



New Trends and Issues Proceedings on Humanities and Social Sciences



Issue 2 (2017) 65-79

ISSN 2421-8030

www.prosoc.eu

Selected paper of 7th World Conference on Psychology, Counselling and Guidance (WCPCG 2016) 28 - 30 April 2016, Pine Bay Holiday Resort, Kusadasi Izmir, Turkey

Application of multicriterial method in decision process of staff selection

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Suggested Citation:

Boc, K., Vidrikova, D. & Blaskova, M. (2017). Application of multicriterial method in decision process of staff selection. *New Trends and Issues Proceedings on Humanities and Social Sciences*. [Online]. 02, pp 65-79. Available from: www.prosoc.eu

Selection and peer review under responsibility of Prof. Dr. Marilyn Campbell, Queensland University of Technology, Australia

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Abstract

Modern, active, even experience-based methods of instruction are among basic prerequisites for quality higher education. Drawing students into the qualification and education process and attributing them with the role of partners in relation to their teachers already became a necessity. For this reason the article focuses on presentation of process and results of the newest educational experiment realized at Faculty of Security Engineering of the University of Žilina, whose aim was to strengthen the vocational skills and competences of students. Method of continual simulation of activities of virtual company has been selected as experimental educational method. Based on analysis, synthesis and generalization of theoretical knowledge of creative educational methods, the methodological part focuses on detailed description of basis, elements and process of applied simulation; selection of new employees in company that provides services in private security has been simulated. Utilizing data and criteria resulting from simulated analysis of work positions, students subsequently worked in the environment of multicriterial decisions, and applied procedures defined for method of analysis of hierarchical processes. Conclusion of the article discusses and summarizes the key findings and defines recommendations, through which the presented simulation method can acquire even higher quality and can become a fully-fledged part of the educational

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program not only at University of Žilina, but also at other universities that provide education in sphere of security management.

Keywords: education; educational experiment; method of continual simulation of activities; multicriterial method; Analysis of Hierarchical Processes; staff selection; Work Position Analysis; competence; security management;

1. Introduction

Present academic environment has to offer inspirational forms and methods of education which can impress and draw educational attention of skillful, passionate students that desire new knowledge. The teacher should be in close contact with the student and face-to-face instill him the basis of wisdom (Blašková et al., 2015). The scholarship of teaching means that scholars are also learners. Teaching not only involves transmitting knowledge but also involves transforming and extending it. What is needed is a more inclusive view of what it means to be a scholar – a recognition that knowledge is acquired through research, through synthesis, through practice and through teaching (Boyer, 1990, p. 24).

Learning and teaching research is a central and dynamic aspect of the process by which teachers transfer understanding to students and in doing so promote learning. Through the pursuit of knowledge, research-led learning and teaching promotes the development of the Scholarship of Discovery (Clark & Andrews, 2010, p. 12). One of the successful forms of current university education is to draw students directly into the process of education – to prepare the educational process in such way that the students are not only receiving new knowledge, but they become directly the creators of new knowledge, so they directly try out and practice their practical skills and develop their personality competencies.

Socio-constructivist approaches to education represent a radical turning point in how the learning process is regarded as a process of discovering, constructing and reconstructing knowledge, attitudes, competence and values on the basis of one's own activity and existing experience with the help of the teacher and in cooperation with classmates. Stress is laid on comprehension and the ability to make use of knowledge to solve problems in real life situations, understanding the sense of learning, adopting one's own attitudes and viewpoints, and strengthening responsibility for one's own learning (Spilková, 2011, p. 118).

In aspirational learning contexts, where bridges are built linking research and teaching activity, students could learn to discover the world by doing 'real' research, underpinned by collaboration and scholarship, much earlier than at present (Lueddeke, 2008, p. 12). Knight (2001) advises that the undergraduate program could be "structured ...so that students get progressively less help and guidance from teachers as they encounter more complex situations..." along with time "for strategic thinking, reflection, planning and portfolio-making..." (p. 375). In other words, student in current university education leaves the role of passive listener and attendee of lectures, and becomes an active element of educational process, taking on himself the role of partner of his teacher, where together with the teacher they reveal, deduce, synthesize, argue and build new knowledge. Precisely such joint and proactively acquired knowledge creates a basis of professional trajectory of the student, and decides his future success.

For university to achieve such educational level it means that it has to move the philosophy of education and research into another, higher, more sophisticated position. As states Vašutová, student subject (a student) is considered a primary source of changes in university education, determining the concept of education and ways to improve its quality (2005). It is obvious that students vary enormously in learning styles, i.e. in ways and speed of collecting and processing information, forming

knowledge and applying it under new circumstances. Individual learner differences are apparent but important is to know underlying actions in the personality (Šimonová, Poullová & Bílek, 2010).

