# DATA ANALYSIS FROM AREA OF STRATEGIC PLANNING

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***Abstract:*** *The text deals with the data analysis from an area of the strategic planning. It focuses on a searching of association rules by the Apriori algorithm. The administrative district of municipalities with extended powers in the Czech Republic were chosen as objects and were described by indicators based on the strategic planning. In the data pre-processing, selected rates of dynamics of the monitored indicators were calculated. Values of the average absolute increase of indicators were converted and were used to the searching of the association rules. Achieved results of three models were compared (e.g. by the support, confidence, rule support, and lift) and described. These models were differed in the way of the association rules searching (i.e. measure of the rule confidence; measure of the confidence difference; and measure of the confidence ratio). The association rules can serve as a support for a preparation of new strategic plans for e.g. municipality, region. Problem areas of the mentioned units could be selected on the basis of the achieved association rules.*

***Keywords:*** *Data, Analysis, Strategic Planning, Apriori, Association Rules.*

***JEL Classification:*** *C39, R58.*

## Introduction

A systematic management of any organization, enterprise, municipalities or regions is the purpose of a strategic planning. It is aimed at the stimulating and mobilizing to use all own resources most effectively and it reflects changes in its immediate environments quickly and effectively. The concept of strategy represents a comprehensive set of standard, proven steps and tools that are used to change management, but also represents the very process of managing these changes. It is one of the most important tools of the regional development on all levels (whether for municipalities and micro-regions across the development strategy of the larger cities to national level) [4], [11], [20].

Today we can see the views that the management at the regional or municipal level is different than the company's management for companies and businesses. Although this strategic planning is not required by law, the § 38 par. 1 Act no. 128/2000 Call., About municipalities and Act no. 320/2000 Call., On financial control obliges legal obligation to manage economically, efficiently and effectively. The basic theoretical concepts, systems and methodologies engaged in the area of the strategic planning are valid for municipalities in the same way as for other levels of management. However, for the strategic planning at the municipal level there are certain specifics. These include the specifics of autonomous activities of the community and a direct contact with the population [17], [21]. We can see the strategic planning as a systematic way how to organize the changes and produce a broad consensus in the entire society and a common vision for the (socio)economic future [13].

The objective of this paper is to do an analysis of data from the strategic planning to Administrative district of municipalities with extended powers (MEPs) in the Czech Republic. Although the practice of the strategic planning does not take place at this level, (takes place e.g. at the level of municipalities, regions), it was used available data for the

MEP to represent the appropriate data mining methods in the monitored area of the strategic planning. Based on the key areas that fall into the category of the strategic planning, there were selected 23 basic indicators (attributes). They describe the problems of the strategic planning at the level of cities, towns and regions. They are focused for example on the areas of demography, tourism and unemployment which are still discussed (e.g. in [12], [15], [19]). Due to unavailability of data, some indicators from other areas are not included (e.g. brownfields, environmental); more about used attributes is in [16].

## 1 Problem formulation

In the Czech Republic, there are 205 MEPs in all regions (with the exception of Prague). The website of the Czech Statistical Office was a source of the data for the individual MEPs. We dealt with data from years 2001 to 2013. In a data pre-processing phase relative indicators (to the comparison of the individual MEPs (e.g. per 1,000 inhabitants; per hectare of the total area of the MEP)) were created. The next step in the data pre-processing was the calculation of some selected rates of dynamics of the monitored indicators by which it is possible to determine the fundamental development of the time series. An absolute increase, average absolute increase, growth rate, average growth rate and relative growth are examples of these rates of dynamics by [2]. As an input to the creation of a data matrix, the average absolute increase was chosen. The calculation of the average absolute increase $\Delta_{aver}$ is the following (1):

$$\Delta_{aver} = \frac{(y_2 - y_1) + (y_3 - y_2) + \ldots + (y_T - y_{T-1})}{T - 1}, \tag{1}$$

