RESOURCE CONSTRAINED PROJECTS PRIORITIZATION WITH MCDM METHOD – CASE STUDY: SERBIAN RAILWAY INFRASTRUCTURE PROJECTS

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Abstract: Transport infrastructure development is one of the most important factors for a country's progress. Problem of transport projects prioritization is complex task due to many facts relevant in this process, such as: the need for large capital investments; the national budget constraints; a long period of project preparation; etc. Also, in this process numerous stakeholders are involved who often have different interests. The challenge that is considered in this paper is to develop an investment plan for railway projects realization in accordance with limited budget.

The proposed model has two stages: a projects' ranking and a projects' selection. Based on multi-criteria decision making method, the weights of railway projects are defined. The projects are ranked using the Analytic hierarchy process. The next stage, the projects' selection is done by the Excel Solver. The selection of projects is made in accordance with the available budget and projects' weights.

All data are taken from the Serbian National Programme of Public Railway Infrastructure for the period 2017-2021, as the last official national document and Master Plan for Railways for 2012-2021 for the Republic of Serbia.

The main contribution is developed MCDM methodology for single resource constrained projects prioritization that can be applied in any industry, not just transport.

Keywords: Multi-criteria decision making; Analytic hierarchy process; Project prioritization; Railway infrastructure projects

1. INTRODUCTION

Development of quality transport infrastructure is a precondition and one of the most important factors for a country's progress around the world. It has been confirmed by so many cases how transport infrastructure has added a momentum and efficiency to the world economies. Also, transport infrastructure facilitates the development of connections between regions within a country and between countries, and thus supports the formation of mutual economic, social and cultural relations. The transport
Infrastructure investments are driven by the policies of public authorities and ministry in charge. These entities are highly involved in decisions making processes about transport infrastructure development. In all European countries, the infrastructure manager is either the state or a public company, whereby the public authorities support financially all the capital investments.

The railway transport has been seen as a backbone for sustainable transport system. It has an essential role for the economies and the quality of life worldwide. It is the most environmentally-friendly, but also economically-cost effective, mode of transport. However, many years of the neglect and the lack of investments into railway network have led to the poor conditions’ of railway infrastructure which is one of the reasons for decreasing of railway transport demands on the transport market. So, in order to increase the volume of railway transport and to take advantage of all benefits offered by the railway transport it is necessary to prepare sustainable national investment plans for improving railway infrastructure.

The main challenge considered in this paper is to define an investment plan for realization of railway infrastructure projects when the objective is to maximize the effects of these projects, but with limited budget. The model for the resource constrained projects prioritization is developed. The proposed methodology is made in two stages: a projects’ ranking that is done with the AHP approach, and a projects’ selection that is done with the Excel Solver.

The model is tested and verified with the real data from planned railway projects on Serbian railway infrastructure network. All data are real data from Serbian National Programme of Public Railway Infrastructure for the period 2017-2021, as the last official national document (hereafter: NP) and Master Plan for Railways for 2012-2021 for the Republic of Serbia (hereafter: MPR).

The paper is organized as follows. After Introduction, the second section is dedicated to the problem description. The elements of the model, i.e. alternatives and criteria, are thoroughly defined. The third section presents the model for the resource constrained projects prioritization. This section also gives more details about applied approaches. The last section is dedicated to the final conclusion and future research.

2. THE PROBLEM DESCRIPTION

The rail infrastructure can function for a very long time without any investment in its maintenance because it has a long service life. Without regular investment in its maintenance, trains can run, but at the same time the maintenance costs, as well as the costs of the procurement of materials, increase, whereas the quality of rail services simultaneously decreases. Consequently, there is a need for huge and expensive investments that cannot be avoided (Macura and Bojović, 2013).

In the Republic of Serbia, there were no significant capital investments in the rail infrastructure or even in its regular maintenance until 2013 although rail lines are about 45 years old on average.

Unfortunately, it is evident that the rail sector has not been in focus for a certain time. In accordance with this, there are some facts published in the Business plan of Serbian...
infrastructure manager: only in 34 km of the whole rail network in Serbia is it possible for trains to run at a speed higher than 100km/h, which is only 1.4% of the whole network (Serbian Railways Infrastructure, 2018).

