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Principles of Effectiveness and Transparency in Public Administration by Financing of Basic Transport Services

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Abstract: Fulfillment of effectiveness and transparency principles in public administration by financing of basic transport services (BTS) relates closely to trends of sustainable development (SD) in the Czech Republic. The trends are to increase the quality and efficiency of public administration; to deal with the availability of basic local public services to the general public; the support and the implementation of new information technologies in public administration etc. The goal of the article is to give information about a designed prediction model (PM). The PM is focused on prediction of bus carriers revenues by force of neural networks (NN). The revenues are part of a demonstrable loss calculation. The subsidy size of separate bus line connection is determined on the basis of demonstrable loss. Clerical worker will be able to determine funds size needed for financing of demonstrable loss of bus carriers.

Key – words: sustainable development, public administration, principle, prediction model, neural nets

1 Introduction

Sustainable development [1] provides a new framework for the strategy of civilization development. The concept is based on the classic and broadly accepted definition adopted in 1987 by the World Commission on Environment and Development, under which development is considered sustainable if it meets the needs of the present generation without compromising the ability of future generations to meet their own needs. The content was subsequently developed at national as well as international levels; the most recent of major events, the World Summit on Sustainable Development (Johannesburg 2002), emphasized that the objective was to achieve development ensuring a balance between the three fundamental pillars: social development, economic development and environmental protection;development should be grasped as a constant challenge stimulating the social process of learning and self-organization.

The Strategy for SD should be an important basis for the strategic decision-making of individual ministries and for inter-ministerial co-operation and co-operation with major groups.

The strategic and partial goals and instruments of the Czech Republic Strategy for SD are formulated to eliminate, as much as possible, any imbalance between the economic, environmental and social pillars of sustainability. They are designed to ensure the highest attainable quality of life for the present generation and to create preconditions for the high-quality life of future generations. This is to be attained among others through the following strategic goals:

- support of economic development respecting the carrying capacity of the environment and ensuring the sustainable funding of public services (sustainable economy);
- support of the development of public services and social infrastructure;

From the perspective of sustainability, among others the following should be considered as weaknesses of the Czech Republic's economy and its most important sectors:

- the condition of public finances is unsustainable in the long term;
- insufficient regard for efficiency, evenness and environmental considerations in the creation and/or application of economic instruments (subsidies, grants, incentives);
- inadequately defined and supported public interest in a high quality transport service in municipalities and regions, unequal economic conditions for public and individual transport as a result of the non-payment of external costs by direct users, lack of interest among the general public in public transport.

Threat to the SD of the Czech Republic's economy can be also lagging behind in the field of information technologies and the opportunity is possible to consider a rise in the role of information technologies.

From point of view of good governance the insufficient transparency and integrity (resistance to corruption) of public administration at all levels are threats for SD too.

Basic principles of public administration that it should be to follow in activities are:

- principle of consistent observance law, reliability and predictability;
- principle of openness and transparency (actions, decision making financial funds management;
- principle of responsibility;
- principle of effectiveness;
- principle of observance of equality principle, objectivity and protection against abuse.

Among the main challenges for the SD of the Czech Republic in the field of good governance are increase the quality and efficiency of public administration and solution of the availability of basic local public services to the general public.

2 Financing of Public Administration

How to divide and to use financial resources of public budgets with the goal to achieve of great effectiveness by supplying of public services from point of view of the state and point of view of the self-government it is issue question of public service financing in the Czech Republic.

A fiscal federalism theory [2] deals with the effectiveness increase of the financial resources allocation. Problem with no effective allocation of financial resources in budgets for public services security in public sector is one of the basic reasons of the theory elaboration. It concerns this requirement:

- the public sector decentralization to lower government levels including self-government;
- the effectiveness increase by financing of public sector requirements in meaning of Pareto's effectiveness;
- to improve the quality of democratic decision making about financial flows in the budget system, the decision making about resources allocation and to improve a decision responsibility of relevant authorities on all public administration levels.