For the purpose of increasing of applicability of the faculty graduates of fields of study “protection of persons and property” and “citizen safety”, a pilot project has been realized, whose goal was to create conditions for students to acquire practical vocational experiences and skills. The substance of the project consisted of creation of virtual company that provided services in physical security according to the Act no. 473/2005 Coll.

The aim of this article is presentation of process and results of the newest educational experiment realized at Faculty of Security Engineering of the University of Žilina, whose aim was to strengthen the vocational skills and competences of students.

2. Particularities of the approach to solve staff selection

Particularities of the approach consisted of two elements:

- Identification of criteria resulting from the analysis of security environment.
- Utilization of Analysis of Hierarchical Processes (hereinafter “AHP”) method to decide about suitability of an applicant.

An algorithm for selection of persons has been used for staffing of the company, based mainly on analysis of work position. Operation of this virtual company has been focused on provision of guard service (Boc & Vidriková, 2014). Particularities of execution of guard service require application of differentiated approach. A theoretical basis or procedure and content structure of analysis of work position has been created for students. Security analysis of the object and its surroundings became part of this basis (Figure 1).

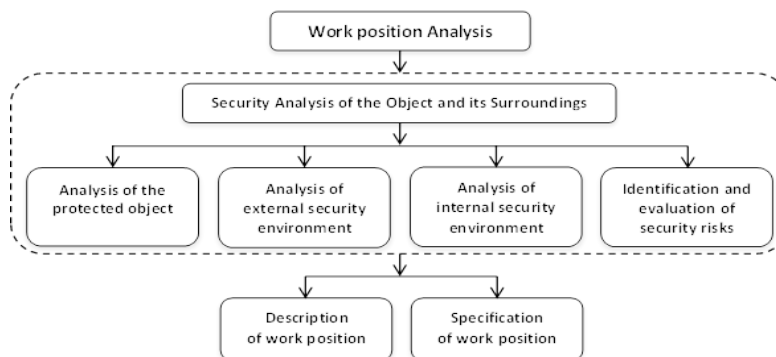


Figure 1. Work Position Analysis (Vidriková & Boc, 2014)

A goal of security analysis is evaluation of conditions and influences significant for providing of services, especially of guard service. It identifies the existence of relevant security risks generated by external and internal environment, protected asset located in the work position, their causes or sources. It evaluates the importance, probability of occurrence and consequences of risk, as well as level of adequacy of existing measures accepted for decreasing of probability or preventing the consequences of the risks.

Content of analysis of security environment is a systematic, purposeful process of acquiring, collecting and processing of information about demographic, socio-economic, socio-psychological,

criminalistics and criminological, as well as other particularities of the environment, which may represent the sources of security risks or threats. Security analysis of the object and its surroundings is carried out based on norm STN ISO 3000:2011 Risk Management. Result of the analysis significantly modifies criteria of selection of persons to work in guard service. It allows creation of model of employee based on requirements of security environment, character of the object and the client. These subsequently transform into criteria for potential applicants.

For students' needs, within the virtual company created by them, and for their acquirement of practical habits, requirements (criteria) were applied to create a model of employee in function of Manager in sphere of guard and investigation services and self-protection. Within personnel selection, the applicants who fulfilled requirements for general skills, vocational knowledge and skills were identified. Other criteria for selection were different requirements resulting from analysis of the security environment. Method of multicriterial decision has been applied to evaluate adequacy of individual applicants. Currently there are multiple such methods known, which can be used in a decision-making process such as this. According to complexity (from the simplest to the most complex) it is possible to rank them thus:

- Decision Matrix Method (hereinafter "DMM").
- Forced Decision Matrix Method (hereinafter "FDMM").
- Analysis of Hierarchical Process Method (hereinafter "AHP").

All these methods allow, based on definition of requirements, to compare multiple defined variants according to exactly defined (accepted or determined criteria) requirements and at the same time distinguish the requirements according to their weight. During the processing, individual variants of the solution are quantitatively evaluated as for how they meet the selected criteria. Within the process of staff selection it has been decided that AHP method will be used.