In period from 2013 to the end of 2018 were finished several railway projects where about 223 km of main railway lines are reconstructed and modernized. Aim of two railway projects was doubling of single tracks railway line so in this period was constructed 35 km of new railway tracks. Besides that, in period of 2017 to the end of 2018 the first phase of the renewal of the regional railways was carried out, within which about 271 km was renewed. Works which are currently underway are works on two sections of Belgrade-Budapest railway line from Belgrade to Novi Sad and work on renewal of 192 km of regional lines.

The plan presented in the NP relevant for the 2017-2021 period considers the construction of new rail lines, the recovery and maintenance of the existing rail lines; priorities, as well as a schedule for their implementation, the costs and the sources for their financing are defined.

Public investment is the field of the public finance management in the Republic of Serbia which has been paid great attention to. Strengthening the framework for public investments management intensifies new infrastructure projects and raises the quality of the existing infrastructure (Ministry of Finance of the Republic of Serbia, 2019). Capital projects, i.e. loans for projects, have become an integral part of the Budget of the Republic of Serbia by adoption the Regulation on the content, method of preparation and evaluation, as well as monitoring of the implementation and reporting on the implementation of capital projects (Ministry of Finance of the Republic of Serbia, 2017).

In order to keep the achieved fiscal stability, the financing of new capital projects will primarily be possible by freeing the fiscal space, which means that in the process of proposing projects, budget users should present the proposed, the existing and new projects within the limits proposed by the Budget Law (Ministry of Finance of the Republic of Serbia, 2018).

In the case when a budget beneficiary proposes several different capital projects for their inclusion in the priority areas of financing, the beneficiary should prioritize those projects according to their significance.

In order to perform the prioritization of rail projects, all of the considered railway infrastructure projects in the NP are presented in Table 1, together with their main characteristics, i.e. their length and the number of tracks.

Table 1. Considered alternatives

| Alternative | Length | No. of tracks |
|-------------|--------|---------------|
| A1 Niš – Preševo – North Macedonia border | 92 | 1 |
| A2 Resnik – Klenje – Mali Požarevac – Velika Plana | 84 | 2 |
| A3 Velika Plana – Gilje | 49 | 2 |
| A4 Paračin – Stalač | 22 | 2 |
| A5 Stalač – Đunis | 17.7 | 1 |
| A6 Đunis – Niš | 40 | 2 |
| A7 Golubinci – Šid – Croatia border | 81 | 1 |
| A8 Pančevo – Vršac – Romania border | 75 | 1 |
| A9 Stalač – Kraljevo – Rudnica | 149 | 1 |
| A10 Valjevo – Vrbnica – Montenegro border | 209.4 | 1 |
Figure 1 shows the railway network in the Republic of Serbia with considered alternatives, i.e. railway projects. All projects are on the railway Corridor 10, except A8, A9 and A10.

All relevant criteria are presented in Table 2. Here are given the measure of each criterion and type of criterion (whether it has to be minimized $\leq$, or maximized $\geq$).
Table 2. Considered criteria

| Criteria | Measure | Type of criterion |
|----------|---------|-------------------|
| X1 Investment cost | EUR/km | $\triangleleft$ |
| X2 The part of Corridor 10 | Yes/No [1,2] | $\triangleleft$ |
| X3 Rail infrastructure capacity utilization | The percent of rail line capacity utilization [%] | $\triangleright$ |
| X4 Maturity of the project | None, Initial, Intermediate, Final Stage [0,1,2,3] | $\triangleleft$ |
| X5 Traffic volume | [train/day] | $\triangleright$ |
| X6 Social aspect | [population/km] | $\triangleright$ |
| X7 Cost per minute saved for passenger traffic | [EUR] | $\triangleright$ |

Criterion X1 – Investment cost

Capital investment costs are taken from the NP and they are presented as unit cost per kilometer of a single track railway line. This criterion varies across the projects because of planned scope of the projects which depends on types of improvement (renewal, reconstruction, modernization or construction of new railway lines).

Criterion X2 – The part of Corridor 10

The Pan-European Rail Corridor 10 is a very important corridor that has a total length of 872 km on the territory of the Republic of Serbia, which presents about 23% of the railway network. Considering the significance of this corridor, which is the main transit route and the shortest route between Greece, the Middle East and Western Europe, the revitalization of railway sections along this corridor has a higher priority for providing capital investments.

