

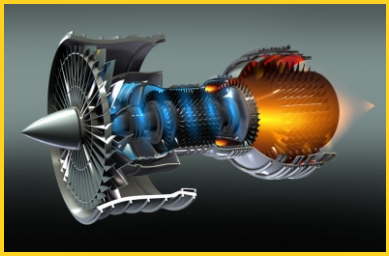




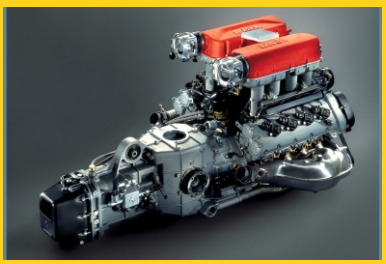

Technical University of Sofia

50 Years Faculty of Transport

ANNIVERSARY SCIENTIFIC CONFERENCE on Aeronautics, Automotive and Railway Engineering and Technologies

BulTrans-2013

PROCEEDINGS

Sponsored by:

Research and Development of TU-Sofia

BALKAN STAR

SSAB

MOTO-PFOHE

AVL

София Франс Аутo

KNORR-BREMSE

TRANSWAGON Plc
TRADITION SINCE 1980

АВТОМОТОР
КОРПОРАЦИЯ

АЕБТРИ

Lufthansa Technik
Sofia

TURBOTRUCKS
your partner on the road

DB SCHENKER

ETA АУТО ООД

KONČAR

October 16-18, 2013
Sofia, Bulgaria

Http://bultrans.tu-sofia.bg

SCIENTIFIC COMMITTEE:

Chairman:
Prof. M. Hristov, Rector, TU Sofia, Bulgaria

Members:
Prof. A. Ams, TU-Bergakademie-Freiberg, Germany
Prof. B. Belnikolovski, TU Sofia, Bulgaria
Prof. E. Bratschitsch, University Graz, Austria
Prof. P. Dimitrov, TU Sofia, Bulgaria
Prof. P. Getsov, Bulgarian Academy of Science, Bulgaria
Prof. A. Dimitrov,. TU Varna, Bulgaria
Prof. R. Rusev,.University of Rouse, Bulgaria
Prof. S. Karapetkov, TU Sofia, Branch Sliven, Bulgaria
Prof. D. Katsov, TU Sofia, Branch Plovdiv, Bulgaria
Prof. G. Kolarov, Hamburg University, Germany
Prof. I. Korobko, TU Sofia, Bulgaria
Prof. J. Majerčák, University of Žilina, Slovakia
Prof. F. Massouh, Arts et Metiers ParisTech, France
Prof. S. Medvedsky, University of Žilina, Slovakia
Prof. N. Nenov,Kableshkov Transport University, Bulgaria
Prof. M. Sitarz, Silesian University of Technology, Poland
Prof. D. Stoyanov, TU Sofia, Bulgaria
Prof. M. Svitek, TU in Prague, Czech Republic
Prof. K. Vesselinov, TU Sofia, Bulgaria
Prof. V. Zhivkov, TU Sofia, Bulgaria

ORGANIZING COMMITTEE:

Chairman:
Assoc. Prof. T. Evtimov, Dean of FT, TU Sofia, Bulgaria

Vice-Chairman:
Assoc. Prof. B. Gigov, TU Sofia, Bulgaria

Members:
Assoc. Prof. O. Krastev, TU Sofia, Bulgaria
Assoc. Prof. V. Iliev, TU Sofia, Bulgaria
Assoc. Prof. L. Kunchev, TU Sofia, Bulgaria
Assoc. Prof. K. Velkov, TU Sofia, Bulgaria
Assoc. Prof. M. Pejkova, TU Sofia, Bulgaria
Assoc. Prof. N. Nikolov, TU Sofia, Bulgaria
Assoc. Prof. M. Todorov, TU Sofia, Bulgaria

Secretariat:
Assist. Prof. Pl. Punov, TU Sofia, Bulgaria
Assist. Prof. N. Pavlov, TU Sofia, Bulgaria
Assist. Prof. Kr. Georgiev, TU Sofia, Bulgaria
Eng. Ph. Mihaylov, TU Sofia, Bulgaria

