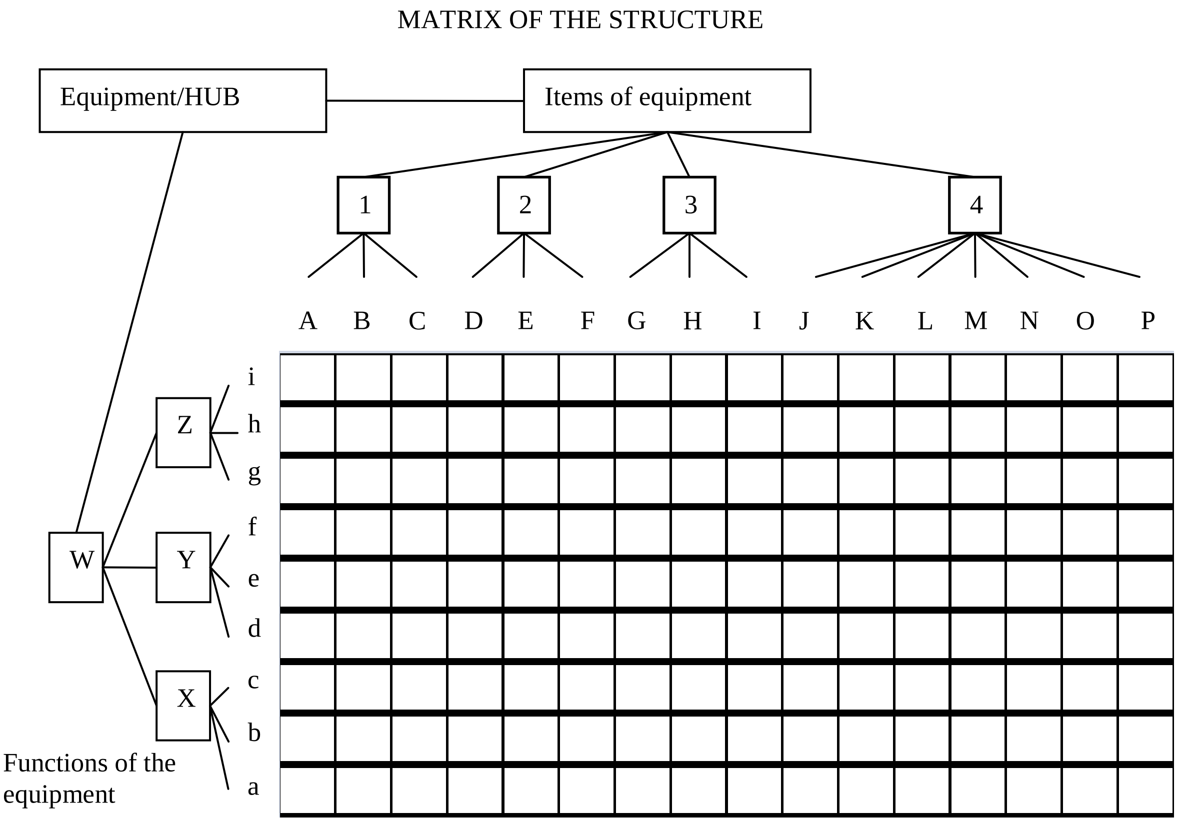

Fig. 1. General matrix of the post office structure. (Source: GRACIN, J., STIPETIČ, A.: Desingning Postal Network Units, In: Promet – Traffic & Transportation, University of Zagreb, Zagreb, 2009, page 400)

Overall structure of the mail facility can be divided into four main parts, marked with Arabic numerals in the matrix:

1. user premises comprising vestibule (A), post office counter area (B) and space for customer service (C);
2. postal worker´s living quarters divided into compartments (D), outlining the main cash office space (E) and parcel compartment (F);
3. mail processing facilities whose layout allows for the processing of mail (G), preparation of service (H) and dispatch of mail (I);
4. administrative areas where agency director of postal equipment (J), archive (K), social space (L), postmen spaces (M), packages repository room (N), facilities maintenance room (O) and department of electronic transactions (P) are located [1].

In terms of functions and technological processes (W) performed by facility, these processes can be divided into three groups, known as service (X), control (Y) and management (Z).

Services (X) imply postal services (a), telecommunications (b) and electronic transactions (c). Control (Y) consists of checking the documents (d), the operational control (e) and enforcement of guidelines (f). The last group includes the management (Z) consisting of controlling process (g), cash management transactions (h) and service management and maintenance (i) [1].

