3/2016

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(Economics, Management, Marketing, Linguistics, Pedagogy, Education, History)

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CONTENT

Dear readers,

we are honored to present you a new issue of the scientific journal published by the Faculty of Corporate Strategy of the Institute of Technology and Business in České Budějovice. Papers and studies of this issue are thematically focused on trade and economic relations between China and Central Europe. The choice of this topic is the next logical step in strengthening cooperation between Chinese universities and the Institute of Technology and Business.

2016 is the year in which the publisher is celebrating its 10th anniversary and volume 9 of the journal is published. There were good years and bad years in the history of the ITB and Littera Scripta journal as well. However, both have the same long-term trend – positive development. The Institute of Technology and Business expands the range of fields of study and number of students. Littera Scripta continuously improves the quality of published papers, as evidenced by inclusion in the European Reference for the Humanities and the Social Sciences database (ERIH Plus database).

Finally, let us thank all the authors who participated in the creation of this journal issue. Each published article indisputably involves a wide range of valuable information. Thanks also to the reviewers and office workers. We wish all readers to find important information for personal development.

Doc. Ing. Marek Vochozka, MBA, Ph.D.

Ing. Pavel Rousek, Ph.D.

20th December, 2016, České Budějovice

REVIEW PROCEEDINGS

In issue 3/2016 8 reviewed articles written by 14 authors from 5 institutions were included.

Articles

Number of articles received: 12

Number of articles rejected in 1st round of review proceedings: 1

Number of articles rejected in 2nd round of review proceedings: 0

Number of articles agreed to be published: 12

Review conclusions

Number of reviews delivered: 26

• from which was reviewed by reviewer with Doc. or Prof. degree: 10

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Evaluation of the Quality of the Entrepreneurial Environment on the Basis of Fuzzy Logic

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Abstract

Investor's risk involves both economic and non-economic factors, which are evaluated by ratings agencies. Within this context, estimates are calculated of the percentage value of the quality of the entrepreneurial environment "*p*" for selected countries in Europe and Asia. They are based on the modified values of the indices of the partial components of the quality of the entrepreneurial environment (levels of corruption, economic and political stability). The partial components of the rating evaluation are processed by means of fuzzy logic, which enables the description of vague and uncertain input data and sociological-psychological factors that occur during managerial tasks. Fuzzy logic is based on the fundamentals of classic propositional logic, whereby the truth-value of each A statement is generalized as $|A| \in \langle 0,1 \rangle$ and is interpreted as the extent or degree of its truthfulness. Compared to the statistical approach, fuzzy logic is discussed and evaluated in terms of particular managerial tasks.

Keywords: fuzzy logic, entrepreneurial risk, ratings agency, sociological-psychological factors

Introduction

In complex situations that are characterized by unspecified influences and which result in uncertainty, people usually follow the normative rules for a particular situation, or act on the basis of their knowledge and experience, or both. Decision-making and management based on rules is quite easy and reliable, especially in cases of situational management, whereby each situation can be reliably identified and treated in accordance to one relevant rule (Polikar 2006).

In situations where the choice of the relevant rule is not unambiguous it is necessary to accept a compromise. This reflects the fact that the concepts and procedures on which rules are usually based are often vague and ambiguous; who knows the exact meaning of appropriately, carefully, or thoroughly? However, this vagueness and ambiguity are not detrimental in practice because they enable, for example, an experienced financial consultant to "customize" a client´s financial plan on the basis, for example, of their tendency to take risks and their preference for profit.

In light of the large number of concurring factors with sociological-psychological characteristics, many experts in various management branches find themselves in a similar situation to the experienced financial consultant. Managerial decisions are decisions that concern future outputs, which are always uncertain in some aspects (Froot and Stein 1998). This uncertainty is associated with a number of risks, for which a number of quantitative and qualitative procedures are used in order to minimize them. For example, the evaluation of the investment risks of a project are, as standard, quantified on the basis of the expected net value of cash flows after taking into consideration two risk components: a) the possibility of the occurrence of various results as a consequence of the existence of various scenarios - this risk component reflects the existence of external influences, which cannot be excluded (e.g. variations in price levels, demand levels, macro-economic influences, etc.); b) the fact that the particular income from the given project usually fluctuates around its expected value over time - this component reflects internal influences, which the investor may have under their control to a certain extent (Myers 2015; McNeil et al. 2015; Wiesemann et al. 2010). Hašková (2016) also discusses how the standard investment risk can be extended by additional non-economic components in the form of political or environmental risks (e.g. war, expropriation, sanctions, natural catastrophes, etc.).

This article aims to extend the standard procedures for the quantification of an investor's risk by means of fuzzy logic, which primarily concerns the processing of vague values which are the products of uncertain ideas, untested concepts and general thinking. The use of fuzzy logic is used in various managerial disciplines to search for the answers to problems burdened by uncertainty (see Kahraman et al. 2016; Gitinavard et al. 2015; Dong and Li 2016; Chiu and Park 1994).

In this article, fuzzy logic is applied to resolving a practical managerial task, whereby an investment consultant must quantitatively evaluate the quality of the prevailing entrepreneurial environment, whilst taking into consideration the relationship of a particular investor to risk. This evaluation is based on the values of indices (on a scale of 0 to 100) for selected countries in Europe and Asia as published by specialised world ratings agencies (see Table 1). As part of the solution fuzzy logic shows how the ambiguousness, vagueness and uncertainty of the managerial problem can be solved with suitably formulated rules and procedures.

Materials and Methods: fundamentals of fuzzy logic

In the world of expert management, vaguely defined concepts and systems are usually represented by linguistic variables and their linguistic values (so-called terms); the word "linguistic" is used within the context of "communicated in the natural language". The desired relationship between the input and output linguistic variables is determined by complex rules. The tool with which to mathematically solve this type of task is fuzzy logic (for further details on fuzzy logic see, for example, Ross (2010)).

Fuzzy logic may be seen as a certain generalization of classic (two-value) propositional logic (for further details on aspects of propositional logic see, for example, Peregrin (2016) or Peregrin and Svoboda (2016)). Under fuzzy logic, the probability values P (truth) and N (untruth) for propositions A and B are replaced by the numbers 1 and 0 respectively. The truth-values for proposition A and B are therefore designated as $|A| \in \{0,1\}$, or $|B| \in \{0,1\}$ respectively. The truth charts for conjunction, disjunction and negation are expressed in terms of the numerical characteristics of these operators: $|A \wedge B| = \min\{|A|,|B|\}$, $|A \vee B| = \max\{|A|,|B|\}$, $|\neg A| = 1 - |A|$. This, for example, implies that $A \rightarrow B$ (irrespective of whether it does or does not reflect the causality of the phenomena) is $|A \rightarrow B| = |\neg A \vee B| = |\neg(A \wedge \neg B)| = \max\{1 - |A|,|B|\} = 1 - \min\{|A|,1 - |B|\}$.

In practice, the rule in the form of pair (A,B) is also considered to imply (although this is not strictly in adherence with the concept of formal logic) that the "answer to A is B". The common feature of implication is that it is also an asymmetrical relationship. However, its similarity with the "if … then" implication is more formal than factual because |A| and |B| in the (A,B) rule are not fully independent of each other i.e. the degree to which the choice of the (A,B) rule, as well as answer B, is justifiable, should not exceed the degree of certainty that situation A really occurred. Unlike implication, the rule does not claim to be universally truthful. It is for this reason that it may be interpreted as a generalization, which allows for exceptions. Nevertheless, when $|A| = 0$, the justifiability of the choice of the rule $|(A,B)| = 0$, regardless of |B|. In contrast, when $|B| = 0$, it is clear that, regardless of |A|, the (A,B) rule was not chosen. The logical structure of the rule is therefore factually closer to the conjunction of its both sides (left side A and right side B) than to implication, so that $|(A,B)| = |A \wedge B| = \min\{|A|,|B|\}$. It is in this manner that the rule is viewed in this study.

To transform classic propositional logic into fuzzy logic it is sufficient to exchange the two-element set $\{0,1\}$ of truth values of propositions for interval $\langle 0,1 \rangle$ and to interpret the number $|A| \in \langle 0,1 \rangle$ as the extent or degree to which proposition A is true. Within the scope of fuzzy logic it is possible to define the fuzzy set as the U set of all the considered objects (universe of discourse) under the rule $A = \{(x,\mu_A(x)): x \in U\}$, whereby $\mu_A(x): U \rightarrow \langle 0,1 \rangle$ is the function of the affiliation of elements of the universe to fuzzy set A in the form $\mu_A(x_0) = |x_0 \in A|$. It is clear, that should $\mu_A(x): U \rightarrow \{0,1\}$, the fuzzy set transforms into a standard set. Fuzzy sets are suitable tools for the formalization of linguistic variables for vaguely defined tasks, which enable the involvement of the knowledge and

experience of experts in generating a solution in terms of suitable choices for decision-making rules.

Methodology for the application of fuzzy logic to generate solutions for tasks with vague inputs and procedures

The general procedure for generating a solution to a problem on the basis of fuzzy logic is schematically shown in Figure 2. Prior to formulating the fuzzy model, the task assignment must be translated from natural language into the language of fuzzy logic. This involves arranging the input linguistic variables ”n“ into a n-tuple under which the specific sequence of variables will be maintained. Each member of this n-tuple (e.g. input linguistic variable A) is subsequently assigned its set {A*i*: *i* = 1,2,…,m} of formalized terms (fuzzy sets defined by functions of affiliation $0 \leq \mu_{Ai}(x) \leq 1$ over the domain of U_A of basis values for variable A (i.e. $x \in U_A$) – see Figure 1). The form and position of the non-zero fragments of curve μ_{Ai} is attributed by the expert to the distribution of basis values of domain U_A. The set {B*j*: *j* = 1,2,…,*k*} of formalized terms is subsequently analogically assigned to one output linguistic variable B.

It is clear, that in total, “m” possibilities exist for various selections of the A*i* term from the set {A*i*: *i* = 1,2,…,*m*}. If all the term sets of input variables are of the same quantity, then we receive in total, by this method of term selection (each input variable is only selected from its set), m^n n-tuples of selected terms. If T is used to identify the set of n-tuples of terms selected, which is graphically represented by φ: T → {B*j*: *j* = 1,2,…,*k*}, whereby $\alpha_n \in T$, $\beta \in \{Bj: j = 1,2,\ldots,k\}$ and $\varphi(\alpha_n) = \beta$, then the pair (α_n, β) forms an inference rule. During the formulation phase of the inference rules, the expert has the opportunity to bring in their knowledge and experience into the model by selecting the choice of terms to the right sides of the inference rules (the number of various sets of rules which can be produced is equal to the number “*k*” raised to the power “m^n“). The expert does not have this opportunity any more during the task solution phase.

The procedure for generating a fuzzy model solution consists of five steps (see Figure 2 – inside the large frame). The value $x_0 \in U_A$, being a member of the current input n-tuple of basis values of linguistic variables, is assigned the terms *Ai,* where $\mu_{Ai}(x_0) > 0$ (see Figure 3), during the process of “fuzzification“. If x_0 lies in the interval above which the positive parts of curves μ_{Ai} and μ_{Ai+1} of the two terms overlap, then the term *Ai* is selected by it with the truth value $\mu_{Ai}(x_0)$, term *Ai+1* with the truth value $\mu_{Ai+1}(x) = 1 - \mu_{Ai}(x)$, whereas if the opposite is the case, one term is selected by it (e.g. *Ai*) with the truth value $\mu_{Ai}(x_0) = 1$ (from Figure 3 it follows that at least one term has to be selected with the value x_0). The value $\mu_{Ai}(x_0)$, respectively $\mu_{Ai+1}(x_0)$ or only $\mu_{Ai}(x_0) = 1$, can be considered for the rate of justifiability for the selection of the respective term. The situation is identical for the other members of the current input n-tuple of basis values. If $\mu = 1$ can be applied to all of them, then only one n-tuple of α_n* terms is selected by this input, which in view of the fact that no two members of it are part of the same set of terms, means that it is a symbolic notation (selected terms and their split in the n-tuple)

that is identical to the symbolic notation of any $\alpha_n \in T$, i.e. with the left side of an inference rule created by an expert (α_n, β).

If two terms are selected by members of the current input n-tuple during the "fuzzification" process, it is possible to make up more n-tuples α_n^* which are identical in their symbolic notations with the left sides of the inference rules (up to 2n of such α_n^* may exist). Based on this assumption, it is possible through the "application of inference rules", to find the respective term $\beta \in \{Bj: j = 1,2,\ldots,k\}$ for each α_n^*. The n-tuple α_n^*, as selected by measured or otherwise determined values of the current input n-tuple, unlike n-tuple $\alpha_n \in T$ created by an expert, has its origin in reality. It therefore also has a logic notation because it is the conjunction of the n-tuple of proposition type $x_0 \in Ai$, of which the non-zero truth value ($|x_0 \in Ai| = \mu_{Ai}(x_0) > 0$) selected the terms into the n-tuple α_n^*.

If (in the logic notation) $\alpha_n^* = (x_0 \in Ai) \wedge (c_0 \in Cu) \wedge \ldots \wedge (d_0 \in Dv)$, then (see the following part) $|\alpha_n^*| = |(x_0 \in Ai) \wedge (c_0 \in Cu) \wedge \ldots \wedge (d_0 \in Dv)| = \min\{|(x_0 \in Ai)|, |(c_0 \in Cu)|, \ldots, |d_0 \in Dv)|\} = \min\{\mu_{Ai}(x_0), \mu_{Cu}(c_0), \ldots, \mu_{Dv}(d_0)\}$.

The truth value $|\alpha_n^*|$ is the rate of justifiability of the selection of the α_n^* n-tuple on the basis of the input data, which is information that was not available to the expert at the time they formulated the set of inference rules, and which was provided in reality through the input data. This information is used in the "results processing" phase. On the basis of the input data, if α_n^* is the only selected n-tuple (i.e. $\mu_{Ai}(x_0) = \mu_{Cu}(c_0) = \ldots = \mu_{Dv}(d_0) = 1$), then $|\alpha_n^*| = 1$. This means that the term β from the inference rule (α_n, β) is, where the n-tuples α_n^* and α_n are identical from the viewpoint of symbolic notation, the only and the best continual result. For this reason, it may jump the "aggregation" phase and provide its $\mu_\beta = |\beta|$ for final processing in the "defuzzification" phase.

If α_n^* is not the only n-tuple selected by the input data, $|\alpha_n^*| < 1$, the term β is only a partial preliminary result. This means that its truth value, given by the function $\mu_\beta = |\beta|$, should be limited by the value $|\alpha_n^*|$, as stated in the preceding section, to $\mu_\beta^* = \min\{|\alpha_n^*|, \mu_\beta\} = |\alpha_n^* \wedge \beta| = |(\alpha_n^*, \beta)|$. The transition from partial preliminary results to the overall preliminary result calls for the aggregation of all the partial results (i.e. $\mu_{\beta i}^*$, $i = 1,2,\ldots,r$) into a resulting μ_{agg}. This occurs in the "aggregation" phase (see Figure 2), where as a result of logical disjunction, the partial rules created in the preceding stages of the solution (α_{ni}^*, β_i), $i = 1,2,\ldots,r$ are aggregated into proposition $AGG = (\alpha_{n1}^*, \beta_1) \vee (\alpha_{n2}^*, \beta_2) \vee \ldots \vee (\alpha_{nr}^*, \beta_r)$. Then it applies: $\mu_{agg} = |AGG| = \max\{|(\alpha_{n1}^*, \beta_1)|, |(\alpha_{n2}^*, \beta_2)|, \ldots, |(\alpha_{nr}^*, \beta_r)|\} =$

$= \max\{\min\{|\alpha_{n1}^*|, \mu_{\beta 1}\}, \min\{|\alpha_{n2}^*|, \mu_{\beta 2}\}, \ldots, \min\{|\alpha_{nr}^*|, \mu_{\beta r}\}\}$.

The created μ_{agg} function is the universal function of the basis values $p \in U_B$ of output linguistic function B with values in the range $0 \leq \mu_{agg}(p) \leq 1$. In the last phase of generating a solution, μ_{agg} is subjected to "defuzzification", the result of which is the required value p_0. This is the horizontal coordinate of the centre (centre of gravity) of the area limited from above by the course of function $\mu_{agg}(p)$, and which is limited from below by the axis of values "p" and from the left or right by values 0, or respectively 100. This is represented by the expression (1):

$$p_0 = \frac{\int_0^1 p \cdot \mu_{agg}(p)\mathrm{dp}}{\int_0^1 \mu_{agg}(p)\mathrm{dp}} \quad (1)$$

The application of fuzzy logic to the evaluation of rating indices - procedures and results

It is necessary, on the basis of the values of the indices for the partial components of the quality of the entrepreneurial environment (i.e. index of corruption rejection (K), index of economic stability (E) and index of political stability (P)) for the selected countries, as published by specialized ratings agencies, to estimate the respective percentage values (see Table 1). The ratings attributed by agencies range from 0 to 100 points; the higher the value, the better the country's position in the given category. For the purposes of this study, all the data were expressed relatively within the interval ⟨0,1⟩; the higher the value, the "higher quality" position the country holds in the given category.

The algorithm enables the expert to, among other things, take into consideration the specifics of the relation various types of potential investors have to risk.

Table 1. Index values for corruption rejection, economic stability and political stability for selected countries in 2015 reflected in interval ⟨0,1⟩; 0 represents the worst evaluation and 1 the best evaluation.

Country/Index	Index of corruption rejection (K) (interval ⟨0,1⟩)	Index of economic stability (E) (interval ⟨0,1⟩)	Index of political stability (P) (interval ⟨0,1⟩)
Czech Republic	0.56	0.73	0.88
China	0.37	0.52	0.7
Finland	0.9	0.73	0.86
Netherlands	0.87	0.75	0.85
Norway	0.89	0.71	0.9
Poland	0.62	0.69	0.81
Russia	0.29	0.51	0.52
Greece	0.46	0.53	0.6
Turkey	0.42	0.62	0.71

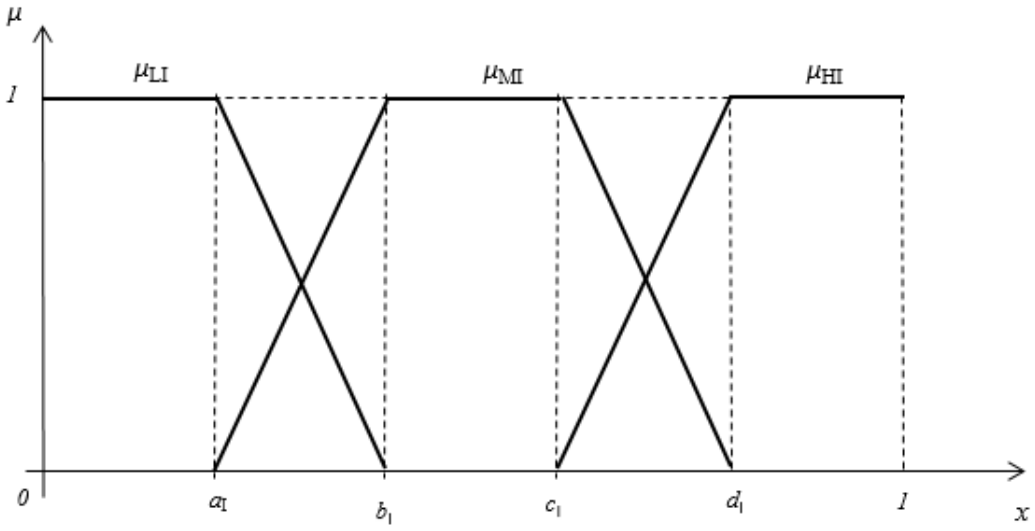
Sources: Corruption Perception Index, 2015; Country Rankings, 2015; Regional Political Risk Index, 2015; data processed by author

Generation of the fuzzy model

Three input linguistic variables are given: K (index of corruption rejection), E (economic stability), P (political stability) with value domains $U_K = U_E = U_P = \langle 0,1 \rangle$, of which the identified basis values are the numbers stated in the respective columns in Table 1. The task is to determine the respective basis values of the output linguistic variable O (quality of the entrepreneurial environment) in the value domain $U_O = \langle 0,100 \rangle$. To do this it is necessary to identify each of the linguistic variables by suitably selected terms

(fuzzy sets created on the respective domains of values U_I, I = K,E,P,O). In this case, the acceptable choice is fuzzy sets of ordered triplets I = (*LI*, *MI*, *HI*) = ({(x,μ_{LI}(x)): x ∈ U_I}, {(x,μ_{MI}(x)): x ∈ U_I}, {(x,μ_{HI}(x)): x ∈ U_I}), I = K,E,P,O, whereby the designation L represents the low value of the linguistic variable, M the mean value, H the high value, and which are defined by the trapezoidal functions of affiliation μ_{LI}(x), μ_{MI}(x) and μ_{HI}(x) (see Figure 1).

Figure 1. Courses of functions of affiliation to terms of linguistic variable I, for I = K,E,P,O



Source: Author

The following therefore apply:

(1) $\mu_{LI}(x) = 1$ for $0 \le x \le a_I$,
$\mu_{LI}(x) = (b_I - x) / (b_I - a_I)$ for $a_I \le x \le b_I$,
$\mu_{LI}(x) = 0$ for $x \ge b_I$

(2) $\mu_{MI}(x) = (x - a_I) / (b_I - a_I)$ for $a_I \le x \le b_I$,
$\mu_{MI}(x) = 1$for $b_I \le x \le c_I$,
$\mu_{MI}(x) = (d_I - x) / (d_I - c_I)$ for $c_I \le x \le d_I$,
$\mu_{MI}(x) = 0$ otherwise

(3) $\mu_{HI}(x) = 0$ for $0 \le x \le c_I$,
$\mu_{HI}(x) = (x - c_I) / (d_I - c_I)$ for $c_I \le x \le d_I$,
$\mu_{HI}(x) = 1$ for $x \ge d_I$

The distribution of the parameters a_I, b_I, c_I, d_I for various I = K,E,P along the horizontal axis of the diagram reflects the distribution of the basis values of these variables. In Table 1, where I = K, a total of 5 basis values are located under the limit of 0.6, unlike for I = P, where only one is under this limit. For this reason $a_K < a_P$. With regards to I = O, where the distribution is unknown and there is no reason to assume asymmetry, it is

therefore assumed that a_0 = 20, b_0 = 40, c_0 = 60, d_0 = 80. By making this choice of parameters for the functions of affiliation to the terms of the input linguistic variables we can take into consideration the structure of the measured or otherwise established data in the fuzzy model.

The next step in the generation of the fuzzy model for the assigned task is to draw up a set of inference rules of type (J_1K,J_2E,J_3P), *JO*) for the allocation of the three output terms to the, in total, 27 ordered triplets of the input terms, where $J_1,J_2,J_3,J \in$ {L,M,H}. The basic strategy here is the selection of *JO,* in which the ordered triplet (J_1K,J_2E,J_3P) prevails in *J*. If none of them prevails, *MO* is chosen. This selection strategy assigns *MO* to, in total, thirteen ordered triplets of input terms; *LO* or respectively *HO* are assigned seven of the remaining cases each (rules made up on the basis of the strategy stated in Table 2). By shifting some of the assignments to the right i.e. from *LO* to *MO* or *HO*, or from *MO* to *HO*, it is possible to compensate, to a certain degree, an investor's excessive fear of risk. Likewise, a shift in the opposite direction (from *MO* to *LO* or from *HO* to *MO* or *LO*) discourages investors who have an indifferent attitude to risk from taking excessive risks.

Table 2. Formulation of the decision-making rules (vague value L marks "low quality", M "mean quality" and H "high quality"

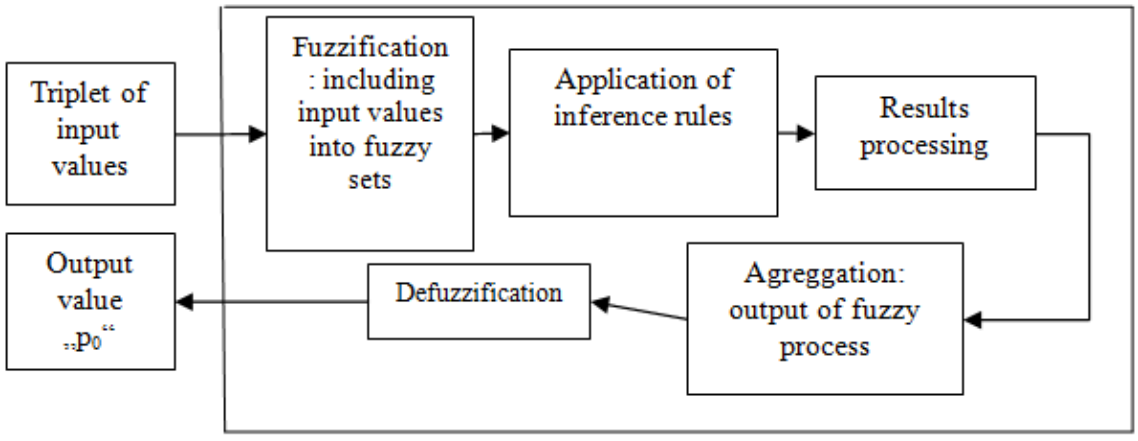
LLL→L	LLH→L	LMH→M	MMM→M	MLL→L	MHM→M	HHH→H	HLH→H	HHM→H
LLM→L	LHL→L	LMM→M	MLM→M	MLH→M	MHH→H	HLL→L	HMM→M	HLM→M
LML→L	LHM→M	LHH→H	MML→M	MMH→M	MHL→M	HHL→H	HMH→H	HML →M

Source: Author

Fuzzy model algorithm for generating a solution to a task

The phases of the fuzzy model algorithm for generating a solution to a task are shown in the following figure:

Figure 2. Scheme of a fuzzy model algorithm for solving a task

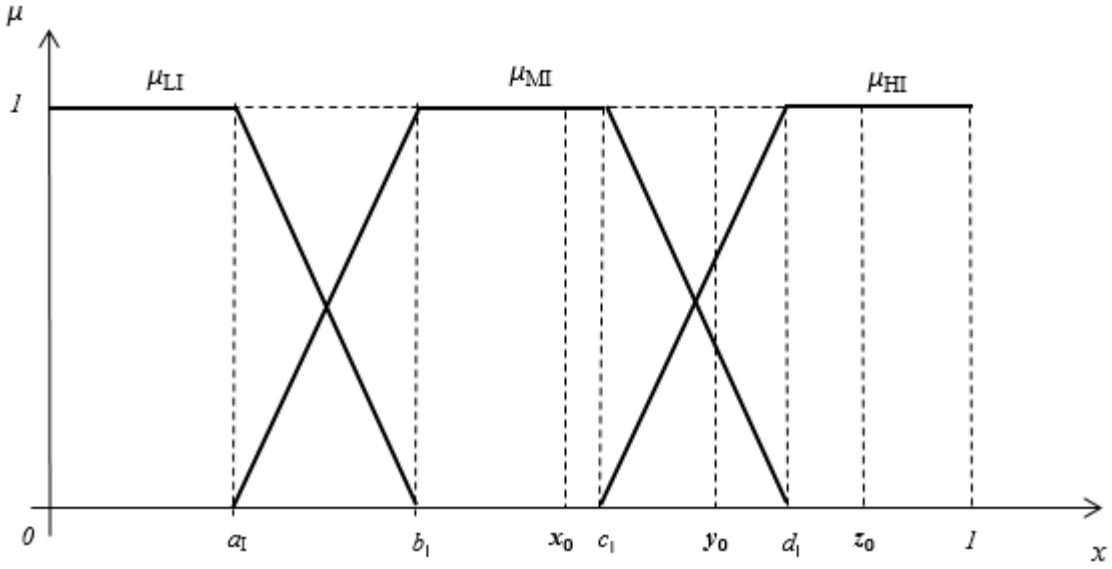


Source: Author

This can best be explained by constructing the parameter p_0 for the Czech Republic. For the purpose of simplifying the respective calculations, the differences in the distribution of the values of the individual indices was ignored (for each of them it is assumed that the parameters for the functions of affiliation to the terms are: a = 0.2, b = 0.4, c = 0.6, d = 0.8).

The ordered triplet of the input basis values (x_0, y_0, z_0), $x_0 \in K$, $y_0 \in E$, $z_0 \in P$ is triplet (0.56, 0.73, 0.88). The inclusion thereof into the respective terms is presented in Figure 3.

Figure 3. Symbolic representation of the affiliation of the input values to the terms



Source: Author

It is evident that the following apply (see formulae for calculations under Figure 1):
$0.56 \in MK$ with the degree of truth $|0.56 \in MK| = \mu_{MK}(0.56) = 1$;
$0.73 \in ME$ with the degree of truth $|0.73 \in ME| = \mu_{ME}(0.73) = (0.8 - 0.73) / 0.2 = 0.35$;
$0.73 \in HE$ with the degree of truth $|0.73 \in HE| = \mu_{HE}(0.73) = (0.73 - 0.6) / 0.2 = 0.65$;
$0.88 \in HP$ with the degree of truth $|0.88 \in HP| = \mu_{HP}(0.88) = 1$.

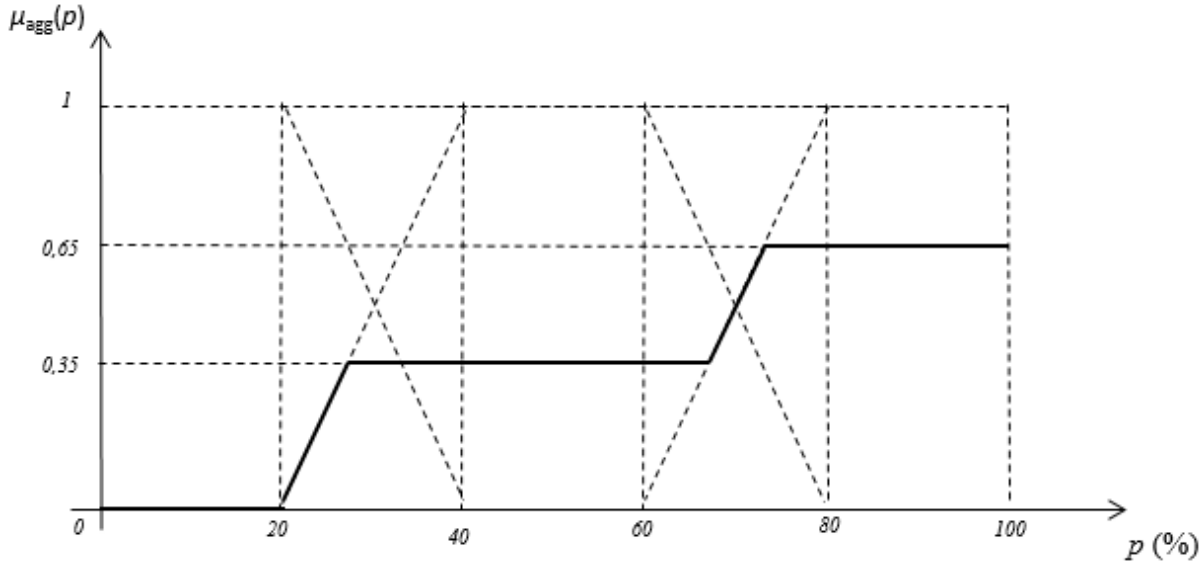
With this, the fuzzification process is completed, whereby the input values for the selected ordered triplets (0.56, 0.73, 0.88) were assigned in symbolic notation as α_{MMH} = (*MK,ME,HP*) and α_{MHH} = (*MK,HE,HP*), or in logic notation as $\alpha_{MMH}^* = (0.56 \in MK) \wedge (0.73 \in ME) \wedge (0.88 \in HP)$, $|\alpha_{MMH}^*| = \min\{1, 0.35, 1\} = 0.35$; $\alpha_{MHH}^* = (0.56 \in MK) \wedge (0.73 \in HE) \wedge (0.88 \in HP)$, $|\alpha_{MMH}^*| = \min\{1, 0.65, 1\} = 0.65$.

By applying the inference rules to the symbolic notation of the ordered triplets, in accordance with rules ((*MK,ME,HP*), *MO*) and ((*MK,HE,HP*), *HO*), the *MO* and *HO* outputs were determined. It then follows that:
AGG = (α_{MMH}^*, *MO*) ∨ (α_{MHH}^*, *HO*) and
$\mu_{agg} = |AGG| = \max\{\min\{|\alpha_{MMH}^*|, \mu_{MO}\}, \min\{|\alpha_{MHH}^*|, \mu_{HO}\}\} =$

$= \max\{\min\{0.35, \mu_{MO}\}, \min\{0.65, \mu_{HO}\}\}$.

The course of the μ_{agg} function is presented in Figure 4.

Figure 4. Graph of function μ_{agg}



Source: Author

On the basis of Figure 4, the value p_0 is determined as being $(0.35 \cdot (30+40+50+60)+0.5 \cdot 70+0.65 \cdot (80+90+100)) / (4 \cdot 0.35+0.5+3 \cdot 0.65) = 71$ % by means of the numerical approximation of the values of the integrals in the formula for the calculation of the horizontal coordinate of the position of the centre of gravity at the end of the methodological part.

The resulting "p_0" values for the selected countries are summarised in Table 3.

Table 3. The "p_0" values for the quality of the entrepreneurial environment indices expressed in percent

Country	Quality Index „p_0" in %
Czech Republic	71
China	50
Finland	86
Netherlands	86
Norway	85
Poland	60
Russia	50
Greece	50
Turkey	54

Source: Author

Discussion of the results from the viewpoint of the investment decision

The preceding section quantifies the estimated parameters for the quality of the entrepreneurial environment (see Table 3) on the basis of the input data published by three selected ratings agencies (see Table 1) and based on the application of fuzzy logic. The stated results approximate the input rating variables on the basis of a fuzzy model algorithm, which enabled the opinions and experiences of experts (managers) to be taken into consideration with regards to the generation of a solution subject to the needs and character of an investor. The resulting "p_0" value, with regards to the necessity to make a decision on an investment, for example in the Czech Republic, may be interpreted as the overall parameter for determining the quality of the entrepreneurial environment for the selected areas of evaluation (it is expressed in percent; the higher the value, the higher the quality of the entrepreneurial environment).

What has not been discussed, and which is also important to take into consideration at this point, is the existence of uncertainty contained in the ratings data (Munda et al. 1995). This uncertainty is linked to the methodology for deriving the ratings data. The methodology utilizes vague procedures based on qualitative evaluations. For example, the modified data used in the analysis for the evaluation of the corruption perception index are based on the rate of perceived corruption in the public sector by those who can come/came into contact with it. In order to achieve the maximum explanatory/predictive value, it is necessary to use more surveys that harness different methodologies for collecting and evaluating data. This uncertainty, for example, from the psychological standpoint of an investor to risk, is reflected in the construction of the function of affiliation μ_x and the formulation of the strategic decision-making rules based on the opinion of the expert and on the "credibility" of initial ratings evaluation.

It is for this very reason that statistical methods for processing uncertain data and/or problems involving sociologically-psychological factors do not have fundamental substantiation. Expressing the index for the quality of the entrepreneurial environment for the concerned managerial task in terms of, for example, the geometrical (X_G) or harmonic mean (X_H) (see Table 4), provides an identical or similar evaluation to the index for the quality of the entrepreneurial environment by "p_0" using fuzzy logic. However, it is impossible to justify choosing the method of statistical averaging because the principles of the procedures for doing so do not take into consideration the basic characteristics of the task to be solved.

Table 4. Evaluation of selected indices of ratings agencies and the approximation of these values using the parameters for the quality of the entrepreneurial environment

Country/Index	Index of corruption rejection (K) (interval ⟨0,1⟩)	Index of economic stability (E) (interval ⟨0,1⟩)	Index of political stability (P) (interval ⟨0,1⟩)	**Index of quality „p_0" (interval ⟨0,1⟩)**	Geometric average of ratings X_G	Harmonic average X_H
Czech Republic	0.56	0.73	0.88	**0.71**	0.71	0.7
China	0.37	0.52	0.7	**0.50**	0.51	0.49
Finland	0.9	0.73	0.86	**0.86**	0.82	0.82
Netherlands	0.87	0.75	0.85	**0.86**	0.82	0.82
Norway	0.89	0.71	0.9	**0.85**	0.83	0.82
Poland	0.62	0.69	0.81	**0.60**	0.7	0.7
Russia	0.29	0.51	0.52	**0.50**	0.4	0.4
Greece	0.46	0.53	0.6	**0.50**	0.5	0.52
Turkey	0.42	0.62	0.71	**0.54**	0.57	0.56

Source: Author

Summary and conclusion

In complex situations that are characterized by unspecified influences and which result in uncertainty, people usually follow the normative rules for a particular situation, or act on the basis of their knowledge and experience, or both. However, different circumstances may arise if a situation is uncertain or the choice of the relevant rule is not unambiguous. This reflects the fact that the concepts and procedures on which rules are usually based are also often vague and ambiguous. A typical example is the area of managerial decision-making with regards to indefinite and future situations burdened by uncertainty. Managers therefore use a number of qualitative and quantitative procedures to minimize that uncertainty and risks.

This contribution utilizes fuzzy logic to extend the standard ways in which to quantify entrepreneurial risk. It enables the uncertainty and vagueness of sociological and psychological factors which occur in managerial tasks, including the uncertainty of the input data, to be comprehensively described. In this study, the fuzzy method is applied to a practical managerial task in which an investment consultant, based on the values of selected indices of three world ratings agencies for selected countries in Europe and Asia, evaluates the quality of the prevailing entrepreneurial environment, whilst taking into consideration the relationship of a particular investor to risk.

The partial components of the ratings evaluations are processed in the following phases using the fuzzy model algorithm presented in Figure 2: ordered triplets of input values are included into fuzzy sets to which inference rules are applied; the partial results are subsequently processed and aggregated within the output fuzzy process and

transformed into resulting values. The resulting values can be interpreted as parameters for determining the quality of the entrepreneurial environment in selected states.

The application of fuzzy logic is discussed and evaluated in comparison to the statistical approach based on the method of averaging. These procedures provide identical or similar results to the fuzzy logic approach. However, it is impossible to justify choosing the method of statistical averaging because the principles of the procedures for doing so do not take into consideration the basic characteristics of the task to be solved.

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Travelling by Train between Czechoslovakia and Germany after the Munich Agreement

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Abstract

The following study attempts to analyse an almost unknown aspect of Czechoslovakian-German relations during the so called "Second Republic" (October 1938 – March 1939), namely the railway traffic between the two countries. It is necessary to realize that railway traffic was the most common means of transport for both people and goods at this time and that it was in both countries' interests to keep it functioning. This paper focuses on the situations and problems that everyday passengers faced. Their experiences were the main factor on which public opinion of the railways was based. The contributory role of freight transport is also analysed in short because of its importance to the functioning of the economy. An important question, which this study attempts to answer as well, is the nature of relations between Czechoslovakian railway employees and their German counterparts. Did these relations copy those in "high politics" at the time? Or, could the professionals on both sides of the new borders cooperate to keep the traffic flowing? With the use of several examples, descriptions are given of experiences with colleagues on the other side of the border that were often positive and whereby both sides understood that it was necessary to keep the traffic flowing. Unfortunately, these efforts were on occasion disrupted by the decisions of political or military leaders.