2.1 Financial System of Territorial Self-government

Financial system of the territorial self-government consists of off budget and municipality budgets and regional budgets. It falls among basis principles of the financial system of the territorial self-government [2]: management according to annual budget; off budget funds restricted creation; determinate municipal and regional autonomy degree; redistribute relations that are based on impartiality and politeness between municipalities and regions; principle of solidarity between rich and poor municipalities; transparency of financial; control degree from side of the central government etc.

The goal of territorial self-government financial system is to contribute to financial resources effective using. The basic activity of territorial self-government is public services security and support of region and municipality development.

2.2 Public Services Financing

A characteristic of public services is following [2, 3]:

- they are useful for all citizens therefore the public interests exist for their security;
- their consumption is collective;
- it often comes up a market failure by them;
- it is more effective if they are secured by the public sector.

The public services financing can be realized in this way [4]:

- the financing from the state budget resources (public services are guarantee or directly subsidized by state by force categories of departments; state funds or another organizations that are established ministries or another state authorities;
- the financing from territorial self-government budgets (municipalities finance public services either from own resources or from another resources; it is realized by force special-bound subsidy from the state budget);
- user of the services participates directly at the public services financing (many of public services are paid; the public services user partially or fully subscribes to costs cover that result from the specific service security);
- combination of the financing forms above (the special way of the financing is cover of a demonstrable loss. It is the difference between sum of economically justified costs that bus carriers spent on fulfillment of the public service obligation and the adequate profit that is in relation to these costs and between revenues that bus carriers obtained by fulfillment of the public service obligation. There is a service payment to end-user. However it does not cover expended service costs. The third subject has to pay off the demonstrable loss (it is the state in public passenger transport);

- the sponsor's financing (there are sponsor's resources or foreign resources; for example financial resources from funds Phare, ISPA a SAPARD).

2.2.1 Public Services Financing in Public Passenger Transport

The BTS security is a condition of access possibility to other public services.

Public passenger road transport and railway passenger transport standards are formulated universally but this universality is an advantage. It makes possible regional authorities to determine the range of BTS according to local conditions. The time and local bus line accessibility is determined in according to local requrements. The Regional Authority is guarantor of this BTS. The Regional Authority responsibility is to grant bus carrier demonstrable loss cover. It is caused by the obligation of the public services contract fulfillment. The special-bound subsidy is appropriated from the state budget for demonstrable loss cover. This situation is designed in the Fig. 1. This kind of the subsidy is possible to use only for a predetermined task fulfillment.

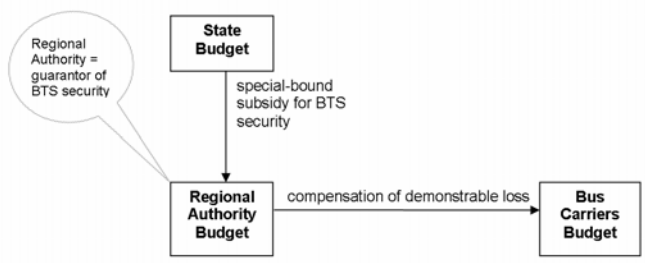

Fig. 1 Subsidization of Demonstrable Loss

3 The Road Traffic Licensing Department Function

One of region functions is to determine extent of BTS [5]. The Regional Authority has a function of the Road Traffic Licensing Department (RTLD) in the Czech Republic. It is in subscriber role of future provided the service by bus carriers to citizens. The bus carriers are providers of the public services.

The RTLD makes contract of public service obligation to security of BTS. There is relation between regional budget and budget of bus carriers which is based on the demonstrable loss. This loss is compensated by the Regional Authority. This situation is described in [6] and in [7].

Existence of the public interest to BTS security through the public service obligations is conditioned by existence of budget resources for this use reserved.