ПРОГРАМЕН КОМИТЕТ:

Председател:
Проф. Марин Христов, Ректор на ТУ- София

Членове:
Проф. Алфонс Амс, ТУ-Фрайберг, Германия
Проф. Борис Белниколовски, ТУ- София
Проф. Емилия Брачич, UAS - Грац, Австрия
Проф. Петър Димитров, ТУ- София
Проф. Петър Гецов, ИКИ, БАН
Проф. Ангел Димитров, ТУ- Варна
Проф. Руси Русев, РУ- Русе
Проф. Станимир Карапетков, филиал Сливен
Проф. Димитър Кацов, ТУ- филиал Пловдив
Проф. Георги Коларов, Хамбург, Германия
Проф. Иван Коробко, ТУ- София
Проф. Йозеф Майерчак, UŽ Жилина, Словакия
Проф. Фалоаз Масу, АМРТ-Париж, Франция
Проф. Щефан Медведски, Жилина, Словакия
Проф. Ненчо Ненов, ТУ "Т.Каблешков" София
Проф. Марек Ситарж, SUT-Катовице, Полша
Проф. Димитър Стоянов, ТУ- София
Проф. Мирослав Свитек, ТУ-Прага, Чехия
Проф. Камен Веселинов, ТУ- София
Проф. Венелин Живков, ТУ- София

ОРГАНИЗАЦИОНЕН КОМИТЕТ:

Председател:
Доц. Теодоси Евтимов, Декан на Транспортния факултет, ТУ- София

Зам. председател:
Доц. Бойко Гигов, ТУ- София

Членове:
Доц. Олег Кръстев, ТУ- София
Доц. Валентин Илиев, ТУ- София
Доц. Лило Кунчев, ТУ- София
Доц. Кирил Велков, ТУ- София
Доц. Мария Пейкова, ТУ- София
Доц. Николай Николов, ТУ- София
Доц. Михаил Тодоров, ТУ- София

Научни секретари:
Гл. ас. Пламен Пунов, ТУ- София
Ас. Николай Павлов, ТУ- София
Ас. Красин Георгиев, ТУ- София
Инж. Филип Михайлов, ТУ- София

ТЕХНИЧЕСКИ УНИВЕРСИТЕТ СОФИЯ

ФАКУЛТЕТ ПО ТРАНСПОРТА

ЮБИЛЕЙНА
НАУЧНА КОНФЕРЕНЦИЯ
С МЕЖДУНАРОДНО УЧАСТИЕ
по авиационна, автомобилна и железопътна техника и технологии

БулТранс-2013

50 години Факултет по транспорта

СБОРНИК ДОКЛАДИ

16 -18 октомври 2013 г.
Технически Университет - София

ISSN 1313-955X

CONTENTS / СЪДЪРЖАНИЕ

Keynote Lectures / Доклади

Секция: **Двигатели с вътрешно горене и алтернативни горива**
Section: **Internal Combustion Engines and Alternative Fuels**

Секция: **Автомобилна техника и технологии**
Section: **Automotive Engineering and Technologies**

Секция: **Железопътна техника и технологии**
Section: **Railway Engineering and Technologies**

Секция: **Мениджмънт и логистика в транспорта**
Section: **Transport Management and Logistics**

Секция: **Авиационна техника и технологии**
Section: **Aeronautics**

Секция: **Динамика, якост и надеждност на транспортната техника**
Section: **Dynamics, Strength and Reliability of Vehicles**

BulTrans-2013
Proceedings
16-18 October 2013
Sofia

STUDY OF RAIL TRANSPORT ALONG THE TRANS-EUROPEAN CORRIDORS OF THE REPUBLIC MACEDONIA

Assoc. MsC PhD student Goran POP-ANDONOV
Mechanical Engineering Faculty, UGD-Stip, Macedonia
goran.pop-andonov@ugd.edu.mk

ASSOC. PROF. PHD SVETLA STOILOVA
Faculty of Transport, Technical University, Sofia, Bulgaria
stoilova@tu-sofia.bg

Assoc. Prof. PhD Dejan MIRAKOVSKI
Mechanical Engineering Faculty, UGD-Stip, Macedonia
dejan.mirakovski@ugd.edu.mk