Key words: railway traffic, Munich Agreement, Second Czechoslovak Republic, Czech-German relations

Introduction

The Munich Agreement was without doubt an important turning point in the history of Czechoslovakia, both in terms of relations with Germany and the country´s internal development. Historical research almost exclusively focuses on questions concerning the politics or problems of ethnical (self-)identification (Gebhart and Kuklík 2004). Other areas of life such as the economy, transport and sports, amongst other things, have

remained outside the main fields of interest for research. In this study the focus is on an almost unknown aspect of Czechoslovakian-German relations during a period of Czechoslovak history which is now widely referred to as The Second Czechoslovak Republic (October 1938 – March 1939), in particular on railway transport between the two countries. There are a number of important basic questions that this paper seeks to answer. Under which conditions could passengers and freight trains cross the border? How did passengers react to the new conditions? Did the relations between the Czech and German passengers, railway employees, policemen and other groups, copy those in "high politics", or could these groups find a compromise to keep the railway traffic flowing?

Other researchers may have added more questions or chosen to answer different ones. However, this study does not have the ambition to provide a complete and exhaustive analysis of the consequences of the Munich Agreement. Such an ambition would be better fulfilled in a book rather a short study like this one. It is for this reason that the questions were chosen as they are and do not cover the most important spheres of political and economic relations. The aim is to give a more plastic exemplification of a part of life in the Second Republic to which little attention has been paid to establish what the perception of the railways was at the time.

The material for this study is based on documents housed in the Archive of the Ministry of Foreign Affairs of the Czech Republic, the National Archive of the Czech Republic (Collection of the Press Department of the Ministry of Railways) and from former published studies dedicated to single railway routes (Sýkora 2003; Omelka 2002). The history of the railways in the withdrawal areas of Czechoslovakia has already been analysed (Bufe, Schröpfer and Losos 2003), however this work mainly concentrates on the railway traffic during the Second World War. In contrast, the studies published by Ivan Jakubec focus on different periods or themes, namely the period ending before the signing of the Munich Agreement and the first few years after the First World War (Jakubec 1997), the analysis of the parallel development of the Czechoslovak and German railways, but with little insight into the mutual contacts between the two railway companies (Jakubec 1991), and the period after the Second World War (Jakubec 2006). The economic impact of the withdrawal from the Sudeten-areas in general, without any special focus on the railways, was analysed by the economic historians Jaromír Balcar and Jaroslav Kučera in their work which focused on Czech-German economic relations (Balcar and Kučera 2013). All of the aforementioned studies are recommended reading for the further understanding of the analysed topic.

Establishing the new border

The consequences for the Czechoslovak railway network as a result of the Munich Agreement can be expressed in numbers. The area that the Germans annexed covered 28,800 km^2 with a railway network covering 3,525 km. This was equivalent to 26% of the entire track system or, to make it even clearer, the length of the entire track network of the

wholeSlovakia at that time. To operate in the withdrawal areas, the Czechoslovak railway company ČSD was forced to provide 33,000 freight wagons, almost 900 locomotives and more than 2,000 wagons for passenger transport (Archive of the Ministry of Foreign Affairs of the Czech Republic, Section IV).

Taking over the withdrawal area was not completely without problems. Many Sudeten-Germans did everything to make the situation for the Czechoslovak side as hard as possible. For example, at the station Vroutek (north of Pilsen), a Sudeten-German station worker, Mattusch, hailed the last train to Czechoslovakia, which his former colleagues were leaving the station on, with the Nazi salute (Sýkora 2003). At the same time, many Czechoslovak employees committed small isolated cases of sabotage to equipment, wagons and locomotives before leaving their former work positions. Unfortunately, although their wrath and frustration were easy to understand, their sabotage served German negotiators well. They were able to argue that Czechoslovakia had not kept to its side of the agreement and could therefore not expect any good will from the German side in return (Archive of the Ministry of Foreign Affairs of the Czech Republic, Section VI). However, within this context it must be mentioned that even many Sudeten-German employees preferred to move to the rest of Czechoslovakia rather than stay and become citizens of the Third Reich. The main reason was either their Jewish origin or their leftist political orientation (Archive of the Ministry of Foreign Affairs of the Czech Republic, Section VI).

The situation became more complicated by the behaviour of the German army, the *Wehrmacht,* whose soldiers persisted in occupying places that had been agreed would stay on the Czechoslovak side of the new border. Attempts to convince the soldiers to leave these places were in general not successful. Since the Czechoslovak army was, according the Munich Agreement, not allowed to resist, these places remained on the German side (Archive of the Ministry of Foreign Affairs of the Czech Republic, Section VI).

The new border was definitively agreed upon on 10th October 1938. On the following day, negotiations began in Berlin on establishing the flow of railway traffic under the new circumstances. It took more than two weeks to hammer out a final agreement, which was signed on 27th October. However, even within the first days of October 1938 several attempts had been made to re-establish the flow of traffic over the new border. Surprisingly, the initiatives often came from the German staff. Unfortunately, the local headquarters of the *Wehrmacht* did not allow any of these attempts to succeed and traffic came to a halt for almost the whole month.

The result of the Berlin negotiations was a strongly reduced passenger railway service. Services were re-established on only the 13 most important railway links. The number of border checkpoints was reduced and the number of passenger services on most of these routes limited to 2-3 trains a day. It should be noted that as late as September 1938 there were still 13 local and 6 long distance train services every day on these routes. The agreement on passenger services was in stark contrast to that for freight services. The agreement simply defined that the number could change without restrictions and was

subject to actual demand. Germany was in need of continuous and flexible deliveries of various Czechoslovak products in order to fulfil its own four year economic plans (Archive of the Ministry of Foreign Affairs of the Czech Republic, Section IV).

On 21 railway links, most of them only of local importance, traffic was not re-established at all. The agreement also defined the conditions for the use of the network for extraterritorial traffic, whereby both countries could use sections of the railway network located on the other state´s area. The Germans in particular used these sections to start moving army units and heavy weapons, which awoke mixed feelings and nervousness in the Czechoslovak population (National Archive of Czech Republic, Collection of Press Department of the Ministry of Railways). According to the agreement, Czechoslovak tickets in the Sudeten-area could continue to be used. The reason was simple – the German railway company DRB (for a detailed description of the development of the company´s name, see Jakubec 1991) did not have enough of the printed tickets for this area. Even the Czechoslovak operating instructions remained valid.

Despite the agreement, traffic was not re-established as it should have been. The *Wehrmacht* continued to refuse to let the railways operate freely. In several cases, passenger trains were stopped at gunpoint by soldiers armed with machine-guns. It must have been a terrifying experience for those civilian passengers sitting behind the windows looking out (National Archive of Czech Republic, Collection of Press Department of the Ministry of Railways).

It is also important to note that the new border stations often did not have sufficient capacity to handle the new conditions: "The station in Mělník has become one of the largest border stations. There is a toll-house which clears hundreds of wagons every day. Mělník station is too small to handle such a high volume of traffic. Those who suffer the most from this are the people from the village of Blaty that have to cross the railway directly beside the station. Because of the level of railway traffic, the gates are closed almost non-stop. It sometimes takes half an hour until the railway crossing is free to cross again." (National Archive of Czech Republic, Collection of the Press Department of the Ministry of Railways).

It was not only the population living in the neighbourhood who suffered from these new conditions. Working under these provisory conditions was not easy for the staff either, as another article describes: "A little bit further up, there´s an old, decommissioned 3rd class wagon with icicles hanging from its roof. On the one side there is a shield with the inscription ´Toll-house Zlatá Koruna ČSD´. As we can see, the claims of our toll-officers of the need to quickly build a border station are not unjustified." (National Archive of Czech Republic, Collection of the Press Department of the Ministry of Railways). In the beginning, journalists showed quite a high level of understanding. After a month, when the situation had still not improved, they started to become more critical: "The causes of the problems in the flow of traffic are indeed not the fault of the Czechoslovak Railways, but still, the company should try to do more to improve the situation." (National Archive of Czech Republic, Collection of the Press Department of the Ministry of Railways)

Continuing traffic problems

After the situation stabilised, the Czechoslovak mobilisation schedule was cancelled and a "normal" civilian schedule was employed. The changed circumstances brought with it new complications for passengers along the actual border. Many trains were now classified as being simultaneously domestic and international with the trains effectively having to be divided into four parts: special wagons for passengers travelling within Czechoslovakia, special wagons for passengers travelling within Germany, special wagons for passengers travelling from Czechoslovakia to Germany and special wagons for passengers travelling from Germany to Czechoslovakia. It is clear, that such a complicated system was not welcomed by the passengers. Many newspapers published sharply critical articles, asking rhetorical questions like "How will an old grandmother understand this?" (National Archive of Czech Republic, Collection of the Press Department of the Ministry of Railways). It was also not easy for passengers to understand that some (usually the international) wagons were almost empty during the journey, whilst others (usually the domestic ones) were overcrowded.

These problems were not only limited to the Czechoslovak side. In the Sudeten withdrawal area DRB was responsible for operating the railway network. As previously mentioned, the Czechoslovak operating instructions, signal systems, interlocking plants, etc. remained valid. Unfortunately for DRB, they were faced with the problem of having an insufficient number of employees familiar with the milieu. As a result, small accidents happened which complicated the situation even more. Surprisingly, the company that received the most criticism was the Czechoslovak ČSD, which was seen to be incapable of handling the impact of the accidents. In contrast, the employees of DRB who caused the accidents were applauded for their willingness to solve the problems as soon as possible (National Archive of Czech Republic, Collection of the Press Department of the Ministry of Railways).

In the middle of December, DRB asked ČSD for help with personnel. The newspapers commented by saying "This is the best advert for our Czech railway staff." (National Archive of Czech Republic, Collection of the Press Department of the Ministry of Railways). It is hardly a surprise that railway employees were unwilling to return to their former work places where they had had many bad experiences. DRB applied for approximately 2000 workers, but got only about 300 – it was simply impossible to convince more people to return (National Archive of Czech Republic, Collection of the Press Department of the Ministry of Railways).

Nevertheless, the situation slowly stabilised. On the 10th December 1938, German fees became valid in the Sudeten-area. DRB had managed to create a sufficient supply of tickets for the new railway stations. During December 1938 and January 1939, new international train services began to operate, among them the slightly exotic route Berlin – Prague – Istanbul.

Freight traffic

As mentioned above, the Berlin agreement set out the conditions for freight traffic so that Germany could import practically everything it needed from Czechoslovakia. Unfortunately, it did not work as easily in the opposite direction. Through the withdrawal from the Sudeten-area, Czechoslovakia lost 97% of its deposits of lignite. The import of lignite from Germany was influenced by all the problems DRB was facing in the Sudeten-area. Shortly before the beginning of winter, the import of this necessary raw material fell to only 40 wagons per day. At this point ČSD offered to help by providing staff familiar with the conditions in the areas where lignite was exploited. DRB refused to accept the offer, probably on political grounds according to an order from Berlin (National Archive of Czech Republic, Collection of the Press Department of the Ministry of Railways). The situation with regards to lignite deliveries became so bad that Czechoslovak business leaders seriously began to consider suggestions to import lignite from other countries, even from as far away as the United Kingdom (Archive of the Ministry of Foreign Affairs of the Czech Republic, Section IV). It wasn´t until February that the situation stabilised, but by that time the winter had almost past and the demand for lignite did not reach the peaks it had in the previous months.

The problematic situation with sending freight into the withdrawal areas was misused by several private companies that began to offer and provide transportation over the new border, of course for much higher prices that ČSD (Jakubec 1991). This was loudly criticised in the newspapers, but no one was ever indicted for this amoral behaviour (National Archive of Czech Republic, Collection of the Press Department of the Ministry of Railways).

Last days before the occupation

On 14th February 1939, just before the occupation of the residual part of Czechoslovakia, DRB opened an information office in Prague in order to better inform tourists and travellers about travel conditions, tariffs, connections, etc. In addition, literally a few hours before the occupation began on the 13th March 1939 (officially valid from the 15th March), the methods for paying for lignite deliveries were changed.

During the occupation itself, rail traffic between Czechoslovakia and Germany was completely halted. When the trains began to run again on the 18th March, it was under completely different conditions. In what was symbolic of the importance of railway traffic, the final train that crossed the border before the occupation was carrying Czechoslovak president Emil Hácha from negotiations with Adolf Hitler in Berlin.

Conclusion

When drawing conclusions on the question of the relations between Czechs, respectively Czechoslovakians and Germans, it is necessary to differentiate between those Germans from the Sudeten-area and those Germans from Germany, Reichsdeutsche. Whilst the first

group actively sought to harm their former colleagues and countrymen as much as possible, Reichsdeutsche railway employees wanted to keep the flow of rail traffic moving and generally did not follow the official aggressive politics against Czechoslovakia. However, for objectivity´s sake it must be said that not all Sudeten Germans were motivated by hate and other negative feelings against Czechs and Czechoslovakia; their attitudes were also motivated by their desire to bring to Germany as many advantages as possible, which was in turn considered to be an act of enmity by those on the Czech side. Reichsdeutsche had no reason to hate Czechoslovakia and most of all wanted to be proud of their work. However, in some cases, when the German employees were not familiar with the milieu, like in the lignite mining areas, the traffic nonetheless almost totally collapsed.

With regards to Czechoslovakian newspapers and their style of reporting, it can be said that there was an obvious tendency to describe and present Germany as an example worth following. This was of course not the case at the time immediately after the Munich Agreement was signed. However, later on, during autumn 1938, this tendency became stronger and stronger. This was particularly evident in articles describing the small accidents in the withdrawal areas or on the border crossings. It is clear that whilst the Czechoslovak authorities were criticised for their incompetency, their German counterparts were being praised for their efficiency. Even in situations where Germany was criticised as well, as was the case with the insufficient deliveries of lignite, the criticism of the Czechoslovakian side was more aggressive and could in many cases actually be described as German-friendly. This is all the more interesting and surprising because the Czechoslovak Second Republic was characterized by a spirit of attempting to establish a good and friendly relationship with Germany. Railway oriented articles from this time are not an exception.

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Usage of Generalized Regression Neural Networks in Determination of the Enterprise's Future Sales Plan

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Abstract

Neural networks have recently been gaining popularity in the business practice. Research has even confirmed their better performance over traditional methods. This paper gives an overview of one of the types of neural networks, generalized regression neural networks. These are then used to establish a plan for the future sales of a company. However, generalized regression neural networks also have their drawbacks. They are oversized and have a long computation time. Despite these disadvantages the article searches for, based on data from the profit and loss accounts of the food company Friall, s.r.o. from the years 1995-2015, the dependence of revenues on production factors. 1000 random neural structures are generated, from which the 5 most appropriate are preserved using the method of least squares. Additionally, a sensitivity analysis is conducted to determine how the individual production factors affect the firm's ability to generate revenue. The proposed neural network is potentially applicable in practice when compiling the financial plan of a company derived from the amount of sales.

Keywords: Generalized Regression Neural Networks, enterprise's sales, production factors, neural structure

Introduction

Neural networks have already a rich history in business applications. In various areas of business, the neural networks were examined and compared against other methods of prediction (Vrchota 2013). In most cases, their performance was found to be superior though sometimes, certain negative aspects as computation time or programming experience were mentioned. The last progress in neural networks development have brought in more efficient and client-friendly models that can be more readily used in practice.

Construction of Generalized Regression Neural Networks

According to Dvořáková and Vochozka (2015) a generalized regression neural network (GRNN) is often used for function approximation. It has a radial basis layer and a special linear layer. All GRNNs have four layers (input layer, hidden layer, pattern or summation layer, and decision layer). The most significant disadvantage of GRNN models if compared to multilayer perceptron networks is their size and longer computation time during scoring since there is one neuron for each training row (Vochozka and Sheng, 2016).

The basic GRNN equation is (1):

$$Y(x) = \frac{\sum Y_i e^{-\left(\frac{d_i^2}{2\sigma^2}\right)}}{\sum e^{-\left(\frac{d_i^2}{2\sigma^2}\right)}} \quad (1)$$

where $d_{i^2} = (x\text{-}x_i)^T (x\text{-}x_i)$, x is the input sample, x_i is the training sample, d_{i^2} is the Euclidean distance from the x and x_i and it signifies how much the training sample can contribute to the output of the particular test sample. The spread constant, σ, is the only unknown parameter and it can be tuned by training process to an optimum value where the error will be very small.

As already mentioned above, the main disadvantage of GRNN (and of neural networks in general) if compared to other probabilistic methods is that it requires substantial computation time. There are several ways to overcome this disadvantage. One is to use a clustering versions of GRNN or precisely, a double clustering version (Specht, 2006) because one use of the clustering algorithm is not sufficient. According to Specht, the second clustering not only speeds up the testing but also replaces the division required for kernel regression with simply the search for the nearest neighbour.

Usage of GRNN-based models in business practice

The history of application of neural networks in business is already rather long and abundant. Since the researches have produced numerous studies, some of recent papers focus on the various approaches to application of neural networks in business. One of such researchers, namely Tkáč and Verner (2016), provides a systematic overview of neural network applications in business between 1994 and 2015 and concludes that the most of the researches has aimed at financial distress and bankruptcy problems, stock price forecasting, and decision support, with special attention to classification tasks. Neural networks were also successfully used for forecasting of chain supply (see Chen, Wee and Hsieh 2009), production and inventory management (Wang 2005) and demand (Kourentzes 2013).

Very often, neural networks have been compared against classical statistical methods. In most literatures, neural networks were found to perform better (Zhang, Cao and

Schniederjans 2004; Kourentzes 2013; Arunraj and Ahrens 2015; Mitrea, Lee and Wu 2009; Gazdíková and Šusteková 2009; Vojteková and Bartošová 2009).

Besides conventional multilayer feedforward network with gradient descent backpropagation, various hybrid networks or combinations of neural networks and other methods have been developed in order to improve the performance of standard models. Also, neural networks were used along with various data pre-processing and sorting methods (Lahmiri 2016) or, on the other hand, data provided by neural networks models were post-processed (e.g. Tsai and Chiou 2009, used data predicted by the neural network model to construct a decision tree model to generate useful decision rules for earnings management).

Lahmiri (2016) employed GRNN for training and testing patterns extracted by variational mode decomposition (VMD) and empirical mode decomposition (EMD), both of which methods have been successfully applied to adaptively decompose economic and financial time series for forecasting purpose. He compares these two GRNN-based models to feedforward neural networks and autoregressive moving average (ARMA) process and finds the VMD-GRNN models as suitable to analyse noisy data (an advantage of VDM over EMD), fast in processing and simple to implement which makes is very attractive to users.

Numerous models of future earnings and sales of a company have been suggested but most of them were not able to predict future without a significant error (Slabá 2016). As Höglund (2012) states, the reason is that most of the models used were linear ones while, as shown in several studies, the nature of future earnings is non-linear. Neural networks offer an alternative way to deal with the non-linearity. Höglund compared two models based on traditional statistical approaches and three models based on neural networks (self-organizing map, multilayer perceptron and GRNN) and found that the GNRR model performed best, being followed by the other two neural network models.

The aim of the article is to find a suitable GRNN for the prediction of sales of a company on the example of a particular enterprise.

Materials and Methods

We can generally define the activities of a company as the conversion of production factors to products. The economic theory proposes labour, land and capital as production factors (Stehel and Vochozka 2014). Some economists additionally include know-how, or even money, among factors of production. However, these factors are not entirely appropriately defined for the practice of enterprise economy (Vochozka, Rowland and Vrbka 2016). Therefore, for example Wöhe and Kislingerová (2007) determined the factors of production to be management work, dispositive work, material and fixed assets. It is thus possible to work with production factors at company level and infer a correlation between production factors as inputs and company sales as outputs.

Our model company will be the corporation Friall, s.r.o. This is a South Bohemian food company, which (Friall 2016), "is the largest manufacturer of frozen potato products in the Czech Republic and employs an average of 100 workers. The company specializes exclusively in the production of **deep-frozen potato products**, and also offers the option of pallet storage in refrigerated chambers with a capacity of **4,000 pallet places**."

We will therefore search for the dependence of sales of a commercial enterprise on production factors, or the consumption of which. Profit and loss accounts for the years 1999-2015 are available, a total of 17 entries for each item of a profit and loss account.

For the purpose of fulfilling the objectives of the article, we will be interested in these profit and loss account entries:

1. Revenue from sales of own products and services,
2. Consumption of material and energy,
3. Personnel expenses,
4. Depreciation of tangible and intangible fixed assets.

Personnel expenses include the salaries of both management and executives. In addition, we incorporated social and health insurance, which is in its way income tax. The depreciation of fixed assets expresses the share of fixed assets consumed in a given marketing year, and therefore must be reflected in the profit or loss of the current year.

For the preparation of the data file, MS Excel will be used. DELL software Statistica, version 7, will be used for calculation. This will then be processed by an intelligent task solver.

We are looking for an artificial neural network capable of predicting the future development of revenues from own goods and services sold by a food manufacturing enterprise operating in the South Bohemian Region.

All used quantities are continuous. The data will be divided into three groups:

- Training: 70 %,
- Testing: 15 %,
- Validating: 15 %.

The seed for random selection was set to a value of 1000. Subsampling will take place randomly. Subsequently, 1000 artificial neural structures will be generated, from which we will retain 5 most appropriate results [1].

For GRNN the activation function is determined as follows:

$$e - \left(\frac{d_j^2}{2\sigma^2}\right) \qquad (2)$$

Other settings will stay default.

[1] This is determined using the method of least squares. When differences between newly generated networks stop being substantional, training will be terminated.

Subsequently, a sensitivity analysis will be performed, from which we will determine how individual production factors affect the company's ability to generate revenues from sales of own products and services.

Results and Discussion

We have obtained the five best neuron networks by generation as described in the methods of the study. They are listed in the table numbered 1.

Table 1. Generated and preserved neuron structures

Index	Profile	Train Perf.	Select Perf.	Test Perf.	Train Error	Select Error	Test Error	Training/ Members	Inputs	Hidden (1)	Hidden (2)
1	GRNN 3:3-11-2-1:1	0,802038	0,853132	0,932658	0,000017	0,000006	0,000015	SS	3	11	2
2	GRNN 3:3-11-2-1:1	0,803192	0,853603	0,932780	0,000017	0,000006	0,000015	SS	3	11	2
3	GRNN 3:3-11-2-1:1	0,805938	0,854734	0,933077	0,000017	0,000006	0,000015	SS	3	11	2
4	GRNN 1:1-11-2-1:1	0,921977	0,893857	0,894949	0,000019	0,000005	0,000014	SS	1	11	2
5	GRNN 2:2-11-2-1:1	0,888524	0,821596	0,898864	0,000018	0,000005	0,000014	SS	2	11	2

Source: Author

The neural structures are composed of four layers: the input layer, first hidden layer, second hidden layer and output layer of neurons. The first three generated networks accept all three production factors, which are the consumed material and energy, personnel costs and the depreciation of fixed assets, as input quantities. The fourth generated structure assumes the use of a single factor of production, the consumption of material and energy. The fifth preserved network calculates only with the consumption of material and energy and with the depreciation of fixed assets. All networks have 11 neurons in the first hidden layer, 2 neurons in the second hidden layer and 1 neuron in the output layer.

The characteristics of each variable in the individual sets of variables (i.e. training, testing, and validating) are listed in table number 2.

Table 2: Statistical characteristics of individual sets of data

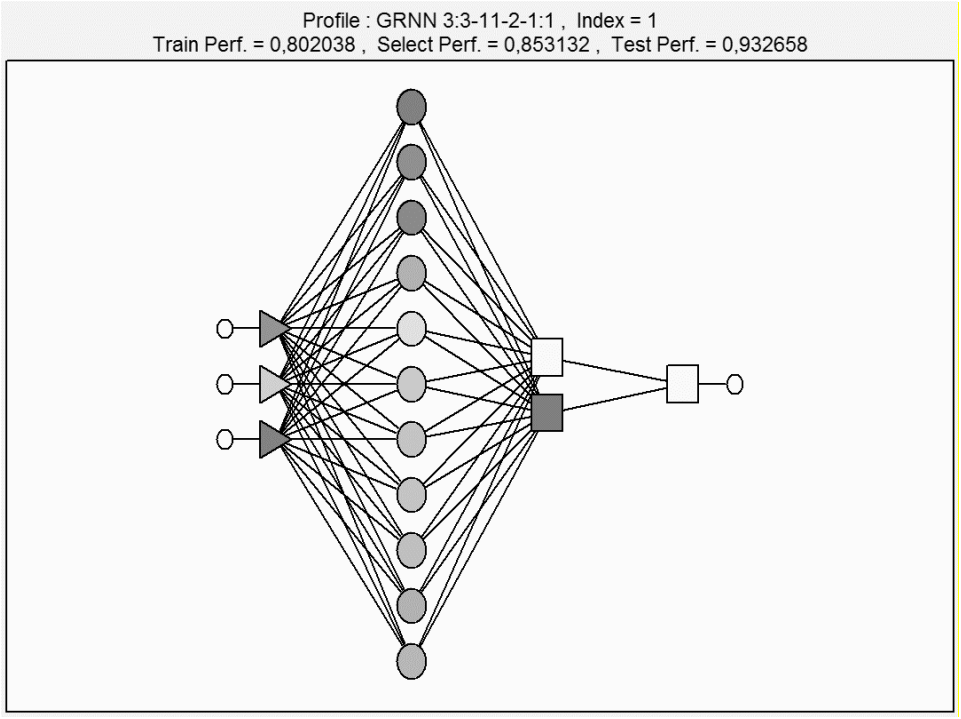
	Data Mean	Data S.D.	Error Mean	Error S.D.	Abs E. Mean	S.D. Ratio	Correlation
T.Sales of own products and services.1	213380,0	44045,2	3283,0	35325,9	25928,8	0,8	0,9
T.Sales of own products and services.2	213380,0	44045,2	3280,1	35376,8	25950,4	0,8	0,9
T.Sales of own products and services.3	213380,0	44045,2	3272,4	35497,7	26001,7	0,8	0,9
T.Sales of own products and services.4	213380,0	44045,2	2499,4	40608,7	28013,1	0,9	0,9
T.Sales of own products and services.5	213380,0	44045,2	2148,7	39135,2	28196,2	0,9	0,9
S. Sales of own products and services.1	211405,4	12314,4	6363,9	10505,8	11013,8	0,9	0,6
S. Sales of own products and services.2	211405,4	12314,4	6347,4	10511,6	11003,2	0,9	0,6
S. Sales of own products and services.3	211405,4	12314,4	6307,8	10525,5	10977,8	0,9	0,6
S. Sales of own products and services.4	211405,4	12314,4	4056,8	11007,3	10083,6	0,9	0,7
S. Sales of own products and services.5	211405,4	12314,4	3839,3	10117,4	9497,6	0,8	0,6
X. Sales of own products and services.1	222908,2	33579,1	-2588,5	31317,9	25003,4	0,9	0,9
X. Sales of own products and services.2	222908,2	33579,1	-2612,2	31322,0	25000,5	0,9	0,9
X. Sales of own products and services.3	222908,2	33579,1	-2669,1	31331,9	24993,8	0,9	0,9
X. Sales of own products and services.4	222908,2	33579,1	-5932,7	30051,6	23526,2	0,9	0,9
X. Sales of own products and services.5	222908,2	33579,1	-6101,4	30183,1	23398,7	0,9	0,8

Note: T signifies training, S testing and X the validating data set.

Source: Author

For illustrative purposes, the scheme GRNN 3:3-11-2-1:1 is shown on figure number one, it is respectively the first generated and stored neural network.

Fig. 1: Scheme GRNN 3:3-11-2-1:1



Source: Author.

We are searching for the one of the five preserved networks that exhibits the highest performance in all three data groups, ideally a similar performance in all three and is generally the least error-prone. Network number 4, GRNN 1:1-11-2-1:1, thus looks the best optically.

It is additionally advisable to perform a sensitivity analysis and to determine the most important variable. Concrete results are given in table number 3.

Tab. 1: Analysis of sensitivity

	Material and energy consumption	Personnel costs	Depreciation of intangible and tangible fixed assets
T.Ratio.1	1,123959	1,131887	1,066473
T.Rank.1	2,000000	1,000000	3,000000
S.Ratio.1	1,093352	0,979107	1,080824
S.Rank.1	1,000000	3,000000	2,000000
X.Ratio.1	1,075594	0,988749	1,003419
X.Rank.1	1,000000	3,000000	2,000000
T.Ratio.2	1,122912	1,130728	1,065911
T.Rank.2	2,000000	1,000000	3,000000
S.Ratio.2	1,093071	0,979128	1,080692
S.Rank.2	1,000000	3,000000	2,000000
X.Ratio.2	1,075448	0,988863	1,003422
X.Rank.2	1,000000	3,000000	2,000000
T.Ratio.3	1,120440	1,127990	1,064584
T.Rank.3	2,000000	1,000000	3,000000
S.Ratio.3	1,092394	0,979178	1,080367
S.Rank.3	1,000000	3,000000	2,000000
X.Ratio.3	1,075093	0,989138	1,003429
X.Rank.3	1,000000	3,000000	2,000000
T.Ratio.4	1,084824		
T.Rank.4	1,000000		
S.Ratio.4	1,127061		
S.Rank.4	1,000000		
X.Ratio.4	1,117767		
X.Rank.4	1,000000		
T.Ratio.5	1,092300		1,043531
T.Rank.5	1,000000		2,000000
S.Ratio.5	1,120519		1,084893
S.Rank.5	1,000000		2,000000
X.Ratio.5	1,113627		1,004778
X.Rank.5	1,000000		2,000000

Source: Author

The analysis always calculates the weight and order of importance among input values for all input values. We have three input values, five preserved networks and always

three sets. In total, we are working with 36 variable sets (two networks do not use all three input variables). The depreciation of fixed assets is not the most important value in any of the preserved neural structures. Personnel costs are defined in only three cases as the most important value - i.e. ranked in the first place. In other cases, therefore the vast majority of the sets, the most important value is materials and energy consumption. Thus it is obvious that material consumption is a relatively major production input.

Conclusion

The aim of this paper was to find a suitable GRNN for predicting sales on the example of a particular company.

The aim of the paper has been met. The best neuron structures were generated and retained. The most appropriate among them seems to be GRNN 1:1-11-2-1:1, despite only considering a single factor of production - materials and energy consumption. It is thus obvious that production in the Friall company is materially demanding and so there is no need to take the remaining two variables into account for the prediction. This has emerged from the sensitivity analysis.

The proposed neural structure is applicable in practice when compiling the financial plan of a company, which is always derived from the amount of sales. But the truth is that the proposed model always assumes that demand for the company's products is not limited. It further assumes that only productive capacities can be limited in this case.

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Mutual Foreign Trade between China and the Visegrad Group

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Abstract

Foreign trade is very important in today's globalized world. China is currently the exporter number one and the importer number two in the world. The European Union is one of the largest economies in the world. International cooperation between China and EU regions is, therefore, very important. This text focuses on mutual foreign trade between China and the Visegrad Group. Visegrad Group is specialized in the production of whole cars and vehicle parts. There is a difference in origins of products for consumption and origins of products for investments in Visegrad Group. Chinese importers neglect the potential of V4 countries yet. There is necessary to liberalize the mutual foreign trade, cooperation, specialization and technology transfer in the future.

Keywords: Macroeconomic Indicators, Trade Indicators, Foreign Trade

Introduction

This paper seeks solutions to increase trade of goods and services between China and the Visegrad Group. There is a short description of analyzed countries, description of their macroeconomic and trade indicators in this paper. Based on the current state of trade are designed recommendations for the future. The purpose of this paper is to find the possibilities of deeper cooperation between the Visegrad Group and China.

Description of analyzed countries

China

The People's Republic of China (hereinafter referred to as CHN or PRC) is the world's most populous state with a population over 1.3 billion citizens and total area more than 9.5 million square kilometers.

Export commodities are electrical and other machinery and machines (including data processing equipment, computers, broadcasting equipment and integrated circuits), apparel, furniture and textiles (Central Intelligence Agency 2016, Observatory of Economic complexity 2016).

Chinese import commodities are electrical and other machinery (including integrated circuits), oil, crude petroleum and mineral fuels and others like nuclear reactors, soybeans and so on (Central Intelligence Agency 2016, Observatory of Economic complexity 2016).

Visegrad Group

The Visegrad Group (hereinafter referred to as Visegrad or V4) is an alliance of four Central European countries:

- Czechia (hereinafter referred to as CZ or CZE)
- Hungary (hereinafter referred to as HU or HUN)
- Poland (hereinafter referred to as PL or POL)
- Slovakia (hereinafter referred to as SK or SVK)

The population of these countries is 64 million citizens (circa 21 times smaller in comparison to China) and total area 533 thousand square kilometers (circa 18 times smaller than China). So it's similar to one of the Chinese provinces.

Export commodities of Central European region are especially machinery and transport equipment like cars and vehicle parts (Central Intelligence Agency 2016, Observatory of Economic complexity 2016). Some countries are also specialized. Czechia on chemicals like packaged medicaments, Poland on food and rolled tobacco, Hungary on raw material and Slovakia on electrical equipment especially video displays.

Import commodities are quite similar to export commodities: machinery equipment, vehicle parts, cars and crude petroleum (V4), computers (CZ), petroleum gas (HU), electrical and broadcasting equipment (SK) (Central Intelligence Agency 2016, Observatory of Economic complexity 2016).

Macroeconomic indicators of analyzed countries

It is necessary to measure the main economic indicators to understand the overall state of the economy properly. These main indicators are a gross domestic product (current state, growth rate and per capita), unemployment rate and inflation rate.

Table 1: Macroeconomic indicators of analyzed countries

Country	**GDP** (billion USD[1],2015 est.)	**GDP** real growth rate, 2015 est.)	**GDP per capita** (USD, 2015 est.)	**Unemployment rate** (2015 est.)	**Inflation rate** (2015 est.)
China	19,390.0	6.9 %	14,100	4.2%	1.4%
V4	1,757.0	N/A	27,500	N/A	N/A
Czechia	332.5	4.2%	31,600	6.5%	0.3%
Poland	1,005.0	3.9%	26,500	10.6%	-0.9%
Hungary	258.4	2.9%	26,200	6.9%	-0.1%
Slovakia	161.0	3.6%	29,700	10.6%	-0.3%

Source: Central Intelligence Agency (2016); Author's calculations

The EU is more advanced economy than China. Also, V4 (as the new EU member states since 2004) have about twice higher GDP per capita than China. However, China is the much larger economy and its growth rate is much higher. Also, the unemployment rate is better in China. Even Chinese inflation rate achieves better values because the threat of deflation reduces the economic growth potential in V4 countries.

Trade indicators of analyzed countries

This paper focuses on foreign trade between China and V4 for this reason this part is devoted to trade indicators of analyzed countries. Trade indicators are export, import, openness index, the balance of trade (current state and share of GDP) and trade to GDP ratio.

[1] Purchasing power parity.

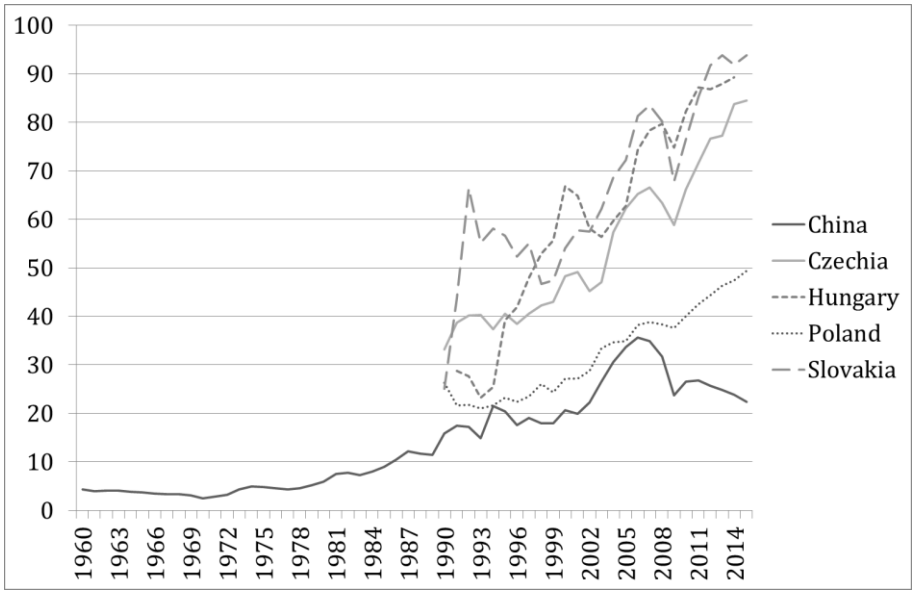
Table 2: Trade indicators of analyzed countries

Country	**Export** (billion USD, 2015 est.)	**Import** (billion USD, 2015 est.)	**Openness Index[2]**	**Balance of Trade** (billion USD)	**Balance of Trade** (% of GDP)	**Trade to GDP Ratio**
China	2,270.0	1,596.0	19.9%	674.0	3.5%	46.9
V4	478.0	457.7	53.3%	20.2	1.1%	N/A
Czechia	133.8	124.0	77.5%	9.8	2.9%	152.6
Poland	190.2	187.5	37.6%	2.7	0.3%	91.1
Hungary	97.6	92.9	73.7%	4.7	1.8%	170.7
Slovakia	56.4	53.3	68.1%	3.1	1.9%	182.4

Source: Central Intelligence Agency (2016); World Trade Organization (2016); Author's calculations

According to the information above, V4 is circa twenty times smaller (21 times according to citizens, 18 times according to an area) than China. However, its export and import are larger than expected (export is circa five times smaller and import twelve times smaller). It means countries of V4 are more open economies. This situation is confirmed by openness index.

Fig. 1: Timeline of Export (% of GDP)



Source: Author, Data: World Bank (2016)

Data table of this chart is in appendix 1. There are few facts to see in the chart.

[2] The openness index is a ratio of total trade (export + import) to the GDP.

1. Countries of V4 have a similar history in the 20th century (Austria-Hungary, two world wars, plan economy, market economy). Also, they have similar export parameters, namely big changes between the late 1980s (plan economy) and the early 1990s (market economy).
   a. There was a rapid increase of export in Czechoslovakia (Czechia and Slovakia) after the Velvet Revolution in 1990 and 1991.
   b. There was also a slight decrease of import in Hungary and Poland in from 1990 to 1993.
2. Long-term growth of export in the whole world including China and V4 is caused by permanent globalization.
3. Massive export in the period from 2006 to 2008 and enormous decline in 2009 is caused by "the Great Recession". The same phenomenon is also typical for the whole world not just for analyzed countries.

Foreign trade within analyzed countries

According to Observatory of Economic Complexity (2016), there is some special product imported and exported between China and V4 more than in the rest of the world. Let's have a look at these commodities.

Export from V4 to China

This part contains a detailed analysis of export from the Visegrad Group to China.

Table 3: Trade indicators of analyzed countries

Exporter and Importer	**Export and Import** (billion USD, 2014)	**Importance for Exporter** (% of Export)	**Importance for Importer** (% of Import)	**Commodities**
From V4 to China	9.42	1.69%	0.61%	Cars Vehicle parts Refined copper
From Czechia to China	2.26	1.4%	0.15%	Vehicle parts Liquid pumps El. accessories
From Poland to China	2.44	1.2%	0.16%	Refined copper Vehicle parts Furniture
From Hungary to China	2.52	2.4%	0.16%	Cars Engines Locomotive parts
From Slovakia to China	2.20	2.8%	0.14%	Cars Machinery Air pumps

Source: Observatory of Economic Complexity (2016); Author's calculations

Let's have a look at the differences in Chinese total import and Chinese import from V4. China imports cars, vehicle parts, and refined copper from V4 countries and other machinery, fossil fuels, and others from the rest of the world. As we can see, nothing is similar. It could have two different reasons:

- The little importance of V4 countries for Chinese importers.
- High specialization of V4 countries.