where $y_t$ is time series, t = 1, 2, …, T. In total 45 MEPs were excluded from the data set for a lack of data for the year 2013. The values of the average absolute increase of the attributes higher than 0 were converted into the value 1 (the average absolute increase showed a positive development); values less than or equal to 0 into the value 0 (the average absolute increase showed a negative development). The positive or negative development of the indicators only was taken into account (the exact values of the average absolute increase $\Delta_{aver}$ were not used by the creation of any models). The data matrix A was created and contained 160 MEPs described by 23 attributes $a_1$, $a_2$, …, $a_{23}$ (Tab.1). Based on frequencies (values were 1 or 0) selected attributes were excluded from the data set (i.e. the Age index ($a_{13}$) and the Legal entities ($a_{19}$); an occurrence of the value 0 for the attribute $a_{13}$ was 3%; for the attribute $a_{19}$ 1%).

***Tab. 1: Data dictionary***

| ID | Description of Attribute | Value |
|---|---|---|
| $a_1$ | MEP | 2101 - 8122 |
| $a_2$ | Region | Stredocesky, Jihocesky, Plzensky, Karlovarsky, Ustecky, Pardubicky, Vysocina, Jihomoravsky, Olomoucky, Zlinsky, Moravskoslezsky |
| $a_3$ | Development of indicator Number of inhabitants | {0;1} |
| $a_4$ | Development of indicator Farmland | {0;1} |
| $a_5$ | Development of indicator Forest land | {0;1} |
| $a_6$ | Development of indicator Built-up area | {0;1} |
| $a_7$ | Development of indicator Population density | {0;1} |
| $a_8$ | Development of indicator Live births | {0;1} |
| $a_9$ | Development of indicator Deaths | {0;1} |
| $a_{10}$ | Development of indicator Balance of migration | {0;1} |
| $a_{11}$ | Development of indicator Marriages | {0;1} |
| $a_{12}$ | Development of indicator Divorces | {0;1} |
| $a_{13}$ | Development of indicator Age index | {0;1} |
| $a_{14}$ | Development of indicator Jobseekers | {0;1} |
| $a_{15}$ | Development of indicator Vacancies | {0;1} |
| $a_{16}$ | Development of indicator Applicants per one vacancy | {0;1} |
| $a_{17}$ | Development of indicator Unemployment rate | {0;1} |
| $a_{18}$ | Development of indicator Physical persons | {0;1} |
| $a_{19}$ | Development of indicator Legal entities | {0;1} |
| $a_{20}$ | Development of indicator Completed apartments | {0;1} |
| $a_{21}$ | Development of indicator Flats in family houses | {0;1} |
| $a_{22}$ | Development of indicator Beds | {0;1} |
| $a_{23}$ | Development of indicator Number of guests | {0;1} |

*Source: Authors*

## 2 Methods

The object of modeling is to find a set of association rules (rules) [6], [10], [18], [22] described area of strategic planning of MEPs in the CR. An Apriori algorithm [1], [8], [7], [14], [22] was used to the discovering of association rules in the data. Association rules are statements in this form (2):

If antecedents(s) Then consequent(s). (2)