Assoc. Prof. PhD Zlatko SOVRESKI
Mechanical Engineering Faculty, UGD-Stip, Macedonia
zlatko.sovreski@ugd.edu.mk

Dejan KRSTEV, MsC PhD student
Mechanical Engineering Faculty, Ukim-Skopje, Macedonia
krstev.deni@gmail.com

Assoc. Prof.PhD Zoran PANOV
FPTN, UGD-Stip, Macedonia
zoran.panov@ugd.edu.mk

Abstract:
In the study has been done a research on the Trans – European corridors that are passing try the Republic of Macedonia – N8 (East – West) corridor connecting the Adriatic with the Balkan region and sides of the Black Sea and corridor N10 (North – South), connecting parties of Western Europe with Greece. These corridors are part of the program of the Macedonian government to build missing parts of railway infrastructure.

Keywords: *railway industry, optimization scenarios, AHP methodology*

1. Introduction

Macedonia is located at the junction of the main roads in Southeastern Europe making it an important transit route in the land traffic between Central Europe, Aegean Sea, Black Sea and the Adriatic Sea. This position contributes to the development of international traffic through two corridors passing through the state along the two main axes: North-South (Corridor X) and East-West (Corridor VIII) known as the pan-European corridors that are connected in the trans-European transport networks. Macedonia is a small landlocked country located in the southern central part of the Balkan peninsular. Several important transport corridors are connecting Macedonia with Central and Eastern Europe, the South and Southeast and beyond. The general infrastructure of the state is relatively good and can be considered as good basis for further modernization. Macedonia is relatively open to international economic exchange, but because it is a small country in size, it is very sensitive to external changes and negative impacts that have occurred several times since independence in 1991. The economic situation has now stabilized and is making a good progress according to plan and the process of economically reforms. The Supervisory Board of Infrastructure for South East Europe, managed by the European Commission, international financial institutions and the Stability Pact for South Eastern Europe have identified major priority infrastructure projects for transport, energy and telecommunications in the region. The priority was to designing an integrated regional transport strategy, consistent with the trans-European network and pan European corridors. The network is formed by corridors whose definition is initiated at the Conference of the Pan-European transport in Helsinki and main roads and railways defined in the "ECE" at the UN.

2. Pan-European corridors X and VIII

The railway network is also following the above corridors. The total length of the main rail network is 699 km. Main Line of Corridor X that starts from Tabanovci to Gevgelia through Skopje and Veles is a single track, and it is electrified with relay signaling system that allows good communication system [1].

This line can operate in several sections with speed of 100km/h and it is with a normal track. Along this corridor in use are 29 stations. But up front a certain period, was taking into account that 85% of international and transit transport takes place in Corridor X, priority at that period was placed on increasing the capacity and speed of some sections which will result in the raising of standards to international levels. The opinion above isn't wrong, but in recent time government of Macedonia considered that a good deal of international transport i.e. exports and import of goods and passengers for the most part would take place through Corridor VIII. The total length of the Corridor VIII (Figure 1) is approximately 308km in the Republic of Macedonia which 152km are built and operating. There remain approximately 89km for building to the border with Republic of Bulgaria. The total investment required for completion of this section is 235.4 million.

Approximately 66km are needed to connect with Albania. It is estimated that the total investment in connection with Albania would be around EUR 242milioni. The Corridor starts from the ports of Bari and Brindisi in Italy, and through the port of Durres and Vlore in Albania reaches the capital Tirana. The rail connection continues on towards the boundary between Albania and FYR Macedonia [2].

After crossing the border between Albania and FYR Macedonia, the main route continues northward, passing through the city of Tetovo and ultimately reaching the capital city of Skopje; from there the route continues moving East, running along the main line, which crosses all of northern FYR Macedonia, up to the zone bordering on Bulgaria. Having crossed the border, the route continues in Bulgarian territory, moving north East and reaching the capital, Sofia; from here it moves east ward once more, passing through all of central Bulgaria, crossing cities and towns such as Plovdiv and Stara Zagora, until it reaches the port of Burgas on the Black Sea.