There are also some differences in Visegrad total export and Visegrad export to China. The main Central European product – cars and vehicle parts – is exported to China and the rest of the world as well. Little differences are in other products: medicaments vs. water pumps (CZ), food vs. copper (PL), video displays vs. air pump (SK). However, these secondary differences are not important. This means:

- High specialization of V4 countries in cars and vehicle parts.
- Specialization of Hungary and Slovakia in whole cars.
- Specialization of Czechia and Poland in vehicle parts.

Export from China to V4

This part contains a complete analysis of export from China to the Visegrad Group.

Table 4: Trade indicators of analyzed countries

Exporter and Importer	**Export and Import** (billion USD, 2014)	**Importance for Exporter** (% of Export)	**Importance for Importer** (% of Import)	**Commodities**
From China to V4	50.83	2.15	9.03	Broadcasting eq. Broadcasting acc. Computers
From China to Czechia	17.0	0.72	11.0	Computers Office machines Broadcasting eq.
From China to Poland	22.5	0.95	10.0	Computers Broadcasting eq. Broadcasting acc.
From China to Hungary	5.14	0.22	5.1	Telephones Broadcasting eq. Broadcasting acc.
From China to Slovakia	6.19	0.26	7.9	Broadcasting eq. Broadcasting acc. Computers

Source: Observatory of Economic Complexity (2016); Author's calculations

This part of text analyzes the differences in V4 total import and V4 import from China. V4 needs machines, vehicle parts and crude petroleum for its production of cars and complex vehicle parts (it is imported from the rest of the world). Visegrad consumption (broadcasting technology, computers, telephones) are imported mainly from China. The conclusion is:

- V4 consumption is covered by domestic production and imports from China.
- V4 investments are covered by domestic production imports from the rest of the world.

There are also differences in Chinese total export and Chinese export to V4. China produces and exports machines, information technology, and textiles to the world and broadcasting equipment and accessories and information technology to V4. It means:

- V4 imports from China mainly stuff for consumption (not all machines and IT, just machines and IT for free time).

Potential development of foreign trade of analyzed countries

According to the previous analysis, there are some recommendations for the progress of Sino-Visegrad trade. Application of these proposals for action could increase the effectiveness and the global competitiveness of analyzed regions. Development of foreign trade is depended on private sector and public sector as well. Measurement of private sector competitiveness and evaluation of public sector program efficiency is mentioned in many publications (Viturka 2007, Ochrana et al. 2007, Ochrana and Nekola 2009, Ochrana and Půček 2011).

Recommendations

Liberalization of mutual foreign trade

Liberalization of cross-border movement of people, goods, and services could help increase the competitiveness of imported goods (Hong 2012).

Unfortunately, there are a number of legislative (prohibitive) measures by both sides. It means the government of China, the V4 governments, and EU leadership. Governments might consider, for example, some kind of Euro-Asian Free trade area or support of the One Belt, One Road project.

Cooperation and specialization

Due to historical developments, it is essential for deeper cooperation and international specialization. This will positively affect the efficiency level probably (Vysoká 2010). However, not only productivity is important, there is also necessary to follow the rules of corporate social responsibility (Tokarčíková 2011).

V4 countries are already specialized to cars and vehicle parts production. A huge opportunity is to use this potential in the Chinese market.

Cooperation and technology transfer

Creating of international conglomerates for transferring of technology could help promote the research development. Managers should not forget the impact of working conditions on the output of the production process (Hrubá and Švejdová 2011).

The possibility is the creation of the Visegrad-Chinese companies, which will have an economic interest in such technology transfer.

Limitations and risks

Of course, there are risks and limitations in the implementation of these recommendations. The main limitation lies in the fact that international trade is carried out by numerous independent entities. The influence can be provided mainly by indirect actions and motivations. However, it is still possible.

Conclusion

International trade is more affected by financial crisis and economic crisis than other parts of the four-sector economy (consumption, investment, government spending). Sino-Visegrad mutual foreign trade has some specifics:

1. **Export from V4 to China:** V4 countries are highly specialized in whole car production (Hungary and Slovakia) and vehicle parts production (Czechia and Poland).
2. **Export from China to V4:** V4 consumption is covered by domestic production and imports from China. V4 investments are covered by domestic production imports from the rest of the world.
3. **Comparison of export from V4 to China and export from China to V4:** Chinese importers neglect the potential of V4 countries yet.

In the past, there were some changes in V4 export policies caused by political reasons and by changes in the economy (transformation from plan system to market system). In the future, there will be possibilities for deeper cooperation. It will be necessary to follow current globalization trends. Globalization means, in this case, greater connectivity of economies and more trade between them. In foreign trade, it means especially liberalization of mutual foreign trade, cooperation, specialization and technology transfer.

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Appendix

App. 1: Timeline of Export (% of GDP)

	China	Czechia	Hungary	Poland	Slovakia
1990	15.90366	33.20981	N/A	26.30846	25.03167
1991	17.47893	38.76288	28.7628	21.60121	43.70764
1992	17.27593	40.20641	27.60968	21.76421	66.47422
1993	14.87658	40.2864	23.18756	21.06431	55.13739
1994	21.50616	37.42116	25.39613	21.71112	58.15444
1995	20.36944	40.56148	39.18139	23.29951	56.68491
1996	17.5716	38.43774	41.89898	22.40459	52.28678
1997	19.08699	40.57362	47.93901	23.50889	55.06735
1998	17.93466	42.28342	52.92875	26.09322	46.65717
1999	17.91796	43.0185	55.59998	24.29575	47.47853
2000	20.68066	48.32966	66.8103	27.21293	54.06572
2001	19.97308	49.13565	64.87457	27.22676	57.79478
2002	22.27062	45.24241	58.09572	28.75822	57.48239
2003	26.57197	47.0617	56.4241	33.3913	62.19285
2004	30.55314	57.43016	59.74382	34.64164	68.71248
2005	33.70065	62.31478	62.79331	34.92439	72.28141
2006	35.65157	65.29163	74.30538	38.20039	81.2658
2007	34.93292	66.55278	78.32867	38.82419	83.50006
2008	31.69515	63.36448	79.693	38.31837	80.24342
2009	23.73344	58.81272	74.82264	37.57616	67.82594
2010	26.53255	66.17671	82.3007	40.03232	76.5507
2011	26.77764	71.61544	87.2262	42.53966	85.26876
2012	25.70524	76.63401	86.82261	44.42244	91.78804
2013	24.8061	77.26725	87.95944	46.30284	93.84019
2014	23.91723	83.81754	89.25425	47.45694	91.85315
2015	22.37405	84.48578	N/A	49.36179	93.79512

Source: World Bank (2016)

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Decomposition of EVA Equity to the Sub-operational Plans of a Company

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Abstract

The world is beginning to recognize the need, accuracy and persuasiveness of measuring business performance. Economists are continuously searching for the appropriate tool with which companies can plan, manage and control their business processes and which takes into account current market expectations and requirements. Economic Value Added (EVA) is one of the most important evaluation indicators. This contribution describes the basic characteristics of this indicator and puts forward several options for the calculation of EVA. The options are based on either the accounting (or operative) approach or the financial (or current value) approach, and specifically concerns the calculations of EVA Equity and EVA Entity. The source of the data for the calculations are the annual reports of a transport company for the years 2003-2009. To fulfil the aim of this article, the calculation of EVA Equity is based on the process identified by Neumaierova and Neumaier, and the decomposition of EVA Equity is determined according to the methodology prescribed by the Ministry of Industry and Trade of the Czech Republic. This contribution seeks to decompose EVA Equity, which is viewed as the strategical goal of a company, into partial indicators that can be incorporated into a company´s tactical plan in the form of operative plan indicators.

Keywords: EVA Equity, decomposition, business success, strategic goal, sub-operational plans

Introduction

As societies and economies have developed, more people have begun to realize the importance of the accurate and cogent measurement of business performance.

According to Jarina and Bodorová (2013), the evaluation of a company is one of the most important financial decisions the management of a company can make. Each company aims to maximize its value which leads to growth in shareholder wealth (Majerčíková and Bartošová 2012). It is therefore necessary to find a tool which enables companies to plan, manage and control their business processes. The accuracy of the input data is very important within this context. Dvořáková and Vochozka (2014) point out the need to adapt the tools of measurement according to current market expectations and demands. Existing methods for evaluating the performance of a company do not fully satisfy the increasing demands placed on businesses. They do not allow the evaluation to be made for the long term (Kvach and Il'ina 2013). To properly assess the performance of a company, the concept of profit maximization as the main objective of a company needs to be replaced by the concept of maximizing value (Vochozka and Rowland 2015). At present, Economic Value Added (EVA), which was developed by two Americans – Steward and Stern – in 1990, is perceived to be an accurate measure of financial performance (Chmelíková 2008).

The aim of this contribution is to calculate EVA Equity for a specific company and to put forward proposals for its decomposition into the operative plans of the business.

Literature review

EVA is one of the most important business performance evaluation indicators. It provides a basis for the analysis of the inputs for the calculation of a business´ value, as well as for the inputs for calculating cost of equity (Horváthová, Mokrišová and Suhányiová 2014). Stewart (1991) interpreted EVA as being the residual income that accrues to both a company´s debtholders and its equity holders.

In order to establish whether a company has pursued a strategy focused on EVA growth, it is necessary to identify those factors that affect the size of EVA (Bluszcz and Kijewska 2016). According to Aggarwal and Sharma (2011), the key financial factors that determine EVA are the return on investment, return on equity, capital employed, etc. EVA allows managers to evaluate a company´s economic value, assess funds and efficiently allocate resources, thereby using adjustment items to reflect the true economic value of the company (Huang and Liu 2010).

The concept of EVA is quite simple; it maximizes the spread between the return on capital used to generate profits and the costs of using that capital (Musa 2008). By adopting the concept of EVA, business executives hope to increase the efficiency with which assets and resources are allocated, thereby increasing shareholder wealth (Chmelíková 2008). Adimando, Butler and Malley (1994) claim that EVA is almost 50% better than its closest accounting-based competitor in explaining changes in shareholder wealth.

Vochozka (2009) claims that EVA describes the ability of a company to generate economic profit (economic profit = accounting profit – cost of equity). In contrast to traditional performance metrics, EVA better reflects the real costs of a company because it includes equity costs (Chmelíková 2008).

According to Abate, Grant and Stewart (2004), there are two ways to define EVA – the accounting (or operational) approach and the financial (or present value) approach. Under the accounting approach, EVA is (known as **EVA Entity**) is described by the following equation:

$$EVA = NOPAT - C * WACC \quad (1)$$

where NOPAT stands for Net Operating Profit After Taxes, C stands for Capital Employed to Generate Operating Profit, and WACC stands for Weighted Average Cost of Capital.

NOPAT can be expressed in simple terms as tax-adjusted EBIT (Abate, Grant and Stewart, 2004, pp. 62):

$$NOPAT = EBIT(1-t) \quad (2)$$

where t stands for income tax rate and EBIT stands for Earnings Before Interest and Taxes.

WACC can be expressed as (Bluszcz, Kijewska and Sojda, 2015):

$$WACC = k_e * \frac{E}{C} + k_d * (1 - t) * \frac{D}{C} \quad (3)$$

where k_e stands for Cost of Equity, E stands for Equity, D stands for Debt, t stands for income tax rate, k_d stands for Cost of Debt and C stands for enterprise value; it is equal to the sum of equity and debt.

EVA can also be expressed in terms of the return on capital after tax and the cost of capital (de Wet and du Toit, 2007):

$$EVA = (ROIC - WACC) * C \quad (4)$$

where ROIC stands for the Return On Invested Capital (ROIC = NOPLAT/IC → NOPLAT stands for the net profit (or loss) from the main business minus the tax on the profit), WACC stands for Weighted Average Cost of Capital and C stands for Invested Capital (at the beginning of the year).

EVA can also be determined by subtracting the cost of equity from the earnings (de Wet and du Toit, 2007). Under this method, EVA is often referred to as **EVA Equity**:

$$EVA = Earnings - (k_e * equity) \quad (5)$$

where k_e is the Cost of Equity.

EVA Equity can also be expressed in the form of the following equation:

$$EVA = (ROE - k_e) * equity \quad (6)$$

where ROE stands for the Return on Equity and k_e stands for the Cost of Equity.

The calculation of the k_e indicator (Cost of Equity) is as follows (Stehel and Vochozka, 2016):

$$k_e = \frac{WACC * \frac{D}{A} - \frac{EAT}{EBT} * C * \left(\frac{C}{A} * \frac{E}{A}\right)}{\frac{E}{A}} \quad (7)$$

where A stands for Assets, E stands for Equity, D stands for Debts, EAT stands for Earnings After Taxes and EBT stands for Earnings Before Taxes.

WACC is hereby defined as the sum of interests that reflect certain risks connected with running a business:

$$WACC = r_f + r_{LA} + r_e + r_{FinStab} \quad (8)$$

where r_f stands for the Risk Free rate, r_{LA} stands for the function of the indicators characterizing the size of the enterprise, r_e stands for $r_{entrepreneurial}$ – the function of the indicators characterizing the creation of ROA (Return On Assets) and $r_{FinStab}$ is the function of the indicators characterizing the relationships between the assets and liabilities.

In business practice, there are other ways of calculating the top indicators of business success.

According to Abate, Grant and Stewart (2004) the financial interpretation of EVA is especially appealing to security analysts and portfolio managers. In principle, EVA is directly related to wealth creation via Net Present Value (NPV). In this context, NPV (or MVA, for market value added) can be expressed as the present value of expected future EVA (NPV = MVA = Present Value of Expected EVA).

Sedláček (2007) claims that macroeconomic policy has a substantial impact on the creation of EVA within a company.

Economic Value Added provides a general analysis of business performance. However, the use of EVA Entity, provides a better indicator of business performance for investors i.e. the owners and creditors, whereas EVA Equity is purely relevant to the business owners.

The EVA indicator, due to the way it is constructed, is a base variable for the business performance calculation. The total current value of future EVA is therefore equal to the enterprise value. It can therefore be deduced that a positive development in the indicator can acquire strategic meaning for a company, its owners, or its managers. Company managers observe the interests of the owners. The EVA indicator and its value is therefore the most important strategic aim of a company.

Materials and Methods

The basic data sources for this study were the annual reports (2012) of CSAD Jihotrans, as posted on their website http://spolecnost.jihotrans.cz/ke-stazeni/ za roky 2003-2009[1].

The information held in the Financial Statements of the annual reports, as well as other facts relevant to the financial analysis, were of significance.

The sources of the data used for the calculation are presented in Table 1.

Table 1: Data sources based on the Financial Statements

Name	**Statement**	**Statement Item**
Working Capital	Balance Sheet	(C.I+C.III+C.IV+D.I.2) - (B.III+B.IV.2+B.IV.3+C.I.1)
Total Assets	Asset Balance Sheet	A + B + C + D
Stock	Asset Balance Sheet	C.I.
Receivables	Asset Balance Sheet	C.III.
Short-term Financial Property	Asset Balance Sheet	C.IV.
Current Assets	Asset Balance Sheet	C
Equity	Liability Balance Sheet	A.
Bonds and Bills	Liability Balance Sheet	B.II.6 a B.II.7
Current BC and Financial Aid	Liability Balance Sheet	B.IV.2 a B.IV.3
Long-term BC	Liability Balance Sheet	B.IV.1
Short-term Liabilities	Liability Balance Sheet	B.III
Retained Profit	Liability Balance Sheet	A.III.2+A.IV+A.V
Foreign Capital	Liability Balance Sheet	B
Short-term Foreign Capital	Liability Balance Sheet	B.III + B.IV
Corrupt Sources	Liability Balance Sheet	A + B.IV. + B.II.6 + B.III.9
Profits on Sold Goods	Profit and Loss Sheet	I.
Costs on Sold Goods	Profit and Loss Sheet	A.
Performance	Profit and Loss Sheet	II.
Performance Consumption	Profit and Loss Sheet	B.
Personnel Costs	Profit and Loss Sheet	C.
Depreciation	Profit and Loss Sheet	E.
Interest Costs	Profit and Loss Sheet	N.
Profit per accounting period	Profit and Loss Sheet	***
Total Profit	Profit and Loss Sheet	I. + II. + … + XIII.
Total Costs	Profit and Loss Sheet	A + B + … + T
Profit before interest and tax	Profit and Loss Sheet	*** + S+ Q + N
Profit	Profit and Loss Sheet	I. + II.1.

Source: Author

[1] The data for the years 2003 – 2009 were specifically used due to the functioning and availability of the benchmarking model on the webpages of the Ministry of Industry and Trade of the Czech Republic.

For the calculation of EVA Equity, the procedure determined by Neumaierová and Neumaier (2006) was applied. The procedure is presented in Table 2.

Table 2: EVA Equity calculation procedure

Indicator	**Calculation**
EVA	(ROE – r_e) * VK
ROE (Return on Equity)	Economic Result after Taxes / Equity
r_e (alternative costs on capital)	See Rating Model
CZ / Profit	Economic Result after Taxes/Economic Result before Taxes
ROA (Return on Assets)	EBIT / Assets
VK / A	Equity / Assets
UZ / A	Corrupt Sources/ Assets
Interest Rate	Interest Costs / (Bonds + Bank Credit)
Liquidity 3	Current Assets / (Short-term Liabilities + Short-term Bank Credits)
Liquidity 2	(Receivables + Financial Property) / (Short-term Liabilities + Short-term Bank Credits)
Liquidity 1	Financial Property / (Short-term Liabilities + Short-term Bank Credits)
EBIT / V (margin)	EBIT / Total Revenues
V / A (Return on Assets)	Total Revenues / Assets
PH / V	Value Added / Total Revenues
ON / V	Personal Costs / Total Revenues
Depreciation / V	Depreciation / Total Revenues
(Other V – N)	PH / V – ON / V –Depreciation / V
T	Profits

Source: MPO (2006)

On the basis of the above, it was possible to determine the development of EVA Equity in CSAD Jihotrans within the evaluated period.

The EVA indicator for 2009 was subsequently decomposed according to the methodology of the Ministry of Industry and Trade. As a result, the financial indicators, which the business must manage to achieve its strategic aims and excellent results, were identified.

The outputs of the benchmarking model of the Ministry of Industry and Trade were put into tables according to their individual pyramid decompositions so that a comparison could be made to similar businesses in the individual years.

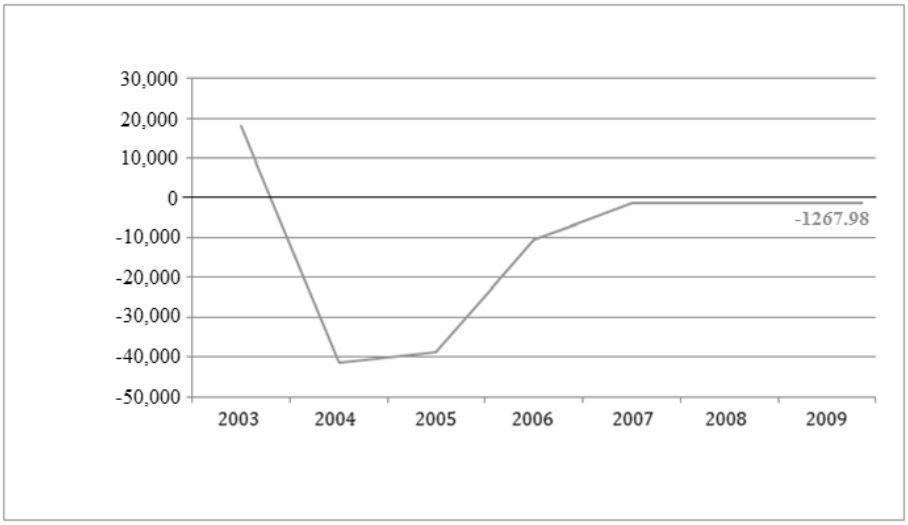
In 2009, the Ministry of Industry and Trade replaced the OKEC classification with the NACE classification. As a consequence of this change, the business is compared, until 2008, to services, and in 2009 to transportation. The reason for this is the fact that the original benchmarking model under the OKEC classification did not include transportation as a separate item.

Results and Discussion

EVA Equity Value

The development of EVA Equity in CSAD Jihotrans is illustrated in Figure 1.

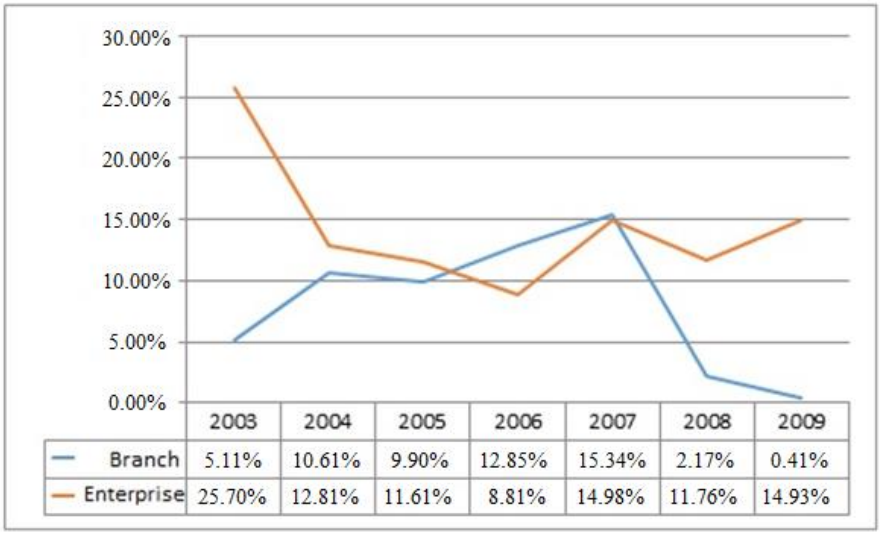
Figure 1: The development of EVA Equity in CSAD Jihotrans – value creation for the owners (in CZK)



Source: MPO (2016), author´s calculations

The EVA Equity value was only positive in the first year of the observed period i.e. 2003. In the following years the value of the EVA Equity indicator was negative. The company was therefore not creating value for its owners. In other words, the company owners could have invested their means in an alternative, equally risky investment, and achieved a higher evaluation. It goes without saying, that such a decision must be preceded by an analysis of the company´s development. If the company´s owner expects long-term negative EVA Equity (regardless of the profit motive), the termination of investments should be considered. This is, of course, subject to the owner behaving rationally and the main motivation for investing being the generation of greater benefits. What is of greater interest in the development of EVA Equity is an analysis of the individual components thereof. The development of Return on Equity is illustrated in Figure 2. The figure compares the development of ROE for the company and the branch in which it operates. It is clear that, with the exception of 2006 and 2007, the company was more successful than the branch as a whole. However, in 2007, the difference between the branch and CSAD Jihotrans was insignificant. Unlike the branch, the company´s ROE was positive throughout the whole of the observed period. Moreover, it can be stated that the development of the company´s ROE was better than the development of its EVA Equity. When focusing on the economic interpretation of ROE, it can therefore be said that this indicator describes the creation of value for a company´s owners. In general, a company´s ROE will be compared to other available investments, for which the risks attached to a specific investment must be taken into consideration.

Figure 2: Development of Return on Equity

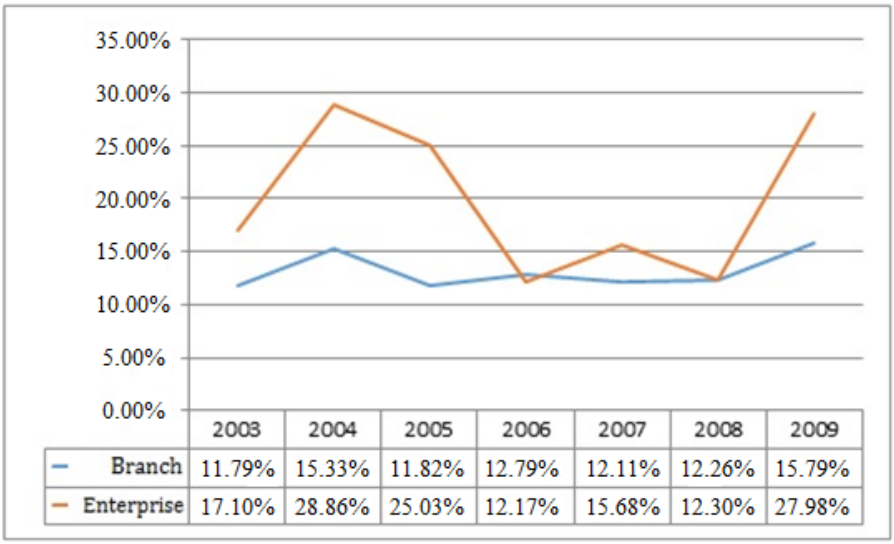


	2003	2004	2005	2006	2007	2008	2009
Branch	5.11%	10.61%	9.90%	12.85%	15.34%	2.17%	0.41%
Enterprise	25.70%	12.81%	11.61%	8.81%	14.98%	11.76%	14.93%

Source: Annual reports (2012), MPO (2016), author´s calculations

Another significant component of the EVA Equity calculation is the value of costs on equity, which corresponds to the amount of risk undertaken. In this case, a much higher value is observed in comparison to the branch (see Figure 3). The company, most probably due to high debt levels, is subject to a higher level of risk, which subsequently influences the economic value added for its owners.

Figure 3: Estimated development of Costs on Equity (k_e)



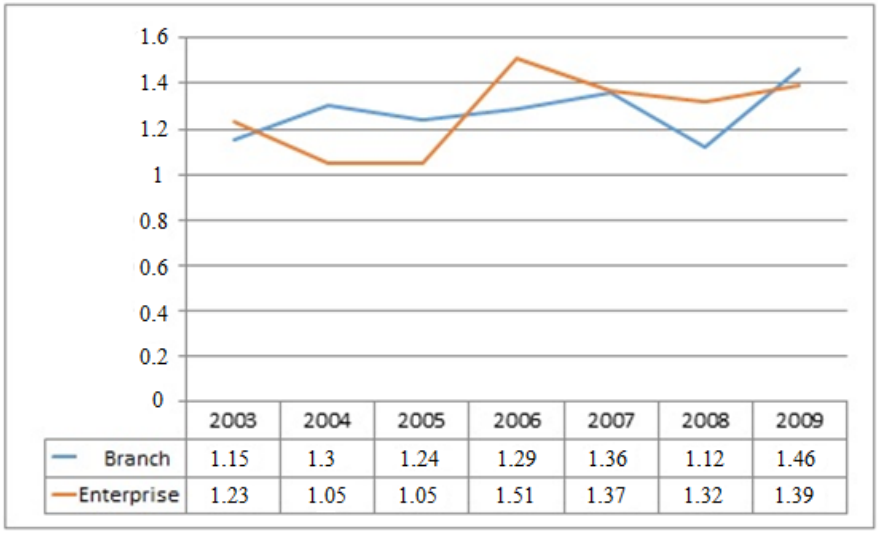
	2003	2004	2005	2006	2007	2008	2009
Branch	11.79%	15.33%	11.82%	12.79%	12.11%	12.26%	15.79%
Enterprise	17.10%	28.86%	25.03%	12.17%	15.68%	12.30%	27.98%

Source: Annual reports (2012), MPO (2016), author´s calculations

Another comparison with the branch was made with regards to liquidity. L3 Liquidity was measured to determine whether the level of risk is or is not higher (in terms of value) as a result of the value of liquidity. Figure 4 clearly demonstrates that this is

indeed not true and that the main factor influencing the high costs on capital is really the financial structure of the given company.

Figure 4: Development of Total Liquidity (L3 in %)

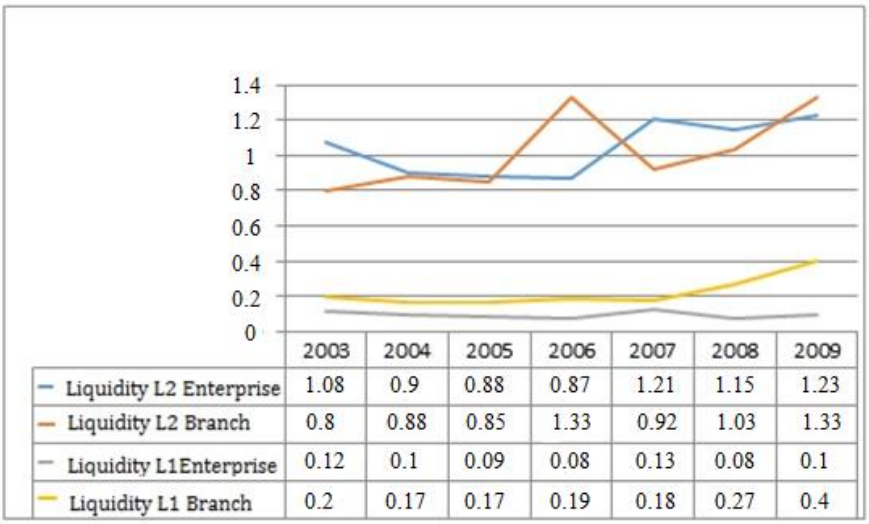


	2003	2004	2005	2006	2007	2008	2009
Branch	1.15	1.3	1.24	1.29	1.36	1.12	1.46
Enterprise	1.23	1.05	1.05	1.51	1.37	1.32	1.39

Source: Annual reports (2012), MPO (2016), author´s calculations

To complete the picture, a comparison of prompt and immediate liquidity was also conducted, which was not taken into account in the estimation of the costs on equity, but which may suggest in what ways the company works with finances. Figure 5 clearly shows that the L2 liquidity maintained by the company is similar to that within the branch, whereas the L1 liquidity for the company and the branch diverge; the company maintains slightly worse conditions, which may indicate a more efficient use of financial sources.

Figure 5: Development of Immediate and Prompt Liquidity (L1 and L2 in %)



	2003	2004	2005	2006	2007	2008	2009
Liquidity L2 Enterprise	1.08	0.9	0.88	0.87	1.21	1.15	1.23
Liquidity L2 Branch	0.8	0.88	0.85	1.33	0.92	1.03	1.33
Liquidity L1Enterprise	0.12	0.1	0.09	0.08	0.13	0.08	0.1
Liquidity L1 Branch	0.2	0.17	0.17	0.19	0.18	0.27	0.4

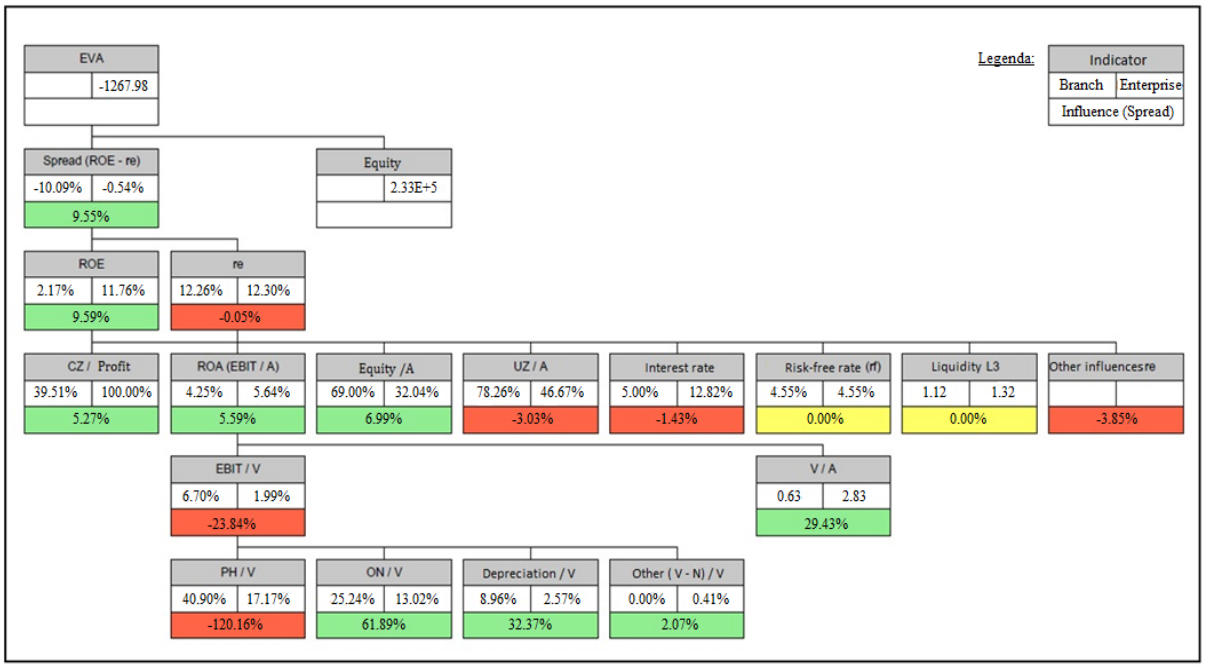
Source: Annual reports (2012), MPO (2016), author´s calculations

On the basis of the poor EVA Equity results, we can categorically state that this is influenced by the structure of the company´s finances and the ratio between chargeable foreign capital and equity. The volume of foreign capital is too high. There is therefore enormous potential to improve the efficiency with which equity is used and, at the same time, to reduce the volume of incorporated foreign capital.

EVA Equity Decomposition

Figure 6 illustrates the decomposition of EVA for 2009.

Figure 6: Decomposition of EVA Equity in CSAD Jihotrans for 2009

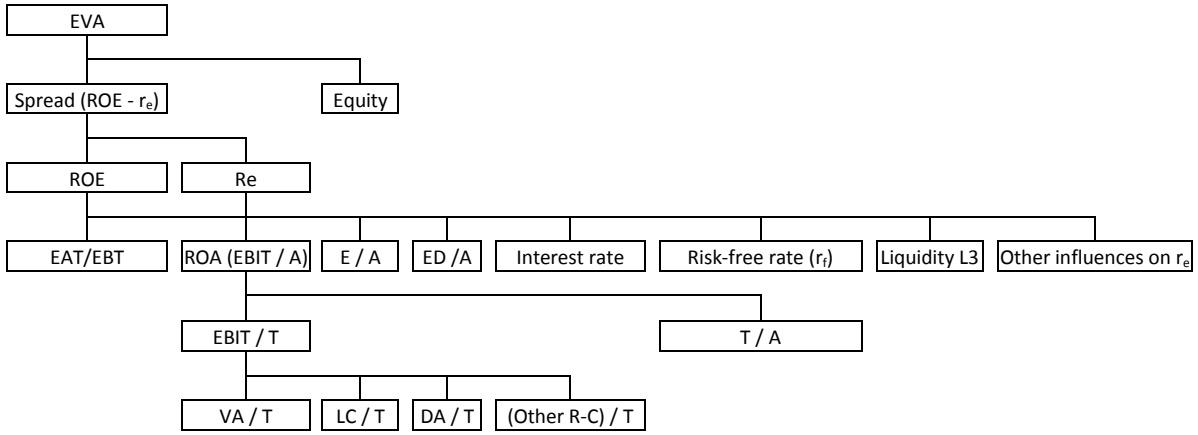


Source: MPO (2009), annual reports (2012)

The variables highlighted in green represent positive values, those in red, negative values.

Figure 7 offers a slightly different view of the decomposition of EVA Equity.

Figure 7: Decomposition of EVA Equity with the option to manage individual indicators.

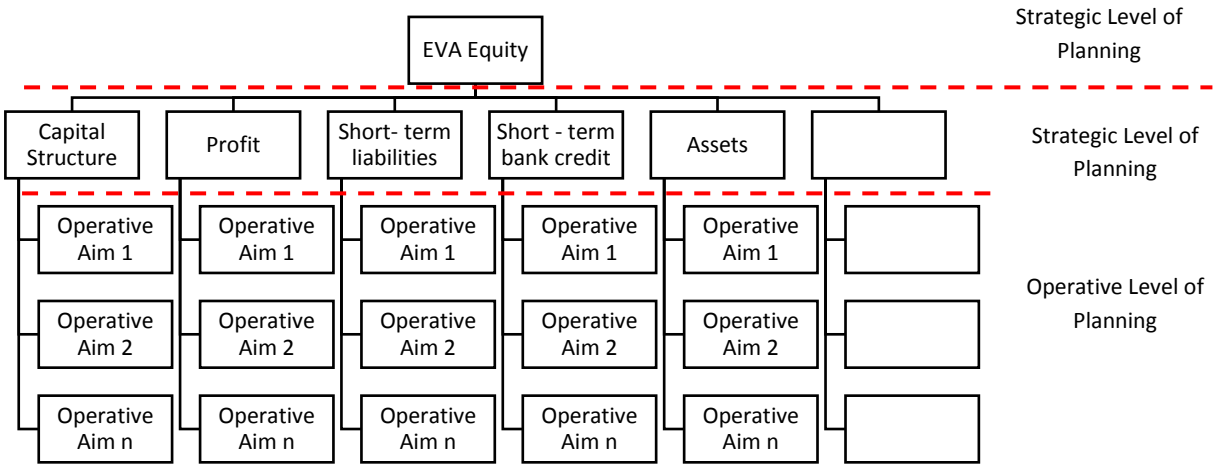


Source: Author

The same variables highlighted in red in Figure 1, which are also referred to in Figure 2, are impossible for the company to control. In contrast, the company can exercise control over the other variables and implement them in its daily plans.

If this interpretation process is continued, the logical conclusion is a specific company plan, respectively a template for creating one. In this case, it is suitable to use and refer to the results of Stehel and Vochozka (2014), specifically the scheme presented in Figure 8 below.

Figure 8: Scheme for Company Plan



Source: Stehel and Vochozka (2014)

The scheme takes the strategic aim, specifically EVA Equity, and divides it into strategic plans for capital structure, profit structure, etc., with planning at the operative level being determined by monthly, weekly or daily results. This structure differs from that put forward by, for example, Kislingerová (2007) and other authors.

Conclusion

The aim of this contribution was to calculate EVA Equity and to suggest its possible decomposition into the operative plans of a specific company.

The aim of the contribution was fulfilled.

The EVA Equity calculation showed that, during the observed period 2003-2009, CSAD Jihotrans only generated positive economic value added in 2003, and only negative values in the following years. On the basis of the analysis undertaken, it can be concluded that the company demonstrated a better ROE than the branch and a similar liquidity to the branch. It was subsequently identified that the negative EVA was the result of excessive costs on capital, which were attributable to the huge volume of chargeable foreign capital.

The second partial aim of this study was the decomposition of EVA Equity according to the methodology of the Ministry of Industry and Trade. As a result, partial values were calculated for the company. This enabled the identification of those variables that the company would and wouldn´t be in a position to influence. This concurred with the work of Stehel and Vochozka (2014), whereby EVA Equity is seen as a strategical aim which a company can decompose into partial indicators, which can subsequently be divided into strategical plans and finally into the form of indicators for an operative plan.