In the time of contracts conclusions (contract part is according to [6] an estimate of the future demonstrable loss that is calculated of bus carriers) RLTD will be able:

- to predicate by force of the PM revenues of bus connections that is content of contract;
- to determine extent of the financial resources that are needed for the demonstrable loss financing;
- to evaluate if the demand of bus carrier for the grant of financial resources is in accordance with reality.

3.1 Prediction Model Propsal for Road Traffic Licensing Department

Phases of the goal realization are represented in the Fig. 2. The first phase is a problem specification. The second phase is a data preprocessing and a data collection. The output of this phase is the data matrix that will be used in the phase of the PM creation. There are used description characteristics, correlation and clusters analysis and Kohonen maps. In the phase of PM creation are used multilayer perceptron neural networks (MPNN). The PM is created in software Clementine 7.0[1]. The final phase is the results evaluation and the results application in given public administration level.

3.1.1 Multilayer Perceptron Neural Networks

The basic element of a NN is a neuron. This is a simple virtual device which accepts many inputs, sums them, applies a transfer function, and outputs the result, either as a model prediction or as input to other neurons. A NN is a structure of many such neurons, connected in a systematic way. The NNs are described for example in [8, 9, 10, 11].

In PM in Clementine are used MPNN. The neurons in such networks are arranged in layers. There are typically three parts in a NN: an input layer with units representing the input fields, one or more hidden layers, and an output layer with a unit or units representing the output fields. The units are connected with varying connection strengths or weights. The network learns by examining individual records, generating a prediction for each record, and making adjustment to the weights whenever it makes an incorrect prediction. This process is repeated many times, and the NN continues to improve its predictions until one or more of the stopping criteria have been met [9].

The training of a multilayer perceptron uses a method called Backpropagation of error. For each record presented to the NN during training, information (in the form of input fields) feeds forward through the NN to generate a prediction from the output layer. This prediction is compared to the recorded output value for

[1] Clementine is an enterprise data mining workbench of SPSS Inc. that enables to quickly develop predictive models using expertise and deploy them into operations to improve decision making. It supports all steps of standard methodology CRISP-DM (Cross-Industry Standard Process for Data Mining).

the training record, and the difference between the predicted and actual outputs is propagated backward through the NN to adjust the connection weights to improve the prediction for similar patterns [9]. For training in Clementine are used following methods: Quick, Dynamic, Multiple, Prune and Exhaustive Prune.

Quick method uses rules of thumb and characteristics of the data to choose an appropriate shape for the NN [9].

Dynamic method created an initial topology, but modifies the topology by adding and/or removing hidden units as training progresses [9].

Multiple networks are trained in pseudo-parallel fashion. Each specified NN is initialized, and all NNs are trained. When the stopping criterion is met for all NNs, the NN with the highest accuracy is returned as the final model [9].

Prune method starts with a large NN and gradually prunes it by removing unhelpful neurons from the input and hidden layers. Pruning proceeds in two stages: pruning the hidden neurons and pruning the input neurons [9].

The Exhaustive Prune method is a special case of the Prune method. This method is usually the slowest, but it often yields better results than other methods [9].