Criterion X3 – Rail infrastructure capacity utilization

The capacity of the railway infrastructure is defined as the number of trains that can run on a particular railway section over a certain period of time (usually 24 hours) taking into account the characteristics and all limitations of that section. The data related to the infrastructure capacity utilization for the presented alternatives were taken from the MPR, except for the Stalac-Kraljevo-Rudnica project were received from the consultants working on the preparation of the Conceptual Design with a Pre-Feasibility Study.

Criterion X4 – Maturity of the project

Maturity of the project is presented as a stage of completion of necessary technical documentation. The term None represents that an alternative does not have any technical documentation. The alternatives in Initial stage are alternatives with at least provided funds for preparation of a Preliminary Design or with prepared Conceptual Design. Intermediate stage is stage where process of preparation of Preliminary Design is underway. Alternatives in Final stage are alternatives with at least prepared Preliminary design.

Criterion X5 – Traffic volume

Criterion of traffic volume is measured in trains per day. Data for this criterion are taken from the MPR, except for project Stalać-Kraljevo-Rudnica. This data is received from the consultants working on the preparation of the Conceptual Design with Pre-Feasibility Study.
Criterion X6 – Social aspect
Criterion Social aspect is measured in population per kilometer and represents a number of direct beneficiaries on micro level (on level of alternative). Data are taken from the Statistical book of Republic of Serbia (Statistical Office of the Republic of Serbia, 2018).

Criterion X7 – Cost per minute saved for passenger traffic
Upgrading of railway infrastructure has a direct benefit for rail user in way of time savings. In this paper only passenger traffic is taken into account because goods mainly transported by train are not affected with travel time. The criterion Cost per minute saved for passenger traffic represents a cost-benefit ratio for which the data for time savings are taken from the MPR, except for the project Stalač-Kraljevo-Rudnica. This data is received from the consultants working on the preparation of the Conceptual Design with Pre-Feasibility Study.

3. PROPOSED MCDM MODEL

The proposed model for resource constrained projects prioritization includes the AHP approach for projects’ ranking, i.e. for the projects’ weights obtaining, and also the application of the Excel Solver for the projects’ selection. The final product is the multiyear investment plan.

After determining the alternatives of the model and all relevant criteria in Section 2, the AHP approach will be briefly described below.

3.1 The AHP approach

The AHP approach was developed by Thomas Saaty (Saaty, 1980). Usually, the structure of the AHP model has three levels: the goal, criteria and alternatives (a model could have more levels; for instance, there can be subcriteria level, etc.). Since its founding in 1980s, this approach has been widely used in the scientific literature as well as in practice, due to many its advantages: the AHP structures the problem as a hierarchy, which is more compatible with the natural cognitive process; both qualitative and quantitative attributes can be considered; allows checking the consistency index of evaluators; group decision making is very well facilitated; there is an user-friendly software; etc.

The AHP approach is widely used in various fields (Macharis and Bernardini, 2015; Vaiday and Kumarb, 2006), here are some of them:

- Transportation (Chin et al. 2019; Macura and Bojković, 2016; Lai et al. 2015; Dhir et al. 2015; Barić and Starčević, 2015; Podvezko et al., 2014; Bojković et al., 2011; Islam and Saaty, 2010; Modarres and Zarei, 2002; Saaty, 1995);
- Logistics (Jain and Khan, 2017; Gurcan et al., 2016; Stević et al., 2015; Büyüközkan et al., 2008; Alberto, 2000);
- Marketing (Erbiyik et al., 2012; Yang and Lee, 1997);
- Project management (Quadros and Nassi 2015; Vargas, 2010; Al-Harbi, 2001)
  ➢ Railway projects: Hamurcu and Eren 2018; Stoilova and Nikolova 2018; Polat and Eray 2015; Macura and Šelmić 2015; Nyström and Söderholm 2010.
To the best of our knowledge the AHP approach with Excel Solver tool for railway projects’ evaluation has not been introduced as such so far. That is why this research is believed to be one of the first steps towards the development of MCDM models with Excel Solver tool for resource constrained projects prioritization in railway industry.

There are some researches (Macharis and Bernardini, 2015; Hüging et al., 2014; Macura et al., 2011) that emphasize the validity of the Multi-Criteria Decision Making methods’ for the transport project appraisal. In the paper (Macharis and Bernardini, 2015) authors gave an overview of the Multi-Criteria Decision Analysis (MCDA) applications for the transport project appraisal. The aim of this paper is to check whether or not there is an increasing of the MCDA methods’ applications in the evaluation of transport projects. The main conclusion of this research was that there is a certain increase of the MCDA methods’ applications, and the most used approach in this field is the AHP.