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Life Proposes, Disability Disposes: An Overview on the Models of Disability with Special Reference to WHO Conceptual Models

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Abstract

This paper aims to review and describe the models of disability i.e. the medical and the social model, the international classification of impairments, disabilities, and handicaps (ICIDH), as well as the International classification of functioning, disability, and health (ICIDH-2 or ICF). The terminology used was also the subject of review due to a lack of clarity about usage. After an in-depth literature review, it was determined that two terms are more widely used in journals, books and government documentation, namely 'disabled people' and 'people with disabilities'. The WHO and the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) definitions are accepted worldwide because they address and acknowledge the issues of disabled people. This article sheds light on the detailed conceptual framework of the ICIDH & ICF and the acceptance of ICF as the main disability guide at the global level. The applications of these models definitely help in understanding the health phenomenon called 'disability' and explain the paramount relationship between disabled people and society as a whole. This could be a 'handbook' for people at different levels in any organization to understand and be aware of different aspects of disability.

Keywords: disability, medical model, social model, ICIDH, ICF

Introduction

We live in a world in denial, where people are discriminated against in all walks of life regardless of their race, religion, gender, disability, etc. The irony of life is that the world still denies the existence of such realistic facts. Unlike developed countries, disability has been neglected for a long time in many third world countries. Disabled people are not the main 'actors' in real life, rather they are portrayed as 'other', 'evil' or an 'issue',

whereby the word 'disability' is synonymous with the word 'failure' (Marks 1997). Ability and disability are complex and multi-factorial concepts which are difficult to explain and on a scale of fitness occupy a position between 'illness' and 'being healthy' (Marks 1997). "Although disability can be attributed to the impairment or physical/mental outcome caused by a medical condition, it is also a social construct that results from the social and physical environment in which a person lives their life" (Altman 2014).

Altman (2014) in her paper explains the cycle of disability. It starts as a process, which can occur for many reasons such as by birth or accident. She further explains that the afflicted condition may or may not leave a physical, mental or emotional impairment on an individual (permanent or temporary), but that it becomes the personality trait of that individual (active or residual impairment due to disease, injury, congenital accident or from birth) (Altman 2014). On the basis of the same conceptual belief, Bickenbach et al. (1999) explains that disability is not restricted to the 'physical' or 'mental' well-being of an individual, but it is also an integrated collection of intrinsic and extrinsic factors i.e. behaviour, conditions, etc., many of which may have originated from our society.

The study of disability is not restricted to any discipline of research. It can be argued to be 'multidisciplinary' because it provides remarkable associations with philosophy, sociology, political science, law, special education, management, etc. In their research, Evans and MacNaughton (2004) highlighted the interdisciplinary-multidisciplinary concept by stating the following: "Interdisciplinary is perhaps easier to claim than it is to demonstrate, and putatively interdisciplinary work frequently turns out to be merely multidisciplinary, in the sense of involving relatively disconnected contributions from different disciplines-contributions which, taken in isolation, exhibit no real trace of contact with any other discipline beyond their own". Winance (2016) confirms that disability research has grown considerably in the last 40 years, either into disability studies or merged into cross disciplinary studies.

The objective of this article is to provide insights into the different models of disability i.e. the social and the medical model and also to provide an understanding of the World Health Organization's conceptual models (ICIDH and ICF) which are the basis for the evaluation, assessment and treatment of diseases and disorders.

The article begins with an introduction to disability, followed by a discussion on the comparative terminology used worldwide for the word 'disability'. This includes a discussion regarding the use of the accepted and legal definition of disability quoted from WHO, UNCRPD and Hungarian legislation. Finally, a detailed literature review follows of the models of disability and the conceptual ICIDH and ICF models. This literature review is part of a planned and comprehensive research project in Hungary. This avant-garde study is expected to provide crucial contributions for the professional inclusion and integration of disabled people. The dearth of literature and the lack of awareness of disability also motivated the authors to add valuable insights and bridge the gap between reality and practice.

Definitions of disability

Prior to discussing the various definitions of disability, it would be appropriate to establish important terminologies used worldwide to address the issue of the 'World's largest minority' (United Nations 2006). Every country has a different legislative approach to defining, identifying and treating disability. There are some common terms used by people all over the world such as, 'handicapped people', 'people with disabilities', 'disabled people', 'physically or mentally challenged', etc.

The commonly used terms within the context of Hungarian legislation are 'disabled persons', 'persons with disabilities', 'people with intellectual disabilities', 'people with altered working capacity' or 'persons with changed working capacity'. The usage depends on the ministry involved (Open Society Institute 2005; NORSA).

In the United Kingdom the correct term 'disabled people' is used, whereas in the United States of America more emphasis is given to 'people with disabilities', and in India to 'persons with disabilities' or 'disabled people' (Erkilic 2011; Mitra and Sambamoorthi 2006).

Kuppers (2010) explains that terms like crippled, retard, spuz had negative connotations and that at beginning of the 21st century terminology began to be more commonly used that was more respectful, namely 'people with disabilities' or 'disabled people'.

Morris (2001) shares her critical views on disability in her paper, entitled "Impairment and Disability: Constructing an Ethics of Care That Promotes Human Rights", and prefers the use of the term 'disabled people' over that of 'people with disabilities'. She also criticises the ideology of disabled people in Britain, where 'disability' refers to discriminating, social rejection and attitudinal obstacles and not to the 'impairment' within the body. There is therefore a difference between impairment (an individual's deformity or disorder) and disability (attitudinal and access issues). This can be further explained with an example, "My impairment is the fact that I can't walk; my disability is the fact that the bus company only purchases inaccessible buses." or, "My impairment is the fact that I can't speak; my disability is the fact that you won't take the time and trouble to learn how to communicate with me." (Morris 2001).

This issue is even mentioned in the ICF manual with regards to concerns over the use of terminology with which to address people who have restrictions or limitations in their body functions and behaviour (WHO 2001). The World Health Organisation leaves this to 'community in discussion' in this article to decide which terminology should be used, be it 'disabled people', 'people with disabilities' or any other name, as they have the right to choose for themselves with which idiom to be addressed. The phrase 'disabled people' is more acceptable than "people with disabilities" because "disability" refers to a multidimensional occurrence which has evolved from people and their surroundings (WHO 2001). The United Nations used the word 'person with disabilities' in their Convention on the Rights of Persons with Disabilities (U. N. 2006). In 2015, the United

Nations, in its report entitled, 'Improvement of disability data and statistics: objectives and challenges', noted that there is a problem with data collection due to a 'lack of a uniform definition and understanding of disability among countries' which is a big challenge(U. N. 2015).

Many organizations and health care institutions all over the world have different methods and terminology for evaluating, assessing, and classifying diseases and disorders, the results of which can determine further treatment and the payment options offered to people (Simeonsson et al. 2000).It is therefore important to have a definition or universal terminology for diseases and disorders in order to create a transparent and systematic form of documentation that is accepted and recognized worldwide, and not just a well-defined monetary structure for treatment.

A group of disabled people, the Union of the Physically Impaired Against Segregation (UPIAS), defined disability as being: "The disadvantage or restriction of activity caused by a contemporary social organization which takes no or little account of people who have physical impairments and thus excludes them from participation in the mainstream of social activities" (UPIAS 1976). In contrast, the definition of disability under the Equality Act 2010 (Equality Act 2010) is: 'A person (P) has a disability if (a) P has a physical or mental impairment, and (b) the impairment has a substantial and long-term adverse effect on P's ability to carry out normal day-to-day activities.'

According to Americans with Disabilities Act 1990 (42 U.S. Code), the term 'disability' means, with respect to an individual:

A. A physical or mental impairment that substantially limits one or more of the major life activities of such an individual;
B. A record of such an impairment (An individual meets the requirement of "being regarded as having such an impairment" if the individual establishes that he or she has been subjected to an action prohibited under this chapter because of an actual or perceived physical or mental impairment whether or not the impairment limits or is perceived to limit a major life activity);
C. Being regarded as having such an impairment.

Hungarian legislature had to make changes to its definition of disability so that it included traits of the social model. The definition of a person living with a disability, as per Chapter 1, Section 4 of the Act, is: 'A person living with a disability is anyone who is to a significant extent or not entirely in possession of sensory – particularly sight, hearing, locomotor or intellectual functions, or who is substantially restricted in their communication and who is thereby placed at a permanent disadvantage regarding active participation in the life of society' (Act XXVI 1998). The UN committee highlighted some minor loopholes in the Act to ensure that the Hungarian government policy would be in full compliance with the UN CRPD convention. They did so because the Disability Act was based on the medical model and that certain areas of disability were not covered e.g. psychiatric patients with (long-term) mental impairment were not included. In April 2013, the Government of Hungary filed an amendment to Act XXVI of 1998 regarding the

definition of disabled people which came into effect from September 2013. (Act XXVI 1998; Balog 2013; NORSA, n.d. and European Parliament 2013).

Act CXCI of 2011 on benefits for persons with changed working capacity and amendments of certain Acts, which came into force on 1st January 2012, states: "Persons eligible for benefits for persons with changed working capacity are those whose state of health i.e. the state of a person's physical, mental and social well-being that occurred due to illnesses or injuries or that can be identified as permanent or terminal setbacks caused by congenital abnormalities, is assessed during a comprehensive assessment by the rehabilitation authority as being 60 per cent or less (hereinafter referred to as 'person with changed working capacity' or 'disabled person.'" (Act CXCI 2011; NORSA).

The United Nations Convention on the Rights of Persons with Disabilities (UN CRPD) does not provide a 'closed' definition as it considers disability as an 'evolving concept' (WHO 2014). Article 1 of the UNCRPD defines persons with disabilities as "those who have long-term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others" (UN 2006). During the drafting of the comprehensive definition of disability, it was initially decided not to have any definition at all. Quinn (2007), cited in Kothari (2010), explains that it was not advisable to have a definition of disability because it was pointed out that people can be discriminated against on the 'grounds of disability' in three different manners: able people who have been treated for a disease or disorder and who do not have it anymore and who are assumed to still have a disability; people who are currently non-disabled but who may or may not develop a disability in the future but who are susceptible to disability; and people who are not disabled but are associated with other disabled people.

On the basis of the above, it is clear that a universal and unanimous definition of disability needed to be found to avoid chaos and to bring transparency to the whole disability movement. According to Leonardi, et al. (2006), the definition of disability needed to take into consideration the basic difference between the 'objective' description from an individual's perspective on their experience with their personal limitations and the 'subjective' appraisals of others. The definition needed to embody approaches to disability, showcase the robust phenomenon of disability, affirm an individual´s health condition, but also address extrinsic factors in the settlement and acceptance of such social concern (Leonardi et al. 2006).Therefore, "Defining disability as an interaction means that "disability" is not an attribute of a person. Progress on improving social participation can be made by addressing the barriers which hinder persons with disabilities in their day to day lives." (WHO 2011).

To summarise, the universal definition of disability embodies two characteristics: an individual's mental and physical traits; and the personal and social constraints attached to those traits, such as is incorporated in WHO manuals and legislature in the UK, USA, Hungary, etc.

Models of Disability

Mankind is dependent on models and theories to be able to understand human behaviour and anatomy. Models of disability have an important role to play in the drafting of procedural legislation, as well for research into , and the understanding of, the complexities of the human anatomy (Llewellyn and Hogan 2000). Llewellyn and Hogan (2010), share the viewpoint of many theorists who feel that models of disability are different in 'real life'. They go on to state that this may be due to the in ability to understand the usage of the model in question and the ability to expand our thinking in the field of disability, which could be starting point of many future postulates.

There are several models of disability based on the differing approaches towards life sciences, politics, society and other diverse fields. Table 1 provides a summary of the different types of models in relation to disability.

Table1: Different types of models of disability

Types of Disability Models	**Characteristics Feature**
Medical Model or Individual Model or Biological-Inferiority or Functional-Limitation Model	- Results from an individual person's physical or mental limitations. - Management of the disability is aimed at a "cure".
Social Model or Minority-Group Model	- Consequence of environmental, social and attitudinal factors. - Effect of disability movement initiated by disabled people.
Charity or Tragedy Model	- Depicts disabled people as victims of circumstance, deserving of pity. - Views disabled people as charitable cases. - Patronizing effect on disabled people. - Widens the gap between disabled people and society.
Religious or Moral Model	- Historically the oldest and is less prevalent today. - Based on religious and cultural beliefs. - Disability associated with guilt, sin and shame.
Expert or Professional Model	- Offshoot of the medical model. - Authoritarian style i.e. over-active service provider and passive client.
Rights-Based Model	- Conceptualized as a socio-political construct within a rights-based discourse. - Not driven by compassion, but by dignity and freedom.
Economic Model	- Defined by a person's inability to participate in work.

	- Used primarily by policy makers to assess the distribution of benefits.
Rehabilitation Model	- Similar to the medial model. - Disability as a deficiency that must be fixed by a rehabilitation professional or other helping professionals.
Empowering or Customer Model	- Exact opposite of the expert model. - Expert viewed as a service provider to the disabled client.

Source: Own construction based on MDRC, n. d.; Disabled World, n. d.; WHO 1980; WHO 2001; WHO 2014.

Louhiala (2009), in her paper entitled 'Philosophy Meets Disability', considers medical and social models as two extreme and important models of disability, whereby the medical model is the 'ingrained' personality of an individual which is physical in nature, and whereby the social model is where disabled people have isolated themselves from society through 'self-imposed exile', which expresses itself in predominantly pessimistic social factors such as negative attitudes.

There is a discussion on which model is the dominant and important one, but there is no consensus. The dilemma is even mentioned in the UNCRPD report: "The charity approach is the oldest of the four, followed by the medical approach. The social and human rights approaches are more recent. Yet, all continue to this day. In spite of the adoption of the Convention, the charity and medical models are still very prevalent—even among the human rights community" (WHO 2014). A brief outline of the medical and social models follows, which form the building blocks of the conceptual ICF and ICIDH models.

Medical Model

In order to understand and define the concept of disability, the medical model is used as the starting point or the dominant model for research. The medical model is based on the notion that the human body suffers from disability for many reasons, be it disease, accident or any other health related issues, and that this can be treated or rehabilitated (Mitra and Sambamoorthi 2006).

The starting point of the medical model is to focus energy on changing the world of a minority group who cannot fit into our society, rather than restructuring or re-establishing our environment to accommodate those people who need adjustments due to their physical and mental incapability (Marks 1997). Llewellyn and Hogan (2010) commented on Marks´ paradigm by saying that the overall picture is that the human being is flexible and `alterable' while society is fixed and unalterable. The disabled person is therefore expected to adapt to the requirements of society, not vice versa. The 'achievements' or 'qualities' of a disabled person are applauded if they overcome their disability by doing something remarkable which is not possible because of their disability (Johnston 1994).

Social Model

The social model, which includes socio-political features, not only brought about changes in the interpretation of the medical model, but also challenged the foundations of the medical model where by disabled people were addressed as socially oppressed and which holds society responsible for the oppression of that minority (Reddy 2011). Hahn (1986) writes, "This stems from the failure of a structured social environment to adjust to the needs and aspirations of citizens with disabilities rather than from the inability of a disabled individual to adapt to the demands of society". This can be explained by taking an example of a man who uses crutches and cannot board a bus due to the physical structure of the bus. The local authorities have to find a way to make changes in the structure of the bus so that it can be accessed by everyone, and not find fault in the man´s legs and crutches. Many disabled individuals maintain the viewpoint that society´s opinion of their disability is more de-motivating than their incapability and that the same society, which is obsessed with their disability reminds them that they have some kind of deformity.

The social definition of disability is conceptualised by Oliver (1995), "the disadvantage or restriction of activity caused by a contemporary social organization which takes no account of people who have physical impairments and learning difficulties and thus excludes them from mainstream social activities".

There has been a conceptual movement initiated by researchers, social workers and people from disabled communities to focus on creating a social community without barriers and which encourages policies that do not discriminate against or raise obstacles (institutional, economic, attitudinal and environmental) to the survival of disabled people (Erkilic 2011).

The social concept of disability, like two sides of a coin, has contrasting and realistic foundations i.e. biology and society: one which emphasizes the characteristics of a disabled individual (body distinctiveness) and the other being the social interpretation of prejudice and interdiction.

Anthropologists are ready to take up this challenge of expanding their knowledge because they feel that ethnography can be an effective and reliable tool for disability studies. It is their understanding that there are further possible avenues of research within the context of the disability-impairment relationship if biomedical concepts and social theories are applied together (Mehrotra 2012).

On the whole, the medical and social models have been well accepted, but neither of them is adequate in relation to disability. A successful model of disability would be one which combines the different perspectives of both models into a new model which can be accepted by its users, disabled communities and governments alike (WHO 2002).

ICIDH: International Classification of Impairments, Disabilities, and Handicaps

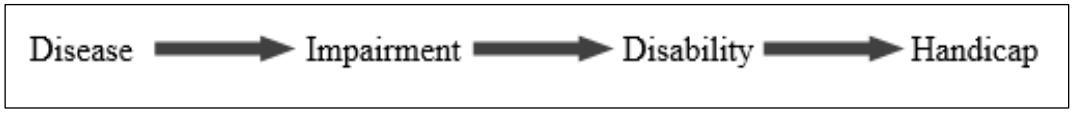
The International Classification of Impairments, Disabilities, and Handicaps (ICIDH), an initiative of the World Health Organisation (WHO), was first published in 1980. The classification sought to create a conceptual framework for the embodiment of the relationship between the body, an individual's disability and an individual's standing in society in relation to long-term diseases, injuries and disorders (WHO 1980).

The ICIDH provides support and addresses the challenges in the day-to-day lives of disabled people, as well as seeks to understand the problems & changes in relation to impairment, disability and handicap. These three form the basic pillars of ICIDH, and in conjunction with the classification, helps to give a descriptive assessment of disabled people in their given surroundings (WHO 1980).

The overall disability of a person is compromised because our social environment does not assess the integration of societal barriers and other related environmental factors because it is suggested, according to ICIDH, that our social environment is rigid (Chopra, Couper and Herrman 2002).

The thinking behind ICIDH provides understanding in three areas. Firstly, in terms of the compilation of the theoretical structure through the introduction of three notions i.e. impairment, disability and handicap (see Figure 1), by which to understand the effects of diseases and disorders on the human body. Secondly, by proposing a classification system for the distinct levels of the effects of diseases. Thirdly, in terms of soliciting intellectual structures which interlink the concepts of impairment, disability and handicap (Badley 1993).

Figure 1: ICIDH



Source: WHO 1980

The ICIDH manual broadly contains three different classifications which are specific and autonomous (see Table 2) (WHO,1980, pp. 13-14; Badley, 1993).

Table 2: Three pillars of the ICIDH classification

Impairment (I)	Disability (D)	Handicap (H)
Impairments (I code), concerned with abnonnalities of body structure and appearance and with organ or system function) resulting from any cause; in principle, inlpairments represent disturbances at the organ level	Disabilities (D code), reflecting the consequences of impairment in terms of functional performance and activity by the individual; disabilities thus represent disturbances at the level of the person.	Handicaps (H code), concerned with the disadvantages experienced by the individual as a result of impairments and disabilities; handicaps thus reflect interaction with and adaptation to the individual's surroundings.

Source: Authors based on WHO 1980 ;Badley 1993

These three ICIDH pillars represent psychological, physiological and anatomical problems. However, even though each concept is different, there is some kind of overlap.

The concepts laid out in the ICIDH are essentially helpful and obligatory criteria for creating policies, particularly in health related disciplines. The ICIDH is a classification which specifically deals with the health related domain, but with a scope of influence that includes population surveys, demographics, city planning and development, alternative medical treatments, the organisation of inter-departmental communications, policy writing, etc. (WHO 1980).

The ICIDH has attracted the world's attention by providing a detailed classification of disability, which brings together the concerns of disabled people. However, it also has its shortcomings and limitations. In their findings, Simeonsson et al. (2000), divided the limitations of ICIDH into three groups - conceptual, taxonomic and practical issues.

Critics of disability have also raised concerns over the ICIDH manual because it does not clearly highlight the social aspects of a given environment and may also be interpreted as advocating the concept of "the medicalization of disablement"(WHO 1980). Gayle-Geddes (2015), points out in her research that the ICIDH approach inclines towards the medical model and is individually centred; it leaves behind the divide between the abilities of disabled people and their social environment.

ICF: International Classification of Functioning, Disability, and Health (ICIDH-2)

In 1993, the World Health Organisation (WHO) initiated the process of revising ICIDH to incorporate three main groups - mental health, children and the environment. There were two drafts of ICIDH-2, namely the "alpha draft" and the "beta-1 draft", which were presented and criticized before the final draft i.e. ICF, was completed, approved and introduced in 2001 (Bickenbach et al. 1999). The ICIDH-2, or ICF classification (revised version of ICIDH), provides a consolidated and well-structured 'dynamic system'(a

change in any one of which is likely to have impacts on the others) for the better understanding of health related causes. The results and explanations were applauded for their neutral language (if not positive) in comparison to the ICIDH model. For example, 'impairment' was replaced by 'body structure and function', 'disability' addressed as 'activity' and 'handicap' re-introduced as 'participation'. The new classification also saw the introduction of 'contextual factors', including sub components like 'environmental' and 'personal factors' (Rosenbaum 2015).

It can therefore be interpreted that ICF or ICIDH-2 was successful in bridging the gap between the social and the medical models, resulting in a bio-psycho-social concept, which unites biological, social and individual aspects into one major universal human phenomenon (Kyrkou 2016).

The reason for the development of ICF was that there was a need to overcome the shortcomings of the 'one way interaction' framework of ICIDH, which could not explain the role of environmental factors in relation to disability. The ICF framework provides a classification for the assessment of disability (based on the "biopsychosocial model"), which takes into consideration the importance of social and environmental factors in the disability assessment procedure and the design of future policies (Chopra, Couper and Herrman 2002; WHO 2001)

The aim of the revised concept was to provide a common understanding and system to help people from various disciplines and sectors (medicine, rehabilitation studies, psychiatry, psychology, education, social work, etc.) to spread awareness of health or health related problems all over the world. Like ICIDH, the concepts within ICF are inter-related and are aimed at devising an understandable and practical language that can benefit users such as health care practitioners, scientific researchers, policy makers and people from different backgrounds in life, including disabled people. The practical benefit of ICF helps in the evaluation and the measurement of disability in medical and social policy scenarios.

ICF can be explained as being two parts – individual and social - of a conceptual body, each part being subdivided into two components (which can be expressed in both negative and positive terms) as follows (WHO 2001):

Part 1: Functioning and Disability

> (a) Body Functions and Structures: The body component comprises two classifications, one for functions of body systems, and one for the body structures. The chapters in both classifications are organized according to the body systems.
>
> (b) Activities and Participation: The activities and participation component covers the complete range of domains denoting aspects of functioning from both an individual and a societal perspective.

Part 2: Contextual Factors

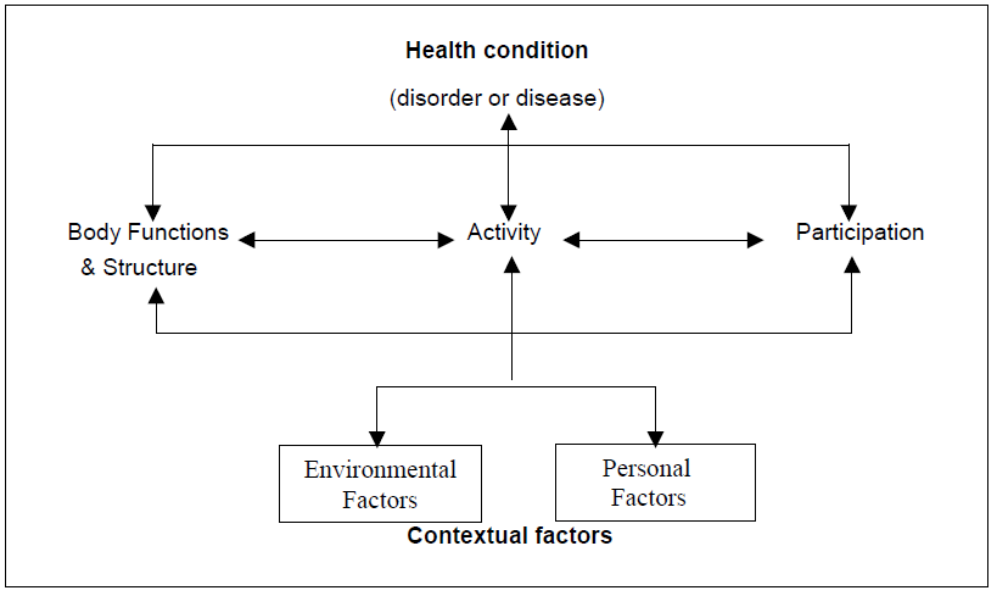
> (a) Environmental Factors: A list of environmental factors forms part of the contextual factors. Environmental factors have an impact on all components of

functioning and disability and are organized from the individual's most immediate environment to the general environment.

(b) Personal Factors: personal factors are a component of contextual factors, but not classified in ICIDH-2 because of the large social and cultural variance associated with them (See Figure 2).

Functioning as a 'common' term covers all the body functions, as well as activities and participation. Likewise, disability as a 'common' term refers to impairment, restrictions to participation and barriers to activity. Environmental factors in ICF are also mentioned which are inter-connected with all these concepts and describe the situations in which an individual lives (WHO 2001).

Figure 2. ICF MODEL



Source: WHO, 2001

The scope and influence of ICF does not only restrict itself to people with disabilities, but applies to all people. The use of ICF has been instrumental in many fields. For example, it is an important tool in statistics, qualitative research, social policy and educational research. The use of ICF, the universal framework for disability, helps to bring transparency, credibility and harmonisation by drafting universal definitions and setting accepted standards for classifications worldwide and as such, by sharing good practises with a wider network of countries, allows the sharing of innovative and cost-effective approaches (WHO 2011). It is also important to note that the definition of disability and the classification structure under ICF are also prevalent in legislation across the world and form important instruments for the disability movement.

In 2007, ICF revised its coverage of disabilities that are rooted in adolescent complexities and subsequently published ICF Children and Youth (ICF-CY). This was done in response to the criticism that the original ICIDH had not placed sufficient emphasis on children and youth (Simeonsson et al. 2000). The ICF-CY is an expanded

version of ICF which covers body functions and structures, activities and environmental standards in relation to infants, toddlers, children and adolescents (Kostanjsek 2011; WHO 2007).

The ICIDH ideology i.e. "consequence of disease" did not form the basis for ICF (ICIDH-2); ICF is more a reflection on the "components of health" (WHO 2001).

We live in a complex society and no one is perfect in today's competitive world. We are dependent on each other for our 'needs' & 'wants' irrespective of mental & physical abilities and disability studies not only explores individual constraints but also the social changes; working towards the cause of benefitting and integrating the entire population into one comprehensive association (Marks 1997).

Conclusion

It can be concluded from this article that there are two criteria for evaluating disability. The first involves the individual's physical & mental state (medical), the second, people´s attitudes and the physical environment (society). The medical and the social models have their own existence in socio-scientific disciplines; neither of them can be written off as obsolete models because they form the basis for future conceptual models. The integration of the social and the medical model has led to the development of a new 'biopsychosocial model' which covers various dimensions of biology, individual health and the social environment. The objective of the ICF is to provide a universal definition and classification of health and disability in a neutral language to the citizens of the world to overcome political, social and individual barriers.

Disability is not an insignificant issue; the well-being of disabled people is an important socio-political agenda point. Unless and until, the thought process of able-disabled people changes, or they start accepting the 'world's largest minority' into their system, the objectives of these models and legislation will not be accomplished. These models can therefore help us to define guidelines and descriptive procedures which include disabled people and which overcome the problems of marginalization and social exclusion. In this regard, this study could have been voluminous if there had been more published papers on the topic available.

The purpose of this review was, by highlighting the various dimensions of disability, to create a platform where globalization, international politics and demographics affect the rights of disabled people. There is a deliberate attempt through this article to provide information to users who are only familiar with the existence of disabled people in society, but have not been exposed to the very important basic concepts thereof. There could be two reasons for this, either there is not enough information available to them, or maybe they have not interacted with any disabled person. The phrase 'necessity is the mother of invention' stands out in this context because we learn and show an interest in certain things in life only when it is essential or we are faced with a dilemma. We tend to show no interest in diseases and disorders unless we are sick ourselves or someone in our family is afflicted. On the basis of the same ideology, the phrase 'ignorance is bliss'

opens our eyes so that we no longer have an ignorant attitude towards disability and motivates us to be more open-mined about other people's existence in society irrespective of race, gender or disability.

Managers can use this article as a 'handbook' to broaden their knowledge in relation to disability and for developing and adopting an empathetic approach towards disabled people at work. The lack of disability awareness in many organisations still needs to be confronted. There is therefore a lot of scope for future studies into how to bridge the gap between society and work culture. The ICF model's environmental and personal factors can be further evaluated to gain access to issues pertaining to the work place. The objectives of concepts and models are not only to provide in-depth information about disability, but also to empower disabled people because they are also not up-to-date about their rights. Both disabled and able-bodied people need to re-think or deviate from stereotypical thought processes or create a new outlook towards disability for the 21st century.

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Foreign trade between China and the Czech Republic

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Abstract

International trade is based on the mutual exchange of goods and services in which one country has a comparative advantage over another. The advantage may relate to the availability of raw materials, knowledge of technologies or the lower cost of production of a certain article. The advantage of such transactions is clear. Each country acquires goods or services that are too expensive or cannot be produced in their own country. However, despite the advantages, there are also a number of obstacles to this trade. These obstacles are not only in the form of transport distances, but also customs barriers and administration.
In spite of the fact that China and Europe are relatively distant from each other, they have been trading together for hundreds of years. In this time, the structure and the amount of goods and services which are traded has changed quite substantially. The aim of this article is to analyse the structure of foreign trade between China and the Czech Republic.

Keywords: foreign trade, China, Czech Republic, balance of payments, GDP

Introduction

The economy of the Czech Republic is export focused (Český statistický úřad 2015). The primary destination for those exports are the countries of European Union, which relates to their regional proximity and the principles on which the EU functions. Due to the implementation of certain measures, exporting to other EU member states has been simplified for swathes of companies and even supported (e.g. cross border co-operation (Dotační info 2016).

The People's Republic of China is also export oriented (BusinessInfo.cz 2016c). Due to the country´s size and position it is logical that those exports are distributed over the whole world.

The distance between Prague and Beijing is 7,456 km (Vzdálenost měst 2016). In spite of this, both countries actively communicate and trade with each other. The co-operation is not purely based on the exports of particular commodities, but also involves the sharing of know-how in the fields of science and research and development. Examples of the importance of the cooperation between both countries are the recent state visit of the Chinese president to the Czech Republic (SMÍŠENÁ ČESKO ČÍSNKÁ KOMORA VZÁJEMNÉ SPOLUPRÁCE, 2016a) and the establishment of a Chinese Centre in České Budějovice (Chinese Centre of VŠTE 2016). The centre was founded by and is run by the Institute of Technology and Business in České Budějovice in co-operation with Chinese universities and institutions.

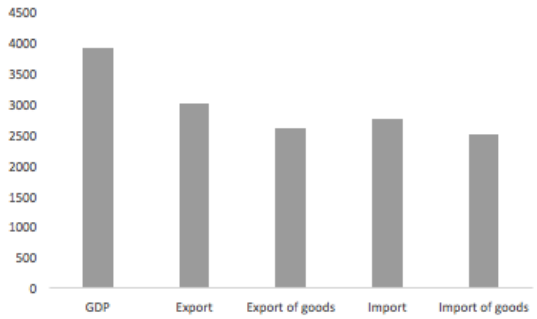
The activities of the entrepreneurial sector are also visible within this context. Various hi-tech technologies from China, especially in the form of mobile technologies, are now available on the Czech market. At the same time, large Czech companies, such as the PPF Group, have being doing successful business in China for several years. Home Credit China, a company owned by the PPF Group, is the largest provider of consumer credit on the Chinese market (SMÍŠENÁ ČESKO ČÍSNKÁ KOMORA VZÁJEMNÉ SPOLUPRÁCE 2016b).

Analysis of Chinese-Czech foreign trade

Czech Republic

As previously stated, the Czech Republic is an open economy. In 2013, the foreign trade turnover participated in GDP with 150 % (Czech National Bank 2014). The share of exports in GDP is visible in Figure 1.

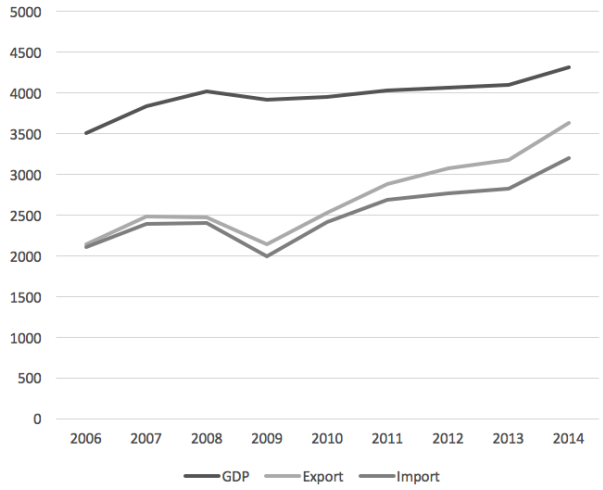
Figure 1: Export share in GDP (in CZK billions)



Source: Česká národní banka 2014.

It is clear from Figure 1 that a substantial part of GDP growth is driven by the import and export of goods. The development of Czech foreign trade and GDP over time is visible in Figure 2.

Figure 2: Development of GDP, exports and imports (in CZK billions)



Source: Český statistický úřad 2016a

GDP was calculated on the basis of the production method at normal prices, i.e. as the sum of the gross added values of the individual institutional sectors or branches and net taxes on products which were not split into sectors and branches.

In Figure 2 it is visible that there is a relationship between export growth and GDP growth. This assumption can be verified by the Pearson r correlation coefficient:

$$r = \frac{\sum(x - \bar{x})\,(y - \bar{y})}{\sqrt{\sum(x - \bar{x})^2 \sum(y - \bar{y})^2}}$$

where $\bar{x}$ is the arithmetic average of exports and $\bar{y}$ is the arithmetic average of GDP.

The results of the performed analysis are given in Table 1.

Table 1: Correlation analysis of GDP and exports

	GDP	*Export*
GDP	1	
Export	0.833494228	1

Source: Author

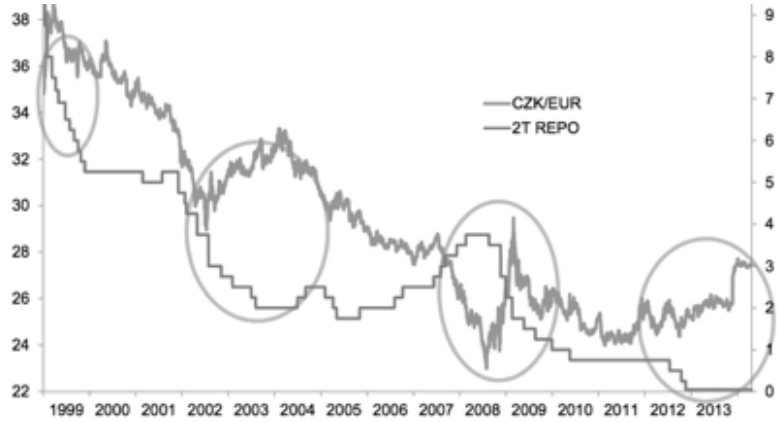
The results show that there is a relatively strong correlation between GDP and exports; the dependence is over 80%. It is highly probable that this dependence is the result of the small size of the economy relative to the large share of exports in the total GDP.
Soukop (2012), states that the relatively large share of exports in GDP is also influenced by the currency rate. Figure 3 shows the development of the EUR-CZK exchange rate in the period 2000 – 2016.

Figure 3: Development of EUR-CZK exchange rate

Source: Exchange Rate/Kurzy CZ (2016)

It is clear that, with the exception of a few short periods, the Czech Crown has strengthened over time. However, since 2014, the exchange rate has visibly stabilized (SCALIA 2008) due to the intervention of the Czech National Bank (Peníze.cz 2013). The reason behind the intervention was the fact that the repo rate stood at 0 for a certain period of time (see Figure 4), which brought with it the threat of deflation and the subsequent reduction in the potential growth of economy that that would bring (Česká národní banka 2014).

Figure 3: Repo rates and currency rate -2T REPO (right axis)



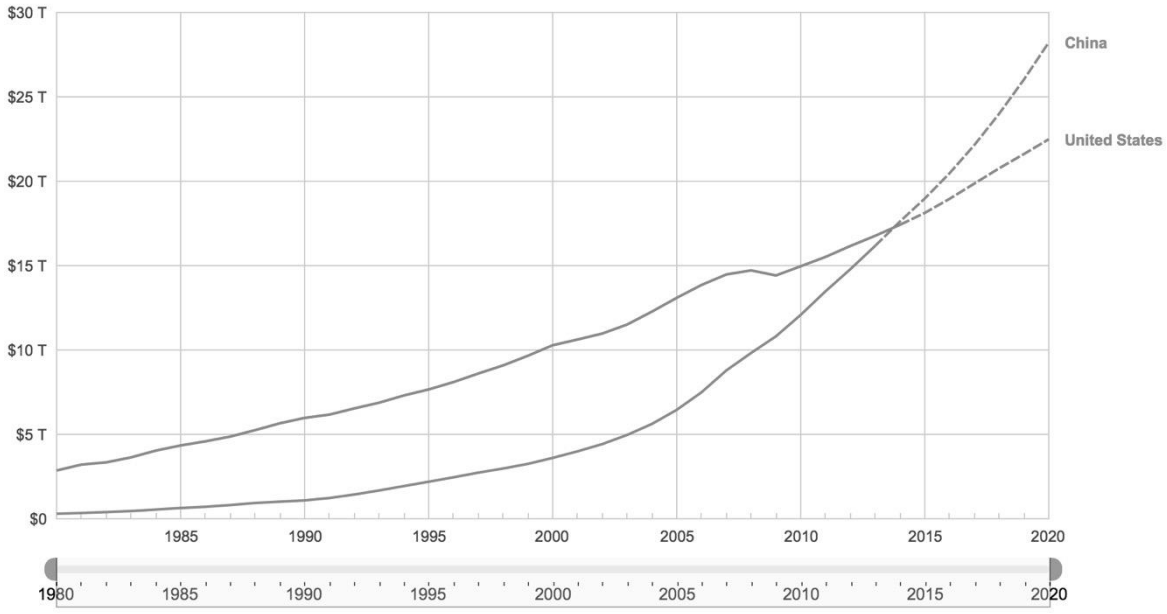
Source: Česká národní banka (2014)

The successful intervention of the Czech National Bank has stabilized the currency rate; the long-term trend towards a strengthening Czech crown has been temporarily halted. However, it is assumed that the currency will eventually be released, which may result in the currency strengthening once again. This is not expected to happen before the end of 2017 (Česká národní banka 2013).

People's Republic of China

In 2014, the People's Republic of China became the largest economy in the world (International Monetary Fund 2015). This was the result of the exceptionally large growth in GDP in recent years (Higgins et al. 2016). Figure 5 compares GDP development for China and the world´s second largest economy, the USA.

