The Use of Analytic Hierarchy Process to Analyse International Corporations' Operating Environment

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ABSTRACT

The paper aims at analyzing the main determinants of International Corporations' behaviours with application of Analytic Hierarchy Process method. In first instance the study focuses on describing the business environment of International Companies. It has been divided in three groups, namely the Operating Environment, the Host – Country Environment and the Global Environment, accordingly to H. Deresky's concept of the Open Systems Model. The following section is a presentation of the Analytic Hierarchy Process method by T.L. Saaty. In next chapter the author proposes the application of AHP method for decision making in a turbulent operating environment of International Corporations. The basic assumption of the paper is that a correct identification of relevant groups of environmental factors allows a better decision making by choosing appropriate solutions from a set of alternatives. The Analytic Hierarchy Process seems to be a useful tool for ranking the relevance of particular elements of hierarchical problems. At the same time it helps the managers choosing the correct way of problem solving, which leads to a better management in complex environments.

Key Words: *International Management, International Corporations, Analytic Hierarchy Process*

INTRODUCTION

The Operating Environment of International Companies is today the key factor determining the chances of their success on a global scale. An appropriate and just recognition of global changes and trends is the first step towards achieving strategic targets. Nevertheless, even in a situation when the politico – economic reality seems to be recognised correctly, the variety of alternative managerial behaviours does not facilitate the life of international managers. The modern Organisation and Management Science offers numerous tools for effective decision making in uncertain environments. Despite their undisputed quality, most of these models do not offer a visualisation of multiple alternative solutions and focus on choosing the best one. In this paper the author proposes the application of T.L. Saaty's Analytic Hierarchy Process method for choosing the optimal decision from a set of alternatives. This method not only allows an effective decision making, but also shows "what is left behind" – what other possibilities were available and to which extent they could contribute to the achievement of a common goal. Besides being an important help for the decision making process, such an approach allows also a later analysis of managerial decisions taken in the past in order to draw conclusions for future time periods.

In first chapter the author proposes a short reminder of the factors influencing the business environment of International Corporations. For this purpose the Open Systems Model concept by H. Deresky will be used.

1. THE BUSINESS ENVIRONMENT OF INTERNATIONAL CORPORATIONS INSIDE THE OPEN SYSTEMS MODEL

The Open Systems Model by H. Deresky [1996, p.13 – 25] is a tool for analysis of business environment of International Corporations. Deresky divides environmental factors into three groups:

- determinants of operating environment – legal regulations, culture in organizational aspect, skills, social responsibility and ethics;

- determinants of host – country environment – economic, political and technological factors, culture in individual aspect and subsidiary – host interdependence;
- determinants of mega environment – global trends and forces, global competition, multinational companies – host – country interdependence, international law and level of global technological advancement.

A correct identification of environmental factors is the first step towards effective decision making. For a deeper study in this area please refer to J. Teczke & R. Gawlik [2007] and R. Gawlik [2007].

2. METHOD PRESENTATION – THE ANALYTIC HIERARCHY PROCESS

The Analytic Hierarchy Process (AHP) as well as its evolution – the Analytic Network Process (ANP), both developed by T. L. Saaty, are tools for decision making. Their application seems to be the most reasonable in situations when the decision problem is characterised by high level of complexity. The AHP method can be applied only in cases when the problem structure can be presented as hierarchical and upper hierarchy elements do not interact nor influence the elements placed lower on the hierarchical ladder. Whereas the application of AHP method should be proposed in first instance as an easier solution (when possible), the ANP method does not fall under the same limitations and should be treated as a development of AHP method for fuzzy and more complicated decision making problems. T.L. Saaty [2001] states that the main difference between both methods is that ANP allows analysing how elements of different factors interact between each other, not only in pairs.