Here is presented the AHP approach through several steps.

**First step**
Definition of the goal, criteria and alternatives.

**Second step:**
The pair-wise comparison matrix development.

In order to compute the weights for the criteria, the pairwise comparison matrix $A$ is developed. The matrix $A$ is a $m \times m$ matrix, where $m$ is the number of criteria. Each element of matrix $A$, $a_{ij}$ represents the importance of the $i$th criterion relative to the $j$th criterion. Whereby, $a_{ji}$ the importance of the $j$th criterion relative to the $i$th criterion, is:

$$a_{ji} = 1/a_{ij}$$

This rule is known as an axiom of reciprocity.

The relative importance between two criteria is measured in accordance with Table 1.

| Value | Importance          |
|-------|---------------------|
| 1     | Equal               |
| 3     | Weak                |
| 5     | Strong              |
| 7     | Demonstrated        |
| 9     | Absolute            |
| 2,4,6,8 | Intermediate values |

**Third step**
The normalized pairwise comparison matrix development.

The normalized pairwise comparison matrix $A_{norm}$ is developed by using the following equation:

$$a'_{ij} = a_{ij} / \sum_{l=1}^{m} a_{lj} \quad (1)$$

**Fourth step**
The criteria weight vector calculation.
The criteria weight vector \( w \) is built in the following way:

\[
    w_i = (1/m) \times \sum_{t=1}^{m} a'_{it}
\]  

(2)

There is a matrix \( S, n \times m \) (where \( n \) and \( m \) are the numbers of alternatives and criteria, respectively) with elements \( s_{ij} \) which represents the value of the \( i \)th alternative with respect to the \( j \)th criterion.

**Fifth step**

The matrix \( B_j, n \times n \) with elements \( b_{ih} \) which represents the evaluation of \( i \)th alternative compared to the \( h \)th alternative with respect to the \( j \)th criterion.

The normalized matrix \( B_{\text{norm}} \) should be developed, in the same way as the normalized matrix \( A_{\text{norm}} \).

**Sixth step**

There is the score vectors \( s_j, j=1,...,m \). The vector \( s_j \) contains the scores of the alternatives with respect to the \( j \)th criterion.

Finally, the matrix \( S \) is obtained.

**Seventh step**

Once the weight vector \( w \) and the matrix \( S \) have been computed, the vector \( v \) is obtained as follows:

\[
    v = S \times w
\]  

(3)

The vector \( v \) presents the final priorities among alternatives.

At the end, the consistency of evaluators can be checked using the eigenvector method. The factor \( \lambda_{\text{max}} \) is used for calculation of the consistency index, \( CI \) (Saaty, 1980).

\[
    \lambda_{\text{max}} = \sum_{j=1}^{m} \left( w_j \times \left( \sum_{i=1}^{m} a_{ij} \right) \right)
\]  

(4)

\[
    CI = (\lambda_{\text{max}} - m) / (m - 1)
\]  

(5)

After the consistency index is calculated, the consistency ratio, \( CR \), can be considered as a relation of the consistency index and the random index, \( RI \). Table 6 presents the values for \( RI \), where \( m \) is the number of elements in a pairwise matrix.

\[
    CR = CI / RI
\]  

(6)

| m | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|----|
| RI | 0 | 0 | 0.58 | 0.9 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 | 1.49 |

Table 4. The values of RI

For \( CR < 0.1 \), the degree of consistency is satisfactory. Otherwise, the judgment of an evaluator should be revised.

**3.2 The structure of the model and results**

An algorithm for considered problem is presented in Figure 2. At the start, there are alternatives and criteria, as the elements of the model. These values are input for the AHP approach. The results of the AHP are the weights of alternatives and criteria.
Besides these values, projects costs and available budget per year are input for the Excel Solver. Some projects will not be implemented in the planned year because of the limited national budget, and they will be deferred for the next year. Every time, when there is a lack of the financial resource, the Excel Solver is used to select the projects for implementation, i.e. to determine those projects that will be postponed. When the year of the start for all considered projects is defined, the algorithm is finished.

The proposed model can be considered through two stages.