Brief summary of the AHP method

AHP, also known as analytic multilevel method, is the most complex of listed methods, but also the best from the qualitative point of view. It removes the limitations of previous methods and at the same time utilizes all their advantages. It is based on the pairwise comparison of level of significance of individual criteria and degree of how the evaluated variants of the solution achieve these criteria. Scale of evaluation is however much more spectral. Evaluation of compared criteria as well as variants is based on expert estimation. Individual influences are evaluated based on scale (equal, weak, medium, strong, very strong). Qualitative evaluation corresponds with numerical values on scale from 1 to 9. Prevalence of influence of either factor (A or B) is marked in appropriate row and under appropriate value of relation strength (Figure 2) (Vidriková & Boc, 2014).

| <i>Factor A</i> | | | | | <i>Factor B</i> | | | |
|-----------------|--------|--------|------|-------|-----------------|--------|--------|-------------|
| 9 | 7 | 5 | 3 | 1 | 3 | 5 | 7 | 9 |
| | | | | | | x | x | |
| Very strong | strong | Medium | Weak | Equal | Weak | Medium | Strong | Very strong |

Figure 2. Example form for determination of mutual relation strength between factor A and B

Two options may be marked in the evaluation form (medium to strong influence of relation as in example case for factor B over factor A). This is for the cases where more accurate (more sensitive) expression of relation between limits of neighboring values needs to be stated.

According to Figure 2, in row of the B factor, in column corresponding to A factor, the resulting value is 6. Other way around, in row of the A factor, in column corresponding to B factor, the inverse value will be listed, i.e. 1/6. Mutual comparison of the same variables is also included into the decision matrix, with value of 1 (equal influence). Further process for determination of weights of criteria and comparison of variants is more complicated compared to the other methods. For each matrix it is necessary to determine a normalized eigenvector corresponding to the greatest real eigenvalue of the matrix. Its components then (as in the forced decision matrix method) determine the weights of criteria and evaluation of variants of solution according to individual criteria. Resultant evaluation of variants is then obtained as weighted sum of determined evaluations multiplied by the criteria weights (Tables 1a – 1e).

Table 1a. Pairwise Comparison of Criteria according to AHP Method (Modified by Authors according to Vojtényiová, 2003)

| Criterion | K ₁ | K ₂ | K ₃ | K ₄ |
|----------------|----------------|----------------|----------------|----------------|
| K ₁ | 1 | 3 | 4 | 5 |
| K ₂ | 1/3 | 1 | 2 | 3 |
| K ₃ | 1/4 | 1/2 | 1 | 2 |
| K ₄ | 1/5 | 1/3 | 1/2 | 1 |

Table 1b. Comparison of Applicants (Ai) according to Criteria C1 (modified by authors according to Vojtényiová, 2003)

| According to C ₁ | A ₁ | A ₂ | A ₃ |
|-----------------------------|----------------|----------------|----------------|
| A ₁ | 1 | 1/3 | 4 |
| A ₂ | 3 | 1 | 6 |
| A ₃ | 1/4 | 1/6 | 1 |

Table 1c. Comparison of Applicants (Ai) according to Criteria C2 (modified by authors according to Vojtényiová, 2003)

| According to C ₂ | A ₁ | A ₂ | A ₃ |
|-----------------------------|----------------|----------------|----------------|
| A ₁ | 1 | 3 | 1/3 |
| A ₂ | 1/3 | 1 | 1/5 |
| A ₃ | 3 | 5 | 1 |

Table 1d. Comparison of Applicants (Ai) according to Criteria C3 (modified by authors according to Vojtényiová, 2003)

| According to C ₃ | A ₁ | A ₂ | A ₃ |
|-----------------------------|----------------|----------------|----------------|
| A ₁ | 1 | 1 | 1/3 |
| A ₂ | 1 | 1 | 1/3 |
| A ₃ | 3 | 3 | 1 |

Table 1e. Comparison of Applicants (Ai) according to Criteria C4 (modified by authors according to Vojtényiová, 2003)

| According to C ₄ | A1 | A2 | A3 |
|-----------------------------|----|-----|-----|
| A1 | 1 | 1/2 | 1/3 |
| A2 | 2 | 1 | ½ |
| A3 | 3 | 2 | 1 |

Process of solution

- I. Realization of pairwise comparison of criteria and comparison of variants according to individual criteria – gaining the matrices.
- II. Determination of eigenvalue of each matrix
 - A. Obtaining of characteristic polynomial
 - a) solve matrix determinant form $(A_i - \lambda .J) = 0$,
 - b) utilize the Fadejev method,
 - c) use available software (recommended are Matlab, Mathematica, etc.).
 - B. Determination of the roots of the characteristic polynomial and obtaining their eigenvalue, for which is valid: $\max |\lambda_i| = \text{eigenvalue}$
 - a) Procedures for dealing with such polynomials (it is appropriate to use e.g. Bairstow method),
 - b) use available software (Matlab, Mathematica, etc.).
- III. Obtaining the values of the eigenvector of the matrix in form of:
$$(A - \lambda .J).x = 0 \tag{1}$$
a homogeneous system of n-equations (with right sides equal to zero). Its solution provides values of so-called self-vector.
 - a) utilize LAR system solution method (e.g. Gauss elimination method, LU decomposition, Gauss – Jordan method),
 - b) use available software (Matlab, Mathematica, etc.).
- IV. Transformation of self-vector of the matrix to normalized self-vector, whose components determine weights of individual criteria and weights of variants according to how they fulfill requirements of individual criteria.
- V. Resulting evaluation and determination of ranking according to the weighted sums. (Vidriková & Boc, 2014).