After T.L. Saaty [1999], situations when the optimal solution has to be chosen from a set of alternatives on a subjective basis (i.e. a managerial decision) the Analytic Hierarchy Process should be taken into consideration. The case of International Corporations acting in a turbulent and uncertain geopolitical environment seems to fall very well under this scope. For this reason the AHP method has been chosen by the author for analyses presented in further parts of the present paper.

According to Saaty [1996, p. 5], the decision making process involves multiple stages, such as "*...planning, generating a set of alternatives, setting priorities, choosing a best policy after finding a set of alternatives, allocating resources, determining requirements, predicting outcomes, designing systems, measuring performance, insuring the stability of a system, optimizing and resolving conflict*". The same author divides the AHP method into three main levels, which are taking into account all of the concerns listed above:

- Main goal level – the goal to be achieved by the analysed decision making process
- Level of criteria and sub – criteria and their indicators – used for evaluation of dominance of factors
- Alternatives – subject to expert opinions with respect to criteria above; also the researched optimal solution arises from this level [*ibidem*, p. 5 – 6].

The core of AHP method consists of pairwise comparisons of different alternatives, criteria indicators and entire criteria between each other. For this purpose a hierarchy composed of factors of lowering importance is being formed. Their gradation constitutes the first step of AHP method. In next step these factors are being analysed in pairs on each hierarchical level. As a result, the dominant factor from the pair below is being linked with the dominant factor from the pair straight above, which gives us a ranking of importance of different criteria. It is important to realise that the gradation allows to include the non – measurable criteria into the decision making process. The transition of non – measurable expert evaluations into numerical data that can be subject for comparisons with existing results of research and available statistical data constitutes the main advantage of AHP method. Last, but not least – obtained numbers are a clear proof for the superiority of alternative *A* over alternative *B* (accordingly to the pre – selected criteria) because of their mathematical notation. The cited transition can be effectuated by applying the following instruments:

- Fundamental Comparison Scale
- Pair – Wise Comparison Matrix
- Consistency Check.

The Fundamental Comparison Scale is performed at the pairwise comparison level. It allows the experts to express their preferences in terms of showing how strong is the dominance of one factor above the other (from the same pair). The expert chooses the most suitable descriptive term to state one factor's dominance over the other from the following set: equal, weak, strong, very strong or absolute. Respectively numbers 1, 3, 5, 7, 9 are attributed. Numbers 2, 4, 6, 8 describe intermediary situations, when a strict choice cannot be made.

T.L. Saaty [1996, p. 17 – 25] defines a pair – wise Comparison Matrix as a rectangular array of numbers issuing from expert ratings. Its mathematical notation equals $\lfloor a_{ij} \rfloor = (n \times n)A$, where $a_{ij} = \frac{1}{a_{ij}}$ and $a_{ij} = 1$, $i = \{1,2,...,n\}$, $j = \{1,2,...,n\}$. An example of Pair – Wise Comparison Matrix has been presented below:

$$A = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ \frac{1}{a_{12}} & 1 & & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & & 1 \end{bmatrix}$$

Such a matrix must be normalized in the following way: $\bar{a}_{ij} = \frac{a_{ij}}{\sum_{j=1}^{n} a_{ij}}$, where $i = \{1,2,...,n\}$. The sum of normalized verses of the matrix allows the calculation of matrix eigenvector.

The goal of Consistency Check is to exclude non – consistent expert opinions. The Consistency Ratio (CR) formula is presented below:

$CR = \frac{CI}{RI}$, where CR – Consistency Ratio; CI – Consequence Index; RI – Random Index.

The Consequence Index can be calculated from the following equation:

$CI = \frac{\lambda_{\max} - n}{n-1}$, where CI – Consequence Index; $\lambda_{\max}$ – matrix eigenvalue; n – dimension of the matrix

The Random Index (RI) values depend from the dimension of the matrix and can be found in Table 1 below:

Table 1: Random Index values

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0,00	0,00	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,49	1,51	1,48	1,56	1,57	1,59

Source: T.L. Saaty [1996, p. 21]

Expert opinions are inconsistent when the Consistency Ratio (CR) value exceeds 0,1.