Figure 4: GDP based on PPP valuation (2016 - 2019 prediction)

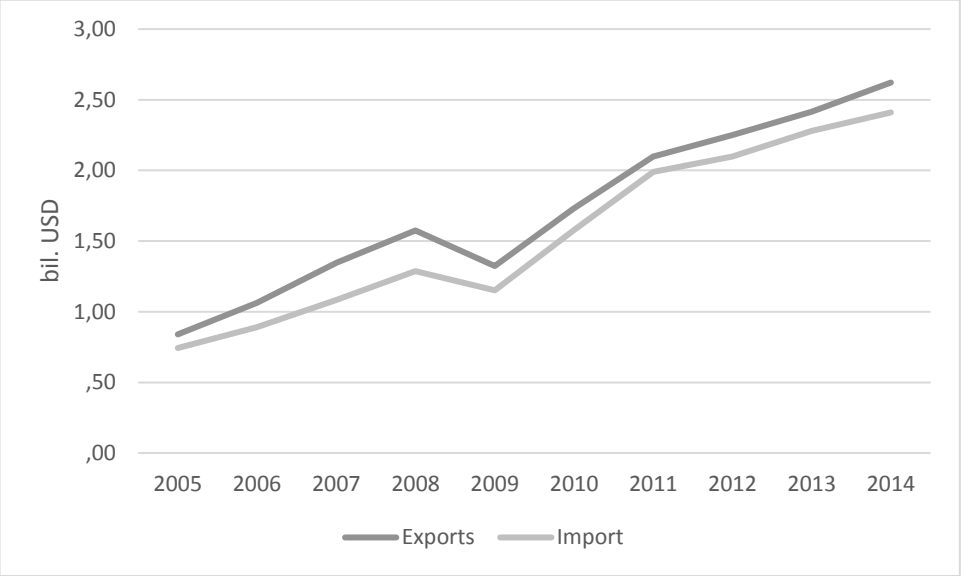


Source: International Monetary Fund (2015)

The growth in Chinese GDP has been dramatic in recent years (National Bureau of Statistic of China 2016), sometimes achieving double-digit figures (Google Public Data 2016). In contrast, the second largest economy grew at a much slower pace. The last time American growth approached that of the Chinese economy was back in 1989 (Google Public Data 2016).

The Chinese economy is a very open economy, which is also supported by its politics (Julien Gourdon et al. 2016). It is the largest exporter and the second largest importer in the world, with a share of 12.4% and 10.3% respectively (World Trade Organization 2015). The development of foreign trade of the People's Republic of China is visible in Figure 6. The growth trend is evident for both imports and exports, which almost run in parallel with each other. In some cases, the total exports of China are so significant that a change in its export policy can result in price increases of any given commodity (Nabeel 2015).

Figure 5: Development of the exports and imports of goods and services of the People's Republic of China



Source: World Trade Organization, 2016.

China´s most important business partners are (IMBRUNO 2016), from the point of view of exports, the world´s largest economies. The size of the economy is decisive, not territorial proximity (MANCHERI 2015). The most important export market is the USA (Junwook 2016, CHI 2016), followed by the EU. China´s five most important export markets are indicated in Figure 7.

Figure 6: China´s most important export partners in 2014

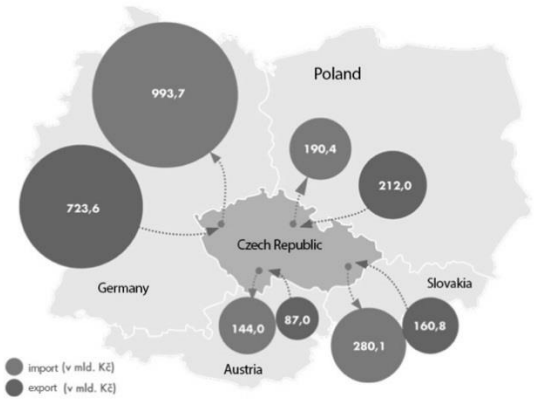
Source: World Trade Organization, 2016.

Mutual relationships between the People's Republic of China and the Czech Republic

The location of the Czech Republic in Europe means that its exports and imports of goods and services are focused on and drawn from those economies which are located in its

direct proximity. More than half of Czech exports are destined for neighbouring states (STATISTIKA&MY 2014 – the values are given in Figure 8).

Figure 8: Exports and imports into neighbouring countries 2013 (in CZK billions)



Source: STATISTIKA&MY 2014

The exception in this regard is the co-operation with China (Stverkova 2016), which, in spite of the fact of the distance, is one of the Czech Republic´s top export markets (18th largest) and the second largest importer of goods to the country (BusinessInfo.cz 2016a). This is extremely positive, at the regional and political levels, in light of the fact that the country´s main export and import partners are first of all from the EU.

In view of the decelerating growth of the EU, the Czech Republic has begun to diversify its foreign policy and identify priority countries with which to develop closer business cooperation. Among these countries are Brazil, China, India, Iraq, Kazakhstan, Mexico, Russia, Serbia, Turkey, Ukraine, USA and Vietnam (National Trade Promotion Agency Trade/CzechTrade 2015). China is by far the most important partner among these countries, with a total share of more than 40 %.

The structure of the exports and imports is given in Table 2. It is evident from the data that imports from China are considerably higher than exports to China. It is also clear that the most important items have a technical character.

Table 2: Structure of the most important imports to the Czech Republic and exports to the People's Republic of China

Export		Import	
EUR mill.	Item	EUR mill.	Item
153.6	Parts of motor vehicles, cars and tractors	3 594.8	Phone appliances, other appliances for broadcasting, voice and data receiving
89.3	Three-wheelers, scooters, prams for dolls, other toys, models, puzzles	3 392.0	Machines for automatic processing, data units, sensors
82.6	Pumps with measuring device, elevators for fluids	1 329.9	Parts of typewriters, computers, automatic data processors
68.2	Wood pulp, chemicals for chemical treatment	662.3	Monitors, projectors without TV, televisions
58.0	Microscopes other than optical diffractographs	490.0	Parts of broadcasting, receivers, televisions
54.8	El. equipment for protection, switching el. circuits, connectors for optical fibres	299.7	Transformers, el. converters, static inductors
52.3	Machine tools for grinding, lapping, polishing etc.	261.5	Integrated circuits, electronic circuits
48.8	Parts of appliances for the protection of circuits of switchboards etc.	239.8	Three-wheelers, scooters, prams for dolls, other toys, models, puzzles
47.8	Phone appliances, other devices for broadcasting, voice and data receiving	220.9	Machines, appliances for printing with aids HS8442 (including copies and faxes), parts
37.0	Pumps, exhausters, air compressors etc.	187.4	Discs, bands, etc., media for recording sound, images, etc. not HS 37

Source: BusinessInfo.cz 2016b.

In the past, Czech exports within the services sector were primarily focused on transport. However, there has recently been rapid growth in the area of proprietary rights to science and research results. In 2014, this item represented more than 40% of the total volume of exported services (BusinessInfo.cz 2016b).

Conclusion

Both the Czech and Chinese economies are export oriented. For the People's Republic of China, the share of foreign trade with the Czech Republic in total GDP is much smaller than the share in total GDP of the Czech Republic´s foreign trade with China. For this reason, China is much less dependent on exports to the Czech Republic. In contrast, the Czech Republic must look for and diversify its range of foreign partners as a means of limiting its exposure to decreases in economic effectiveness being transferred to the inland economy. In this respect, the Chinese market represents the greatest potential for growth (Liu 2016), which makes it one of the most important areas for diversification (Wu 2016).

Of growing interest is the current growth in the mutual exchange of the results of intellectual research and development. This area offers great prospects for the future and is clearly supported by the government representatives of both countries. An example of this cooperation is the second round of Technological Agency DELTA (Technologický agentura České republiky 2015).

At the same time, the Czech Republic provides interesting opportunities for the Chinese. These opportunities will become even more interesting as soon as the Czech currency is gradually released and the currency starts to strengthen.

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M-learning – Use of Mobile Technologies in Teaching

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Abstract

Modern technologies are becoming an important part of education. Its broader application is however hindered not only by the fact that schools are insufficiently equipped with these technologies, but also by the fact that schools are increasingly struggling with its misuse. Examples of misuse include the unethical use of mobile telephones by pupils in classes, the release of manipulated teachers´ records onto the Internet, and the like. However, it is also important to note that schools do not yet offer many opportunities for the meaningful use of these up-to-date technologies. This research project deals with the design of a course on m-technologies for the further education of pedagogues. The output of this research project is an original course that provides a manual for the concrete application of mobile facilities in teaching and the opening of a creative space for teachers in individual schools to approach these problems.

Keywords: m-learning, m-technologies, research, course, ICT

Introduction

The design of an m-technologies course for pedagogues requires not only a contemporary point of view, but also a vision of the future development of new technologies that are appropriate and meaningful for application in an educational environment. According to reports published in 2013 and 2014 in Innovating Pedagogy (Sharples et al. 2015; Kukulska-Hulme and Sharples 2015) it is predicted that the areas of expansion in this field will include m-learning, personal educational environment, MOOC, new subjects in distance education, wiki, blogs, RSS, use of the Creative Commons licence, sharing of electronic study supports through the use of cloud services, u-learning, t-learning, educasting, seamless learning, social networks, omnipresent intelligent telephones and tablets, extended mobile reality, and in general a shift towards the greater utilization of mobile technologies. As a result, new skills, often denoted as skills for the 21st century, will come to the fore.

It is also necessary to be aware of the fact that this period of time is also characterized by the advance of e-technologies. Communication methods in traditional schools was, and still is, for the greater part oriented towards direct verbal and non-verbal forms. However, electronic communications have now permeated the educational space in the form of e-mail, chat, ICQ, Skype, WhatsApp, Viber, Linkedin, Facebook, Cloud, LMS systems, Webinars, Educasting and Podcasting. These are all effective and prospective means of supporting the educational process.

Any new educational programmes should therefore correspond with the up-to-date requirements of pedagogical practice, with a healthy regard for the dynamically developing sphere of information and communication technologies.

Research objectives, research methods

The principal objective of this research project was to analyse the contemporary state of the utilization of mobile facilities and m-learning in teaching, and on the basis of the research investigation to create a functional course on m-technologies for the further education of pedagogues working in technical and science subjects.

The first stage of the research project was to prepare the concept of a course on m-technologies for pedagogues working in technical and science subjects based on a literature search and the study of relevant sources. The concept course would form the basis for effectuating discussions with experts on its applicability and effectiveness. The course would then be revised according to the conclusions drawn from those discussions. The second stage of the research project was to organize and facilitate a course on m-technologies for the further education of the target group, and to subsequently optimize the course structure according to the results of the facilitated course (didactic test, reflection and evaluation of the course by its attendants and a questionnaire). The third stage of the research project was to prepare the dissemination of the final course on m-technologies for the further education of pedagogues.

The opinions of experts with regards to m-learning and the concept course were investigated by way of discussions. These discussions were structured and individual, of which a written record was made.

The results of the facilitated course were investigated by way of a didactic test, in combination with the reflection and evaluation of the course by its attendants. A non-standardized didactic test, consisting of open and closed assignments, was used to assess the results of the teaching. For open assignments, participants were required to provide brief answers, whilst for closed ones, optional answers were given. One of the assignments at the start of the test was dichotomous (Bílek, Doulík and Škoda 2004).

The participant´s opinions on m-learning and its applicability in teaching were determined on the basis of a questionnaire survey. This survey included closed and polynomial questions, with priority being given to optional questions, of which two included a Likert-type scale (Bílek, Doulík and Škoda 2004).

Theoretical bases for the investigated problem

One of the theoretical bases for the research was an analysis of the contemporary state of the utilization of mobile facilities and m-learning. In addition, an analysis was carried out of modern didactic instruments, new subjects in distance education, m–learning and new methods and forms of education.

To complement these analyses, a mapping exercise was undertaken of the contemporary state of, and thoughts about, the utilization of mobile facilities in teaching, as well as the classification and characteristics of mobile electronic facilities. A comparative analysis was also made between traditional forms and methods of teaching with possible new methods through the provision of ICT support, in particular the support of mobile technologies. An extension of this was to study the motivational factors behind the utilization of mobile facilities in teaching and self-study and the importance of m-learning as a support to, and supplement to, up-to-date interactive teaching. This included drawing attention to the opportunities for, and limits of, m-learning in contemporary schools (Svoboda 2009).

The anticipated research solution to the first two stages of the comparative research is based on experiences in Great Britain, Italy and Sweden (Vychová 2010), and that of the International Association for Mobile Education - IAmLearn (Kukulska-Hulme and Sharples 2015) and UNESCO Mobile Learning (Sharples et al. 2015).

Research methodology

For the research part of this project it was necessary to formulate a question, based on the analyses carried out in the theoretical part, as to the role and capacity of m-learning in contemporary schools, related to the possibility to prove its importance as a support to, and supplement to, up-to-date interactive teaching. The concept of the course on m-technologies for pedagogues was the subject of the research investigation in order to gain a comprehensive view of these problems. The main body of the investigation involved discussions with experts from the respective professional community. Their opinions, experiences and comments were a valuable source of information for the first revision of the upcoming course. The revised course was tested in pedagogical practice, whereby the participants were acquainted with the opportunities for the concrete utilization of mobile facilities in teaching, and also by way of various outputs (e.g. didactic test, questionnaire, model scenarios of pedagogical activities, workshops, independent work, discussions, presentations, reflection and evaluation of the course by the participants), which contributed to the final adjustments of the course (Svoboda 2011).

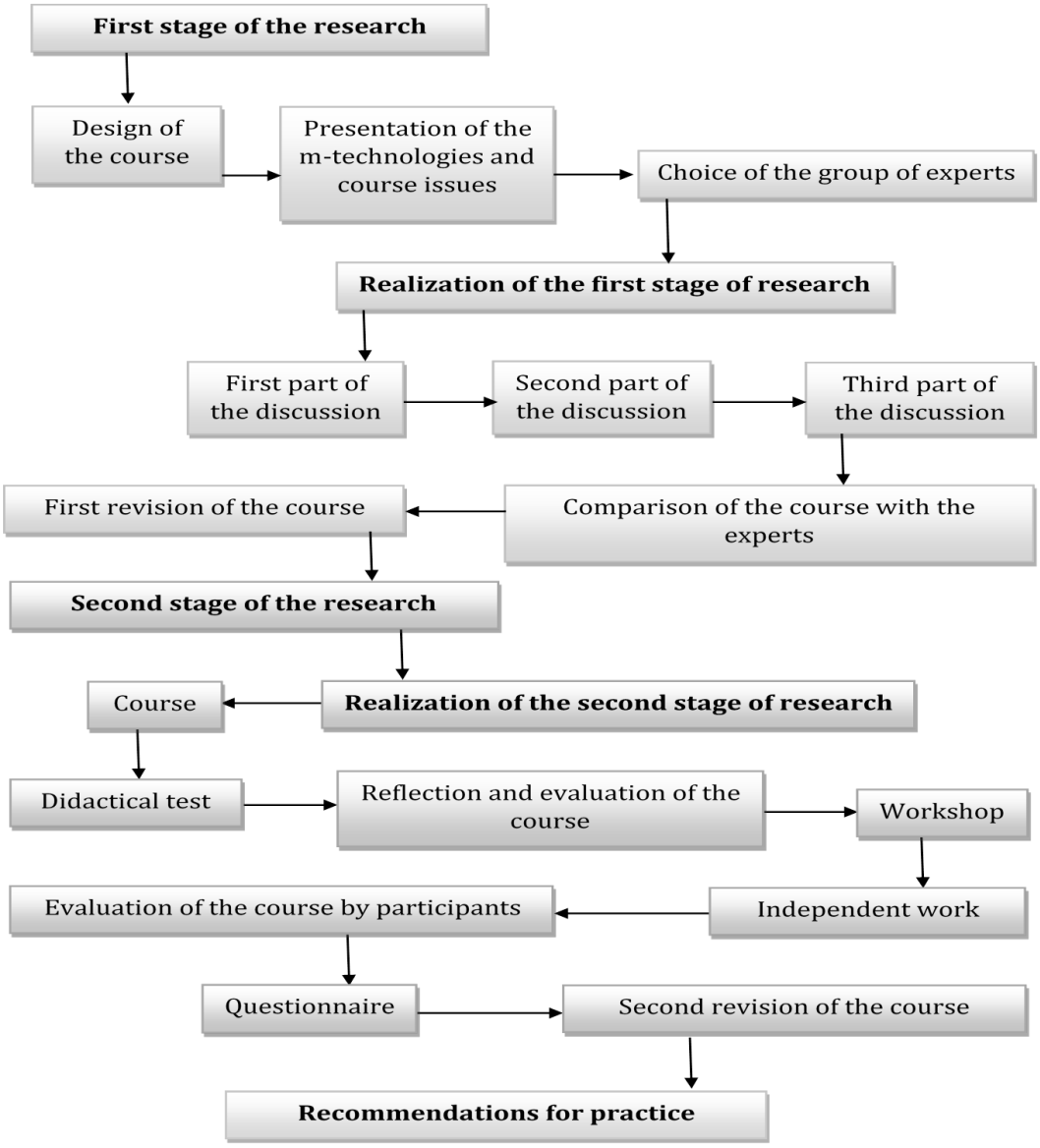
The design of the course on m-technologies for the further education of pedagogues working in technical and science subjects was based on the analysis of the contemporary state of the utilization of mobile facilities and m-learning.

The course was designed with experimental material at its core and was gradually revised to give it its final form. The revisions were implemented after the data

processing from the discussions with experts and after the completion of the course, based on the evaluation of the individual stages and application phases of the course. The participants were grouped on the basis of their qualitative characteristics in order to make the sample as representative as possible (Lašek and Chrzová 2003). In total, 20 participants – experts from various types and levels of schools and education institutions in Bohemia and Moravia – took part. The qualitative characteristics on which the choice of participants were selected were: the sphere of activity in education, pedagogical experience in technical subjects or didactic experience in technical subjects, knowledge of m-learning as a prerequisite, and university education.

Research structure

Figure 1 below represents the structure that was used for the realisation of the research project.



Source: Author

After careful consideration of the objectives it was concluded that it would be appropriate to use a combination of qualitative and quantitative research. The qualitative research, based on the analysis of the expert opinions which contain many subjective points (Chráska 2003; Strauss and Corbinová 1999), was necessary to gain an insight into the actual situation with regards to the level to which m-learning is used in contemporary schools. The quantitative research, for which data was acquired using traditional research instruments (didactic tests, questionnaires), was necessary in order to obtain an overview of the frequency of homogenous statements from course participants (Chráska 2007).

The structured discussions with experts, which formed the first stage of the research project, were split into three parts and contained a prepared set of questions for which responses were sought. The three parts of the discussion were concentrated on the following main topics: course, m-learning, software for m-learning, classification and selected characteristics of mobile devices, advantages and disadvantages of mobile technologies, transfer of data, examples of the utilization of mobile technologies in teaching, types of software and recommended software applications for m-learning, model scenarios of lessons which include the utilization of m-learning, pictorial material - modern technology in chemistry education in which m-learning is utilized (Wolski and Jagodinski 2010). In the final discussion attention was paid to the questions, answers, comments, suggestions and ideas.

For the second stage of the research project, quantitative research was undertaken. This took place on the basis of the revised course after the analysis and data evaluation from the first stage of the research and after the results of the facilitated course were assessed by means of a didactic test and the opinions on the participants on the course and its contents were evaluated in a questionnaire survey.

Interpretation of the first stage results

The analysis and interpretation of the results was based on the specified factors for forming the groups of participants for the analysis of:

1. The overall experience of the experts with regards to e-learning, m-learning, off-line and on-line courses.

The participants were divided into sub-groups with respect to the time horizon of their experiences (great; little; none) and into further sub-groups according to their opinions (motivation; study fields; the upcoming course; inclusion of m-learning into teaching).

2. The barriers influencing the extension of m-technologies in education.

The participants in this group were divided into sub-groups according to the barriers they identified (barrier 1- insufficient equipment in schools; barrier 2 – lack of interest of students; barrier 3 – distrust in new and untested procedures; and barrier 4 – barrier-free utilization of m-technologies in teaching).

3. The upcoming course from the experts´ point of view.

The participants were divide into sub-groups according to their opinions (the upcoming course, narrower orientation, equilibrium of the course, model scenarios, comments and recommendations on the course, types and proposals for applicable themes).

Summary of the first stage of the research

On the basis of the analysis of the responses to the first part of the structured discussions with participants, we can state the following:

1. The courses involving e-technologies are set to expand quickly and will become an integral part of the education process.

2. M-learning is already a reality, primarily for the young generation, but its future in education presents a challenge.

3. M-teaching supports and supplements modern teaching with strong motivational factors. The extension thereof is subject to well thought-out access to individual parts of the curriculum, this being dependent on the choice of themes being so interesting that students will not be interested in digressing to other more interesting topics. M-technologies can be used in all fields of education, most of all in the technical, humanistic and scientific fields.

4. The main obstacles to the utilization and extension of m-learning are a lack of financial means, a certain disbelief in all things new and a lack of information. It is evident that the personality of the teacher plays a considerable role i.e. their interest and willingness to accept m-learning as an effective teaching tool with which to enhance the learning experience.

5. A further condition, and not an inconsiderable one, is the financial resources individual schools have at their disposal for the provision of mobile facilities for teachers and students alike. The potential lack of financial resources can be compensated by the utilization of mobile facilities that almost every student has at their fingertips today. Of significant importance is the time frame for the preparation and realization of m-learning and the incorporation of m-technologies into School Education Programmes. Of equal importance is the preparation of those students seeking to work in the pedagogical profession in the future (Vašutová et al. 2008; Walterová 2002).

Results of the processed discussions with experts and the revised course

During the discussions, the participants were asked to express their opinions on both the theoretical and practical parts of the up-coming course. The objective was to obtain information on their evaluation, comments, suggestions and ideas so that these could be incorporated into the revised version of the concept course.

From the evaluation of the first stage of the research project it can be stated that the majority of the participants responded positively to the up-coming course. After

evaluation of the discussions with the experts, the concept course was duly revised to include their comments.

The theoretical part of the concept course was extended with practical illustrations of the utilization of mobile facilities, with the possibility to work with these facilities in the groups. A short motivational report on m-technologies was also integrated into this part.

Two additional recommendations were also accepted. The first, to include the experiences of participants who already use mobile facilities in teaching, and the second, to ask participants to evaluate examples of the utilization of mobile facilities and model scenarios i.e. to what extent they were interested in the topic and to what degree they grasped these technologies.

The participants expressed their complete satisfaction with the practical part and the model scenarios, so much so that it proved unnecessary to change or supplement it.

Selected recommendations and suggestions of experts for the facilitation of the course

The following suggestions and recommendations were selected with regards to the facilitation of the actual course:

1. The course should be set up in such a manner that: a) it does not only have novelty value with regards to its contributions to complementing and motivating up-to-date teaching, but that its contents are variable enough that it can be further developed and extended; b) it can potentially be used by all types of schools, in various fields, both by talented and handicapped students; c) the opportunity arises to create a databank of model scenarios.

2. Maintaining the current trend is recommended by experts: a) on the basis that it opens up opportunities to cooperate with other schools in the creation of a databank of model scenarios; b) because it raises the awareness among parents about the up-to-date methods of teaching applied in schools, which arouses greater interest in schools and education.

3. The proposal that was put forward by the experts that the course for pedagogues should be focussed on a particular professional orientation (e.g. language teachers, ICT coordinators), was inspiring, as was their suggestion to prepare specialized courses for handicapped and talented pupils or students. This of course requires cooperation with specialists and thorough preparations.

4. Of interest was a suggestion by the experts that, for economic reasons, the courses should be prepared in the schools so that they take advantage of those mobile facilities that they already have at their disposal. Of equal interest was the idea to create a shared space for electronic materials in which interesting documents, references, publications, scenarios, etc. could be held. The experts also stated that they would welcome an insight into the (approximate) costs of the relevant applications, as well as the financial impact of providing and operating such facilities.

5. The response to the question, in which fields of education are m-technologies most efficient and substantially applicable, was unambiguous. The experts felt that the technologies could be used in all fields, in some more progressively than others, with the extent to which being dependent on the given topic. The suggestion was that technical subjects and the transfer of data were more directly predisposed to the use of such applications because it allows for the demonstration of data transfer in a different way. In art subjects, in which m-technologies are not yet widely used, they suggested that, for example, mobile facilities would enable students to quickly source quotations, original texts, EU documents, statistic data, yearbooks, up-to-date wording of laws, etc. This was in contrast to their opinions on medicine, where m-technologies have found wide-ranging uses. M-technologies were also suggested to provide a good solution for ad-hoc situations.

6. The experts were clear that mobile facilities should be used during the whole school year in order to fulfil its purpose and assist in the activation of the individual, as well as the organization of lessons. It was pointed out that to minimize classroom equipment costs, it should be possible to use the notebooks brought by students from home and to involve creative students in the education projects and not put aside applications such as social networks e.g. Facebook.

The aforementioned comments and recommendations signalize the interest of experts in these problems and the usefulness of courses involving m-technologies in contemporary education.

Contents of the facilitated course

The course anticipated the utilization of a wide spectrum of mobile facilities in teaching. The course dealt with the possible utilization of software, electronic presentations, electronic communications, the Internet, and the preparation of classes. It demonstrated the possible meaningful utilization of mobile facilities and m-technologies in teaching and the way in which these facilities can effectively be used.

Mobile technologies (e.g. mobile telephones, mp3, tablets) are more readily available to students and teachers alike than other ICT and therefore its utilization in contemporary school settings should be given serious consideration.

The first part of the course was focused on lectures. This gave the participants an overview of contemporary m-learning issues and an opportunity to orient themselves in these problems under the supervision of a tutor. This included the chance to clarify what opportunities there are to utilize mobile technologies in teaching in general, and at the same time to consider the opportunities open to themselves and to their schools. The content of this part of the course laid the foundations for the processing and facilitation of the teaching activities which involved the mobile facilities and which formed the second part of the course.

In the second part of the course the participants prepared their own teaching activities, facilitated within the constraints of their own possibilities, under the supervision of

their tutor. A part of these lessons constituted massive methodical support, with illustrations and suggestions drawn from real teaching scenarios (Svoboda 2011).

Interpretation of the second stage results

The analysis and interpretation of the data was carried out on the basis of a didactic test (comprising of two calculations: a) the difficulty of the individual test Q assignments (Chráska 2007); and b) the didactic test reliability as per the Kuder – Richardson formula (Gavora 2000)). Tables were drawn up and subsequently used to analyse the data obtained from the questionnaire survey (statistical evaluation of the questionnaire results according to (Gavora 2000)). Of interest was the position on the scale i.e. whether the participants responses were closer to assent or dissent - the statistical significance (Chráska 2007; Gavora 2000). Furthermore, the participants were requested to evaluate and reflection of the course (through free writing, workshops and independent work).

Summary of the second stage of the research

The following findings were made in the second stage of the research project based on the analysis of the facilitated course, didactic test, questionnaire, and participant evaluation and reflection on the actual course.

On completion of the course, the participants proved they had gained the necessary knowledge on m-technologies by passing a test. They proved that they had learned to apprehend the basic terms, classifications and characteristics of mobile facilities, had acquainted themselves with the theory and practical examples of the utilization of mobile facilities in teaching, and were able to orient themselves in the sphere of m-technologies.

Recapitulation of the opinions on the course:

- The importance and objectives of m-learning were clearly comprehended, which proves that m-learning is starting to win recognition and is being adopted as a useful teaching tool.
- Full agreement was expressed with the opinion that m-learning is an appropriate supplement for supporting and enhancing the efficacy of education and that it is an effective instrument for seeking out new and effective teaching methods.
- Full agreement was expressed with the opinion that m-learning is an effective instrument for creating space for talented and handicapped students.
- Full agreement was expressed with the estimation that m-learning, as a part of supplementary teaching methods, is a favourite activity.
- Participants stated that mobile facilities were frequently used, although a number suggested that they use it only occasionally.

- The use of notebooks is extensive and widespread (mobile telephone and other devices are used mainly for sending test questions, schemes or examples. Pocket computers are used the least).
- Mobile facilities are used the most often for technical and science subjects (for non-technical specializations the greatest range of software applications available are for language teaching and physical training).
- The majority of participants agreed with the statement that schools are insufficiently equipped in terms of software for m-learning.
- The majority of participants agreed that schools are insufficiently equipped with hardware for m-learning.
- The participants agreed with the opinion that students predominantly accept the inclusion of mobile facilities into teaching with enthusiasm, seeing the advantages thereof. Some of the participants held a neutral stance on this.
- Knowledge in the sphere of m-learning is diverse. According to the research results it is possible to conclude that the participants evaluated themselves as being moderately critical; they neither considered themselves experts, nor amateurs.
- The majority of participants were motivated after completion of the course and showed an interest in this issue.
- Mobile technologies are used for 1-2 hours per week in teaching (for the creation of e-learning applications; where applicable for mobile facilities, up to 4 hours or more per week).
- The groups succeeded in creating and presenting their own scenarios (they were of a good standard and inspiring for all the participants).
- The participants fully understood the principles behind the creation of scenarios (they themselves were able to create a lesson using m-technologies).

Revision of the course on the basis of the experiences from the facilitated course

The objective of the second stage of the research project was focused on acquiring suggestions, comments, proposals and ideas that could be used to enhance the course.

From the analysis and evaluation of the outputs (facilitation of the course, didactic test, questionnaire, reflection and evaluation of the course by its participants) of the second stage of the research project, it was evident that no fundamental adjustments needed to be made to the content or structure of the course. The course proved to be effective, however, the questions in the didactic test with regards to difficulty will require refining.

From the evaluation of the course it was clear that the majority of participants were satisfied with the course. The participants were able to acquire a good standard of

knowledge from the designed course (this was evident from the evaluation of the didactic test, as well as by their ability to create something new during their independent work i.e. the creation of lessons which utilize m-technologies). The model scenarios were chosen in accordance with their professions in various fields. The participants saw and understood the future potential of m-technologies for the development of new methods and forms of teaching.

The contents of the course can be modified to not only include the suggestions obtained as part of this research project, but also as a result of the developments in mobile facilities and their availability on the market, as well as from the inputs of participants themselves on the basis of the pedagogical - educational activities they implement in practice.

Recommendations for practice

The output of the research project is a functional course entitled "M-learning – use of mobile technologies in teaching", which consists of a theoretical and practical part, and includes a comprehensive range of model scenarios. The course can be used to assist and further educate pedagogues (Svoboda 2011).

Summary and conclusion

This research project presents the results of a survey into the use of mobile facilities in teaching. A practical asset of the research project is an original course on m-technologies created for the further education of pedagogues working in technical and science subjects. The research project is therefore instrumental in opening up the opportunities for the meaningful use of mobile facilities and m-technologies in teaching and illustrates how these facilities can be used.

The opportunities and limits of using mobile facilities in teaching is a new theme, one that is innovative and desirable under current conditions in the Czech education system. The structure of the designed course is open and can be adapted to any field of education in the future. The challenge will be to adapt it according to the changing conditions with regards to the future developments in m-technologies, their accessibility, acquired knowledge, and the creation of appropriate teaching scenarios.

On the basis of the findings from the research project, we can conclude that the acquired results influenced the revision of the course. It is possible to anticipate that these revisions will not be the last because every new course will include fresh and innovative ideas that will enhance it. These enhancements will be driven by the needs of pedagogues, the needs of and opportunities in individual schools, new mobile technologies, orientation of school subjects, and the individual needs of students. However, this will require cooperation between experts, psychologists and pedagogical – psychological advisory centres (Mesarošová and Cápay 2012; Straková 2007). It will also be necessary to broaden the team because this is no more an assignment for an individual, but for a team of researches. Establishing relations with pedagogues from other countries would also be beneficial. In this way, it will be possible to learn from

their experiences in this field and to implement suitable ideas in the Czech Republic too (Georgiev et al. 2006).

The course was accredited by the Ministry of Education (Ministerstvo školství, mládeže a tělovýchovy) and was facilitated at the Pedagogical Research Institute ("Výzkumný ústav pedagogický") and at Charles University in Prague (UK). The course took the form of blended – learning and was positively received by course participants. The outputs of the course i.e. model scenarios of pedagogical activities, are used as shared materials and collated in a portfolio for use by teachers. The course is currently open to pedagogues - teachers in primary schools, secondary schools and higher vocational schools - seeking further education in this field. The course is run at the Technical College (České vysoké učení technické) in Prague and The Masaryk Institute of Higher Studies (Masarykově ústavu vyšších studií) in combination with other education programmes with innovative themes. These education programmes correspond with the requirements for pedagogical practice and with the developments in information and communication technologies in the Czech Republic and in the world. In the foreseeable future, it is reasonable to assume that m-learning will be implemented as an optional school subject.

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The Influence of Stimulating Factors in Continuous Preparation for Overall Results of the Final Examination

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Abstract

The paper presents results obtained from the comparison of two years of students enrolled in the Accounting Theory course in the case of a change in stimulating conditions for obtaining a credit and passing the final exam. The aim of this paper is to statistically verify differences in the achieved results of credit tests between the observed academic years of 2013/14 (438 students) and 2014/15 (429 students) depending on the continuous preparation for the exam during the semester. At the same time the number of final exam dates for the analysed course in the observed years and their results were compared. The benefit of the performed study is to prove the influence of students´ stimulation on their better preparation during the semester and subsequently on reducing the number of exam dates.

Key words: Forms of examinations, motivation, stimulation of students, oral examination, evaluation of testing forms in education

Introduction

Education plays an irreplaceable role in the development of any society. It is a principal factor of long-term success and lasting prosperity (Mulač, Vochozka and Opekarová 2009). Motivation must be considered as a very important factor affecting the quality of performance without the reduced importance of other factors, especially abilities, skills or knowledge on which basis performance is realized (Botek 2012). Motivation is the basis of behaviours and activities that people deliver inside the association in relation to the peculiarity of the challenges that follow a category or another of functional relations. (Muscalu and Muntean 2012). Generally speaking, the way students acquire knowledge and skills varies for each of them. This process is called learning (Polanecký and Raušer 2015). Students´ motivation for gaining better and deeper knowledge during their studies is universally recognized and proved by years of experience. According to Bain (2004) extrinsic motivators include parental expectations, expectations of other trusted role models, earning potential of a course of study, and grades**.** Intrinsic motivators

include fascination with the subject, a sense of its relevance to life and the world, a sense of accomplishment in mastering it, and a sense of calling to it (DeLong and Winter 2002) On the one hand, students at universities approach education and knowledge acquirement as investment in their future life; yet, on the other hand, they view the method of knowledge acquirement in accordance with the applicable economic criteria. They devote only the necessary time and energy to their preparation and studying in order to fulfil requirements. One cannot assume that students will voluntarily spend more of their time studying, i.e. time exceeding the required limit for completion of the course. It is therefore necessary to stimulate students to be motivated to achieve good study results. According to Šimánková (2012) stimulation can be defined as usage of external stimuli to influence certain behavior.

To determine students´ stimulating factors correctly, it is necessary to correctly understand their priority needs. These factors have been dealt by a number of authors. According to Číhalová and Mayer (1997), the evaluation of knowledge should serve for the students´ development and be pedagogically effective. In his survey, Foltýnek (2008) looked into the dependence of day and hour of classes on exam results. The findings have shown that these factors do not significantly influence the overall exam result. The personality of a teacher has only a partial influence. Similar conclusions have been arrived at by Čáp and Mareš 2007). Another discussed issue is the importance of oral or written exam. Wagner (2004) holds the opinion that both oral and written forms of examination are necessary for the proper verification of knowledge.

In individual cases, each form of exam may have its own advantages and disadvantages. In recent years, more and more students have been preferring written tests, oral examination has been considered to be stressful by most students and they have shown worse results in it. Mandová (2006) lists the advantages and disadvantages of exam forms: written tests – the main advantage of written tests is economy of time. The teacher is able to test a larger number of students at the same time. Students answer questions according to their needs, they have more time to think their answers over carefully. The disadvantage of written tests is the fact that they are less objective. The oral examination is definitely more objective, the teacher has the opportunity to examine a wider range of topics, they may specify questions and use additional questions to direct students to right answers. The main disadvantage of oral examination is its time expenditure. Another indicator of worse evaluation is stress, which is very limiting for many students and it also limits the application of their knowledge. Kovářová, Kučera and Navratilová (2012) report that during classes the teacher´s influence does not affect the number of attempts to pass the exam. Only student´s deliberate individual preparation affects the successful completion of the course. Suitable conditions, a sufficient amount of study materials and appropriate stimulation can therefore help students to better master the knowledge for completing the chosen course. Given the current large capacity of universities, it is necessary to pay attention to the personal approach of teachers in the form of consultations and/or creating high-quality and readily available material for home preparation. Reynolds,

Livingston and Willson (2010) emphasize that when evaluating the students´ knowledge teachers must be professionals. They must be able to assess the scope, form and level of the required knowledge, but also to assess the impact of communication on results achieved.

The technological progress of the 21st century enables a comprehensive evaluation of students´ knowledge using computer-based testing. Nevertheless, the influence of this form of testing and ensuring of its unauthorized misuse are also important. Brown, Bull and Pendlebury (2005), as well as Astin and Antonio (2012), describe and emphasize the importance of oral communication in classes in schools. The skill to communicate and impart knowledge is necessary for applying acquired knowledge in practice. This skill is to be practised by presentations during classes, which enables getting feedback from other students. The authors infer from the performed surveys that the issue of evaluating knowledge depending on the use of a written or computerized version of tests is very individual. Nonetheless Chrástka (2006) research shows that stimulation of students´ interest significantly affects the overall evaluation of the course.

The aim of this paper is to compare the results of credits and final exams in two years of students enrolled in the Accounting Theory course offered for the branch of study called Economics and Management depending on the continuous preparation during the semester. The Introduction chapter defines the theoretical framework of solved issues. The methods used in the evaluation of primary research are defined in the Materials and Methods chapter. The Results chapter presents achieved results, their discussion and comparison with similar results in professional literature.

Materials and Methods

The theoretical bases of addressed issues were developed using the analysis of secondary sources - scientific articles and professional literature. The primary data were obtained from the e-learning system called Moodle.czu.cz, which is used to provide support and additional sources for classes and to test students´ knowledge. However, it must be pointed out that the data cannot be obtained from the system in the appropriate categorization and the survey sums were thus obtained by manual categorization and simple data summation.

The aim of the performed survey was to evaluate results of progress credit tests and consequently their influence on the number of exam dates and the overall result of the exam in two years of students enrolled in the Accounting Theory course offered for those studying Economics and Management and taught in the Czech language in the 3rd year of bachelor studies. Two years identical in the number of students in the summer semester of the academic year of 2013/14 and 2014/15 were compared. The first group included 438 students and the second one 429 students. To obtain the credit, the condition of achieving an average of at least 65% of correct answers in four credit tests, which the students take during seminars, was laid down. The subsequent final examination consists of two parts – firstly students pass the written test and in case of

achieving minimum 65% of correct answers they proceed to take the oral exam. In 2013/14, this condition was not adjusted in any way. In the following year of 2014/15, students were stimulated to prepare continuously by laying down the condition that if they achieve outstanding evaluation of the progress credit tests (minimum 85%), they can take the final exam only in writing.

A research question has been formed: Do selected stimulation factors cause improvement of students educational results and reduce the number of exam dates?

Within the evaluation of the achieved averages also the results of men and women were compared on the assumption that both men and women approach the continuous preparation in the same way.