In table 1 is shown the railway corridors in Macedonia and their status.

Table 1. Railway corridors in Macedonia and their status

Railway lines	Location	Status	Speed km/h
Corridor X	Tabanovci- Gevgelija- through Skopje and Veles	Single-track line, electrified. Its last renovation on most sections is already 30 years old.	110 km/h
Corridor VIII	Gorce Petrov-Jegunovci	This line was constructed in 1952/1969 partially and only for freight transport, for the Ferro-nickel mine in Jegunovci	60-80 km/h
Skopje- General Jankovic	Continues to Pristina and connects with the Yugoslav network	Only for freight transport for KFOR needs	60-80 km/h
Branch D of Corridor X	Veles-Bitola	Functions for passenger and freight transport	60-80 km/h
Kumanovo- Beljakovce	Towards the Bulgarian border to the east	This branch may be the first section of the link between the Macedonian Railways and the Bulgarian Railways, on Corridor VIII. Since the beginning of the construction of the new line, this line has been closed.	60-80 km/h
Corridor VIII	Jegunovce- Kicevo	Good conditions and most recent line (1968) works only for livestock transport 2 months annually	80-100 km/h
Corridor X branch B	Veles- Kocani	Closed for passenger transport in the last 2 years, occasionally works for freight	40-60 km/h
Corridor X branch D	Bitola- Greek border	Secondary and low standard lines. It has been constructed in 1939 but closed for the last 5 years.	5-10 km/h
Corridor X	Gradsko- Sivec	Operates only freight transport	40-50 km/h