Thus the matrix represents the general scheme of the post office structure which is possible to apply with smaller or larger restrictions in any postal network based on traditional post offices.

1.2. Post Offices Based on Privatized and Contracted Counter Services

Another possible organization of the network of post offices is based on franchises rather than traditional post offices. In this case postal service provider utilizes the networks of the other distributors, respectively retail outlets. The main advantage of this solution is good knowledge of local markets and also the cost reduction on running their own operations. The most commonly used networks are, for example, groceries, tobacco shops, petrol stations, souvenir shops, etc.

An example of this postal network can be seen in Sweden. The Swedish postal market underwent series of changes after the market liberalization in 1993. One of the most sweeping changes was decision of Swedish national postal operator (Posten AB) to replace traditional post offices with a nationwide network of representatives consisting of shops and service establishments. Restructuring was initiated during the summer of 2001 and concluded a year later, when the new service network had been implemented throughout the country [4].

The main reason for closing down the old network of post offices was the high cost of premises. Customers mainly visited post offices to make and receive payments, not to utilize postal services. The post offices were deemed inflexible and not able to adapt to current consumer habits, due to new methods of payment, for instance by bank and postal giro or by the internet [3].

The number of post offices gradually declined since liberalization in 1993, but as we can see in Table 1, the significant jump came after the restructuring of the postal network.

Year	Number of post offices	Number of agents	Total
1988	2110	0	2110
1989	2075	94	2169
1990	1934	123	2057
1991	1882	150	2032
1992	1773	179	1952
1993	**1473**	**419**	**1892**
1994	1341	537	1878
1995	1289	564	1853
1996	1177	640	1817
1997	1095	730	1825
1998	1020	781	1801
1999	922	853	1775
2000	851	890	1741
2001	840	900	1740
2002	**433**	**1800**	**2233**
2003	440	1800	2240
2004	420	1818	2238
2005	422	1812	2234
2006	382	1801	2183
2007	370	1821	2191

Tab. 1. Number of post offices and agents operating in Sweden in the years 1988 - 2007 (Source: A report for UNI Global Union; What has Postal Liberalization delivered? The Case of Sweden, Posten AB, August 2009).

Another significant decrease is also seen in the year of Swedish postal market liberalization.

From the consumer perspective several aspects have been improved. The major improvement can be seen of how quickly are consumers able to obtain postal services. Consumers also perceive an improvement in clarity in terms of who to turn to in order to purchase stamps, send parcels as well as collect parcels and letters. Further advantages are the availability of postal outlets, prolonged opening hours and also shorter queuing times [4].

1.3. Post Offices Based on Electronic Principles

The last option worthy of mention is complete replacement of traditional post offices by electronic communication. At present this concept is under development, but there are some indications of such possibilities. The last news from postal sector in Sweden inform, that buying and paying for stamps could be replaced by short message service (SMS). In the future all postal services and financial transactions would be gradually implemented. Consumer requirements would be handled through SMS or the internet, and therefore there would not need to visit the post office. Similar principles but in a limited scale can be already seen in the hybrid mail. The following figure shows the possible solution.