The next part of the present paper is an author's attempt to provide a practical example of application of Analytic Hierarchy Process Method. Its subject will be the evaluation of importance of particular determinants of operational environment of International Corporations in order to achieve better managerial results by taking optimal decisions. Consecutive steps of Analytic Hierarchy Process will be described on practical examples below.

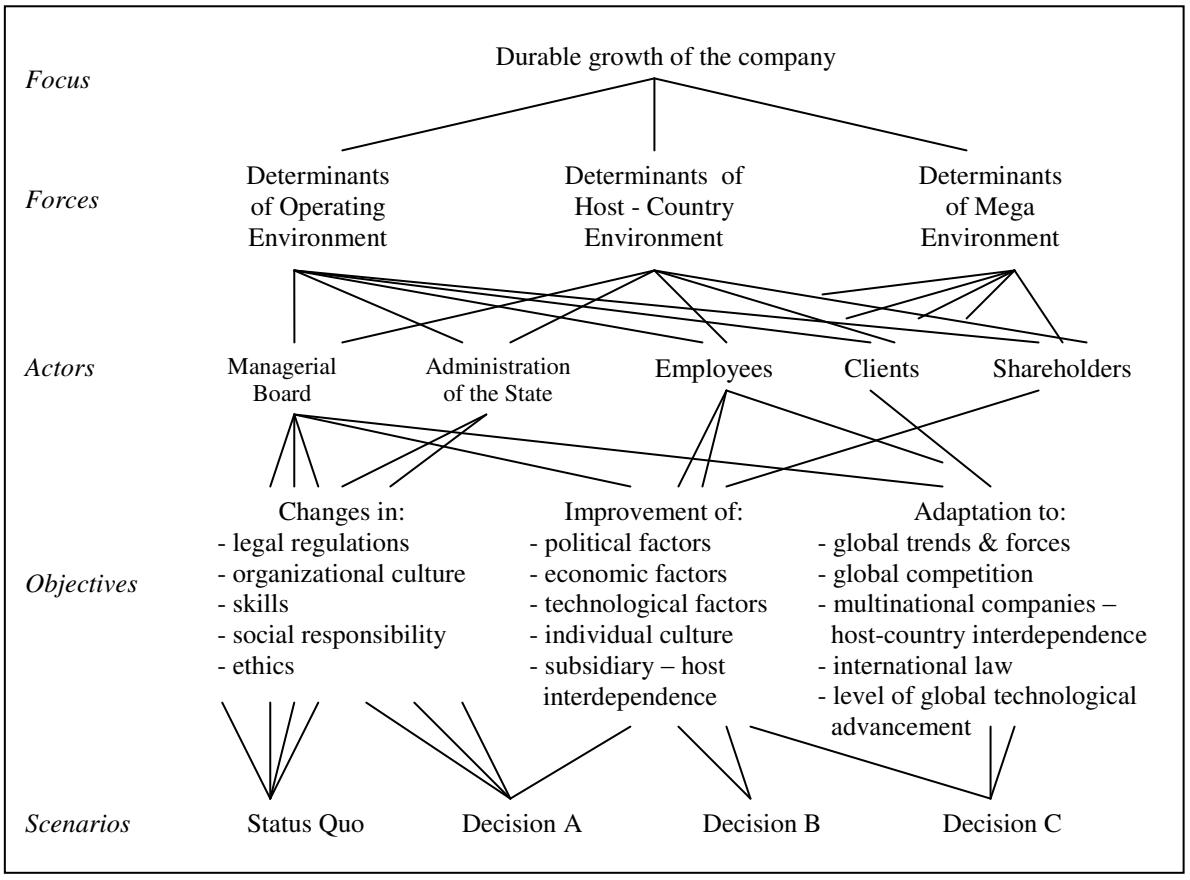
3. SOLUTION PROPOSAL – DECISION MAKING IN TURBULENT ENVIRONMENTS

The substance of the problem to be analyzed is how to choose optimal decisions from a set of alternatives when leading an international company. For this purpose it is important to find out what are the environmental factors that can influence the decision making process. Introductory research lead by the author in his former works allowed enumerating the determinants of operating environment of international companies. Its results have been briefly described in chapter 1 of this paper and more precisely in J. Teczke & R. Gawlik [2007] and R. Gawlik [2007].