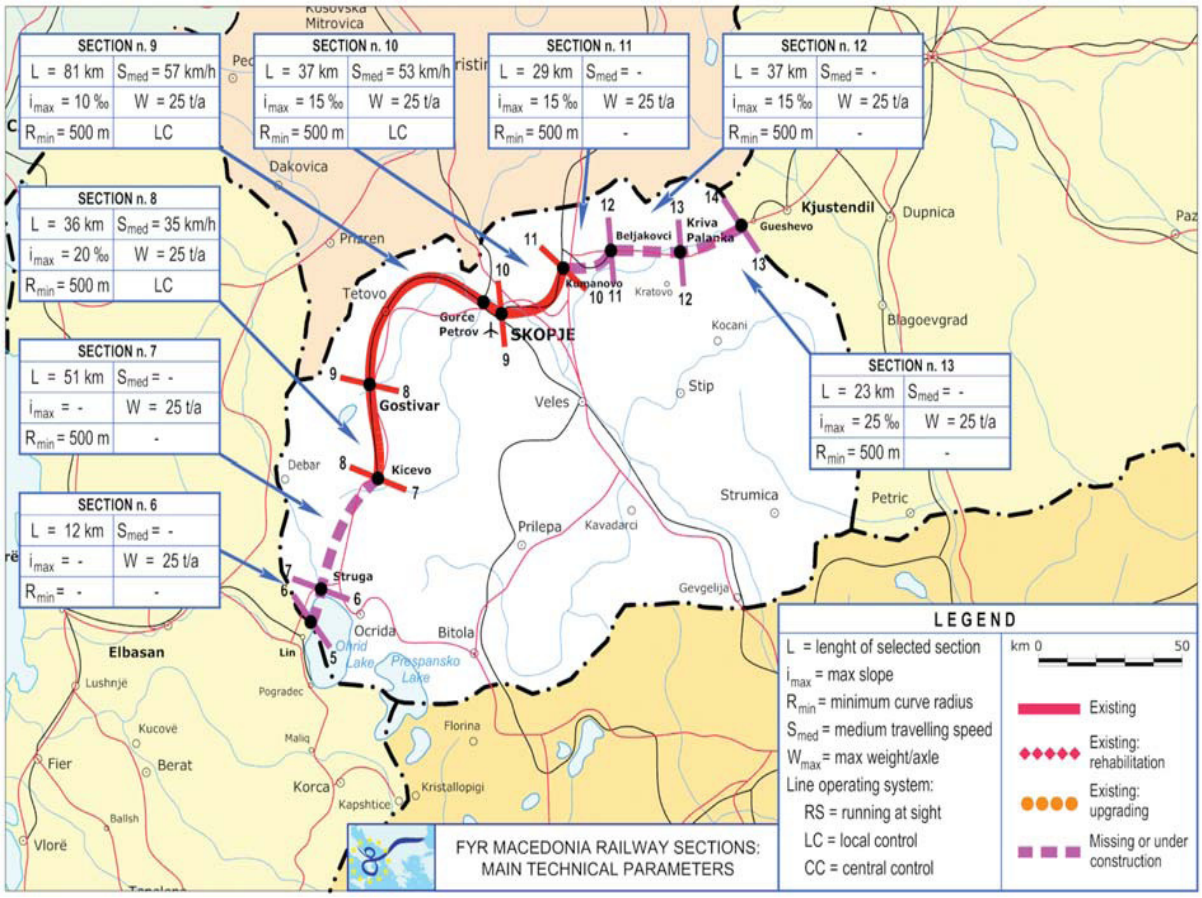

Figure 1. Railway sections in Macedonia

Rail Corridor VIII forms a network with Rail Corridors X, IV and IX. The interconnection nodes are in Skopje, with Corridor X; in Sofia, with Corridor IV; and in Gorna Oriahovica, with Corridor IX.

Along this alignment there are five missing links:

- Lin station (Albania) – FYR Macedonia border
- Pogradec station (Albania) – Greek border
- Kicevo station (FYR Macedonia) – Albanian border
- Kumanovo station (FYR Macedonia) – Bulgarian border
- Gueshevo station (Bulgaria) – FYR Macedonia border.

The entire line, including missing links, is 586 km long, of which 139 km are in Albania, 309 are in FYR Macedonia and 138 km are in Bulgaria. The line is composed by a single track segment, suitable for diesel traction trains. Macedonian ministry of transport and communications in 2011 created a fusibility study for the railway infrastructure of corridor VIII and its predictions of passenger and freight transport for the period of 2015/2040, by incorporating 3 probable scenarios: pessimistic, most likely and optimistic scenario.

3. Issued proposed methodology

The priorities of rail transport development in Macedonia are traffic safety, energy efficiency, competitiveness and provision of quality services to customers. It is also required that rail transport development should be environmentally friendly. Transport sector is the key economic driver in any state, and Macedonia is not an exception in this respect. According to some analysts there is a great influence on economic development which definitely will remain in the future in the transition countries such as the Macedonia.

In recent years, the solution to transport problems has been based on various scientists' researches and their recommendations. In the present paper, a model for evaluating knowledge potential, which is adapted to transport sector and takes into account the specific nature of the criteria describing it is offered and proposed for the future railway infrastructure and transport of passengers and fright at the corridors X and VIII. This AHP criterion is consisting of: education, professional experience, level of responsibility, scope of decision-making, independence in work, and work

culture which will be applied to the resolution of certain major goals connected with the transport of passengers and fright passing through the corridors. It is necessary to identify the needs and aims of passengers transport and fright transport as well as methods of evaluating and improving the quality of passenger transportation by rail. For this purpose, a questionnaire survey of passengers should be conducted and the weights of quantitative criteria should be determined.

AHP methodology

Analytical Hierarchy Process (AHP) is a structured technique with witch is making complex decisions. Before the enactment of "right" decision, AHP helps decision makers to find the one decision that is best for a given target and problem solving. AHP provides a comprehensive and rational framework for structuring trouble making and quantify elements of given problem.

With this multi criterion analysis can be considered many issues like: railway trip quality, time table developing, risks connected with the passenger and freight transport, etc. But first and essential step in optimizing this kind of issues is pursuing an appropriate survey questionnaires, which are prepared and later distributed among the respondents (passengers) and experts, second phase is pursuing and making a diagram for the criteria groups (A,B,C…..N) . Let's say that this are main issues, goals that has to be solve within some transport project, bat all of them has their own sub criterions (example: railway trip quality depends on a) criteria related to the train elements and the technical state of rails (railway track), b) criteria related to railway trip planning and technology, c) criteria related to the safety of railway trip.