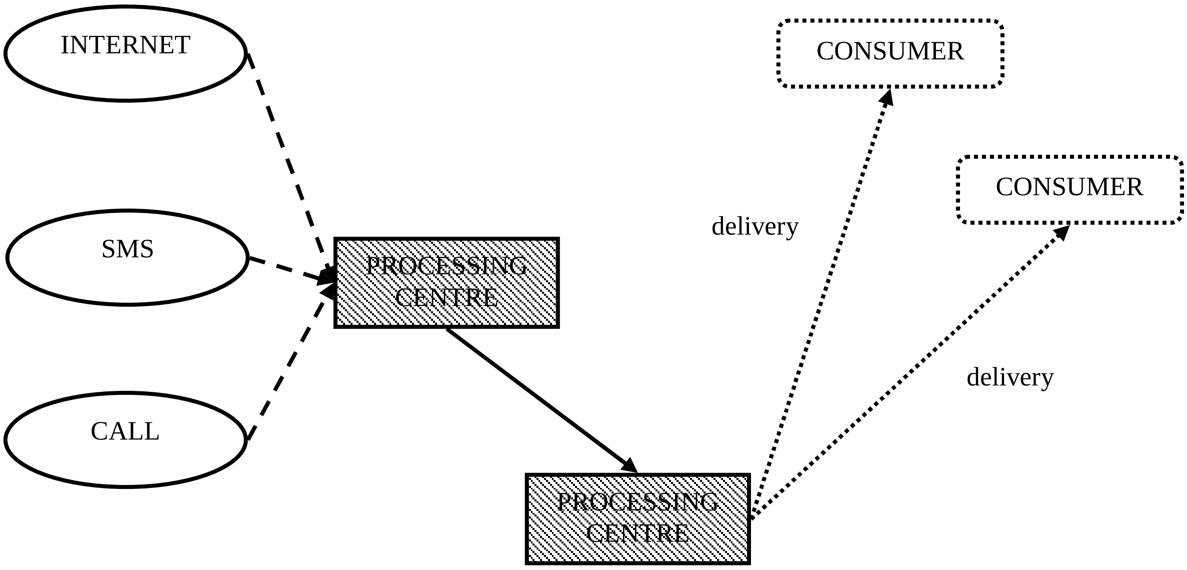

Fig. 2. Diagram of a possible future solution of the organization of the post offices.

2. Conclusion

The article presents existing organizational models of post offices. The most frequently used type of organization, a traditional post office and its typical structure is described. This traditional model of post office is compared to the modified type of organization based on franchises using different retail outlets. In the future, a new concept of electronic communication utilized in postal sector will be of importance and the first steps toward this direction are already visible in several countries, e.g., in Sweden.

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Quality Factors in International Railway Transportation

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Abstract. The paper covers the identification of qualitative factors in international freight railway transportation. There are specified at all the technical and technological factors that influences the services and the satisfaction of customer.

Keywords: international transportation, railway transport, technology in border station, relation form of transport, quality factor

1. Introduction

Determination of main quality factor of international railway transport is difficult process. Individual requirements and demands of costumers in international railway transportation make the determination of main quality factors more difficulty. Also the main indicator of quality of the transport process can include the satisfaction of costumers. From the satisfaction of costumers we can deduced the next important quality factors. The paper gives a basic view on the processes in the international railway transport and mentioned the necessity of monitoring this processes.

2. Quality of international railway transport

A choice of transport mode depends on the quality of services, which are offered to customers. In assessing the quality of international rail transport is needed to identify the factors that affect it. The factors are derived from the requirements of the customer (carrier) for transport. The key factors that most affect the quality of international rail transport include [7]:

- moving speed of consignment (time of transport)
- quality of transport processes on the track
- quality of transport processes in the border stations
- quality of transport processes in the sending and destination station
- quality of transport processes in the intermediate stops.