3. Multicriterial decision utilizing AHP method

Constitution of virtual private security service using method of continual simulation of activities has already been fully proven as successful in conditions of Faculty of Security Engineering of University of Žilina in Žilina (hereinafter FSE ZU) (Boc & Vidriková, 2015). Within the phase of staffing of employees, an algorithm for creation of model employee – Manager in sphere of guard and investigative services and self-protection has been practiced, based on analysis of work position. Based on this analysis resulted following characteristics of activity and requirements, which correspond to current domestic and foreign standards. For the purposes of this article a model structure of work position will be listed in European standard form:

- Characteristic of work position;
- Detailed characteristic of activities;
- Regulated profession;
- International standard classification of occupations (ISCO-08);
- Classification of occupations SK ISCO-08;
- Statistic classification of economic activities (SK NACE Rev. 2);
- European qualification framework (EKR);
- Required degree of education;
- General competencies;
- Vocational knowledge;
- Vocational skills;
- Certificates and other written references;
- Professional practice (Integrated system of type positions, 2016).

Characteristic of work position

Managing employee in sphere of guard and investigative services manages, coordinates and directs execution of activities in sphere of guard and investigative services and self-protection within a company (security agency). Detailed characteristic of activities consists of:

- Executes supervision over difficult and complex cases of search for persons and property, of obtaining, documenting and processing of relevant data, directing execution of guard and investigative services and self-protection, supervises the efficiency and rationality of utilization of forces and resources of the company (security agency), approves of plans, coordinates and executes control of execution in sphere of guard and investigative services and self-protection within the company (security agency);
- Approves the inclusion of persons into detective teams, and plans the detective investigation of difficult and complex cases;
- Manages the cooperation with other subjects when fulfilling the tasks of security agency;
- Approves the documentation for court proceedings or proceedings before an administrative authority;
- Performs control of correctness and integrity of evidence of procedures in sphere of guard and investigative services and self-protection within company (security agency);
- Approves content and structure of interim and final reports;
- Manages and is responsible for personnel management and logistics.

Execution of this profession is regulated by Act no. 473/2005 Coll. on the provision of private security services and on amendments and supplements to certain laws (Private Security Act). International standard classification of occupations (ISCO-08): 1349 Professional services managers not elsewhere classified. Classification of occupations SK ISCO-08: 1349002 Manager in sphere of guard and investigative services and self-protection. Statistic classification of economic activities (SK NACE Rev. 2): 80 Security and investigative services. European qualification framework (EKR): Level 7. Required degree of education: University education of the second degree.

Table 2. General Competences (Integrated system of type positions, 2016)

| Title | Required/Advantageous | Level |
|---|-----------------------|------------|
| analysis and problem-solving | Required | High |
| digital literacy | Required | Advanced |
| environmental literacy | Required | Elementary |
| financial and economic literacy | Required | Advanced |
| dealing with people | Required | High |
| communication in foreign language | Required | Advanced |
| communication in foreign language | Advantageous | High |
| cultivated written expression | Required | High |
| cultivated oral expression | Required | High |
| mathematical literacy | Required | Advanced |
| motivational skills | Required | High |
| organization and planning of work | Required | High |
| personal development | Required | High |
| presentation skills | Required | High |
| flexibility in thinking and negotiation | Required | High |
| decision-making | Required | High |

| | | |
|---------------------------------|--------------|------------|
| independence | Required | High |
| technical literacy | Required | Advanced |
| technical literacy | Advantageous | Advanced |
| teamwork | Required | High |
| creativity | Required | Advanced |
| leadership skills | Required | High |
| driving of motor vehicle | Required | Elementary |
| negotiation | Required | High |