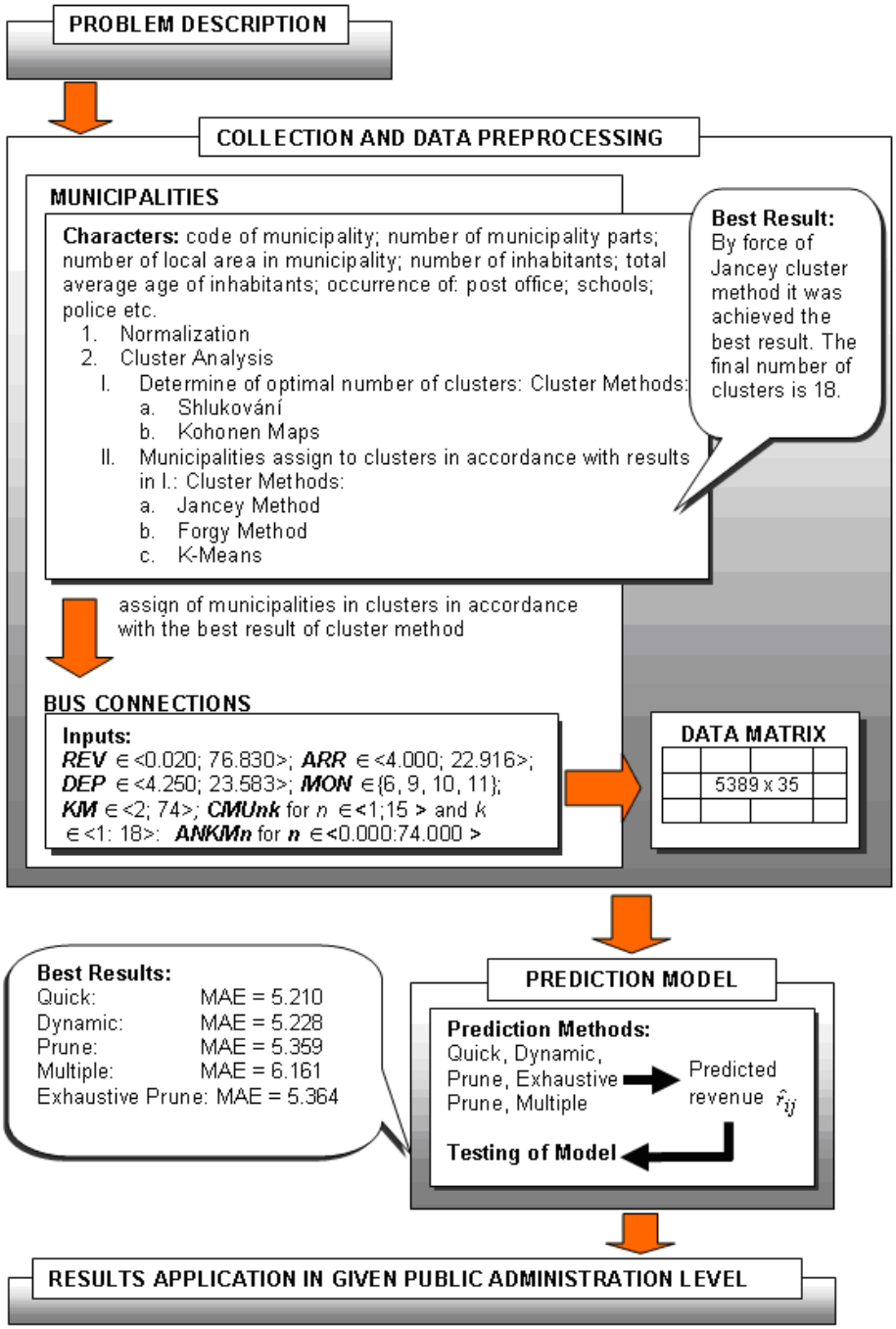

Fig. 2 Phases of Goal Realization

3.1.2 Results of Prediction

The data matrix contents 1 dependent input variable *REV* r_{ij} (revenue to passed kilometer of *i* bus connection in CZK) and other 34 input variables that are independent. There are: *ARR* c_{ij} (an arrival time bus connection to the goal bus stop); *DEP* a_{ij} (a departure time of bus connection from starting bus stop); *MON* f_{ij} (a month when bus carrier carries on transport on bus connection and which they raised revenues); *KM* e_{ij} (a total length *i* bus connection in kilometers); *CMUnk* kn_{ij} (a municipality *n* that was assigned to cluster *k*) and *ANKMn* pn_{ij} (an average number of kilometers in municipality *n* that was assigned to cluster *k*; it follows from number of bus stops in municipality and number of bus connection kilometers passed in municipality *n*)
The output of PM is predicted month revenues to passed kilometer of *i* bus connection of *j* bus line $\hat{r}_{ij}$ where $i \in <1;\ 67>$ and $j \in <1;\ 105>$. The input variables are in Fig. 2.