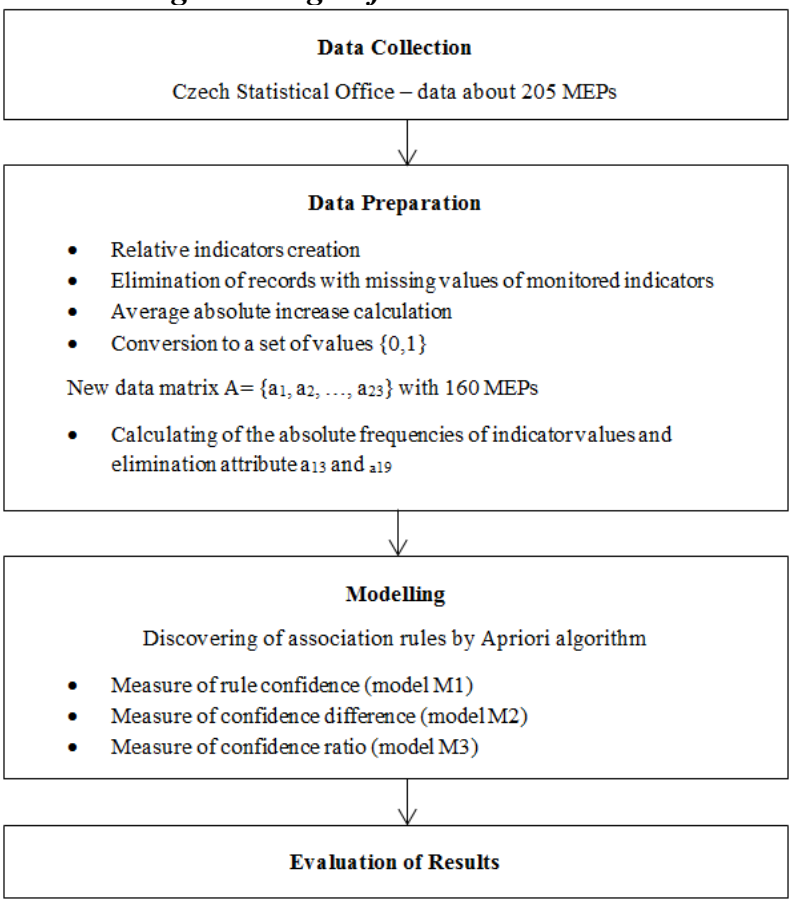
This Apriori algorithm [8] offers several evaluation measures for determining which rules to retain. The different measures will emphasize different aspects of the rules. Values are calculated based on the prior confidence and the posterior confidence).

The set of rules is described by rule ID, instances, support, confidence, rule support, and for example by lift [6], [7], [8]. Instances are calculated as the number of records for which the antecedent is true [9]. The rule support $m_{RS}$ (in %) and confidence $m_C$ (in %) are two measures of rule interestingness. They respectively reflect the usefulness and certainty of discovered rules [6]. The confidence $m_C$ [6], [9] displays the ratio of rule support to antecedent support [9]. The lift $m_L$ is the simple correlation measure [6]. It displays the ratio of confidence for the rule to the prior probability of having the consequent. Rules with the lift different from 1 will be more interesting than rules with lift close to 1 [9]. Application of this algorithm we can see e.g. in [5].

## 3 Problem solving

Three models on the basis of the Apriori algorithm were created in software IBM SPSS Modeler. There were used a measure of "rule confidence" (it is the default method; it uses the confidence $m_C$ (or accuracy) of the rule to evaluate rules); measure of "confidence difference" (absolute confidence difference to prior); and measure of "confidence ratio" (difference of confidence quotient to 1; this evaluation measure is the ratio of rule confidence to prior confidence (or, if the ratio is greater than one, its reciprocal) subtracted from 1. Like confidence difference, this method takes uneven distributions into account. It is especially good at finding rules that predict rare events [9]). Design of the model creation is in Fig. 1.

***Fig. 1: Design of the model creation***




*Source: Authors*

By creation of all three models (M1, M2 and M3) some parameters were set (minimum rule confidence: 80%, minimum antecedent support: 50%, maximum number of antecedents: 7). Models were different by setting of evaluation measures.

**Model M1:** there were found 338 association rules on the basis of the rule confidence. Selected association rules of the strategic planning are in Tab. 2. There are the values of the consequent, antecedent, instance, support $m_S$ (in %) and confidence $m_C$ (in %), rule support $m_{RS}$ (in %), and lift $m_L$. This association rule states

*IF Applicants per one vacancy ($a_{16}$) = 1 AND Live births ($a_8$) = 1 AND Physical persons ($a_{18}$) = 1 THEN Jobseekers ($a_{14}$) = 1.*

The positive development of the average absolute increase in 85 instances out of 160 MEPs for attributes $a_{16}$, $a_8$ and $a_{18}$. It means that the relative number of the occurrence of the antecedent is 53.125%. The confidence $m_C$ is 97.647% and the rule support $m_{RS}$ is 51.875%. The value of the lift $m_L$ is 1.157; this rule is not very interesting (the difference is 0.157).