Another problem arises when the chairman has to choose the best one from different alternative decisions. The problem immensity can be seen through the fact that both measurable (quantitative) and non – measurable (qualitative) criteria have to be considered. This is the moment when different decision – making tools can be applied, among them the Analytic Hierarchy Process.

J. Gawlik & S. Motyka [2006, p. 415] say that "*AHP is a method for modelling decision making problems when there is a necessity of multi – criteria evaluation of decision variants*". The method consist of building a hierarchy in order to classify the large amount of data and issues that need to be taken into account when making decisions. An example of such a hierarchy has been presented below on Fig. 1.

Fig. 1: Hierarchy – decision making for durable growth of an international company

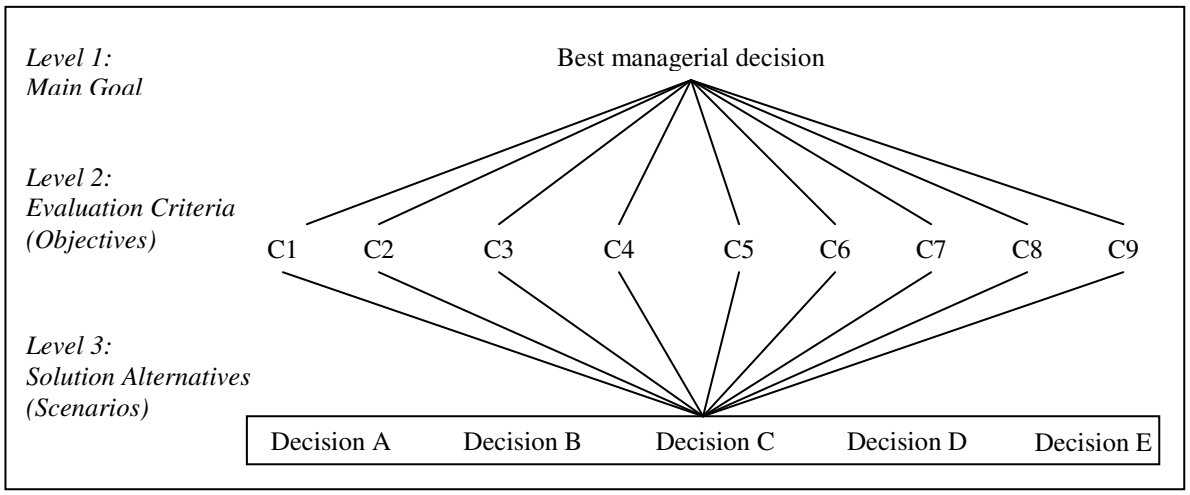


Source: Own elaboration based on T.L. Saaty [1996, p. 13]

In order to perform an analysis with application of Analytic Hierarchy Process the following steps have to be performed respectively:

1. Elaboration of a hierarchy - in this initial step we need to define what the decision problem is, what the goals to achieve through decision making are and what criteria are crucial for the evaluation of solution alternatives. A respective hierarchical diagram has been presented on Fig. 2.

Fig. 2: AHP hierarchy for best decision making



Source: Own elaboration based on T.L. Saaty [1996]

For the purposes of this paper the number of criteria (objectives) in the hierarchy have been limited to nine by taking first three determinants from each of the groups described above (operating, host – country and mega environment). These are the following: legal regulations, culture in organizational aspect, skills, economic, political and technological factors, global trends and forces, global competition and multinational companies – host – country interdependence. Each of these criteria has been attributed a respective symbol (C1, C2, …, C9). Additionally decision alternatives have been attributed letters A, B, C, D, E and signify different decision variants, such as maintaining the status quo (Decision A), investing in innovations (Decision B) and new technologies (Decision C), improving staff qualifications (Decision D) and relocating production plants to countries with cheaper labour (Decision E).