The obtained results were statistically evaluated using the two-sample **t-test** for two independent samples $\mathbf{R_1}$ and $\mathbf{R_2}$, where the null hypothesis was defined as follows: $\mathbf{H_0: R_1 = R_2}$.

Three null hypotheses were defined to solve the issues.

$1H_0$: There is no significant difference between the observed results of progress credit tests in the observed years (R_1 –a sample of results for the academic year of 2013/14, R2 – a sample of results for the academic year of 2014/15).

$2H_0$: There is no significant difference in the final credit test results of the academic year without any stimulating factor and of the year with the stimulating factor (R_1 - a sample of results of the fourth credit test in 2013/14, R_2 - a sample of results of the fourth credit test in 2014/15).

$3H_0$: There is no significant difference in the progress credit test results of men and women (R_1 – a sample of men´s results, R_2 - a sample of women´s results)

For evaluation purposes, arithmetic means ($\bar{x}$), standard deviations (**s**) and variances ($\mathbf{s^2}$) were calculated for compared samples R_1 and R_2. Based on the results, the test criterion (t) for the unpaired t-test with different variances was calculated according to the following formula:

$$t = \frac{\left|\bar{x}_1 - \bar{x}_2\right|}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \qquad (1)$$

$\bar{x}$ - average of the sample

s^2 – variance of the sample

n – number of members of the sample

For the subsequent evaluation it is necessary to select significance level **α** (0.05 and 0.01) in the comparison with the table value of the critical value (**p**), where:

If **p> α,** then the statistical difference between $\mathbf{R_1}$ and $\mathbf{R_2}$ is **insignificant**.

If **$p < \alpha$,** then the statistical difference between **R_1** and **R_2** is **significant at $\alpha = 0.05$ and highly significant at $\alpha = 0.01$.**

The data obtained from the information system called Moodle.czu.cz were evaluated using the Statistica 12 programme.

Furthermore, the number of exam dates in both observed years and also the success rate of students in passing the exam were compared. Results were clearly interpreted in the tables with corresponding comments and discussion bellow. The summarization of the article was formulated in its conclusion.

Results and Discussion

Interpretation of the research results with comments and discussion are given in this chapter.

Table 1 shows the results of the progress credit tests in the observed academic years and it follows that the achieved average of 4 progress credit tests in 2014/15, when the students were stimulated in advance, was in total by almost 10% higher, as well as also the variance of obtained results was lower, and the knowledge was more balanced in the whole year in summary.

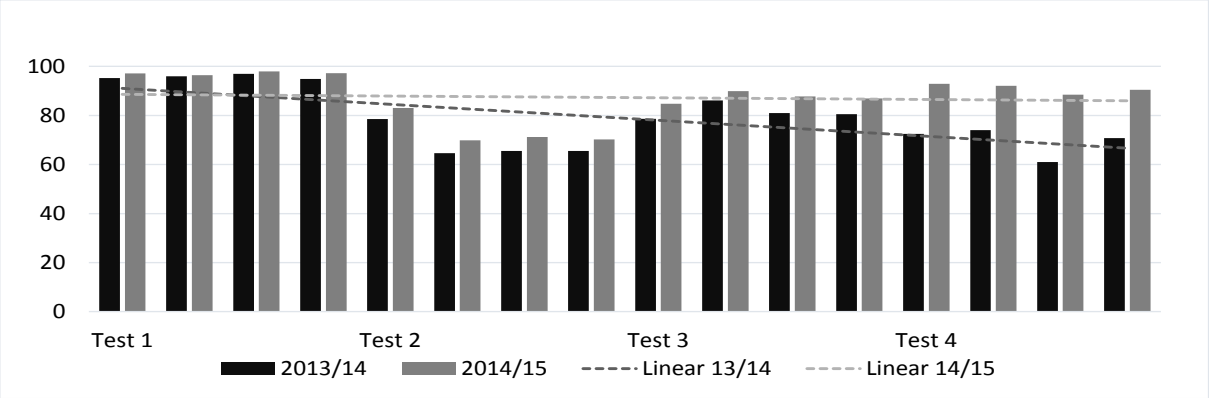
Table 1: Results of progress credit tests in the academic years of 2013/14 and 2014/15

Academic year of 2013/2014				
test 1	test 2	test 3	test 4	Ø test 1-4
95.26	78.49	78.64	72.45	
95.97	65.62	86.13	74.04	
96.97	65.53	80.98	61.02	
94.88	65.53	80.51	70.81	
Ø 95.77	Ø 68.54	Ø 81.57	Ø 69.58	**Ø 78.87**
Academic year of 2014/2015				
test 1	test 2	test 3	test 4	Ø test 1-4
97.15	83.01	84.75	92.94	
96.46	69.88	89.93	92.11	
97.94	71.24	87.71	88.43	
97.27	70.19	86.95	90.47	
Ø 97.21	Ø 73.58	Ø 87.34	Ø 90.94	**Ø 87.27**

Source: Authors

73.1% of students reached the stimulating limit in 2014/15. In the preceding year, when students were not stimulated in this way, only 22.76% of the students achieved this limit. The credit test results are compared in Figure 1.

Figure 1: Comparison of credit test results in 2013/14 and 2014/15



Source: Authors

Table 1 and Figure 1 show a significant difference in the final credit test – test 4, when students of 2013/14 without any stimulating factor and being certain that they will achieve a minimum percentage necessary for obtaining the credit did not complete the final test carefully and, in many cases, only tried the test without any prior preparation. According to the findings from Moodle.czu.cz, the students´ results of test 4, which was the last one, were worse in 73.78% cases than the average of the three previous tests. Of that 32.77% of students had their average worse by more than 30%. In 2014/15, when students were stimulated for the overall test result, only 28.51% of the students achieved worse results in the last test - test 4. The results show that in most cases when the students were stimulated they improved their results in the last test in order to have a chance to achieve the desired result. Also Wagner (2004) has come to the similar findings.

Descriptive statistics are given in Table 2.

Table 2: Descriptive statistics for evaluating the progress credit tests

Academic year			**2013/2014**			
	test 1	test 2	test 3	test 4	Ø test 1-3	Ø test 1-4
Average	95.6195	68.537	81.2558	64.9535	81.8062	77.5916
Median	96	75	88	70	84	79.5
Mode	100	75	88	90	95.333	84
Mode frequency	230	91	103	45	14	10
Standard deviation	8.44668	21.66431	15.73254	26.7977	10.56926	11.73957
Var.coefficient	8.83364	31.60966	19.36174	41.25675	12.91988	15.12995
Academic year			**2014/2015**			
	test 1	test 2	test 3	test 4	Ø test 1-3	Ø test 1-4
Average	97.0184	74.3954	87.5586	90.9011	86.3241	87.4341
Median	100	75	88	95	88	89.1
Mode	100	83	94	100	89.667	multiple
Mode frequency	278	80	107	161	21	9
Standard deviation	6.99075	17.95707	11.61769	11.76682	9.02471	8.17512
Var.coefficient	7.20560	24.13733	13.26847	12.94463	10.45444	9.35004

Source: Authors

The basic descriptive statistical indicators (see Table 2) have proved that the achieved results in 2013/14 were worse and markedly more spread. In the following academic year the motivated students achieved far more balanced and better results, which corresponds to the findings of Kovářová, Kučera and Navrátilová (2012). T-test results are shown in Table 3.

Table 3: T-test results of the compared data from the years of 2013/14 and 2014/15

	Ø 13/14	Ø 14/15	t	p
test 1	95.61945	97.01839	-2.70562	0.006946
test 2	68.537	74.3954	-4.41506	0.000011
test 3	81.25581	87.55862	-6.81886	0
test 4	64.95349	90.90115	-18.6117	0
Ø 1.-3. test	81.8062	86.32413	-6.89782	0
Ø 1.-4. test	77.59161	87.43409	-14.5415	0

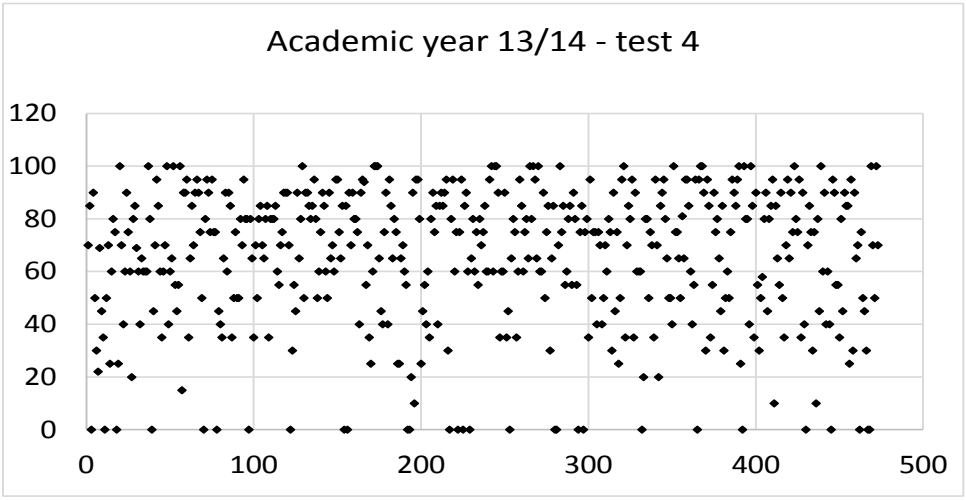
Source: Authors

The statistical evaluation of the t-test for the compared academic years of 2013/14 and 2014/15 (see Table 3) has proved that there is a very significant difference ($p < 0.01$) between the results of individual tests in the observed years.

Null hypothesis 1H$_0$: "There is no significant difference in the progress test results of the observed years," **has not been confirmed.**

It is evident from Figure 2 that many students´ results of the final credit test were very random_in 2013/14; in several cases the students did not even fill in the test and their result was zero.

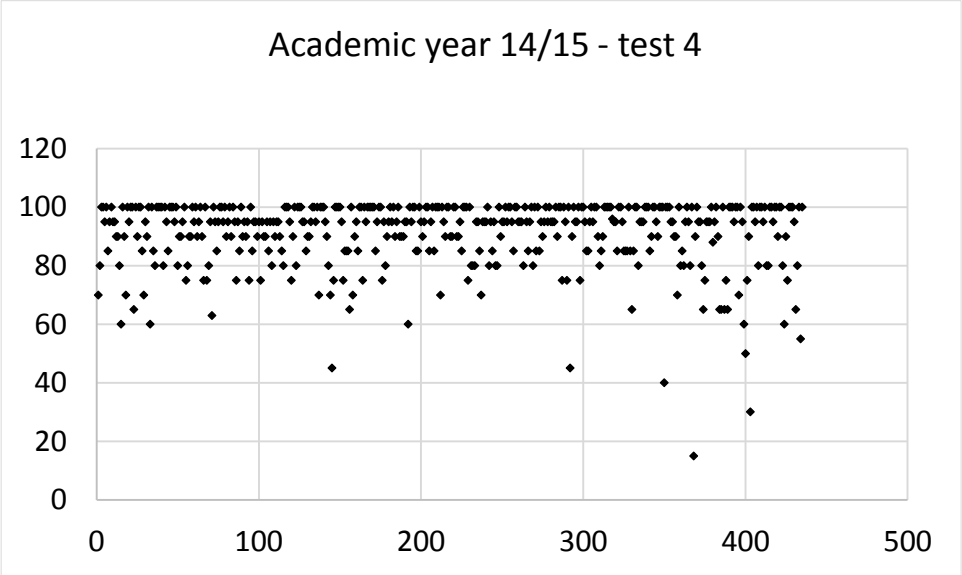
Figure 2: The scope of the final test results of the academic year of 2013/14



Source: Authors

On the contrary, Figure 3 shows that the final test results of the stimulated year of 2014/15 were markedly more balanced and students achieved better results.

Figure 3: The scope of the final test results of the academic year of 2014/15



Source: Authors

The statistical evaluation of the final credit test in comparison with the other progress tests (see Table 4) has proved that the results difference of the fourth credit test is statistically very significant in the academic year of 2013/14. The same applies to the difference between the average of tests 1-3 and that of tests 1- 4.

Table 4: T-test results of the compared data of the fourth progress test with other tests

2013/14	Ø var.1	Ø var.2	t	p
test 4 vs.test 1	64.95349	95.61945	-23.7368	0
test 4 vs.test 2	64.95349	68.537	-2.26167	0.023944
test 4 vs.test 3	64.95349	81.25581	-11.4097	0
test 4 vs.test 1-3	64.95349	81.8062	-12.7235	0
test 4 vs.test 1-4	64.95349	77.59161	-9.39492	0
test 1-3. vs.test 1-4	77.59161	81.8062	-5.80267	0
2014/15	Ø var.1	Ø var. 2	t	p
test 4 vs.test 1	90.90115	97.01839	-9.32177	0
test 4 vs.test 2	90.90115	74.3954	16.03503	0
test 4 vs.test 3	90.90115	87.55862	4.215973	0.000027
test 4 vs.test 1-3	90.90115	86.32413	6.437413	0
test 4 vs.test 1-4	90.90115	87.43409	5.046859	0.000001
test 1-3. vs.test 1-4	87.43409	86.32413	1.901139	0.057615

Source: Own calculations in Statistica 12

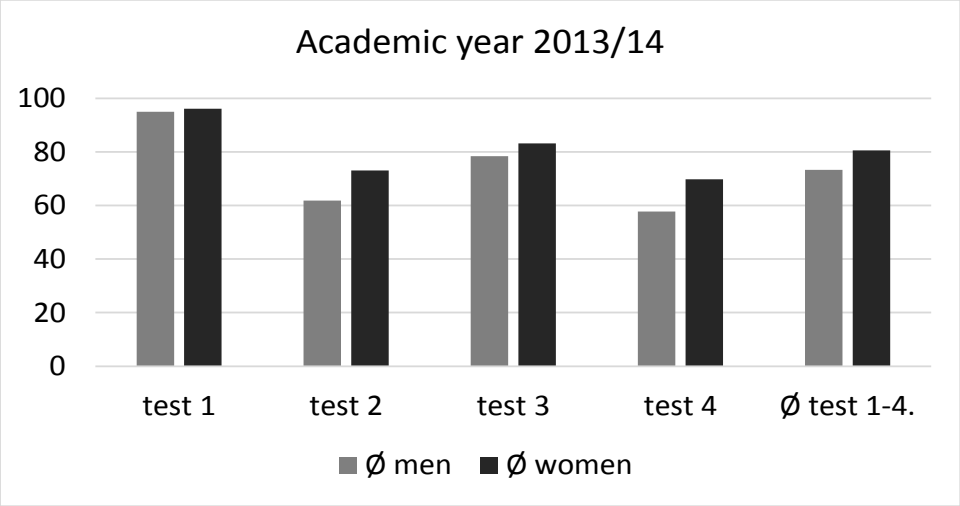
The obtained results confirmed the assumption that the last test in 2013/14 was not completed with a sufficient emphasis on the achieved results. In the stimulated year of

2014/15 the last test results were, on the contrary, better than the results of the previous tests in the same year (see Table 4).

Based on the aforementioned results, it may be stated that **null hypothesis $2H_0$**: "There is no significant difference in the final test results of the academic year without any stimulating factor and of the academic year with the stimulating factor," **has not been confirmed**.

The credit test results of men and women were compared in another evaluation. The evaluation was based on the assumption that the students (both men and women) prepare in the same way throughout the semester. In the academic year of 2013/14 there were 190 men (40.34%) and 281 women (59.66%), see Figure 4.

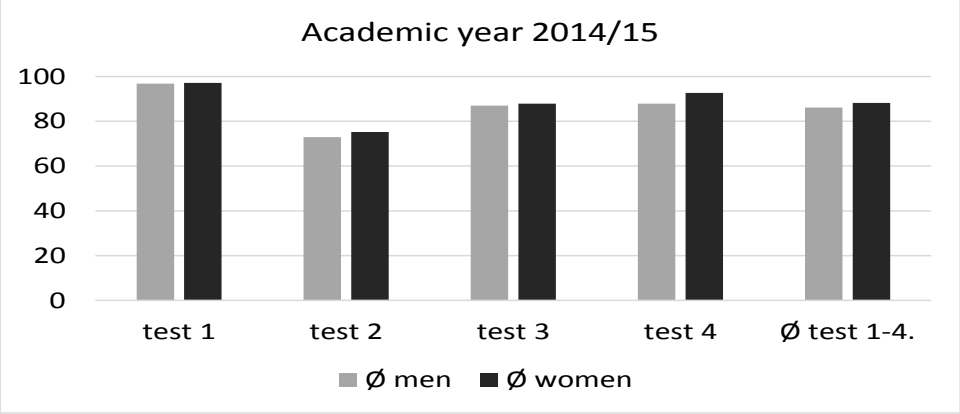
Figure 4: Differences in average results of men and women in individual tests in the year of 2013/14



Source: Own calculations according Moodle.czu.cz data

In the following academic year of 2014/15 there were 163 men (37.56%) and 271 women (62.44%), see Figure 5.

Figure 5: Differences in average results of men and women in individual tests in the year of 2014/15



Source: Own calculations according Moodle.czu.cz data

Table 5: Statistical evaluation of average test results of men and women in the observed academic years

	Academic year 2013/14			
	Ø men	Ø women	t	p
test 1	94,9474	96,0707	-0,73562	0,48625
test 2	61,8474	73,0283	-10,89325	0
test 3	78,3947	83,1767	-5,62893	0,00003
test 4	57,7947	69,7597	-12,00693	0
Ø test 1-4	73,2465	80,5088	-7,96928	0
	Academic year 2014/15			
	Ø men	Ø women	t	p
test 1	96,7927	97,155	-0,52341	0,600958
test 2	72,9634	75,262	-1,29486	0,196057
test 3	86,9573	87,9225	-0,83948	0,401665
test 4	87,8841	92,7269	-4,24067	0,000027
Ø test 1-4	86,1126	88,2338	-2,64066	0,008573

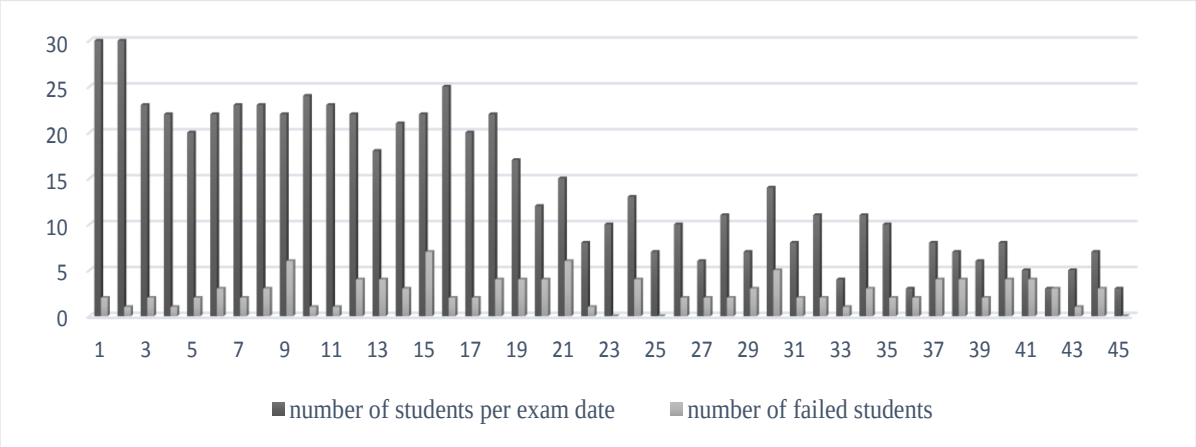
Source: Own calculations in Statistica 12

The statistical evaluation of the progress test results (see Table 5) has confirmed that there is a significant statistical difference in the results of the second to fourth progress credit test in the unstimulated year of 2013/14. As for the following year of 2014/15, the statistical difference was found only in the final, fourth, credit test. It results from the aforementioned evaluation that women achieved statistical better results than men in the non-stimulated year. The same fact occurred in the stimulated year in the fourth credit test, which could still influence the overall average. The statistical evaluation has confirmed that women approach continuous preparation more conscientiously even without any particular stimulation.

Null hypothesis $3H_0$: "There is no significant difference in the progress credit test results of men and women," **has not been confirmed.**

The continuous preparation, which was necessary for obtaining the credit in the Accounting Theory course, subsequently had an impact also on the final examination in the respective year. The difference was reflected in the number of exam dates needed to pass the final examination. 25 exam dates were announced in 2013/14. Due to the fail rate in the oral examination and the necessity to repeat it, other exam dates were added up to a total of 45 dates. Those dates were, however, very little used (see Figure 6).

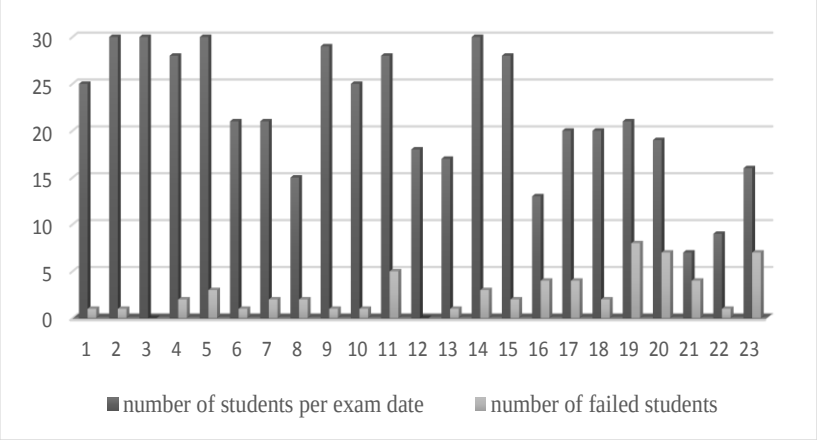
Figure 6: Exam dates and their use by students in 2013/14



Source: Authors

25 exam dates were also announced in 2014/15. Since 73.78% of the students met the condition of excellent results in the progress credit tests and passed the final examination only on the basis of the written test, the repetition rate of exam significantly decreased and the total number of exam dates was not even used (see Figure 7).

Figure 7: Exam dates and their use by students in 2014/15



Source: Own calculations

To objectively compare the students´ results in both years, the first 23 exam dates of both years were subsequently evaluated. In 2013/14 those exam dates were attended by 474 tested participants and 64 of them failed on the first attempt. In 2014/15 those dates were attended by 500 testing participants and 62 of them failed on the first attempt. These figures are entirely comparable (see Table 6).

Table 6: Overall results of the final examination in the selected course in 2013/14 and 2014/15

	2013/2014	2014/2015
Students in total	438	429
Excellent	132	112
Very good	153	207
Good	140	98
Fail	13	12
	∅ 2.078	∅ 2.023

Source: Authors

The comparison of written exam results shows that the remaining 22 exam dates in 2013/14 did not affect the overall results of the Accounting Theory course (see Table 6).

Conclusion

The performed evaluation has proved a statistically significant difference between the results of the progress credit tests in the two observed academic years of 2013/14 and 2014/15, and therefore it may be presumed that the stated stimulating factor had a significant influence on the preparation of students during the semester and subsequently on the number of exam dates to meet the conditions of the final examination. In the case of the stated stimulation, the students worked evenly during the semester and the effects of the continuous preparation on the credit test results were statistically conclusive compared to the preceding academic year. The motivated students then used only a half of the number of exam dates for the final examination with comparable results of the final examination to the previous year.

The concurrent statistical evaluation has shown that the obtained results of women in the unstimulated year were better, while both men and women in the stimulated year approached continuous preparation comparably.

The results have proved that the oral examination is very stressful for the majority of students and in case it is removed, they are willing to pay more attention to their continuous preparation. The comparison of students´ test results from two different years has shown that the overall results of the final examination from both years are comparable and therefore the marked influence of the oral examination on completing the course has not been proved, which is a helpful finding when the present number of students at universities being so high.

The practical benefit of the performed comparison is a confirmation that the emphasis on quality continuous evaluation of students´ knowledge during the semester influences the resulting final evaluation in terms of the necessary pedagogical capacity and at the same time it does not affect the success rate of course completion.

The limiting factor is the fact that the comparison was made for only one selected course. To confirm the obtained results, the comparison will be verified in the broader

context also in the future years, when it will be extended to other branches of study at the Faculty of Economics and Management.

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Cash Management of a Company Using Neural Networks

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Abstract

Cash management is one of the most important indicators of a company´s activities and plays an important part in decision-making. Cash management or cash flow management are incomes and expenses for a certain period. The aim of cash management is to mobilize, check and plan a company´s financial resources, which is not easy. The aim of financial managers is to find an effective and flexible tool for improving the processes for the optimization of cash management. One such tool appears to be a system of artificial neural networks. These networks are very flexible and outperform other models, including linear regression models, in many ways. However, networks also have certain pitfalls, which include the sensitivity of the input data, the longer time associated with training the networks, as well as the lack of possibilities to define the architecture and other parameters of the network. This article attempts to predict the future development of various kinds of cash flows. In so doing, it hopes to identify a suitable neural network that is able to predict these cash flows. This process involved the generation of 1000 accidental artificial neural structures, of which the 5 most suitable were preserved. A sensitivity analysis was subsequently carried out. The results of the research show that neural networks can be effectively used to predict the cash flow developments within a company.

Keywords: cash management, cash-flow, artificial neural network, model

Introduction

Cash management plays an important role in company decision-making. Kroes and Manikas (2014) state that a company´s cash policy is inexorably linked to the company´s operations and includes, for example, working capital in the form of cash receivables from customers, inventory holdings, and cash payments to suppliers. Cash management within companies was one of the first areas to which mathematical programming and operations research was applied.

Cash management is the same as cash flow management. Cash flow management presents the cash inflows and outflows achieved over a certain period of time and is a component of the annual financial statements (Danciu 2013). The functions of cash management include the mobilization, control and planning of the financial resources of a company (Tichý 2008). All companies should minimize the costs associated with the maintenance or lack of cash (Lehutová, Križanová and Klieštik 2013).

According to Pacheco and Morabito (2011), the management of cash flow in a company is a complex financial problem that involves balancing the short-term investments, cash receipts and expenditures, and short-term debts of the company, in order to maximize the financial cash return at the end of a planning horizon. This also encompasses the supply of financial resources for the operating activities of a company. The cash flow management problem includes the formulation of decision rules to control the level of cash balances and the administration of a set of facts structured in time (Brigham and Houston 2013).

According to Kroes and Manikas (2014) a company´s cash flow can be manipulated in three ways, through changes to the:

- time from when goods are sold until the revenue is collected by the company;
- company´s inventory levels;
- time that the company takes to pay its vendors.

Pacheco and Morabito (2011) analysed the viability of applying network models and evaluated their performance in companies in practice. He, Bai and Dong (2011) created a management and control model for cash flow within a company – the model is composed of two parts: strategic management of cash flow and tactical management of cash flow. Other authors, for example, Dong and Li (2014), explored the issue of cash flow risk management strategies.

The management of cash balances is a constant problem in all companies. Moraes and Nagano (2014) claim that this is due to the daily inflows and outflows of cash, irrespective of whether these are generated through the activities of the company or through financial transactions that it negotiated. There is a need to control financial resources in order to obtain the best results for the company (Šalaga and Berzáková 2014). Nevertheless, it is not easy to define the amount of money to be maintained in cash. The objective of many financial managers is therefore to find a flexible and effective tool which improves the process of optimizing cash management. In recent years, the use of artificial neural networks (ANNs) has become popular for this purpose. ANNs can provide comprehensive insights into something that is difficult to obtain through the application of other methodologies.

ANNs are universal and highly flexible function approximators, which were first used in the fields of cognitive science and engineering (Simutis et al. 2007). ANNs focus primarily on computing and storing information within a structure composed of many neurons. According to Cheng, Tsai and Liu (2009), these networks imitate the human brain in terms of learning, recall and generalization, and are usually designed to solve

non-linear or ill-structured problems. In recent years, the application of ANNs has become increasingly popular in company management. They are used for tasks such as pattern recognition, classification and time series forecasting (Vochozka and Rowland 2015). One of the most important components in the success of neural networks is the structure of the ANNs and the data necessary to train the network (Michal et al. 2015). ANNs typically introduce a nonlinear equation into a specified layer. This allows networks to easily capture high order correlations and effectuate nonlinear mapping (Cheng, Tsai and Sudjono 2012). ANNs are more appropriate than linear regression models and other models because ANNs capture decision-making complexities more clearly, predict more accurately, are more robust with regards to missing data, and their performance is not affected by multicollinearity (Namazi, Shokrolahi and Maharluie 2016).

One of the problems that ANNs can face is that of overtraining or over sensitivity to the input data. Dvořáková and Vochozka (2015) touch on another problem; the lack of clear rules for defining the architecture and the different parameters of a network (the most common way to determine the optimal architecture is simply by trial and error). In addition, the training of the network is usually a lot more time-consuming than by other methods (Vochozka and Sheng 2016).

As such, ANNs are not yet widely applied to cash management in companies. In the majority of cases, the application of ANNs has been experimental, and in particular linked to the banking sector and to ATM cash management (Dilijonas and Zavrid 2008; Dilijonas et al. 2009; Venkatesh et al. 2014; Ágoston, Benedek and Gilányi 2016; and more). Furthermore, ANNs in practice are usually used for predicting future business developments, inventory management, cost modelling, assessing the creditworthiness of customers, determining financial plans, providing bank loans or for determining the value of a company.

The main aim of doing business is to generate profits. However, in recent years, many experts have begun to refer to the drawbacks of using profit as a top indicator. They argue that there is a time inconsistency between the income and revenues, and costs and expenses, which generate the receivables and liabilities for a company. This means that the profit may not be purely based on money. This is reflected in the fact, that there have been many cases where companies have fallen into secondary insolvency, i.e. they generate profit, but cannot pay their liabilities. For this reason, the growth in shareholder value is now more often being flouted as the main aim of a company (Kislingerová 2010). This attitude is firmly connected with Value Based Management. One of its pillars is focused on cash flow. To summarize, to create shareholder value, it is necessary to generate cash stocks and ideally free cash flows, i.e. cash flows which may be withdrawn from the company without having a negative impact on its operations.

Cash flow is therefore one of the most important indicators of company activity and the planning thereof is an integral part of a financial manager´s job.

The aim of this study is to apply neural networks to cash flow planning in a specific company.

Materials and Methods

Our model company is Hornbach, a DIY (Do-It-Yourself) store that sells products for home and garden improvements.

For the purposes of the study an analysis was conducted of the time lines of the individual cash flows within the company with a view to predicting their future development. The following cash flows were identified:

1. Net cash flow from operating activity before tax, changes in operating capital and extraordinary items (further A*),
2. Net cash flow from operating activity before financial items, tax and extraordinary items (further A**),
3. Net cash flow from operating activity (further A***),
4. Net cash flow relating to investment activity (further B***),
5. Net cash flow relating to financial activity (further C***),
6. Net increase, or decrease in financial means (further F),
7. The state of financial means and cash equivalents at the end of the accounting period (further R).

The data for each of the identified cash flows were available for the years 1998-2016 (i.e. as on the day the statements were draw up – in reality 1997-2015). The used data set was considered to be sufficient to fulfil the aim of this study. However, it would also have been possible to use the bi-annual or quarterly data, but training the neural network would have been lengthier.

MS Excel was used for the preparation of the data file. DELL Statistica software (versions 7 and 12) was used for the calculations. The results of these calculations were subsequently processed by the automatized neural networks.

The purpose of the above was to identify an artificial neural network (three-layer or four-layer perceptron neural network), which would be able to predict the future development of the identified Hornbach cash flows.

All the used values were continuous. The data was split into three groups:

- Training: 70 %
- Testing: 15 %
- Validation: 15 %

The seed for the random choice was fixed at a value of 1000. Subsampling took place randomly.

In total, 1,000 random artificial neural structures were generated, of which the 5 most suitable were retained. The most appropriate neural structures were selected based on the lowest error rate, and vice versa on the highest predictive power (see Table 1)[1].

The following types of neural networks were applied:

1. Linear neural networks (hereinafter referred to as Linear)
2. Generalized regression neural networks (hereinafter referred to as GRNN)
3. Neural networks – radial basic function (hereinafter referred to as RBF)
4. Multiple perceptron neural networks – three layers (hereinafter referred to as MLP)
5. Multiple perceptron neural networks – four layers (hereinafter referred to as MLP).

The following activation function was used for the hidden and output layer of neurons:

1. *Linear function:*

$$y = k * x * w \tag{1}$$

where:

y is output;
k is transmitting function;
x is input;
w is synaptic weight.

2. *Sigmoid function:*

$$S(t) = \frac{1}{1 + e^{-t}} \tag{2}$$

A maximum of 5 neurons were used in the hidden RBF layers.

A maximum of 11 neurons were used in the hidden three-layer perceptron networks.

A maximum of 11 neurons were used in the hidden layers of the four–layer perceptron networks.

All the other settings were default settings.

A sensitivity analysis was subsequently conducted to determine the most appropriate and the most accurate neural structures. In this way, we determined how the development of the individual cash flows is dependent on time.

Results and Discussion

The application of the methodology outlined in this article produced the five most suitable neural networks presented in Table 1.

[1] Determined by the method of smallest squares. If the differences between the newly generated networks are no longer essential, the training comes to an end.

Table 1: Generated and preserved neural structures

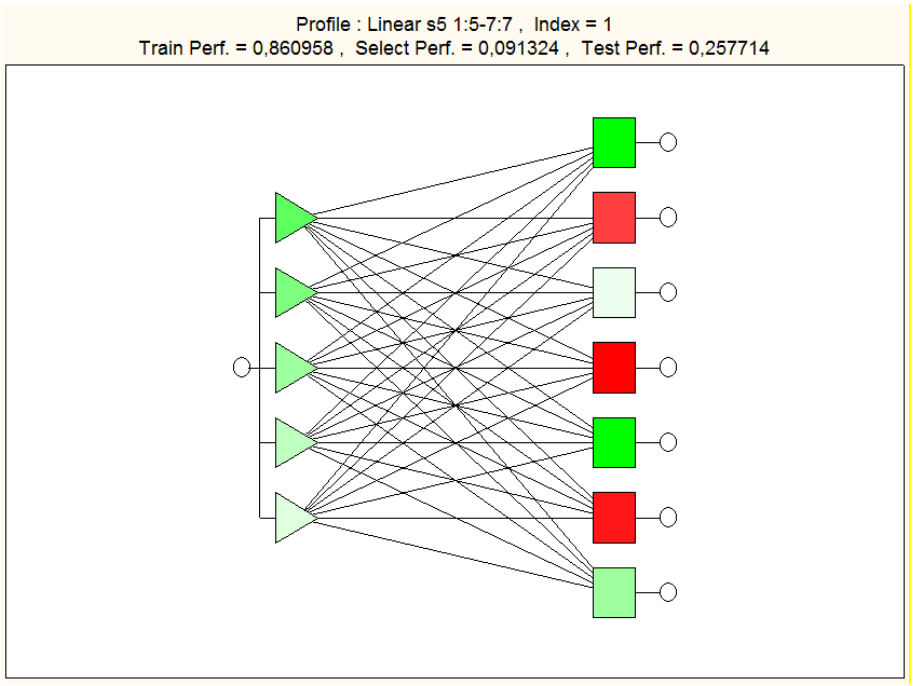
	Profile	Train Perf.	Select Perf.	Test Perf.	Train Error	Select Error	Test Error	Training/ Members	Inputs	Hidden (1)	Hidden (2)
1	Linear s5 1:5-7:7	0.860958	0.091324	0.257714	1.499147	1.537050	1.510939	PI	1	0	0
2	MLP s5 1:5-11-11-7:7	0.244904	0.323720	0.014999	0.357907	0.123054	0.340600	BP1b	1	11	11
3	RBF s5 1:5-2-7:7	0.362111	0.467259	0.210522	0.000014	0.000025	0.000025	KM,KN,PI	1	2	0
4	RBF s5 1:5-3-7:7	0.107195	0.182759	0.669986	0.000006	0.000017	0.000028	KM,KN,PI	1	3	0
5	GRNN s10 1:10-5-8-7:7	0.120684	0.801228	0.421092	0.000006	0.000016	0.000029	SS	1	5	8

Source: Author

The list of preserved networks is quite manifold and includes a linear neural network, a four-layer perceptron network, two basic radial function neural networks, and a generalized regression neural network. Based on the assignment, all of them only use one input value, i.e. time.

The scheme for network one, i.e. Linear s5 1:5-7:7, is presented in Figure 1. As can be seen, the network uses five neurons in the first layer and seven neurons in the output layer, as determined by the number of output values.

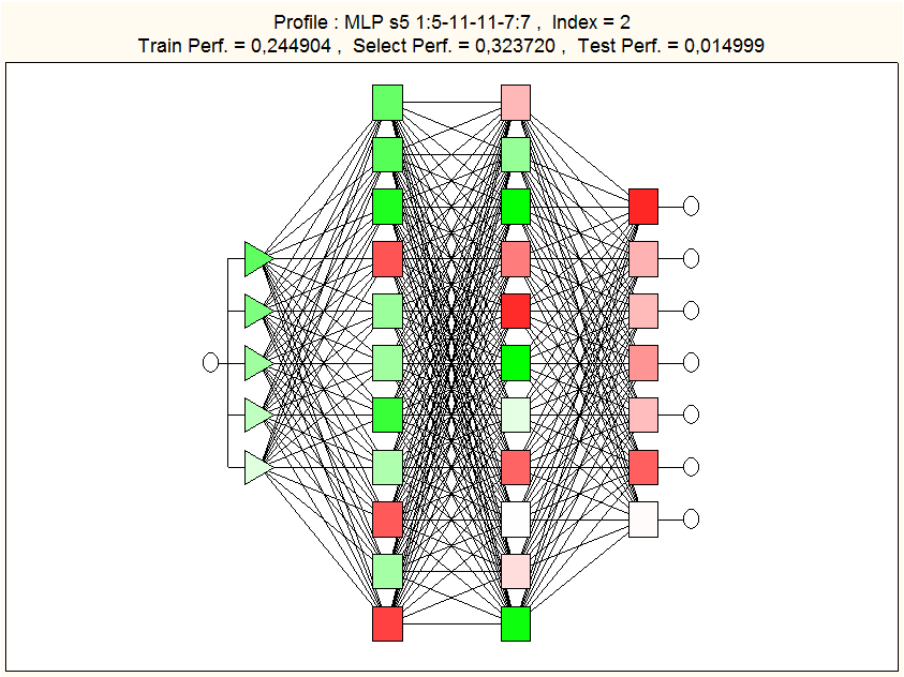
Figure 1: Scheme for Linear s5 1:5-7:7



Source: Author

The scheme for the second retained network is presented in Figure 2.