1) The first stage means the projects' ranking, i.e. the projects' weights obtaining. This calculation is made with the AHP approach (Dimitrijević, 2017). The elements of the model are 10 railway projects (Table 1) and 7 relevant criteria (Table 2). The input for the AHP model are data from Table 5. Based on these values, the pair-wise comparison matrices, presenting the comparison of alternative related to each criterion, are made.

Figure 2. The algorithm of the proposed model
Table 5. Input data

|   | X1 (mil.EUR/km) | X2 [1,2] | X3 [%] | X4 [0,1,2,3] | X5 [train/day] | X6 [population/km] | X7 [EUR] |
|---|----------------|----------|--------|-------------|----------------|---------------------|---------|
| A1 | 1.7            | 1        | 55     | 1           | 27             | 6300                | 3.67    |
| A2 | 2.05           | 1        | 69     | 1           | 27             | 21782               | 8.82    |
| A3 | 2              | 1        | 21     | 2           | 65             | 2359                | 22.05   |
| A4 | 1.8            | 1        | 29     | 2           | 34             | 2730                | 25.48   |
| A5 | 3.1            | 1        | 80     | 3           | 38             | 7410                | 9.08    |
| A6 | 2              | 1        | 23.8   | 2           | 38             | 10684               | 28.88   |
| A7 | 1.54           | 1        | 32     | 1           | 28             | 2782                | 47.17   |
| A8 | 1.2            | 2        | 71     | 0           | 48             | 2518                | 6.83    |
| A9 | 1.34           | 2        | 31     | 1           | 22             | 2220                | 2.47    |
| A10| 1.1            | 2        | 71     | 1           | 54             | 1241                | 1.91    |

Table 6 presents the pair-wise comparison matrix for criteria. Based on this matrix, the criteria weights are defined.

Table 6. Pair-wise comparison matrix for criteria

|   | X1 | X2 | X3 | X4 | X5 | X6 | X7 |
|---|----|----|----|----|----|----|----|
| X1| 1  | 3  | 5  | 0.3333 | 5  | 7  | 5  |
| X2| -  | 1  | 3  | 0.2   | 3  | 5  | 2  |
| X3| -  | -  | 1  | 0.14286 | 0.5 | 3  | 0.3333 |
| X4| -  | -  | -  | 1     | 5  | 7  | 5  |
| X5| -  | -  | -  | -     | 1  | 3  | 2  |
| X6| -  | -  | -  | -     | -  | 1  | 0.3333 |
| X7| -  | -  | -  | -     | -  | -  | 1  |

The final weights for all alternatives and criteria are obtained and presented in tables 7 and 8.

Table 7. The alternatives' weights and rank

| Alternative                                         | Weight | Rank |
|----------------------------------------------------|--------|------|
| A1 Niš – Preševo – North Macedonia border         | 0.0897 | 7    |
| A2 Resnik – Klenje – Mali Požarevac – Velika Plana | 0.0771 | 10   |
| A3 Velika Plana – Gilje                           | 0.1160 | 3    |
| A4 Paračin – Stalač                                | 0.0987 | 4    |
| A5 Stalač – Djunis                                | 0.1388 | 1    |
| A6 Djunis – Niš                                    | 0.0983 | 5    |
| A7 Golubinci – Šid – Croatia border                | 0.0804 | 8    |
| A8 Pančevo – Vršac – Romania border                | 0.0949 | 6    |
| A9 Stalač – Kraljevo – Rudnica                    | 0.0795 | 9    |
| A10 Valjevo – Vrbnica – Montenegro border         | 0.1265 | 2    |
Table 8. The criteria weights and rank

| Criteria                                      | Weight  | Rank |
|-----------------------------------------------|---------|------|
| X1 Investment cost                            | 0.2660  | 2    |
| X2 The part of Corridor 10                    | 0.1468  | 3    |
| X3 Criteria of rail infrastructure capacity utilization | 0.0557  | 6    |
| X4 Maturity of the project                    | 0.3334  | 1    |
| X5 Criteria of traffic volume                 | 0.0882  | 4    |
| X6 Social aspect                              | 0.0251  | 7    |
| X7 Cost per minute saved for passenger traffic | 0.0849  | 5    |

2) The second stage is the projects' selection, i.e. the multiyear investment plan development.