2. Expert evaluations 1 – pairwise comparisons between each pair of criteria (objectives). In first instance the expert's task is to rank which of two objectives from each pair is stronger with respect to the overall goal, which is the durable development of a given international company. The pairwise comparison matrix for expert evaluations of relevance of criteria C1 – C9 with respect to overall goal has been shown on Table 2 below.

Table 2: Expert evaluations 1 - pairwise comparison matrix with respect to overall goal

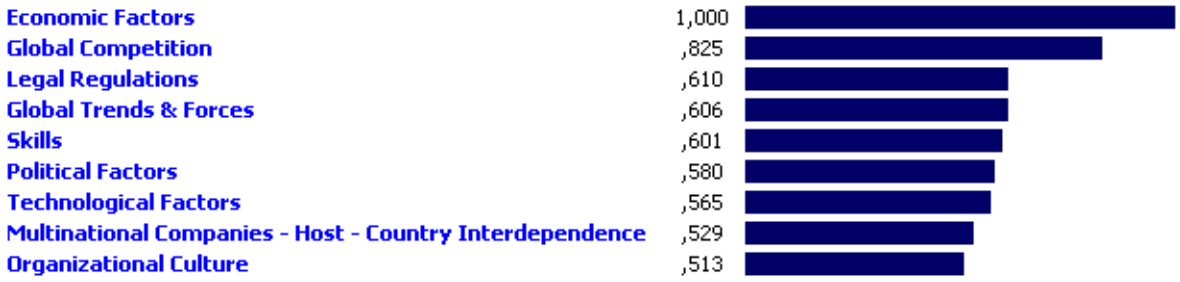
	C1	C2	C3	C4	C5	C6	C7	C8	C9
C1		1,29	1,39	1,59	1,11	1,18	1,24	1,13	1,13
C2			1,28	1,37	1,45	1,08	1,22	1,3	1,12
C3				3,19	1,17	1,01	1,2	1,59	1,14
C4					1,53	1,64	1,37	1,48	1,38
C5						1,21	1,44	1,26	1,16
C6							1,37	1,53	1,25
C7								2,07	1,14
C8									1,73
C9									

Source: Own elaboration based on Expert Choice 11.5.883 software calculations;

Overall Consistency Ratio CR = 0,02 < 0,1 => expert opinions are consistent

Normalised results of these pairwise comparisons (normalised pairwise comparison matrix eigenvector) show that economic factors are a strong priority, when compared to the rest of the determinants of International Companies operating environment (see Table 3).

Table 3: Synthesis of expert evaluations of relevance with respect to overall goal



Source: Own elaboration based on Expert Choice 11.5.883 software calculations

Overall Consistency Ratio CR = 0,02 < 0,1 => expert opinions are consistent

3. Expert evaluations 2 – in the second part of expert evaluations decision alternatives are being assessed. Pairwise comparisons between each pair of decisions (alternatives) with respect to every of the objectives is being made. The pairwise comparison matrix for expert evaluations of priority of alternatives with respect to criteria C1 – C9 has been shown on Table 4 below.