Figure 2: Scheme for MLP s5 1:5-11-11-7:7

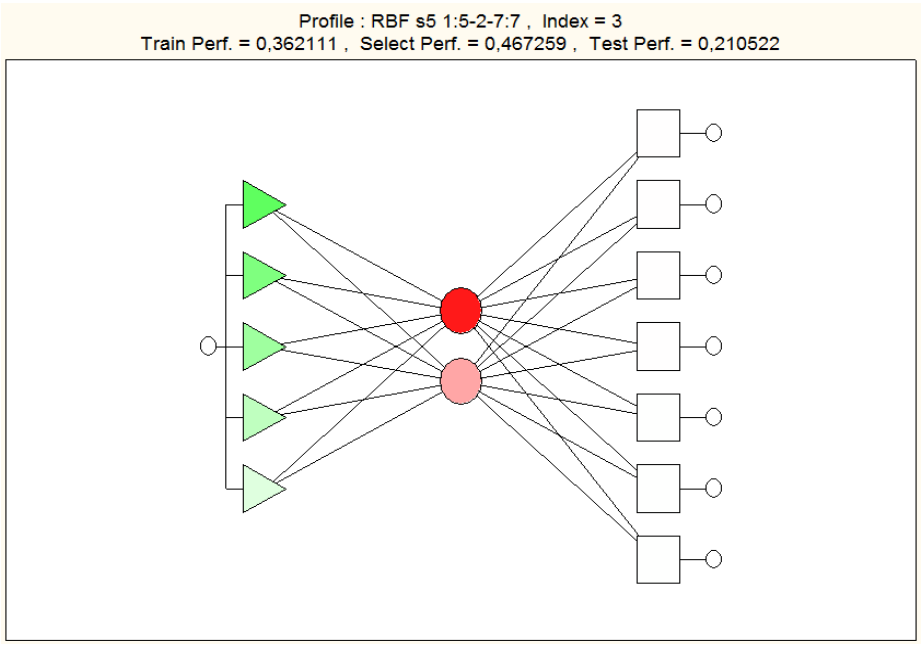


Source: Author

The four-layer-perceptron neural network MLP s5 1:5-11-11-7:7 also uses one input and generates seven outputs, thereby utilising eleven neurons in both hidden layers.

The scheme for the retained RBF neural network is presented in Figure 3.

Figure 3: Scheme for RBF s5 1:5-2-7:7

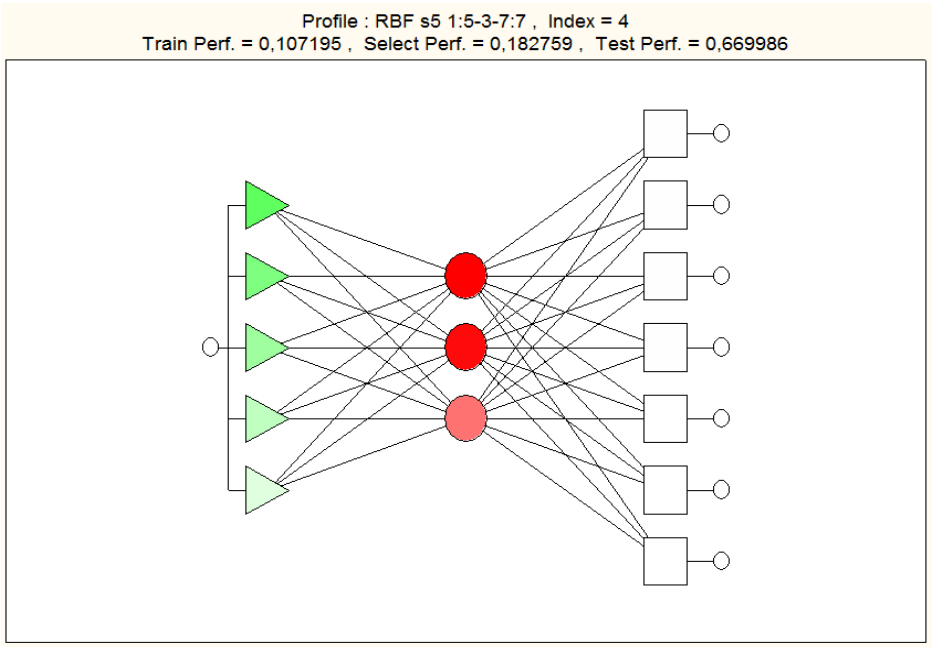


Source: Author

In this case, the neural network uses two neurons in its hidden layer.

The scheme for the fourth retained neural network, once again of the RBF type, is presented in Figure 4.

Figure 4: Scheme for RBF s5 1:5-3-7:7

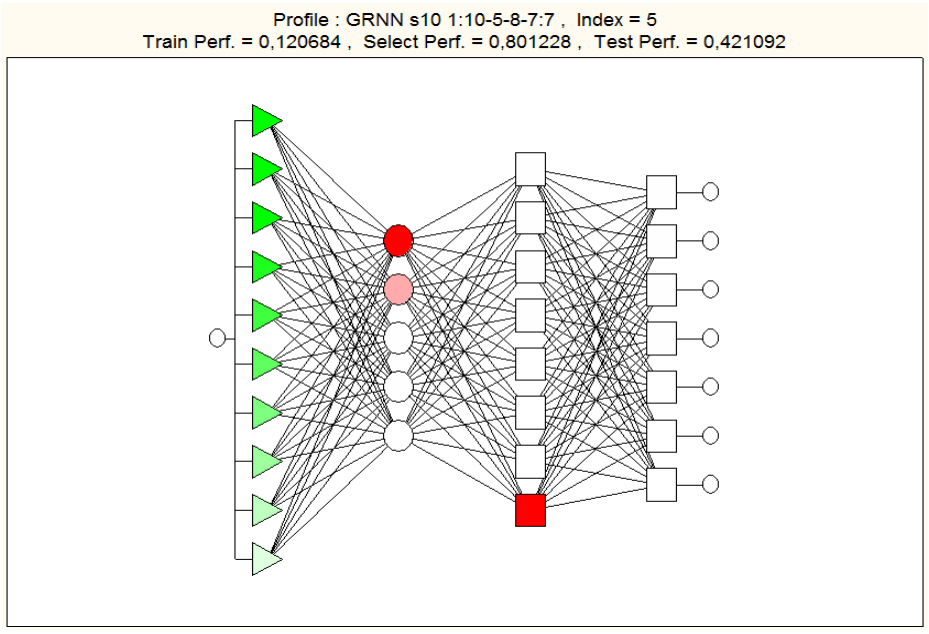


Source: Author

In this case, RBF s5 1:5-3-7:7 uses three neurons in its hidden layer.

The scheme for the fifth retained neural network is presented in Figure 5.

Figure 5: Scheme for GRNN s10 1:10-5-8-7:7



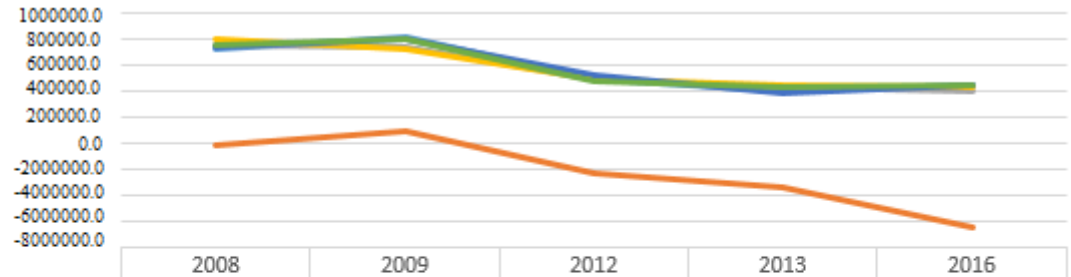
Source: Author

The last of the generated neural networks is the generalized regression neural network GRNN s10 1:10-5-8-7:7. The structure utilizes five neurons in the first hidden layer and eight neurons in the second hidden layer.

It was difficult to determine which of the generated and retained networks was able to best predict the future development of cash flows for the enterprise. It was therefore considered suitable to eliminate those networks for which the residua were higher on average, i.e. where they differ more from the reality in the evaluated period. For this reason, we evaluated each cash flow separately through a prism of all the generated and retained neural networks.

Figure 6 presents the real course of the net cash flows from operating activities before tax, changes in operating capital and extraordinary items for the followed period, as well as the course of the functions used to predict this cash flow in the identical period.

Figure 6: Predicted and actual net cash flows from operating activities before tax, changes in operating capital and extraordinary items



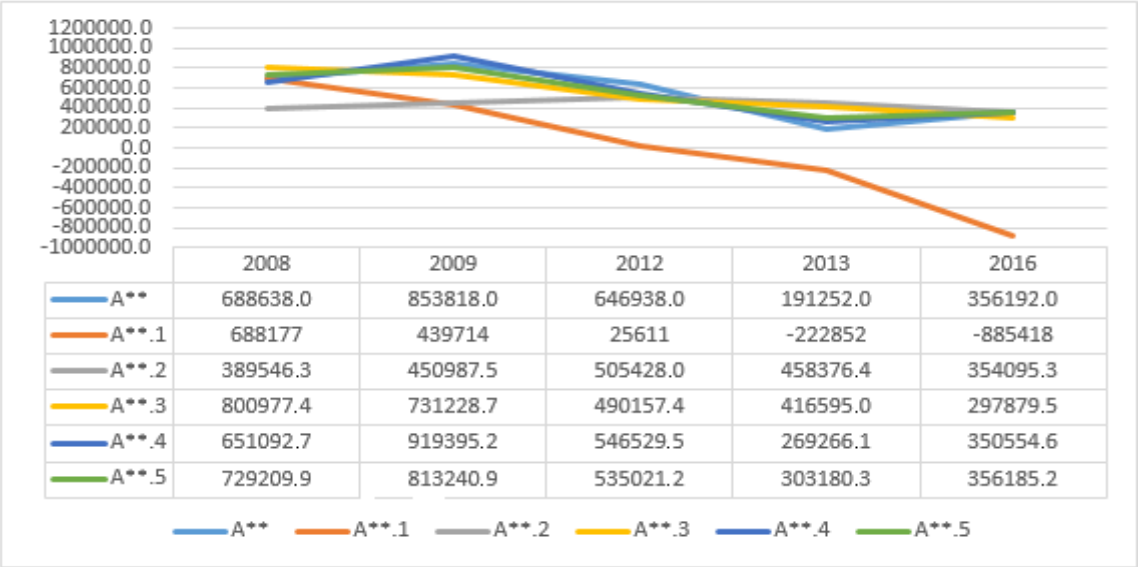
	2008	2009	2012	2013	2016
A*	731981.0	824239.0	495243.0	4044785.0	447078.0
A*.1	-14669	90195	-224396	-329260	-643850
A*.2	760555.1	746266.2	500088.1	428672.9	408157.7
A*.3	807598.3	723523.2	497845.3	447760.3	426598.9
A*.4	742092.7	806577.7	522285.1	383774.2	448596.3
A*.5	754641.6	801568.9	473035.4	427004.1	447076.3

Note: Values are stated in TCZK (thousands of Czech Crowns)
Source: Author

A* represents the real course of the cash flow. The other curves are identified according to the relevant number allocated to the retained neural network (see Table 1). It is evident from Figure 6 that neural network 1 falls outside the acceptable values. In contrast, the other networks optically predict the course of the cash flow.

The predicted and actual net cash flows from operating activities before financial items, tax and extraordinary items are presented in Figure 7.

Figure 7: Predicted and actual net cash flows from operating activities before financial items, tax and extraordinary items



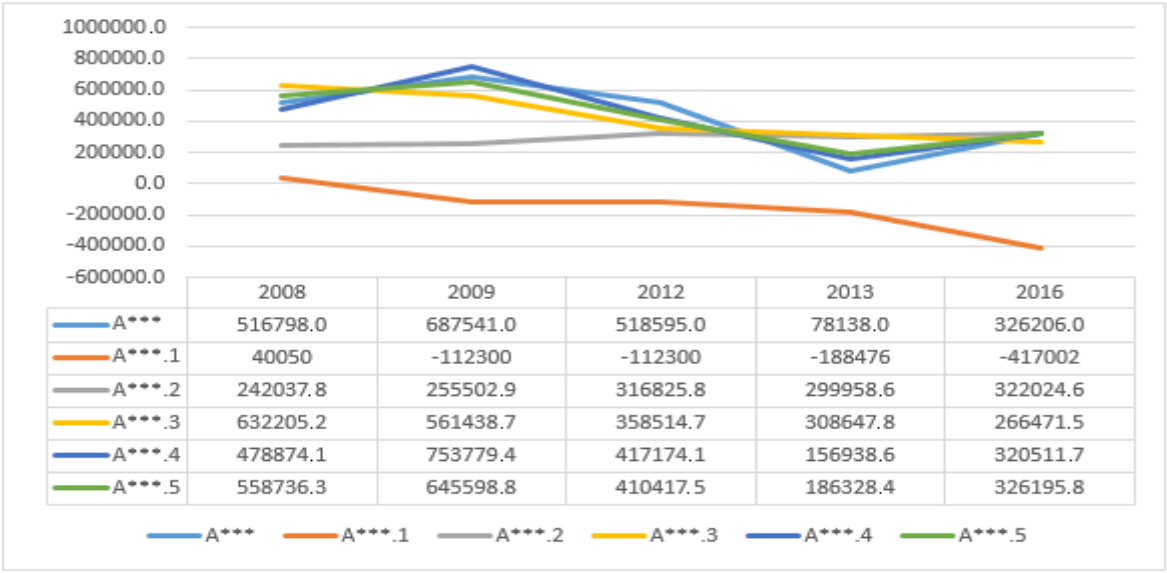
	2008	2009	2012	2013	2016
A**	688638.0	853818.0	646938.0	191252.0	356192.0
A**.1	688177	439714	25611	-222852	-885418
A**.2	389546.3	450987.5	505428.0	458376.4	354095.3
A**.3	800977.4	731228.7	490157.4	416595.0	297879.5
A**.4	651092.7	919395.2	546529.5	269266.1	350554.6
A**.5	729209.9	813240.9	535021.2	303180.3	356185.2

Note: Values are stated in TCZK
Source: Author

A** represents the real course of the cash flow. The other curves are identified according to the relevant number allocated to the retained neural network (see Table 1). It is evident from Figure 7 that neural networks 1 and 2 are not reliable predictors and are therefore not usable.

The predicted and actual net cash flows from operating activities are presented in Figure 8.

Figure 8: Predicted and actual net cash flows from operating activities



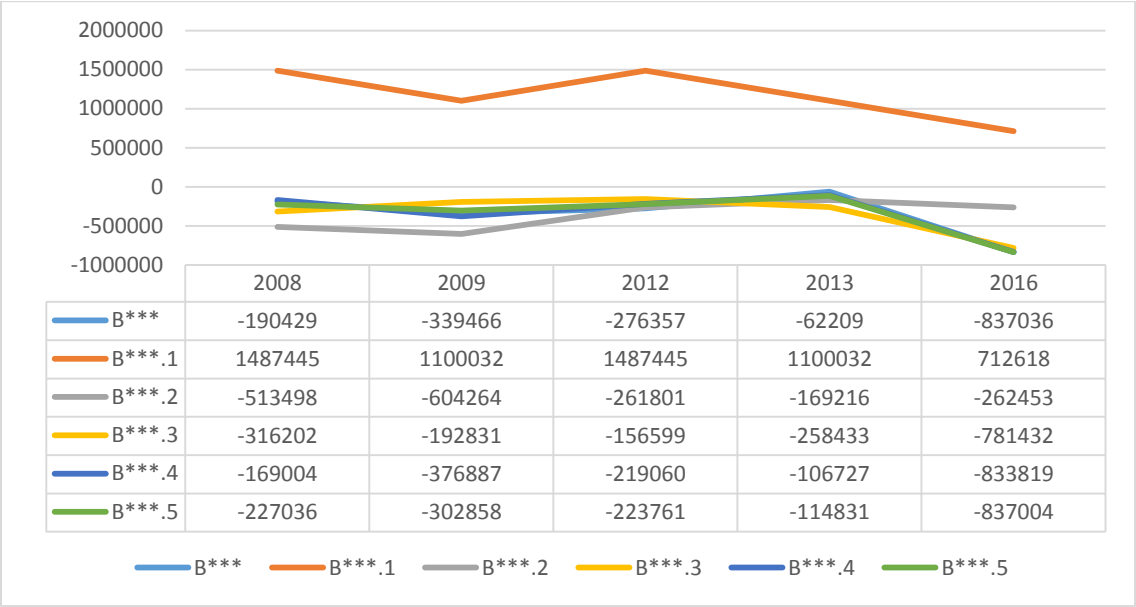
	2008	2009	2012	2013	2016
A***	516798.0	687541.0	518595.0	78138.0	326206.0
A***.1	40050	-112300	-112300	-188476	-417002
A***.2	242037.8	255502.9	316825.8	299958.6	322024.6
A***.3	632205.2	561438.7	358514.7	308647.8	266471.5
A***.4	478874.1	753779.4	417174.1	156938.6	320511.7
A***.5	558736.3	645598.8	410417.5	186328.4	326195.8

Note: Values are stated in TCZK
Source: Author

A*** represents the real course of the cash flow. The other curves are identified according to the relevant number allocated to the retained neural network (see Table 1). It is evident from Figure 8 that neural networks 1, 2 and 3 are not usable, although network 3 shows a smaller deviation than networks 1 and 2.

The predicted and actual net cash flows relating to investment activities are presented in Figure 9.

Figure 9: Predicted and actual net cash flows relating to investment activities



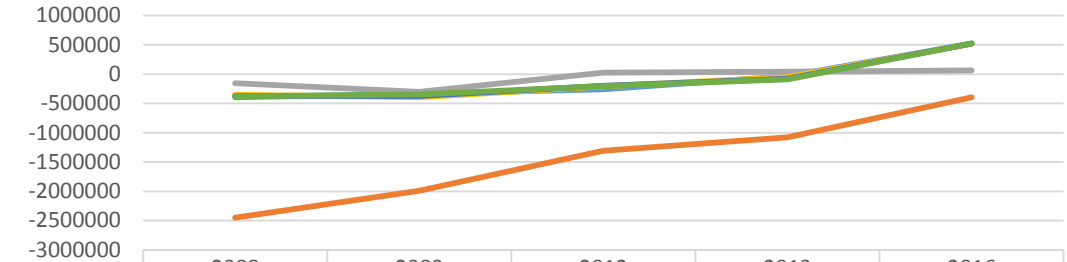
	2008	2009	2012	2013	2016
B***	-190429	-339466	-276357	-62209	-837036
B***.1	1487445	1100032	1487445	1100032	712618
B***.2	-513498	-604264	-261801	-169216	-262453
B***.3	-316202	-192831	-156599	-258433	-781432
B***.4	-169004	-376887	-219060	-106727	-833819
B***.5	-227036	-302858	-223761	-114831	-837004

Note: Values are stated in TCZK
Source: Author

B*** represents the real course of the cash flow. The other curves are identified according to the relevant number allocated to the retained neural network (see Table 1). It is evident from Figure 9 that the neural structures of networks 1, 2 and 3 are not reliable and therefore cannot be used, although the deviation for networks 2 and 3 is smaller.

The predicted and actual net cash flows for financial activities are presented in Figure 10.

Figure 10: Predicted and actual net cash flows for financial activities



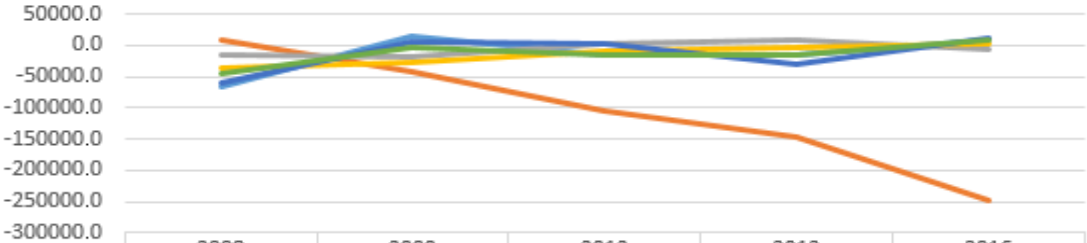
	2008	2009	2012	2013	2016
C***	-393116	-332632	-256700	-31700	520266
C***.1	-2448226	-1991535	-1306498	-1078153	-393116
C***.2	-156804	-302163	23922	41042	66370
C***.3	-350824	-396587	-209936	-53213	516678
C***.4	-370298	-372486	-195678	-79112	523692
C***.5	-378260	-347485	-201439	-86946	520243

Note: Values are stated in TCZK
Source: Author

C*** represents the real course of the cash flow. The other curves are identified according to the relevant number allocated to the retained neural network (see Table 1). It is evident from Figure 10 that neural network 1 and possibly 2 are unusable.

Figure 11 shows the predicted and actual net increase or decrease in financial means, i.e. cash.

Figure 11: Predicted and actual net increase or decrease in cash



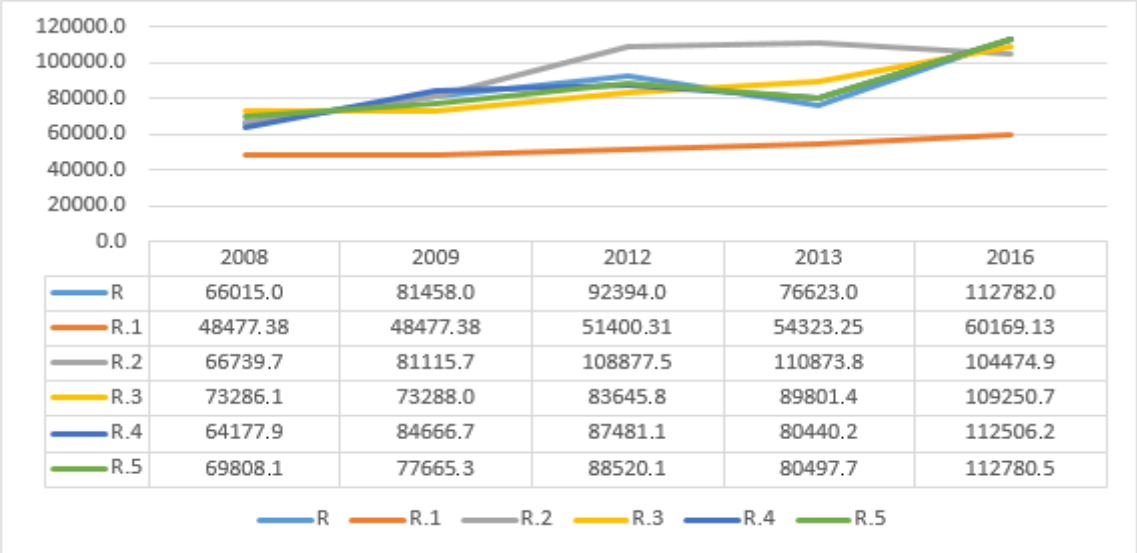
	2008	2009	2012	2013	2016
F	-66747.0	15443.0	-14462.0	-15771.0	9436.0
F.1	7738	-41063	-105274	-146369	-249106
F.2	-15343.4	-18654.9	2244.2	8966.9	-6847.4
F.3	-34820.9	-27979.0	-8020.5	-2997.7	1717.1
F.4	-60428.3	4406.7	2436.2	-28900.3	10384.7
F.5	-46559.3	-4745.0	-14782.6	-15448.7	9435.0

Note: Values are stated in TCZK
Source: Author

F represents the real course of the cash flow. The other curves are identified according to the relevant number allocated to the retained neural network (see Table 1). It is evident from Figure 11 that the most suitable neural network is network 5, i.e. GRNN s10 1:10-5-8-7:7.

The predicted and actual state of cash and cash equivalents at the end of accounting period are presented in Figure 12.

Figure 12: Predicted and actual state of cash and cash equivalents at the end of accounting period.



	2008	2009	2012	2013	2016
R	66015.0	81458.0	92394.0	76623.0	112782.0
R.1	48477.38	48477.38	51400.31	54323.25	60169.13
R.2	66739.7	81115.7	108877.5	110873.8	104474.9
R.3	73286.1	73288.0	83645.8	89801.4	109250.7
R.4	64177.9	84666.7	87481.1	80440.2	112506.2
R.5	69808.1	77665.3	88520.1	80497.7	112780.5

Note: Values are stated in TCZK
Source: Author

R represents the real course of the cash flow. The other curves are identified according to the relevant number allocated to the retained neural network (see Table 1). It is evident from Figure 12 that the best neural network is network 5, and if there is tolerance for a small deviation also network 4.

Table 2 provides a summary of the usability of the individually retained neural structures.

Table 2: Evaluation of the retained neural networks

Neural network	A*	A**	A***	B***	C***	F	R
Linear s5 1:5-7:7	NO	NO	NO	NO	NO	NO	NO
MLP s5 1:5-11-11-7:7	YES	NO	NO	NO	NO	NO	NO
RBF s5 1:5-2-7:7	YES	YES	YES	NO	YES	NO	NO
RBF s5 1:5-3-7:7	YES	YES	YES	YES	YES	NO	YES
GRNN s10 1:10-5-8-7:7	YES	YES	YES	YES	YES	YES	YES

Source: Author

On the basis of the results of the performed analysis, we can conclude that the most reliable and useful neural structure is that of network 5, i.e. GRNN s10 1:10-5-8-7:7, followed very closely behind (and still usable) by neural network 4, i.e. RF s5 1:5-3-7:7.

Conclusion

The aim of this study was to apply neural networks to cash flow planning in a specific company, namely Hornbach.

As part of the study, neural structures were generated, of which the five best were retained. The principle differences were identified between the predicted and actual values for the individual networks, which were then subjected to a sensitivity analysis. The results of this analysis showed that the most reliable and suitable network was a generalized regression neural network (i.e. GRNN s10 1:10-5-8-7:7). This network was found to be able to accurately predict various kinds of cash flows within Hornbach. Similarly, but with a more limited application, the radial basic function neural network RBF s5 1:5-3-7:7 was found to be accurate, but not highly accurate, in predicting the state of cash and cash equivalents at the end of the accounting period. The other networks were shown to be largely inaccurate and therefore not usable in practice.

On the basis of the results of the study, it can be concluded that neural networks can be successfully and effectively applied by companies for predicting developments in cash flows. However, it should be noted that each company must generate its own unique neural structure(s) to do so.

The suggested neural structures can be used in practice for drawing up the financial plans of a company (as was verified in the case of Hornbach). To modify the result, it is possible to use the causal or intuitive methods of financial planning.

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Usage of Multiple Perceptron Neural Networks in Determination of the Financial Plan

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Abstract

Financial planning within a company represents one of the basic activities of a company as well as a very demanding activity of the financial manager. Based on the main principles of economy and data from the previous periods (especially main financial statements – balance sheet, profit and loss, cash-flow statement) the future development of the given company is predicted. Different mathematical and statistical models and methods including statistical, causal and intuitive methods are used to carry this out. Some models, such as artificial neural networks, represent a very efficient method for prediction. The article identifies company revenues as the initial indicator in setting a company´s financial plan. Multilayer perceptron neural networks are very often used for their prediction. Information on Hornbach Company´s Profit and Loss Statement from the period of 1999 to 2015 is used as input data. A total of 1000 artificial neural networks is generated, out of which 5 most appropriate are maintained. Sensitivity analysis is also carried out. The contribution finally states that in practice, the suggested neural structures are useful for compiling a company financial plan which is always derived from the amount of sales.

Keywords: multiple perceptron neural networks, financial plan, sales prediction, neural structure, model

Introduction

Financial markets around the world have become increasingly interconnected. Financial globalization has brought considerable benefits to national economies, investors and savers, but it has also changed the structure of markets, creating new risks and challenges for market participants. Not only the effects of globalization in the financial and insurance markets are at the centre of researcher's interest (Ceniga and Šukalová 2011), but also new methods and solutions to new conditions are being considered.

Methods of preparation of financial plan

A financial plan is „a comprehensive evaluation of an individual's current pay and future financial state by using current known variables to predict future income, asset values and withdrawal plans (Investopedia, 2016). In business, a financial plan can refer to the three primary financial statements - balance sheet, income statement, and cash flow statement. These three constitute a business plan (Homolka and Fábera 2013).

According to Mulačová (2012) financial plan can also refer to an annual projection of income and expenses for a company, division or department, and it can also contain pro forma and prospective statements. "Prospective financial statements are of two types-forecasts and projections. Forecasts are based on management's expected financial position, results of operations, and cash flows" (Rittenberg, Johnstone and Gramling 2012).

Though the term ´financial plan´ is widely used, what precisely a financial plan is, can be a little bit confusing, especially in industry. For example, the Standards of Professional Conduct (CFA 2014) publication explains the process of financial planning, but does not contain the term ´financial plan´. It implies that there are no specific templates for a financial plan and the plan is often prepared with regard to specific needs of the company or clients, using many variables such as current net worth, tax liabilities, asset allocation or estate plans.

Construction of multiple perceptron networks

Comparability and mathematical aspects of the indicators of financial analysis in the evaluation of the company enable various approaches and mathematical and statistical solutions (Vojteková and Bartošová 2009; Gazdíková and Šusteková 2009). Some of them, such as Artificial Neural Networks, offer solutions to very complex models enhanced by artificial intelligence principles (Klieštik 2013).

Artificial Neural Networks (ANN) are computation models inspired by biological neural networks, particularly by the behaviour of neurons, to approximate functions that are unknown in model populations and environments that constantly change (Dvořáková and Vochozka 2015).

The most commonly used ANN class is the multilayer perception (MLP). In MLPs and other types of ANNs, simple processing units called nodes (which simulate neurons) are linked via weighted interconnections. The interconnection weights function as multipliers that simulate the connection strengths between neurons. The nodes are commonly arranged in three or more layers. An input layer accepts the values of the predictor variables presented to the network (e.g. clinical variables, financial variables, levels of service) while one or more output nodes represent(s) the predicted output(s) (e.g. prediction of treatment outcome, business performance, quality degree). One or more hidden layers of node link(s) the input and the output layers (Michal et al 2015).

A multilayer perceptron (MLP) is a feedforward artificial neural network model which is more powerful than the single-layer model. An MLP consists of multiple layers of nodes in a directed graph, with each layer fully connected to the next one. Except for the input nodes, each node is a neuron (or processing element) with a nonlinear activation function. MLP utilizes a supervised learning technique called backpropagation for training the network. MLP is a modification of the standard linear perceptron and can distinguish data that are not linearly separable.

Since the financial plan consists of various financial statements, the forecasting process can be divided to prediction of various figures, such as costs forecasting or demand forecasting (Klieštik and Majerová 2015). Fildes et al. (2008) aimed at forecasting and operational research and they successfully examined computationally intensive methods and applications in operations and marketing. Multilayer networks were successfully applied in cost prediction by many researchers (Huang, Xue and Dong 2015; Nagaraj and Selladurai 2003; Lin and Chang 2002; Wang, Stockton and Baguley 2010). Cost prediction is very important, but the factors of influencing cost are many and complex and the factors affect each other. Thus enterprise cost is difficult to be predicted correctly.

Neural networks were also successfully used for forecasting of chain supply (see Chen, Wee and Hsieh 2009), production and inventory management (Wang 2005; Liiv 2006; Doganis, Aggelogiannaki and Sarimveis 2008; Mansur and Kuncoro 2012) and demand (Kourentzes 2013). Neural network models were found the most efficient as compared to traditional method of forecasting.

Zhang, Cao and Schniederjans (2004) used Neural Networks models to forecast earnings per share models. They compared four types of models: univariate-linear, multivariate-linear, univariate-neural network, and multivariate-neural network using a sample of 283 firms spanning 41 industries. The proved that the neural network model was accurate than linear forecasting models and pointed out limitations of the forecasting capacity of investors in the security market.

Financial planning within a company represents one of the most demanding activities of a financial manager. Based on the data from the previous period and knowing the basic principles of economy predicts the future development of a very difficult organism, such as a company definitely is (Stehel and Vochozka 2016).

In general, I use three methods to set a financial plan. It is statistical, causal and intuitive methods (Vochozka, Rowland and Vrbka 2016). Statistical methods determine the future values of individual items of a financial plan based on time series. Causal methods suppose that the financial manager will observe changes of economical, legislative and other external environment of an enterprise, and based on these they will revise the results of previous methods so that they respond to the assumed development. Intuitive methods are based on knowledge and experience of the predictor who, without justifying it into detail, guesses the enterprise´s future development. In all three cases, we are simplifying hundreds and thousands of factors influencing the company´s life to a

much lower amount, and from this simplified reality we derive the company´s future development.

Quite correctly it may be assumed that a financial manager will use all three methods compiling a financial plan. First, they will predict the basic variables of a financial plan through statistical methods. Company revenues are, indisputably such a variable, we may derive the rest of the financial plan values from them by the causal method. Subsequently, we will fit them within a certain logical frame.

The aim of this contribution is to find a suitable multilayer perceptron network useful for prediction of a company´s revenues as the initial indicator during a financial plan compilation based on an example of a specific enterprise.

Materials and Methods

The activity of an enterprise is defined briefly as an input exchange (production factors) into outputs (products). Business theory defines as production factors management work, dispositive work, material and fixed assets (Wöhe a Kislingerová 2007). The output defining the performance of an enterprise is revenue. Revenues are the basic building block on which the enterprise builds its entire financial plan.

The Hornbach corporation that deals with sale of handy-men goods, gardening goods and house-work goods, will be our model enterprise. Thus, we will be looking for the dependence of a business enterprise revenues on production factors, respectively their use. Profit and Loss Sheets from the years of 1999 to 2015 are available, thus 17 records at each Profit and Loss Statement item. To fulfil the aim of this contribution, we will be interested mainly in the following items of Profit and Loss Sheet:

1. Revenues for the sale of goods,
2. Costs on Sold Goods,
3. Personal Costs,
4. Depreciation of Long-term Fixed and Intangible Assets.

Personal costs include management wages but also the wages of executive workers. Moreover, we have included social and health insurance, which is, in a way, an income tax. Long-term Asset Depreciations express a share of long-term assets which was used up in the given economic year, and thus it must reflect in the economic result of an ordinary year.

To prepare a data file MS Excel will be used. The Statistica Programme in versions 7 and 12 by the DELL Company will be used to carry out the calculations. Subsequently it will be processed with the help of automated neural networks. We are looking for an artificial neural network (three-layer of four-layer perceptron neural network) which will be able to predict the future development of revenues for the sold goods of a business enterprise operating in the Czech Republic. All variables used are continuous.

The data will be divided into three groups:

- Training: 70 %,
- Testing: 15 %,
- Validational: 15 %.

The seed for a random choice has been determined at the value of 1,000. Down-sampling will be run randomly.

Consequently, 1,000 random artificial neural structures will be generated out of which 5 most suitable results will be retained.[1]

Activating functions in the hidden and output neuron layer will be:

1. Linear function:

$$y = k * x * w \tag{1}$$

where:

y means output,
k transmitting function,
x input,
w synaptic weight.

2. Step function:

$$S(t) = \begin{cases} 1 & ; \ t \geq 0 \\ 0 & ; \ t < 0 \end{cases} \tag{2}$$

where:

t means time.

3. Saturating linear function:

$$S(t) = \begin{cases} 1 & ; \quad t > 1 \\ t & ; -1 \leq t \leq 1 \\ -1 & ; \quad t < -1 \end{cases} \tag{3}$$

4. Sigmoid function:

$$S(t) = \frac{1}{1 + e^{-t}} \tag{4}$$

5. Hyperbolic tangent function:

$$S(t) = \frac{1 - e^{-t}}{1 + e^{-1}} \tag{5}$$

Other setting will be default. Subsequently, sensitivity analysis will be carried out. Thus, we will define how individual manufacturing factors influence the company´s ability to generate revenues for own product and service sale.

Results and Discussion

Having applied the contribution methodology we are gaining the best five generated neural networks. Their list is given in Table No. 1.

[1] That will be determined through the smallest squares´ method. If the differences between newly generated networks will not be significant, the training will be finished.

Tab. No. 1: Generated and Retained Neural Structures

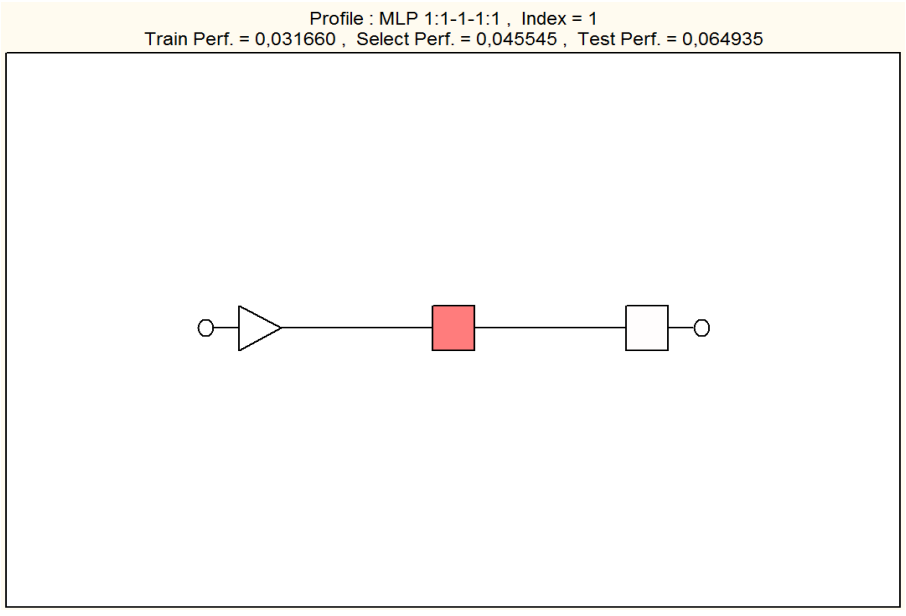
Index	Profile	Train Perf.	Select Perf.	Test Perf.	Train Error	Select Error	Test Error	Training/ Members	Inputs	Hidden (1)	Hidden (2)
1	MLP 1:1-1-1:1	0,031660	0,045545	0,064935	0,012026	0,010140	0,016830	BP100,CG 20,CG0b	1	1	0
2	MLP 1:1-2-1:1	0,049389	0,045536	0,082864	0,016738	0,009803	0,021813	BP100,CG 20,CG2b	1	2	0
3	MLP 1:1-1-2-1:1	0,062101	0,042136	0,106837	0,020204	0,009424	0,027445	BP100,CG 20,CG7b	1	1	2
4	MLP 1:1-1-3-1:1	0,053437	0,042817	0,097727	0,017672	0,009390	0,025138	BP100,CG 20,CG4b	1	1	3
5	MLP 2:2-10-1:1	0,095757	0,008098	0,184332	0,031129	0,001749	0,053612	BP100,CG 20,CG7b	2	10	0

Source: Author

It is neural structures composed of three or four layers: input layers, the first hidden layers, possible second hidden layers and output neuron layers. The first two and the fifth neural networks are three-layer perceptron networks. The third and fourth structure is a four-layer perceptron network. The first four networks work with only one input variable.

The scheme of network no. 1, i.e. MLP 1:1-1-1:1 is denoted in Picture No. 1. It is clear that the network uses only one of three input variables. Specifically, it is the costs on sold goods, and personal costs.