Relevant input for this stage are: the assumed budget per year (Table 9), the start date and estimated duration for all projects (Table 10), presented through the Gantt chart (Figure 3). The suggestion for decision makers, when a certain project should start (Figure 5), is provided by the Excel Solver.

Let us assume that there is a certain amount of the money for each year, as it is shown in Table 9.

Table 9. Data for the budget

| Year     | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|----------|------|------|------|------|------|------|------|------|------|------|
| Budget limit per year (mil. EUR) | 350  | 250  | 200  | 200  | 200  | 300  | 300  | 200  | 120  | 120  |

Table 10 presents several data: when certain project starts and estimated project’s duration, as well as the total costs for each project.

Table 10. Duration time and total costs for all alternatives

|     | Start [quarter and year] | Duration [months] | Total costs [mil. EUR] |
|-----|--------------------------|-------------------|------------------------|
| A1  | Q4 2022                  | 36                | 160                    |
| A2  | Q1 2023                  | 54                | 340                    |
| A3  | Q1 2022                  | 30                | 200                    |
| A4  | Q1 2022                  | 18                | 80                     |
| A5  | Q1 2021                  | 48                | 150                    |
| A6  | Q1 2022                  | 30                | 150                    |
| A7  | Q4 2022                  | 48                | 250                    |
| A8  | Q1 2023                  | 36                | 96                     |
| A9  | Q1 2024                  | 60                | 200                    |
| A10 | Q2 2022                  | 48                | 230                    |

* Q1, Q2, Q3, Q4 as the first, second, third, fourth quarter of a year
Gantt chart is a type of a bar chart that presents a projects' schedule. Here are presented all projects with their start times and how long they will be implemented (Figure 3). This chart is made before the proposed algorithm is applied.

Let us assume that the budget is limited. At the beginning of each year there is a certain amount of the money, which presents the available budget for all projects planned for that year. So, some projects will be implemented in the planned year, but some of them will not be finished, because of the limited budget. Which project will be finished or not is the answer that the Excel Solver should give to the decision makers.

Following figure presents how the Excel Solver provided the decision about projects' implementation, i.e. postponement. Here is shown example for 2022, with six planned projects: A1, A3, A4, A6, A7 and A10. Total requested budget is 1070 mil.EUR (160+200+80+150+250+230=1070). The available budget is 250+200=450 mil.EUR, where 250 mil.EUR is planned budget for 2020 (Table 7) and 200 mil.EUR is the rest from 2021 (the planned budget for 2021 is 350 mil.EUR, but after the implementation of the project A5, which costs 150 mil.EUR, there is the rest of 200 mil.EUR). Considering that there is no enough money for all planned projects, some projects will be postponed. For the considered example, the Excel Solver gave the suggestion that the projects A3, A4 and A6 should be implemented, but A1, A7 and A10 should be postponed (Figure 4: Column "Decision", variable 0/1 means postponement/implementation, respectively). This is also presented in Table 11, the third row.
Table 11 presents the multiyear railway investment plan that is developed based on the proposed algorithm (Figure 2).

Following figure presents the new Gantt chart, based on the previous table. This chart is made after the proposed algorithm is applied.
Some projects will be postponed even for few years due to lack of the financial resources for their implementation. In the presented example, without budget limitation all projects would be implemented and finished until 2030, but with budget limitation this period is moved to the 2033.

According to the latest European Union guidelines for the development of the trans-European transport network, deadline for Member states for development finalization of all transport projects of the Core network is 2030 (Regulation 1315/2013, 2013). Although the Republic of Serbia is not yet a member of the European Union, the developed investment plan for the railway infrastructure shows that even under the limited budget, there is a possibility of meeting the EU’s target.

4. CONCLUSION

Transport system is crucial factor for the economy growth and the level of standard of living. An adequate infrastructure is a precondition for a good transport system. The railway transport has been seen as a backbone for sustainable mobility, so the investments in this transport mode are of the high importance.

In this paper, the model for a sustainable investment plan related to the railway projects’ prioritization is developed. Firstly, all relevant projects are ranked with the AHP approach, and then based on the Gantt chart linked to these railway projects, the multiyear investment plan is developed.

Future research will be dedicated to analysis of the investment plan development under the uncertain conditions, such as uncertainty in financing of the projects, or how to develop a multiyear investment plan with some imprecise or missing data. Also, the sensitivity analysis should be done in order to check the robustness of the model.

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