AHP approach allows the researchers to determine the weights of the criteria of the same hierarchical level with respect to higher level criteria or to determine hierarchically unstructured criteria weights. Experts compare all the evaluated criteria R_i and $R_j\,(i, j = 1,.., n)$, where n is the number of the compared criteria [3].

The method described above is easy to use because it is easier to compare pairs of criteria than all of them at a time. In this case, it is much more important a particular criterion which is compared to another. It is also possible to transform qualitative criteria estimates elicited from experts into the quantitative ones. The matrix of the comparison of evaluation criteria ($a_{ji} = 1/a_{ij}$) is as follows:

$$A = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ 1/a_{12} & 1 & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ 1/a_{1n} & 1/a_{2n} & \dots & 1 \end{bmatrix} \quad (1)$$

We will use the 4-th method:

1. The elements of each row are multiplied together and the results obtained are written as follows:

$$\omega_i'' = \prod_{i=1}^{n} a_{ij} \quad (2)$$

2. *n-th* root is extracted from the element of each row (since the number of the criteria compared is $n = 6$, the 6-*th* root is extracted). The results obtained are written as follows:

$$\omega_i' = \sqrt[n]{\prod_{j=1}^{n} a_{ij}} \quad (3)$$

3. Let us add together the elements of this row:

$$\sum_{i=1}^{n} \omega_i' = \sum_{i=1}^{n} \sqrt[n]{\prod_{j=1}^{n} a_{ij}} \quad (4)$$

4. Let us divide each element of this row by the sum obtained, i.e. the evaluations normalization:

$$\omega_i = \sqrt[n]{\prod_{j=1}^{n} a_{ij}} \Big/ \sum_{i=1}^{n} \sqrt[n]{\prod_{j=1}^{n} aij} \quad (5)$$

Thus, the eigenvector $\boldsymbol{\omega}$ is found (step 4). The sum of its elements is equal to unity:

$$\sum_{i=1}^{n} \omega_i = 1 \quad (6)$$

Conclusion

The suggested AHP methodology by T. Saaty , can be used in evaluation and optimization on many issues concerning railway transport, and as that kind of methodology requires highly developed logical thinking of decision – makers. Highly qualified experts are required because the consistency of estimates. The estimate of a single highly competent expert is more important than the estimates provided by several or even tens of inexperienced specialists (not capable of thinking logically). This methodology along with the simulation analysis will be used in preparation of the future Project – "Optimization and economical analysis of rail transport within the trans-European rail corridors in the Republic of Macedonia" made by the scientific stuff from the TU-Sofia, Bulgaria and the State

University of “Goce Delcev”-Stip, Mechanical faculty, Macedonia within of two years period.

References

[1] Macedonian ministry of transport and relations, Economical and financial evaluation, fusibility study for corridors X and VIII, Project financed by EBOR, 2011.

[2] CORRIDOR VIII, Pre – feasibility study on the development of the rail axis, Final report, September 2007, Funded by Italian ministry of international Trade.

[3] Henrikas Sivilevičius & Lijana Maskeliunaite (2010). The criteria for identifying the quality of passengers’ transportation by railway and their ranking using AHP method, Transport, 25:4, 368-381.

ПРОУЧВАНЕ НА ЖЕЛЕЗОПЪТНИЯ ТРАНСПОРТ ПО ТРАНСЕВРОПЕЙСКИТЕ КОРИДОРИ НА РЕПУБЛИКА МАКЕДОНИЯ

докт. Горан Поп-Андонов, доц. д-р Светла Стоилова,
Катедра "Железопътна техника", Технически университет, София;
доц. д-р Деян Мираковски, доц. д-р Златко Соврески, доц. д-р Зоран Панов, УГД-Щип, Македония;
докт. Деян Кръстев, УКИМ-Скопие, Македония

Резюме: В доклада се изследват Транс - европейските коридори, които минават през Република Македония - N8 (Изток - Запад) коридор, свързващ Адриатика с Балканския регион и страните на Черно море и коридор N10 (север - юг), свързваща страните на Западна Европа с Гърция. Тези коридори са част от програмата на македонското правителство за изграждане на липсващите части от железопътната инфраструктура.
Ключови думи: железопътен сектор, сценарии за оптимизация, AHP методология