Pic. No. 1: MLP 1:1-4-1:1 Scheme

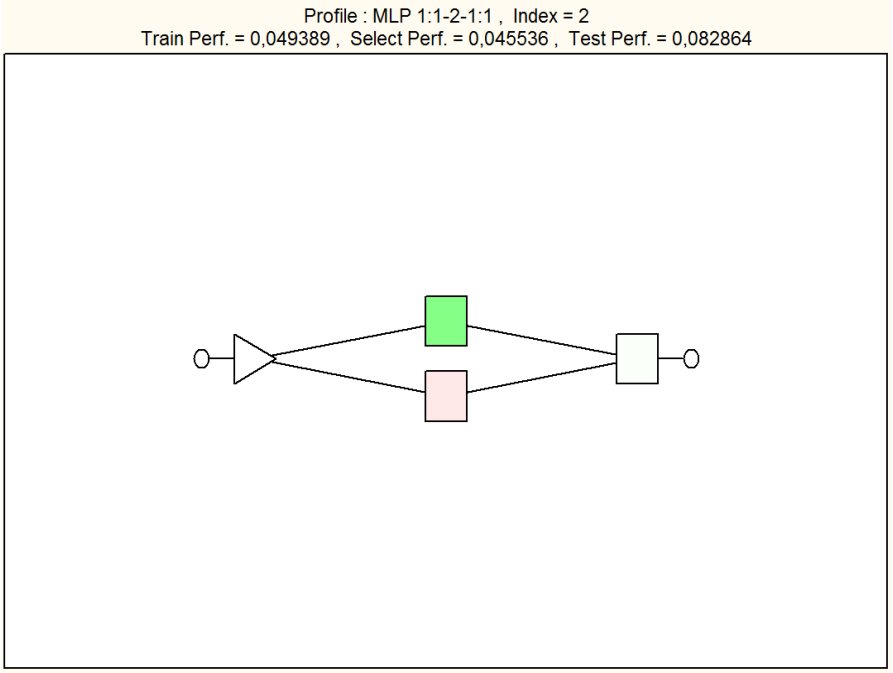


Source: Author

The network uses only one neuron in the hidden layer. Thus it is clear that the structure guesses a straight dependence between sold goods and the costs on sold goods. The enterprise would, in such case, prove a minimum of fixed assets.

The scheme of the second generated and retained network is the object of Picture No.2.

Pic. No. 2: MLP 1:1-2-1:1 Scheme

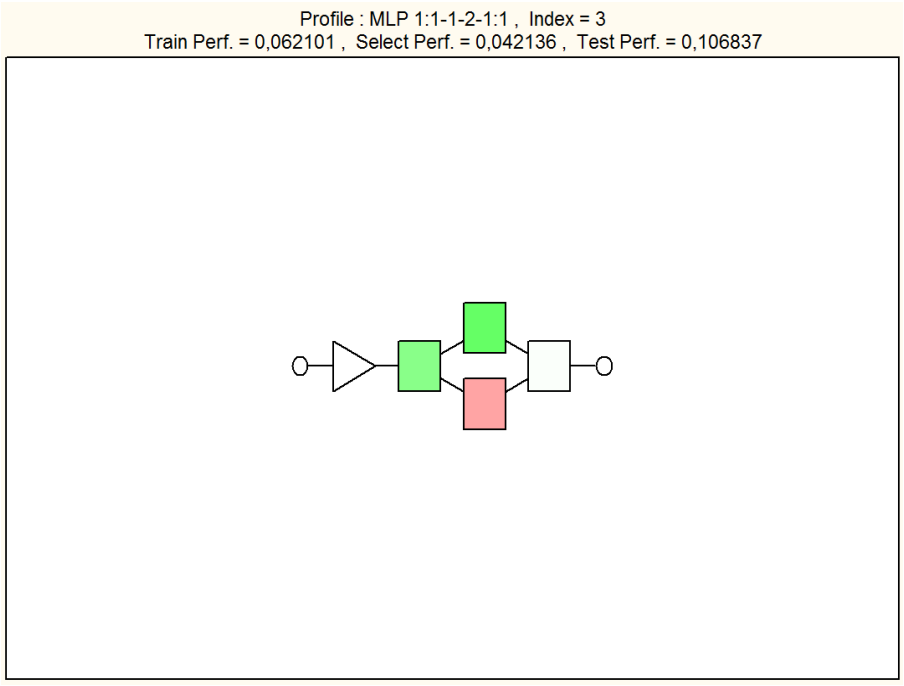


Source: Author

MLP 1:1-2-1:1 uses also one manufacturing factor – costs on sold goods. Compared to the network No. 1 it has two neurons in the hidden layer.

The scheme of the third retained MLP neural network is depicted in picture No.3.

Pic. No. 3. MLP 1:1-1-2-1:1 Scheme

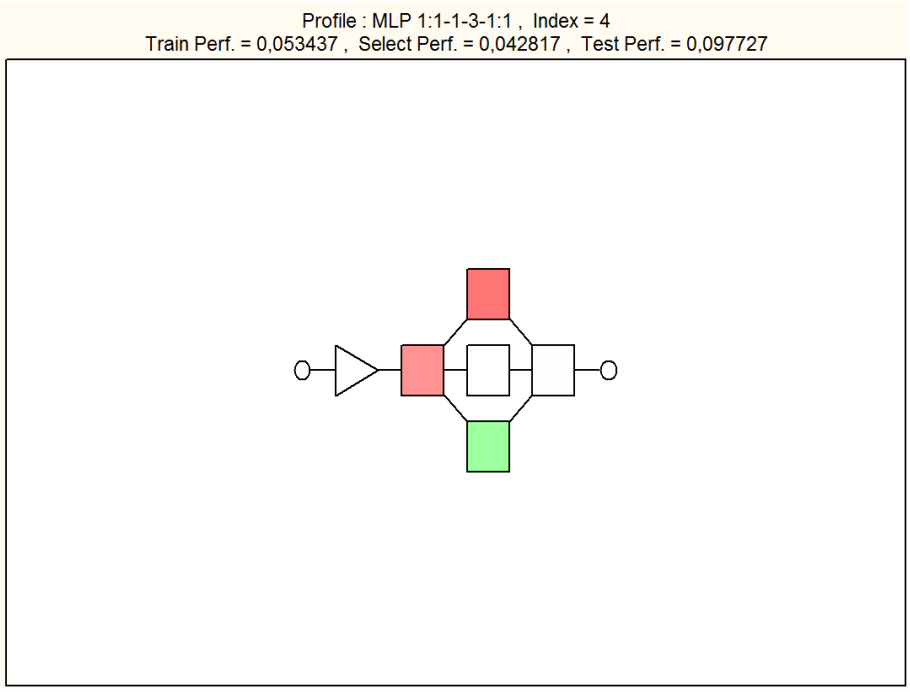


Source: Author

In this case it is a four-layer perceptron network which has one neuron in the first, hidden layer, in the second hidden layer it has two neurons. But, again it uses the only manufacturing factor – costs on sold goods.

Fourth, the MLP 1:1-1-3-1:1 network was generated. Its scheme is denoted in Picture No. 4.

Pic. No. 4: MLP 1:1-1-3-1:1 Scheme

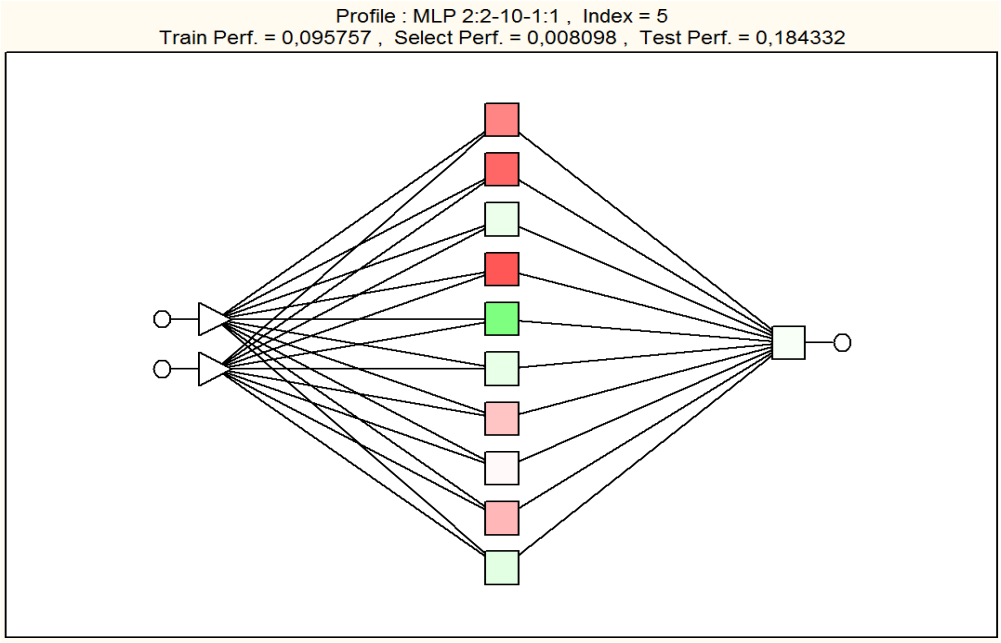


Source: Author

The four-layer perceptron network uses again one manufacturing factor – costs on sold goods. In the first hidden layer there is one neuron situated, in the second hidden layer there are three neurons.

The scheme of the fifth generated and retained neural network is depicted in Picture No. 5.

Pic. No. 5: MLP 2:2-10-1:1 Scheme



Source: Author

Three-layer perceptron network uses, besides costs on sold goods, also the depreciation of long-term assets.

In fact, it is impossible to deduce which of the generated networks offers the highest performance. Always, it is necessary to judge the training, evaluating and validational data set. If we do this also in this case, it is impossible to choose the most suitable network with certainty. Differences between them are in no way significant and thus, all generated and retained networks appear to be suitable for prediction of revenues. To illustrate this fact clearer, Table No. 2 is inserted.

Tab. No. 2:Predicted Revenues for the Sale of Goods

Year	Revenues for Sale of Goods	Revenues for Sale of Goods 1	Revenues for Sale of Goods 2	Revenues for Sale of Goods 3	Revenues for Sale of Goods 4	Revenues for Sale of Goods 5
1998	83757	122342	-17517	-14274	48602	-82267
1999	808224	798194	731043	666492	721494	752830
2001	2071204	2093514	2111236	2059710	2079557	2060963
2004	3391570	3569323	3612563	3631455	3623793	3514715
2006	3891625	3952558	3991291	4014722	4006266	4053053
2007	4461412	4524297	4548199	4558225	4553813	4717636
2008	5040467	5054933	5056613	5028740	5033096	5220847
2012	4980238	4927769	4935504	4919107	4920969	4672983
2013	4787998	4841803	4853371	4843863	4844173	4612308
2015	5096173	5113031	5111794	5078160	5083733	4976125
2016	5554350	5543607	5517834	5431210	5447129	5650056

Note: Values are given in thousands of CZK.

Source: Author

Using the table it is possible to compare the real amount of revenues for sale of goods in individual years with the prediction according to individual retained neural networks. Based on the residues we will thus guess the possible absolute error in partial years. At the first sight it is obvious that not even in a table the prediction of future revenue development we will be able to find any significant differences between individual networks and thus we may state that all generated and retained neural networks seem to be useful in practice.

Nevertheless, interesting results are provided by sensitivity analysis. Its results are given in Tab. No. 3.

Tab. No. 3. Sensitivity Analysis

Data Set	Costs on Sold Goods	Depreciation of Long-term Fixed and Intangible Assets
T.Ratio.1	27,0313	
T.Rank.1	1,0000	
S.Ratio.1	22,7269	
S.Rank.1	1,0000	
X.Ratio.1	15,7151	
X.Rank.1	1,0000	
T.Ratio.2	19,4248	
T.Rank.2	1,0000	
S.Ratio.2	23,2347	
S.Rank.2	1,0000	
X.Ratio.2	12,2156	
X.Rank.2	1,0000	
T.Ratio.3	16,0975	
T.Rank.3	1,0000	
S.Ratio.3	24,0430	
S.Rank.3	1,0000	
X.Ratio.3	9,7461	
X.Rank.3	1,0000	
T.Ratio.4	18,4016	
T.Rank.4	1,0000	
S.Ratio.4	24,1788	
S.Rank.4	1,0000	
X.Ratio.4	10,6244	
X.Rank.4	1,0000	
T.Ratio.5	14,3966	3,12024
T.Rank.5	1,0000	2,00000
S.Ratio.5	157,9418	35,70914
S.Rank.5	1,0000	2,00000
X.Ratio.5	5,3997	1,21572
X.Rank.5	1,0000	2,00000

Note: T stands for the testing set of data, S stands for the sentinel set and X stands for validation set of data.

Source: Author

The analysis always calculates the weight and order of importance between input variables, in all input variables. Out of three input variables the models chose, in four cases, only one input variable, i.e. costs on sold goods, in the fifth case it also included depreciation of long-term assets. The sensitivity analysis thus contains 18 data sets. It may be concluded that revenues for sold goods are in the case of Hornbach corporation determined as costs on sold goods. Other manufacturing factors do not play a significant role. The result may be understood as very positive for the corporation. In case only straight costs are created it may influence its economy result much easier. It may apply a

suitable cost policy and thus increase possible revenues. The result is to a certain extent also a commitment for the management how to retain personal costs and depreciations on the same level.

Conclusion

The aim of this contribution was to find a suitable multi-layer perceptron network useful for predicting enterprise revenues as an initial indicator compiling a financial plan on an example of a specific enterprise.

The aim of this contribution has been fulfilled. Five best neural structures have been generated and retained. Among the predicted values of individual networks significant differences have not been identified. All generated networks are useful for an evaluated enterprise. Sensitivity analysis has subsequently proved that future revenues may be estimated as a base of sold-goods costs. Only in the case of the fifth generated network long-term asset depreciations were used. They do not have to be used in the application necessarily. Their significance is comparatively small. They take almost 18.6% in Model No.5.

The suggested neural structures are useful in practice for an enterprise financial plan composition (it has been proved in case of Hornbach Corporation) which is always derived from revenue amount. Nevertheless, the truth is that the suggested model always assumes that demand for the company´s products is not limited. Further, it is assumed that only manufacturing capacity may be limited in this case. The financial manager will then follow the revenue estimation with the application of causal methods and subsequently of intuitive methods.

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Predicting Future GDP Development by Means of Artificial Intelligence

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Abstract

GDP measures the monetary value of the total production of goods and services in a given country over a certain period of time. GDP establishes the economic performance of a country or region and is useful for comparing differences in the living standards of nations. In general, three methods exist for determining GDP, based on production, expenditure and income. In today's modern world, economists are looking for other appropriate and improved models for the management and prediction of all economic indicators. Artificial intelligence is among those methods that have gained in importance because of its very good predictive ability over conventional statistical and mathematical models. It consists of a time series, for example, but especially of artificial neural networks. This paper describes the known applications of artificial intelligence for the prediction of GDP and then applies neural networks to predict the GDP growth of Eurozone countries until the year 2025. The selected neural structures exhibit satisfactory numerical characteristics and are equivalent to expert evaluations of GDP development. They therefore appear to be a useful tool for predicting GDP.

Keywords: GDP, Artificial Intelligence, Artificial Neural Network, prediction, Eurozone

Introduction

Gross Domestic Product (GDP) is defined by the OECD (2001) as 'an aggregate measure of production equal to the sum of the gross values added of all resident and institutional units engaged in production (plus any taxes, and minus any subsidies, on products not included in the value of their outputs)'. It measures the monetary value of the aggregate production of goods and services in a country during a given time period (quarterly or yearly). Nominal GDP estimates make it possible to determine the economic performance of a whole country or region, and to make international comparisons.

However, it does not reflect differences in the cost of living and the inflation rates of the countries; therefore using gross domestic product (at purchasing power parity) (GDP PPP) on a per capita basis is arguably more useful when comparing differences in living standards between nations.

The structure of the GDP indicator

There are three ways of determining a nation's GDP, all of which should, in principle, give the same results. The most direct way is the product approach, which is the sum total of the outputs of every class of enterprise. The expenditure approach works on the principle that all of the product must be bought by someone, therefore the value of the total product must be equal to total expenditures. The income approach works on the principle that the incomes of the productive factors must be equal to the value of their product, whereby GDP is determined by finding the sum of the incomes of all producers.

Under the expenditure method, GDP (Y) is calculated according to (1):

$$Y = C + I + G + (C - M) \quad (1)$$

where C stands for consumption, I is investment, G stands for government spending, and X and M represent imports and exports respectively.

Artificial intelligence in forecasting

Artificial intelligence denotes a flexible and rational machine or piece of computer software that is able to change its actions in order to maximize its chance of success. Machines and programmes have become increasingly capable of solving extremely complex problems and situations and are able to help people in decision making, including sorting and assessing large amounts of data.

Central areas of artificial intelligence include reasoning, knowledge, planning, learning, natural language processing, perception and the ability to move and manipulate objects. Central approaches include statistical methods, computational intelligence, soft computing and traditional symbolic artificial intelligence. Planning includes prediction because without the ability to reasonably predict the future status quo, no effective planning can be made. Planning principally includes a periodical ascertainment as to whether the situation has changed to such an extent that it requires a change of plan or not.

Neural networks

Artificial Neural Networks are computation models inspired by biological neural networks, more precisely by the behaviour of neurons. They basically approximate functions that exist in model populations and environments that constantly change. Artificial Neural Networks are able to offer solutions to very complex models enhanced by artificial intelligence principles (Klieštik 2013).

In various areas of business, artificial intelligence has been applied to help forecast diverse conditions. Various approaches and mathematical and statistical solutions have been used to ascertain comparability and evaluate mathematical aspects of the indicators of economic analyses (Vojteková and Bartošová 2009; Gazdíková and Šusteková 2009). Neural networks have, not unexpectedly, been compared to classical statistical methods and, in most literature, were found to perform better (Zhang, Cao and Schniederjans 2004; Kourentzes et al. 2013; Arunraj and Ahrens 2015; Mitrea, Lee and Wu 2009).

The economic and business predictive methods that were based on artificial neural networks were found to perform far better than classical statistical methods, although at times, they were accompanied by certain negative aspects and usually required extensive computation time or expert programming experience. The progress made in neural network development has brought with it more efficient models that can be more readily used in practice. The approach is to combine the neural networks with other methods to enhance speed or achieve more precise results. Various hybrid networks or combinations of neural networks and other methods have been developed in order to improve the performance of standard models. In other cases, neural networks were used along with various data pre-processing and sorting methods (Lahmiri 2016) or, in contrast, the data provided by neural network models were post-processed (e.g. Tsai and Chiou 2009, who used data predicted by a neural network model to construct a decision tree model to generate useful decision rules). The double clustering version (Specht 2006) is another example worthy of mention. According to Specht, the second clustering not only speeds up the testing, but also replaces the division required for kernel regression with simply the search for the nearest neighbour. The proper application of the neural model also depends on the character of the data - neural networks are especially suitable for long-term predictions with nonlinearities. Neural networks also offer an alternative way to deal with nonlinearity. Höglund (2012) compared two models based on traditional statistical approaches and three models based on neural networks (self-organizing map, multilayer perceptron and GRNN) and found that the GRNN model performed best, followed by the other two neural network models.

Time series

Time series are an ordered sequence of values of a variable at equally spaced time intervals (Lobos and Szewczyk 2014). Time series are used in many applications, such as economic forecasting. Time series analysis accounts for the fact that data points taken over time may have an internal structure (such as autocorrelation, trend or seasonal variation).

Time series processes are often described by multiple linear regression (MLR) models (2):

$$y_t = X_t\beta + e_t \qquad (2)$$

where y_t is an observed response and X_t includes columns for contemporaneous values of observable predictors. β are the partial regression coefficients that represent the marginal contributions of individual predictors to the variation in y_t when all of the other predictors are fixed. e_t is universal for differences between predicted and observed values of y_t due to process fluctuations in β, measurement errors in X_t, and model misspecifications.

Curak, Klime and Curak (2009) researched methods for forecasting economic growth using financial variables and compared linear regression and neural network models with regards to their ability to predict GDP growth. In the long-term, since nonlinearities could exist in the relationship between the variables, neural networks improve forecasting accuracy. Neural network models outperform linear regression models in forecasting accuracy. However, they suggest that in forecasting a macroeconomic variable such as GDP growth, in order to achieve better forecasting performances, both the linear regression and the neural network models can be combined.

The effects of disaggregation on forecasting non-stationary time series were tested by Poncela and García-Ferrer (2014). Using dynamic factor models, they compared the forecasts obtained directly from the aggregated series based on its univariate model with the aggregation of the forecasts obtained for each component of the aggregate. The results were then applied to the quarterly gross domestic product (GDP) data of several European countries in the Eurozone and to their aggregated GDP. The results were subsequently compared to the prediction obtained directly from the modelling and forecasting. Overall, the findings showed evidence that the factor model outperformed the remaining forecasts, probably due to its better behaviour at the turning points.

Predicting GDP

To determine whether the downturn in GDP of the USA was predictable, Balcilar, et al. (2015) used a small set of variables - real GDP, the inflation rate and the short-term interest rate – but a rich set of models – atheoretical and theoretical models (structural and time series), linear and nonlinear, and classical and Bayesian. After testing the models on limited data, they used the best model within each category to generate ex ante out-of-sample predictions of the real GDP. The findings showed that the nonlinear dynamic stochastic general equilibrium model (DSGE) performed the best overall for the ex post out-of-sample RMSE averaged across all horizons, as well as in tracking the turning point in the Great Recession, using ex ante out-of-sample predictions. This occurred despite the limited economic structure considered in Pichler's (2008) model, which introduces misspecifications. In other words, although our DSGE model entered the forecasting horserace at a disadvantage, it outperformed the 'atheoretical' time series models.

Saman (2011) modelled various scenarios of the Romanian GDP development with neural models. He strived to determine the nonlinear relation between investments and GDP and proposed two nonlinear models of GDP in relation to domestic investments, direct foreign investments and the real interest rate. The models were based on the

kinds of neural network models already used for the prediction of macroeconomic variables, but he further enhanced them to be more accurate in a crisis situation characterized by structural breaks in data. A structural break that appears in linear models is a special form of nonlinearity that the neural net can learn. Both of the models presented good performance measures on the dataset, especially the long-term model.

Similarly, Tkacz (2001) applied neural networks to the forecasting of Canadian GDP growth with the same goal – to improve the accuracy of financial and monetary forecasts of Canadian output growth by using leading indicator neural network models. Although he found that neural networks yield statistically lower forecast errors for the year-on-year growth rate of real GDP relative to linear and univariate models, he claims that the forecast improvements are less notable when forecasting quarterly real GDP growth and that neural networks are unable to outperform a naive no-change model. He asserts that neural networks offer little value for short-term forecasts of GDP growth, whereas they perform noticeably better in long-term forecasts. Forecasters of macroeconomic variables could therefore achieve greater degrees of success if they focused on long-term forecasts.

Kiani (2016) employs eighteen USA macroeconomic time series variables to investigate the possible existence of asymmetries in business cycle fluctuations in the series. The study findings show statistically significant evidence of asymmetries in all the series which indicates that business cycle fluctuations in the series are indeed asymmetric. The results of the asymmetric business cycle fluctuations in real GDP are in line with other recent studies. In another study, Kiani (2010), uses neural networks to predict fluctuations in economic activity in selected members of the Commonwealth of Independent States using macroeconomic time series modelled recursively 1-10 quarters ahead and out-of-sample using a flexible ANN in conjunction with macroeconomic time series, so that all the countries achieve greater accuracy.

Ao and Tang (2007) published research on forecasts and analysis of the (1979-2003) GDP growth rate through chaotic time series forecasting methods. They performed a simulation forecast of the increasing rate and used back propagation neural networks as a method to predict the fitting errors of chaotic time series that didn't fit the actual fluctuation of small sample discrete data very well, which was especially true for long-term economic forecast errors. With their method, forecasting precision was greatly enhanced compared with only chaos forecasting and nonlinear regression methods.

On the basis of the Turkish economy, İnsel, Sualp and Karakas (2010) ran a detailed econometric and comparative analysis of the ARMA and neural network of the changes in real gross domestic product, among other economic indicators, based on monthly data. The results indicate that, when evaluated for their forecast performances, the neural network and ARMA models differ considerably depending upon the movements in the variables and the length of the sample period. Overall the predictive performance of both models was identical.

Sinclair, Stekler and Kitzinger (2010) applied the directional forecast approach to real GDP and inflation and undertook separate analyses of the Fed's forecasts. Their comparative method only applied to qualitative directional predictions since it considered a limited amount of information, the direction of change. They concluded that though some of the inflation forecasts, examined separately, were not valuable, the joint pattern of GDP and inflation projections was generally in accord with the economy's movements. Finally, we must note that this is a procedure for evaluating GDP growth and inflation forecasts.

The accuracy of macroeconomic forecasts can also be assessed at a regional level. Furthermore, regional indicators play a crucial role for forecasting regional GDP. Lehmann et al. (2013) strived to overcome the problem of a 'data-poor environment' at the sub-national level by complementing various regional indicators with more than 200 national and international indicators. They calculated single-indicator, multi-indicator, pooled and factor forecasts in a 'pseudo-real-time' setting. The results showed that forecast accuracy was significantly increased if compared with an autoregressive benchmark model, both for short-term and long-term predictions.

The forecasting of a business cycle with chaotic time series based on a neural network with weighted fuzzy membership functions was researched by Chai and Lim (2016). They presented a forecasting model for cyclical fluctuations in the economy based on the time delay coordinate embedding method. A comparative study was conducted using other methods based on wavelet transform and Principal Component Analysis for the performance comparison. The results were tested using a linear regression analysis to compare the approximation of the input data against the target class (GDP). Unlike the other two models, the chaos based model captured the nonlinear dynamics and interactions within the system and significantly improved the prediction capability - it demonstrated a far better approximation between the forecasted trends and the target class GDP, thereby identifying it as an excellent predictor of predominantly economic situations.

The aim of this article is to predict, with the help of neural networks, the development of the GDP of Eurozone countries until the year 2025.

Materials and Methods

Information on the development of the GDP of Eurozone countries is available on the server of the World Bank (2016). Specifically, data for the years 1960 to 2015 were used. The information is presented in millions of US dollars.

It was necessary to search for the time series of GDP growth in the reference period and, based on the results, to estimate the GDP growth of Eurozone countries until the year 2025. The prediction is therefore for the next ten years.

There were 56 rows of data available. MS Excel was used for the preparation of the data file. DELL Statistics software, versions 7 and 12, were used for the calculation. This was subsequently processed by automated neural networks.

All the used quantities were continuous. A module of time series created by regression was used. The data was divided into three groups:

- Training: 70%
- Testing: 15%
- Validating: 15%

The seed for random selection was set to a value of 1000. Subsampling took place randomly.

1000 artificial neural structures were subsequently generated, of which the 5 most appropriate were retained[1].

The following types of neural networks were used:

1. Neural network of the radial basic function (hereinafter also referred to as RBF);
2. Multiple perceptron of neural network (hereinafter also referred to as MLP).

The following was used as the activation function for the hidden and output layers:

1. Regression output encoding:
   a. Linear function:

$$y = k * x * w \tag{3}$$

where: *y* means output, *k* is transmitting function, *x* input, *w* synaptic weight.

   b. Step function:

$$S(t) = \begin{cases} 1 & ; \quad t \geq 0 \\ 0 & ; \quad t < 0 \end{cases} \tag{4}$$

where: *t* means time.

   c. Saturating linear function:

$$S(t) = \begin{cases} 1 & ; \quad t > 1 \\ t & ; \quad -1 \leq t \leq 1 \\ -1 & ; \quad t < -1 \end{cases} \tag{5}$$

   d. Sigmoid function:

$$S(t) = \frac{1}{1 + e^{-t}} \tag{6}$$

   e. Hyperbolic tangent function:

$$S(t) = \frac{1 - e^{-t}}{1 + e^{-1}} \tag{7}$$

A maximum of 11 neurons were used in the hidden layer of the RBF. A maximum of 20 neurons were used in the three-layer perceptron neural network.

Other settings were set as default.

[1] This is determined using the method of least squares. When differences between newly generated networks stop being substantial, training will be terminated.

Results and Discussion

The data was divided into three sets - training, testing and validating. The selection process was conducted randomly. Table 1 contains the basic data statistics of all three sets and simultaneously the compiled statistics of the entire series.

Table 1: Basic description statistics of the observed data set

Samples	Data statistics(GDP_euro)	
	Year	GDP
Minimum (Training)	1960.000	245,386
Maximum (Training)	2015.000	14,113,386
Mean (Training)	1988.825	5,834,212
Standard deviation(Training)	17.023	4,745,143
Minimum (Testing)	1965.000	408,114
Maximum (Testing)	2012.000	12,634,445
Mean (Testing)	1984.875	4,344,530
Standard deviation(Testing)	17.618	4,354672
Minimum (Validating)	1967.000	483,435
Maximum (Validating)	2003.000	8,850,018
Mean (Validating)	1983.500	3,465,192
Standard deviation (Validating)	21.521	3,323,065
Minimum (missing)		
Maximum (missing)		
Mean (missing)		
Standard deviation (missing)		
Minimum (Overall)	1960.000	245,386
Maximum (Overall)	2015.000	14,113,386
Mean (Overall)	1987.500	5,282,969
Standard deviation (Overall)	16.310	4,497,609

Source: Author

1000 neural networks were generated on the basis of the data sets. The five networks with the best statistics were retained. An overview of the obtained and preserved neural networks is given in Table 2.

Table 2: Overview of generated and preserved neural networks

Overview of active networks (GDP_euro)											
In	Networks name	Train. perform.	Test. perform.	Valid. perform.	Training error	Testing error	Valid. error	Train. Algorit.	Error function	Act. hidd. layer	Output act. fun.
1	RBF 1-10-1	0.995070	0.997693	0.998798	9.410417E+10	8.253469E+10	2.982181E+10	RBFT	Sum of sq.	Gauss	Identity
2	RBF 1-12-1	0.992732	0.991593	0.998530	1.433152E+11	2.161152E+11	2.769664E+10	RBFT	Sum of sq.	Gauss	Identity
3	RBF 1-11-1	0.994419	0.990489	0.999191	1.078230E+11	1.891966E+11	1.337156E+10	RBFT	Sum of sq.	Gauss	Identity
4	RBF 1-11-1	0.993065	0.992708	0.999446	1.363225E+11	1.985018E+11	2.274212E+10	RBFT	Sum of sq.	Gauss	Identity
5	RBF 1-13-1	0.993868	0.986834	0.998600	1.194787E+11	3.213900E+11	3.197014E+10	RBFT	Sum of sq.	Gauss	Identity

Source: Author

It is interesting that all the preserved neural networks are based on the radial basic function. It is clear from the table that all demonstrate excellent characteristics, as far as

performance and error are concerned, in all three data sets. All five networks use the Gaussian curve as their activation function in the hidden layer, and identify the same function in their output layer. At first glance, it is therefore possible to generalize and state that the RBF is suitable for generating time series using regression.

Table 3 contains an analysis of the correlation coefficients of all the generated and preserved networks divided into training, testing and validating data series.

Table 3: Correlation coefficients of the individual data series

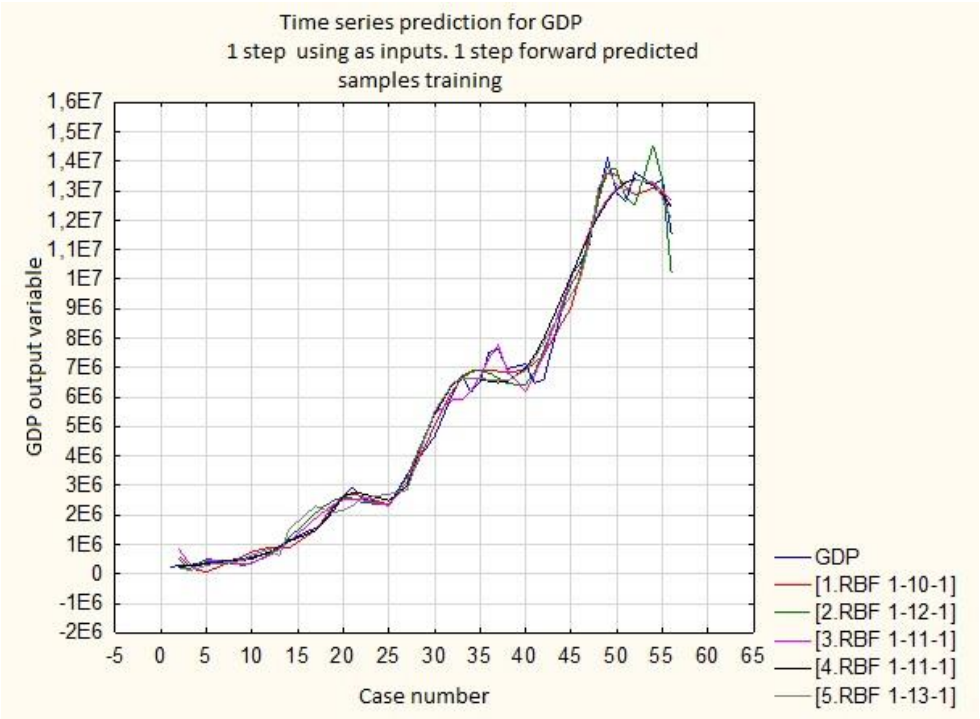
	Correlation coefficients (GDP_euro)		
	GDP	GDP	GDP
1.RBF 1-10-1	0.995070	0.997693	0.998798
2.RBF 1-12-1	0.992732	0.991593	0.998530
3.RBF 1-11-1	0.994419	0.990489	0.999191
4.RBF 1-11-1	0.993065	0.992708	0.999446
5.RBF 1-13-1	0.993868	0.986834	0.998600

Source: Author

From the given information it can be concluded that a very strong correlation exists in all five cases. The values of all data sets have values higher than 0.99.

On this basis, it is possible to compare each network with the actual performance of the economies of the Eurozone countries. The comparison is presented graphically in Figure 1 below.

Figure 1: Development of GDP, real and as predicted by neural structures



Note 1: The numbers of cases highlight each year, whereby the number 1 represents the year 1960 and 56 the year 2015.

Note 2: To compile the graph, only the training data set was used i.e. the one on the basis of which the model was created.
Source: Author

At first glance it can be claimed that all the networks faithfully copy the development of real GDP. It was therefore necessary to analyse residues in order to specify which of the networks was the most exact.

For this purpose, a sum of the residues was made:

1. RBF 1-10-1: - USD 2 million
2. RBF 1-12-1: - USD 136,044 million
3. RBF 1-11-1: - USD 1 million
4. RBF 1-11-1: - USD 113,563 million
5. RBF 1-13-1: - USD 213,182 million

It goes without saying, that a simple sum without the comparison of residues from the individual years may distort the result. However, it provides the first information on the value of the prediction of the individual networks. Ideally the sum of the residues should approach the value 0. From the obtained result, it was possible to conclude that the best result was achieved by network number 3, which was followed closely by network number 1.

On the basis of the defined individual models it was possible to continue onto the second part of the study, namely the prediction of the future development of the GDP of Eurozone countries for the years 2016 to 2025.

The results of the prediction are given in Table 4.

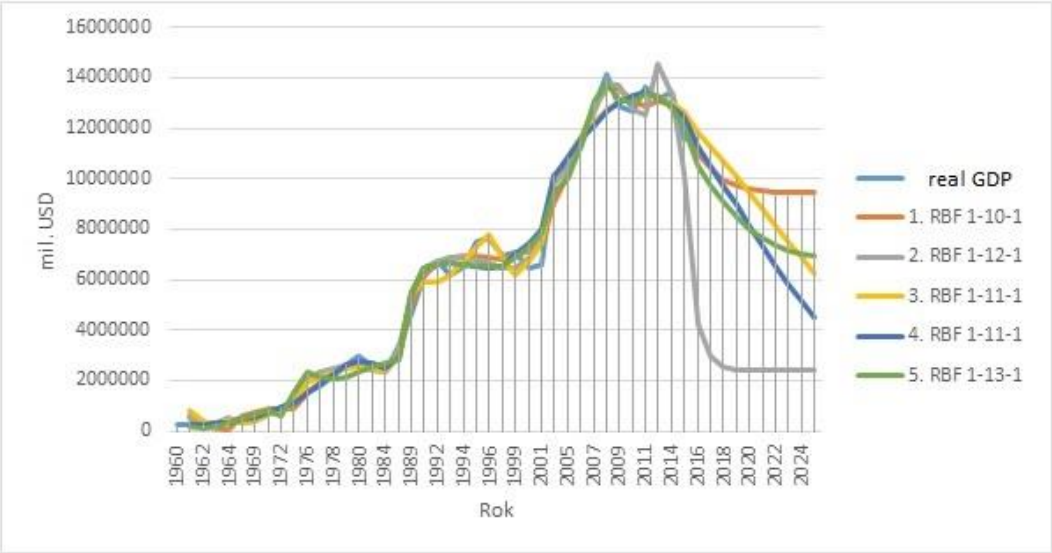
Table 4: Prediction of the development of GDP in Eurozone countries between 2016 to 2025

Cases	Table with user predictions (GDP_euro)					
	1.GDP_(t)	2.GDP_(t)	3.GDP_(t)	4.GDP_(t)	5.GDP_(t)	Year_(t-1)
1	11,013,754	4,224,724	11,798,496	11,235,908	10,491,802	2016.000
2	10,402,862	2,999,311	11,265,609	10,515,368	9,759,768	2017.000
3	9,971,310	2,550,408	10,685,157	9,742,087	9,092,758	2018.000
4	9,707,705	2,425,570	10,069,328	8,937,703	8,507,094	2019.000
5	9,566,949	2,398,247	9,430,340	8,123,308	8,017,747	2020.000
6	9,500,830	2,393,028	8,780,070	7,318,568	7,633,060	2021.000
7	9,473,396	2,391,850	8,129,717	6,540,968	7,350,520	2022.000
8	9,463,313	2,391,413	7,489,510	5,805,220	7,157,252	2023.000
9	9,460,024	2,391,192	6,868,474	5,122,876	7,034,218	2024.000
10	9,459,070	2,391,072	6,274,268	4,502,155	6,961,294	2025.000

Source: Author

Figures 2 is a graphical comparison of the predicted period and the previous period.

Figure 2: Development of GDP of Eurozone countries between 1961 and 2025



Source: Author

It is clear from the graph that an enormous drop in the GDP of Eurozone countries is predicted for the future period. On the basis of recent economic developments, mainly in the last few years, it is possible to conclude that a drop can be expected. In the case of the second, third and fourth networks, it is possible to talk more about a fall rather than a drop. In the case of the fifth network, the drop in GDP is also considerable, however, the model assumes it will bottom out and stabilize around the year 2023. The first RBF also assumes a large decline in GDP, but assumes that the developments surrounding the observed macroeconomic indicator will begin to stabilize in 2017.

On the basis of the residue analysis and conducted prediction of future development, it can be said with certainty that the most satisfactory results were generated by the first neural network, specifically RBF 1-10-1.

Conclusion

The aim of this paper was to predict the development of GDP of Eurozone countries until the year 2025.

Firstly, models of neural structures were generated and retained. It is of interest that all the preserved networks exhibited similar characteristics - not only where performance is concerned, but also their specification (type of neural structure, initiation function, error, etc.). On the basis of the conducted analysis, the RBF 1-10-1 network was determined to be the best. Not only did it exhibit satisfactory numerical characteristics - minimal residues, but it came substantially close to expert analysis of the possible development of GDP. The results of the analysis were the selection of the best artificial neural network and the prediction of GDP development of Eurozone countries.

The aim of this article was therefore fulfilled. The truth is, however, that the chosen prediction period of 10 years is very long. Despite making estimates for aggregated quantities, thereby minimising errors, it would have been highly appropriate to focus attention on the individual countries of the Eurozone, or eventually the individual fractional variables. This would have, with high probability, provided even better results.

In light of the obtained results, it can be stated that the RBF models appears to be the most useful tool for predicting GDP.

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