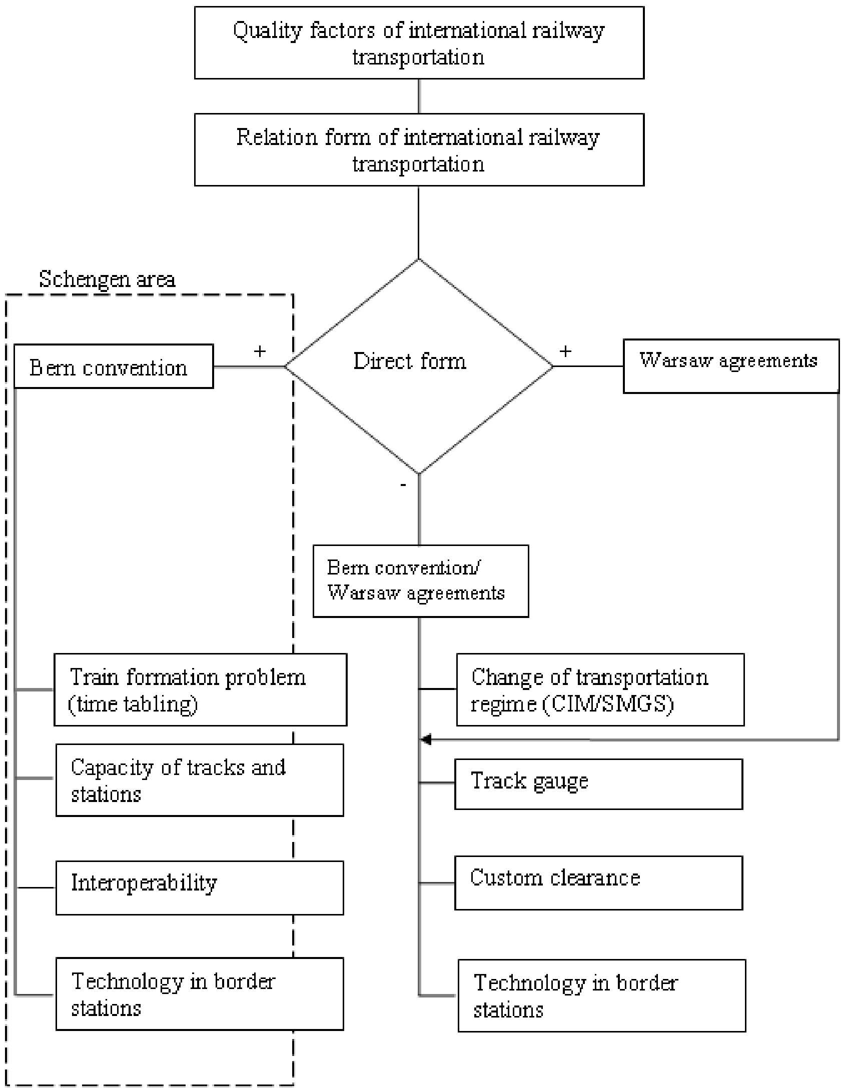

Fig.1. Technical factors affecting transportation and speed of international rail transport

3. Selected quality factors in international railway transport

3.1. Transportation time

On of the main quality factor of international railway transport is speed of moving the consignment. Detailed analysis of transport processes of the wagon loads by crossing the border involves two main fields of activities. First is the international transport policy and second are the technological processes in border stations. After that follows the identification of processes that have the largest influence on the dwell time of trains in the border station. Transportation time (delivery time) is result of presence of several factors, but it does not prevent us consider them separately.

The transportation process in international railway transport is influenced by several factors that interlock each other. They affect the quality of services provided by railway undertakings in international transport. Quality factors of the international railway transport have an influence on the speed of moving (delivery time) in the transportation processes. Fig. 1 shows the complex of factors that are crucial in determining the delivery time as well as their compliance.

Relation form of international railway transportation depends on the customer's decision. All the next factors are part of international transport policy in railway transport and of the internal organization of train service by railway undertakings. Currently, in most cases, international rail connection between two countries uses the direct relation form. The indirect relation form is used only to change transport regimes (SMGS/CIM and vice versa). On the territory of COTIF can railway undertakings and its costumers make a separately deal about conditions of transport. In case of using SMGS regime is not possible make separately deal about of transport conditions, because railway undertakings and costumers are under strictly obligation of SMGS agreement.

Transportation time is affected by external environment too, i.e. economical environment, political arrangement and technical interoperability between different national railways systems.

3.2. Schengen area

European Union's Schengen area has a significant impact on the speed of international railway transport. Due the cancellation of implementing controls in internal borders of EU has subsequently also been removed the control activities in border stations by participating railway undertakings on international railway transport. Regulation and activities of EU member countries participating in the Schengen Agreement are based on the Convention Implementing the Schengen Agreement.

Basic terms of the Implementing Convention are [6]:

- internal borders: shall mean the common land borders of the contracting parties, their airports for internal flights and their sea ports for regular ferry connections exclusively from or to other ports within the territories of the contracting parties and not calling at any ports outside those territories.
- external borders: shall mean the contracting parties' land and sea borders and their airports and sea ports, provided that they are not internal borders.

Implementing the Convention contains provisions for subsequent transport and movement of goods (Title V of the Convention) [6]:

- The contracting parties shall jointly ensure that their laws, regulations or administrative provisions do not unjustifiably impede the movement of goods at internal borders.
- The contracting parties shall facilitate the movement of goods across internal borders by carrying out formalities relating to prohibitions and restrictions when goods are cleared through costume for home use. Such customs clearance may, at the discretion of the Party concerned, be conducted either within the country or at the internal borders. The contracting parties shall endeavor to encourage customs clearance within the country.
- In accordance with Community law, the contracting parties shall waive, for certain types of plant and plant products, the plant health inspections and presentation of plant health certificates required under Community law.
- The contracting parties shall step up their cooperation with a view to ensuring the safe transportation of hazardous goods and undertake to harmonize their national provisions adopted pursuant to international Conventions in force.