The data matrix contents 5 389 objects (bus connection s_{ij} that are described with variables above). It is divided into training set and testing set. From training set it is chosen a part of date for validation. According to [12] a possible size of validation set is in range from 10 % to 50 %. The size of testing set is 1796 objects. It is one third of objects from the total size of the data matrix.

Many tests were realized in the PM. The methods above were used for the NN training. The tests differ in setting stop criterions (time 2, 5 and 10 minutes for NN training) and size of validation sets (15 % - 40 %). The best results of test from methods are in Table 1.

Table 1 The best results of PM

Method of NN training	Topology of NN	CPA in [%]	MAE in [CZK]	Standard Deviation
Dynamic	211-9-6-1	93.53	5.23	7.82
Ex. Prune	211-30-18-1	93.54	5.36	7.98
Multiple	211-52-1	92.08	6.16	8.66
Quick	211-10-1	94.03	5.21	7.93
Prune	156-11-1	93.71	5.36	7.97

The results in Table 1 were achieved with 10 minutes of NN training time and with 15 % of validation set.

The best result of PM is extracted from method Quick. Time of NN training is 10 minutes. The NN achieved CZK 5.21 of mean absolute error (MAE). Calculation of MAE is following:

$$MAE = \frac{1}{1796}\sum\left|\left(r_{ij} - \hat{r}_{ij}\right)\right|. \qquad (1)$$

The overall predicted accuracy (CPA) of NN training is 94.03. Calculation of *PA* is following:

$$PA = \left(0.5 - \left|\frac{(r_{ij} - \hat{r}_{ij})}{r_{max} - r_{min}}\right|\right)100 \text{ (v [%])}. \qquad (2)$$

The PA is calculated for each record, and the overall accuracy CPA is the average of the values for all records in the training data.
The NN topology is following: 210 neurons create the input layer, one layer is hidden with 10 neurons and the output layer with one neuron represents the output field. The Fig. 3 shows the predicted and the actual revenues comparison of 30 bus connections sample.

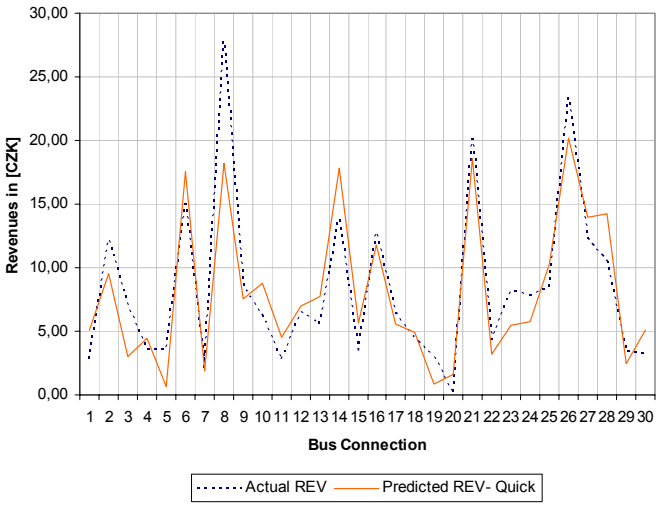

Fig. 3 Comparison of Predicted and Actual Revenues

The Multiple method is the worst of all. It achieved CZK 6.16 of MAE. The CPA is 92.08 and topology of NN is 211-52-1. Stopping criterion was setting on 10 minutes of NN training.