Table 4: Expert evaluations 2 - pairwise comparison matrix with respect to objectives

Ideal mode		PAIRWISE	PAIRWISE	PAIRWISE	PAIRWISE	PAIRWISE	PAIRWISE	PAIRWISE	PAIRWISE	PAIRWISE
Alternative	**Total**	**C1 (L: ,105)**	**C2 (L: ,088)**	**C3 (L: ,103)**	**C4 (L: ,172)**	**C5 (L: ,099)**	**C6 (L: ,097)**	**C7 (L: ,104)**	**C8 (L: ,142)**	**C9 (L: ,091)**
Decision A	,544	,874	,493	,845	,467	,901	,343	,295	,207	,649
Decision B	,909	,837	,987	1,000	1,000	,815	,883	1,000	1,000	,523
Decision C	,802	,853	,779	,978	,764	,898	1,000	,734	,758	,466
Decision D	,691	,815	1,000	,915	,628	1,000	,432	,453	,549	,540
Decision E	,723	1,000	,666	,882	,883	,905	,252	,594	,354	1,000

Source: Own elaboration based on Expert Choice 11.5.883 software calculations;

Overall Consistency Ratio CR = 0,02 < 0,1 => expert opinions are consistent

4. Evaluation of solutions – this phase leads to final results. Necessary calculations to perform are the following: normalization of obtained matrixes, calculation of criteria eigenvector and calculation of alternative solutions eigenvector, which in other words is the calculation of weights of particular alternative decisions in the process of achieving the assumed main goal.

Table 5 shows the final result of Analytic Hierarchy Process analysis with respect to assuring a durable growth for a given international company. The obtained vector values before normalization signify approximated weights of particular criteria (objectives) with respect to their participation in the realization of assumed goal. One can clearly see that the most suitable strategy would be a pro – innovative approach inside the company. It is also important to realize, that the distance to the "second best" solution (new technologies) is rather short. This means that a decision of investing in new technologies instead in innovations could also bring positive results. Normalization of the obtained vector constitutes a useful tool for analysis of resulting priorities. Table 6 presents the same vector after normalization.

Table 5: Durable growth of an international company – weights of alternative solutions

Source: Own elaboration based on Expert Choice 11.5.883 software calculations;

Overall Consistency Ratio CR = 0,03 < 0,1 => expert opinions are consistent

Table 6: Durable growth of an international company – weights of alternative solutions – eigenvector after normalization

Source: Own elaboration based on Expert Choice 11.5.883 software calculations;

Overall Consistency Ratio CR = 0,03 < 0,1 => expert opinions are consistent

5. Expert opinions consistency check – last, but very important step. If we want the performed measurements and calculations to be credible, the consistency ratio (CR) has to be below 0,1 (10%) for each part of the hierarchical model. In presented example the consistency ratio CR differs from 0,02 to 0,03, which both are values below 0,1. This means that expert opinions are consistent and therefore reliable. Consistency ratio values for referred AHP steps can be found in the text above under Tables 1 – 6.

CONCLUDING REMARKS

Author's main concern after the performed analysis is whether pairwise comparisons inside the Analytic Hierarchy Process will not result in excluding important decision making factors. For this reason the author will focus in future on Analytic Network Process by T.L. Saaty, which is a development of AHP model presented in the present paper. It seems that omitting relevant decision making factors is less likely to happen when applying the ANP method, which will be examined in detail in further research. At the same time we need to state clearly that the Analytic Hierarchy Process does not eliminate decisions other than the "first best" solution. It assigns them priority ranks instead. The manager can always choose another alternative to the one proposed by the analysis, having some information that have not been included in the model.

All calculations, expert evaluations and syntheses have been performed in 15 days trial version of computer aided decision making software Expert Choice, ver. 11.5.883. As this paper is only a presentation of the method, expert evaluations have been assigned randomly and number of objectives limited to 9 (software trial version limitation). Therefore obtained results can be interpreted only as simulated values, not real ones.