***Tab. 2: Selected association rules by the rule confidence method***

| Antecedent | Consequent | Instances | $m_S$ [in %] | $m_C$ [in %] | $m_{RS}$ [in %] | $m_L$ |
|---|---|---|---|---|---|---|
| $a_3 = 1$ and $a_{18} = 1$ | $a_7 = 1$ | 88 | 55.000 | 97.727 | 53.750 | 1.612 |
| $a_{16} = 1$ and $a_8 = 1$ and $a_{18} = 1$ | $a_{14} = 1$ | 85 | 53.125 | 97.647 | 51.875 | 1.157 |
| $a_{23} = 1$ and $a_{18} = 1$ | $a_{22} = 1$ | 81 | 50.625 | 91.358 | 46.250 | 1.169 |
| $a_8 = 1$ and $a_5 = 1$ and $a_{18} = 1$ | $a_{14} = 1$ | 94 | 58.750 | 90.426 | 53.125 | 1.072 |
| $a_8 = 1$ and $a_{21} = 1$ and $a_{14} = 1$ and $a_{18} = 1$ | $a_{16} = 1$ | 80 | 50.000 | 90.000 | 45.000 | 1.210 |

*Source: Authors*

**Model M2:** There were found in total 49 association rules by the confidence difference of the Apriori algorithm (model M2). Examples of these rules are in Tab. 3. The first association rule is the following:

*IF Number of inhabitants ($a_3$) = 1 AND Physical persons ($a_{18}$) = 1 THEN Population density ($a_7$) = 1.*

In this example, the average absolute increase of these attributes were for individual MEPs during the reporting period, a total positive in 88 of 160 cases. It means, the support $m_S$ is 55.000%. The confidence $m_C$ is 97.727%. On the basis of the lift value ($m_L$ is 1.612) it is possible to rank among more interesting rules achieved by the confidence difference method.

**Model M3:** On the basis of the confidence ratio (model M3) in total 58 association rules were found. Examples of these rules are in Tab. 4. The association rule

*IF Live births ($a_8$) = 1 AND Flats in family houses ($a_{21}$) = 1 AND Jobseekers ($a_{14}$) = 1 AND Physical Persons ($a_{18}$) = 1 THEN Applicants per one vacancy ($a_{16}$) = 1*

ranks among the more interesting rules on the basis value of the lift parameter ($m_L$ is 1.21). For this rule is true that the average absolute increase of attributes $a_8$, $a_{21}$, $a_{14}$, and $a_{18}$ recorded the positive development is 80 instances. It follows that the support $m_S$ is 50.000%. The confidence $m_R$ is 90.000% and the rule support $m_{RS}$ is 45.000% (this value ranks among the smallest values of all achieved association rules).

***Tab. 3: Selected association rules by the confidence difference method***

| Antecedent | Consequent | Instances | $m_S$ [in %] | $m_C$ [in %] | $m_{RS}$ [in %] | $m_L$ |
|---|---|---|---|---|---|---|
| $a_3 = 1$ and $a_{18} = 1$ | $a_7 = 1$ | 88 | 55.000 | 97.727 | 53.750 | 1.612 |
| $a_{23} = 1$ and $a_{18} = 1$ | $a_{22} = 1$ | 81 | 50.625 | 91.358 | 46.250 | 1.169 |
| $a_3 = 1$ and $a_7 = 1$ and $a_{14} = 1$ | $a_8 = 1$ | 81 | 50.625 | 87.654 | 44.375 | 1.150 |
| $a_8 = 1$ and $a_{14} = 1$ and $a_5 = 1$ and $a_{18} = 1$ | $a_{16} = 1$ | 85 | 53.125 | 87.059 | 46.250 | 1.171 |
| $a_{22} = 1$ and $a_{21} = 1$ and $a_{14} = 1$ and $a_5 = 1$ | $a_{16} = 1$ | 80 | 50.000 | 85.000 | 42.500 | 1.143 |