3.1.3 Results of Prediction by Input Variables Decreasing

The high value of Pearson correlation coefficient ρ_{ij} [13, 14] from the set of variables is set as a criterion of the variable select that will eliminated from the PM. The pair of variables *DEP* and *ARR* achieves the highest value of Pearson correlation coefficient ρ_{ij}. The value of this coefficient is 0,998.

Without the variable *DEP* or *ARR* it was realized 27 tests. The tests differed in the setting of NN training method (the Multiple method was eliminated on the basis of the previous results). The best results were realized by using method Quick and Exhaustive Prune. The MAE of the predicted value *REV* by method Quick

without the variable *DEP* is 5.13. Without the variable *ARR* it is 5.17. The MAE of the predicted value *REV* by method Exhaustive Prune is 5.13. This result of MAE is the best. The NNs were trained 10 minutes. The size of the validation set was 15 %.

Because the data from matrix are chosen randomly it was realized 30 tests with this setting. It was achieved an average MAE and an average CPA. The results of method Exhaustive Prune and Quick are in Table 2.

Table 2 Average MAE and average CPA from 30 tests

Method of NN training	Average MAE in [CZK]	Average CPA in [%]
Quick	5.38	93.42
Ex. Prune	5.47	93.39

The MAEs from 30 tests by method Quick are in Fig. 4. The MAEs by method Exhaustive Prune are in Fig. 5.

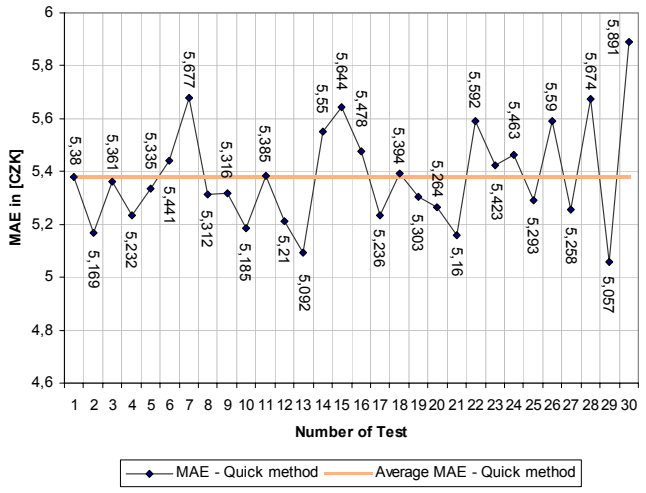

Fig. 4 MAE of 30 Tests by Method Quick

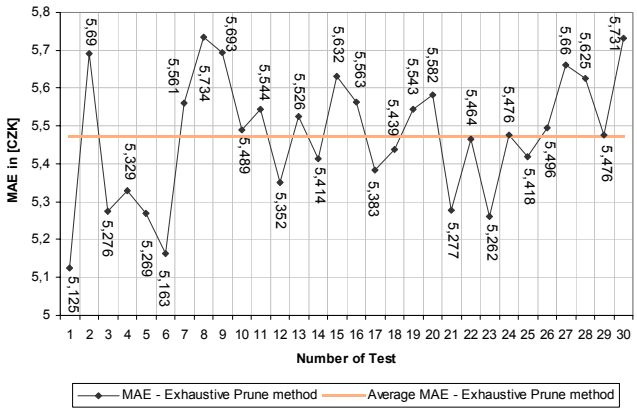

Fig. 5 MAE of 30 Tests by Method Exhaustive Prune

The Quick method achieved better results than Exhaustive Prune method. The best model was created with method Quick.

4 Conclusions

Many tests were realized in PM of month revenues on the basis of NNs. The best result CZK 5.05 was extracted from method Quick. The PM achieved accuracy of prediction in value 93.56 %. The prediction was realized by force of MPNN.

Implementation and use of PMs on the basis of NN or other prediction methods in decision-making process of public administration is the way how to increase the effectiveness and the financial resources distribution not only in the RTLD but in other spheres of public administration.

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