REFERENCES

1. H. Deresky [2006], *International Management. Managing Across Borders and Cultures*, Pearson Education International, Vth ed., New Jersey
2. J. Gawlik & S. Motyka [2006], *Zastosowanie analitycznego procesu hierarchicznego do oceny rozwiązań innowacyjnych*, in: *Komputerowo zintegrowane zarządzanie* – R. Knosala (ed.) & others, Oficyna Wydawnicza Polskiego Towarzystwa Zarządzania Produkcją, Opole, t. I, p. 411 – 419
3. R. Gawlik [2007], *The Influence of Intergovernmental Organizations on Main Determinants of the Open Systems Model with Correlation Analysis Method Application* in: *The 11th International Conference on Human Aspects of Advanced Manufacturing Agility and Hybrid Automation (HAAMAHA): Managing Enterprise of the Future,* Conference Proceedings*, IAE Press*
4. M. Kamal, Al-Harbi & Al-Subhia [2001], *Application of the AHP in project management*, in: *International Journal of Project Management*, 19 (2001), p. 19 – 27, Elsevier
5. D. Knights & H. Willmott [2007], *Introducing Organizational & Behaviour Management*, Thomson Learning
6. P. Ostry [1998], *Technological Productivity and the Multinational Enterprise*, in: *Journal of International Business Studies* 1998/29/1
7. T.L. Saaty [2001], *The Analytic Network Process: Decision Making With Dependence and Feedback*, 2nd ed., RWS Publications, Pittsburgh
8. T.L. Saaty [2001], *Creative Thinking, Problem Solving and Decision Making*, RWS Publications, Pittsburgh
9. T.L. Saaty [1999], *Decision Making for Leaders: The Analytic Hierarchy Process for Decisions in a Complex World: 1999/2000 Edition*, 3rd Rev. ed., RWS Publications, Pittsburgh
10. T.L. Saaty [1996], *The Analytic Hierarchy Process*, RWS Publications, Pittsburgh
11. T.L. Saaty & L.G. Vargas [2000], *Models, Methods, Concepts & Applications of the Analytic Hierarchy Process,* Kluwer Academic Publishers, Norwell
12. T.L. Saaty & L.G. Vargas [1994], *Decision Making in Economic, Political, Social and Technological Environments With the Analytic Hierarchy Process*, RWS Publications, Pittsburgh
13. J. Teczke & R. Gawlik [2007], *The Influence of Non - Governmental Organizations on Main Determinants of the Open Systems Model with Application of the Correlation Analysis Method*, in: Global Business And Technology Association *9th Annual Conference Proceedings: Achieving Competitive Advantage Through Managing Global Resources*, L. Fuxman, N. Delener (eds.) & others, New York

Analiza otoczenia biznesowego przedsiębiorstw międzynarodowych przy zastosowaniu metody analitycznego procesu hierarchicznego

Celem prezentowanego artykułu jest identyfikacja i analiza głównych czynników determinujących zachowania przedsiębiorstw międzynarodowych za pomocą metody analitycznego procesu hierarchicznego (AHP). Pierwsza część badania stanowi opis otoczenia biznesowego przedsiębiorstw międzynarodowych, które zostało podzielone na trzy grupy: otoczenie operacyjne, kraju przyjmującego i globalne. Podział pochodzi z modelu otwartych systemów autorstwa H. Deresky. Druga część to prezentacja metody analitycznego procesu hierarchicznego autorstwa T.L. Saaty'ego. W kolejnym rozdziale autor proponuje zastosowanie metody AHP do wspierania procesu decyzyjnego w warunkach turbulentności otoczenia biznesowego przedsiębiorstw międzynarodowych. Główną tezę badawczą artykułu stanowi stwierdzenie, że odpowiednie rozpoznanie istotnych grup czynników środowiskowych pozwoli na optymalizację procesu podejmowania decyzji. Miałoby to się dokonać poprzez wybór odpowiednich rozwiązań z zestawu alternatyw decyzyjnych. Analityczny proces hierarchiczny wydaje się być użytecznym narzędziem do oceny istotności poszczególnych elementów problemów hierarchicznych. Jednocześnie narzędzie to pomaga menadżerom na wybór odpowiednich sposobów rozwiązywania problemów, co z kolei prowadzi to możliwie optymalnego zarządzania w skomplikowanym otoczeniu.
Słowa kluczowe: zarządzanie międzynarodowe, przedsiębiorstwa międzynarodowe, analityczny proces hierarchiczny

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