4. Quality of transportation processes

4.1. Change of transport regime and the diversity of rail track

Transport regime usage has a significant impact to the overall quality of international railway transportation. Growth in the volume of trade between EU Member States and the Russian Federation, respectively Asia (especially China), also creates the potential for growth in the volume of traffic transferred between transportation modes CIM/SMGS. At the contact points of these transportation regimes is a need to change the contract of carriage from CIM to SMGS. Railway undertakings and his costumer currently can use the product of international transport committee (CIT) – consignment note CIM/SMGS. This consignment note compress time of processing attended documents on the border station and removes the risk of error, which would be created by the rewrite consignment notes by changing of the transportation regime.

Second field of quality factors by the crossing border is different rail gauge. At the meet point of track lines of Schengens area and east countries (Belarus, Ukraine and Russia) uses the EU countries the normal gauge 1435 mm (except for Baltic countries and Finland) and east countries uses wide gauge 1520 mm. The first possibility to overcome the technical problem due different rail gauge is reloading of goods from normal gauges wagon to wide gauges wagon or vice versa. The second possibility is interlacing of rail bogies. Effect of these activities, reloading goods or interlacing of rail bogies, is extending the moving of goods from sender to consignee and delivery time.

4.2. Technology in border station

Technological process of border station has an important impact to international railway transport. Technology determines the follow-up activities concerned wagon loads by crossing the border and railway undertakings are exchanging the responsibility for transportation. Technological steps must be established and follow the guiding principles:

- maximum parallel running of the activities
- ensure the coordination of the personnel
- continuously introducing the new technologies and techniques to operational processes
- eliminate unnecessary dwell times, more efficient use of resources, facilities, staff, etc.

Technological steps in border stations are not the same for each station. Their development depends on:

- number of railway undertakings, which use the border station
- volume of international freight railway transport
- track gauge
- relation form of international railway transport
- geographical location of border station within Schengen area.

5. Quality of traffic processes

Traffic processes are created on the requirement from transportation processes. From the network-wide are important train formation problem and capacity of track, station and other facilities.

5.1. Train formation problematic

Train formation problematic depends on several possibilities and needs of railway undertakings and his costumers. In the international train formation is need to define:

- full train loads (logistics trains)
- single wagon loads.

Problematic of logistic train is much simpler as the single wagon loads. Logistics train does not travel during the marshalling yards, therefore selection of transportation route is oriented to the fastest route from sender station to forwarding station.

Direction on network of single wagon loads in international railway transport requires usage of several marshalling yards for consignments transportation. The international transportation process of single wagon loads is too complicated and thereafter slowdown. There is not common solution for train formation problem (unit to participate RU on international railway transport). Rationalization of international train formation (technology) requires:

- restrict the shunting with international wagon loads
- concentrate the shunting with international wagon loads from border stations to marshalling yards intended for international train formation
- concentrate the tariff points for acceptation of wagon shipments in international transport to certain railway stations
- create conditions for better capacity utilization of load normative for trains
- running the trains according to the time table
- comply the reciprocity of manipulated wagons on the basis of agreements.

5.2. Capacity of railway station and track lines

Railway infrastructure capacity is expressed by the number of the trains or of the couple of trains, which is sustained and regularly manageable on the given track in the certain time period regarding the permanent technical and traffic equipments, type of rail vehicles and the way of the traffic organization. [5] There is need to define the theoretical and the effective (practical) capacity.

To ensure the maximum speed of international rail transport is there necessary to redirect the consignments flow to the Trans-European rail corridors. Limiting factor can be the capacity of the track sections, so it is necessary to know the possibilities of railway infrastructure capacity and the track capacity in border stations.

6. Conclusion

Railway undertakings that have a high level of quality of services can achieve higher market share in rail transport. The most important quality factors in international transportation are these factors: techniques, technological and economical.

Traffic and transportation processes have an important contribution to the quality of international railway transport. These processes affect delivery times, speed of movement and timeliness of wagon loads delivery.

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The Department of the railway transport, Faculty of Operation and Economics of Transport and Communications University of Žilina solve the European project "**Transfer of innovative knowledge and technology in logistics and transport processes**“, ITMS project code 26220220006. The aim of the project is development of the simulation model which is the technologic progress of transportation and logistics processes.

There are solved five activities in this project:

- 1.1 The Development of Advanced Technologies in the Management of Traffic Operations and Logistics Processes,
- 2.1 Implementation of technology in the management of traffic operations and logistics processes in the simulation model,
- 2.2 Simulation Model Function Testing in the Management of Traffic Operations and Logistics Processes,
- 2.3 Developing a Manual for Handling Simulation Model,
- 2.4 Supplying of technical equipment with a focus on IKT technologies.

Web site of the project: http://pipdal.uniza.sk/

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