*Source: Authors*

***Tab. 4: Selected association rules by the confidence ratio method***

| Antecedent | Consequent | Instances | $m_S$ [in %] | $m_C$ [in %] | $m_{RS}$ [in %] | $m_L$ |
|---|---|---|---|---|---|---|
| $a_{16} = 1$ and $a_{21} = 1$ and $a_5 = 1$ and $a_{18} = 1$ | $a_{14} = 1$ | 85 | 53.125 | 96.471 | 51.25 | 1.143 |
| $a_{23} = 1$ and $a_{18} = 1$ | $a_{22} = 1$ | 81 | 50.625 | 91.358 | 46.250 | 1.169 |
| $a_8 = 1$ and $a_{21} = 1$ and $a_{14} = 1$ and $a_{18} = 1$ | $a_{16} = 1$ | 80 | 50.000 | 90.000 | 45.000 | 1.210 |
| $a_3 = 1$ and $a_7 = 1$ and $a_{14} = 1$ | $a_8 = 1$ | 81 | 50.625 | 87.654 | 44.375 | 1.150 |
| $a_8 = 1$ and $a_{14} = 1$ and $a_{18} = 1$ | $a_{16} = 1$ | 95 | 59.375 | 87.368 | 51.875 | 1.175 |

*Source: Authors*

## 4 Discussion

An interpretation of found knowledge is an important step in the process of the data mining [1], [3]. The interestingness, usefulness and intelligibility are main criteria for assessment of the knowledge. The basic question is, what is an importance of found knowledge for experts and end users. We can speak by [3] about knowledge in accordance with the common sense (in our case *If the population grows, then the population density is increasing.*); about knowledge in accordance with knowledge of experts (e.g. *If number of craft trades is increasing, then the capacity of accommodation facilities increases;* it can inform about development of the hostelry trades in area*)*; about new, interesting knowledge which gives the view on the given area; about knowledge which expert has to analyse, because it is not clear what it means, but it may be beneficial; and about knowledge which is contrary to expert knowledge.

An evaluation of the knowledge is based on various numerical parameters; in the case of the association rules, the support and confidence are examples of these parameters. It should be emphasized that not everything what is clearly demonstrated in the data, has the importance for the experts [3].

In the given area, the most association rules (in total 338) were achieved by the rule confidence method of the Apriori algorithm (the model M1). The maximum value of the support $m_S$ was 90.000%, of the confidence $m_C$ was 97.895%, of the rule support $m_{RS}$

80.625%, and of the lift $m_L$ 1.643 (Tab.5). Based on the confidence difference evaluation measures (the model M2) 49 rules were achieved and by the application of confidence ratio (the model M3), there were 58 rules. The maximum support $m_{Smax}$, maximum confidence $m_{Cmax}$, maximum rule support $m_{RSmax}$ and lift $m_{Lmax}$ were identical for models M2 and M3. We can see in Tab. 5 the model M2 by the confidence difference and model M3 by the confidence ratio achieved lower values of the maximum support $m_{Smax}$ ($m_{Smax}$ is lower by 5.625% relative to the model M1on the basis of the rule confidence; and $m_{RSmax}$ is worse approximately about 9.500%).

***Tab. 5: Evaluation of models***

| Model | Count of Rules | $m_{Smax}$ [in %] | $m_{Cmax}$ [in %] | $m_{Lmax}$ | $m_{RSmax}$ [in %] |
|---|---|---|---|---|---|
| M1 (rule confidence) | 338 | 90.000 | 97.895 | 1.643 | 80.625 |
| M2 (confidence difference) | 49 | 84.375 | 97.895 | 1.643 | 71.250 |
| M3 (confidence ratio) | 58 | 84.375 | 97.895 | 1.643 | 71.250 |

*Source: Authors*

Because of higher values of the lift $m_L$ it is possible to state that attributes describing the development of the population living in the MEPs in the Czech Republic rank among the most interesting rules. These were attributes: Number of inhabitants $a_3$, Population density $a_7$, and Forest land $a_5$. The association rules composed of these attributes achieved the highest value of the lift $m_L$.

Rules related to the area of the unemployment rank among more interesting rules, too. These were mainly indicators: The Jobseekers ($a_{14}$), Applicants per one vacancy ($a_{16}$) in conjunction with the indicator Live births ($a_8$); where the positive development of $a_8$ had an influence on the indicator of the unemployment rate.

The selected association rules obtained on above mentioned method of the Apriori algorithm were compared with the data of the individual MEPs. The comparison of the data of the MEP Pardubice and selected association rules is in Tab. 6.

***Tab. 6: Application of selected association rules to data MEP Pardubice***

| Antecedent | Consequent |
|---|---|
| $a_{16} = 1$ and $a_8 = 1$ | $a_{14} = 1$ |
| $a_{16} = 1$ and $a_{22} = 1$ and $a_{18} = 1$ | $a_{14} = 1$ |
| $a_{23} = 1$ and $a_{18} = 1$ | $a_{22} = 1$ |
| $a_8 = 1$ and $a_{14} = 1$ and $a_{18} = 1$ | $a_{16} = 1$ |

*Source: Authors*

The association rule *IF Applicants per one vacancy ($a_{16}$) = 1 AND Live births ($a_8$) = 1 THEN Jobseekers ($a_{14}$) = 1* can be used for the MEP Pardubice (although, in the years from 2001 to 2013 there were several decreases of the indicator Live births ($a_8$), which however did not affect the overall development of the average absolute increase of the indicator during the time period.

The association rule IF *Number of guests ($a_{23}$) = 1 AND Physical persons ($a_{18}$) = 1 THEN Beds ($a_{22}$) = 1* it is true for the MEP Pardubice and covers two areas of the strategic planning. It is the area of tourism and area of the business. The positive development of the indicators Physical persons ($a_{18}$) and Number of guests ($a_{23}$) in the antecedent had the

influence on the indicator Beds ($a_{22}$). The positive development of the indicator Number of guests ($a_{23}$), which recorded the second biggest growth during the reporting period (it follows from the data before transformation), could be due to an increase of business in the provision of accommodation options (it is represented by the indicator Physical persons ($a_{18}$) in this association rule). The positive development of $a_{18}$ of the MEP Pardubice caused more than double the growth of the indicator Beds ($a_{22}$). The indicator Legal entities ($a_{19}$), which was excluded, would probably be part of this association rule. This one ($a_{19}$) and the indicator Physical person ($a_{18}$) are focused on business.

## Conclusion

The application of the Apriori algorithm on data from the area of the strategic planning was the content of this paper. The MEPs in the Czech Republic were chosen as objects and were described by 23 indicators based on the strategic planning. We focused on MEPs because of the availability of data from the given area, although the practice of the strategic planning does not take place at this level.

In the data pre-processing phase, selected rates of dynamics (i.e. the absolute increase, average absolute increase, growth rate, average growth rate, etc.) of the monitored indicators, by which it is possible to determine the fundamental progression of the time series, were calculated. Values of the average absolute increase of indicators were converted to values 0 or 1 (it follows from the positive or negative development of indicators on the basis of the average absolute increase values) and were used to the searching of the association rules.

Three models (M1, M2 and M3) based on the Apriori algorithm were created. They were differed in the way of the association rules searching (i.e. measure of the rule confidence; measure of the confidence difference; and measure of the confidence ratio). These models were compared and selected association rules of the individual models were described. It was mentioned that it is possible to apply the association rules on the data of the individual MEPs. The example of the MEP Pardubice was described in the context of the achieved association rules by the models.

The association rules could serve as a support for a preparation of new strategic plans for each unit (e.g. municipality, region). Problem areas of the units could be selected on the basis achieved association rules. For units that are facing a high unemployment rate, the priority should be to create conditions that would cause an influx of new businesses in the area. From achieved results of the models follows that the MEPs should aim attention to the tourism sector. Based on the result of the Apriori algorithm it can be deduced that higher number of tourists could affect the unemployment in the monitored area.

In the future work are going to focus on the other algorithms for the searching of association rules; deal with the collection of more appropriate indicators to modeling and work with the other rates of dynamics in the area of the strategic planning.

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