Table 3. Professional Knowledge (Integrated system of type positions, 2016)

| Title | Required/Advantageous | Level |
|--|------------------------------|--------------|
| analysis and problem-solving | Required | High |
| digital literacy | Required | Advanced |
| environmental literacy | Required | Elementary |
| financial and economic literacy | Required | Advanced |
| dealing with people | Required | High |
| communication in foreign language | Required | Advanced |
| communication in foreign language | Advantageous | High |
| cultivated written expression | Required | High |
| cultivated oral expression | Required | High |
| mathematical literacy | Required | Advanced |
| motivational skills | Required | High |
| organization and planning of work | Required | High |
| personal development | Required | High |
| presentation skills | Required | High |
| flexibility in thinking and negotiation | Required | High |
| decision-making | Required | High |
| independence | Required | High |
| technical literacy | Required | Advanced |
| technical literacy | Advantageous | Advanced |
| teamwork | Required | High |
| creativity | Required | Advanced |
| leadership skills | Required | High |
| driving of motor vehicle | Required | Elementary |
| negotiation | Required | High |

Table 4. Professional Skills (Integrated system of type positions, 2016)

| Title | Required/Advantageous | EKR |
|--|------------------------------|------------|
| analysis of needs in sphere of training of security employees | Required | 7 |
| coordination of deployment of security employees, technical means and vehicles | Required | 7 |
| leading of subordinate employees for protection of property and persons, complex management of company that provides services of private security according to Act no. 473/2005 Coll. on private security | Required | 7 |
| ensuring realization of business relations and contracts | Required | 7 |
| representation of client/office/institutions in negotiations with persons and entities, with government or other bodies, in administrative proceedings, in civil proceedings, etc. | Required | 7 |
| representation of organization in negotiations with offices and institutions | Required | 7 |
| representation of organization in negotiations with partners/institutions | Required | 7 |

For execution of this profession, following certificate is required: Professional competence certificate for persons charged with execution of physical protection, investigation, professional training and consulting for operators (type "P") according to Act no. 473/2005 Coll. (§19 - 20). For execution of this profession, following professional practice is recommended: 6 or more years (Professional practice has not been listed among decision criteria, since the applicants fulfilled this requirement).

Based on listed model structure of requirements, a template of applicant has been created, disposing of individual competences. According to this template, a personnel selection of applicants has been performed. 17 potential applicants have been included into the selection process. Only 3 of these applicants converged to the template applicant. Within the decision process it was necessary to decide the adequacy of one of these three selected applicants, who were, according to their competencies, professional knowledge, skills and acquired certificates, matched the created template. Criteria for evaluation were their different individual characteristics. For objectiveness of the decision process a multicriterial decision method AHP (analysis of hierarchical processes) has been selected. It has been applied using software tool Expert Choice v. 11.5 (trial).

The method used should have provided an answer to the question, which one of the applicants, labeled with numbers 1 to 3, is the most adequate one from the viewpoint of their complex individual characteristics. Personnel selection has been performed based on criteria that were based on the created template applicant. Given criteria and alternatives result from Figure 3.

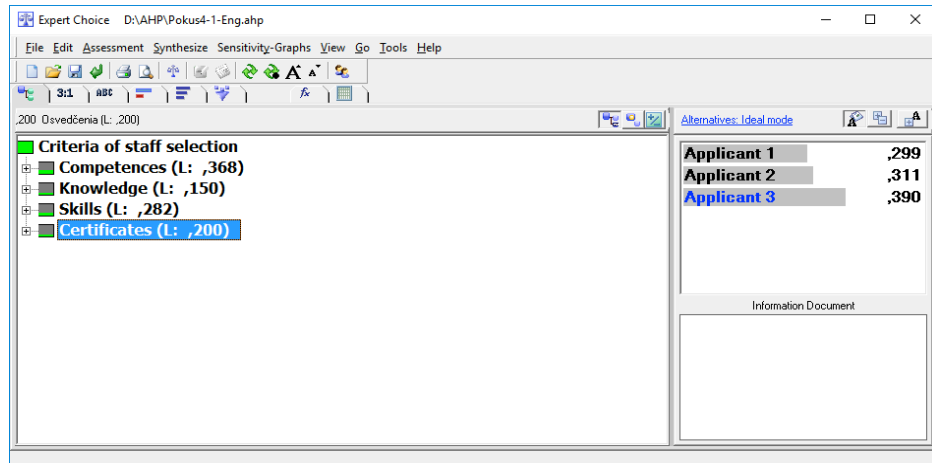


Figure 3. Entering inputs for use of AHP method in Expert Choice environment

Basic criteria of personnel selection are, based on their content, necessarily different. Different requirements for his general competences, professional knowledge, skills and professional certificates were identified in relation to potential employee. Importance of individual basic criteria, just as they resulted from the analysis of work position, is pairwise expressed on Figure 4.

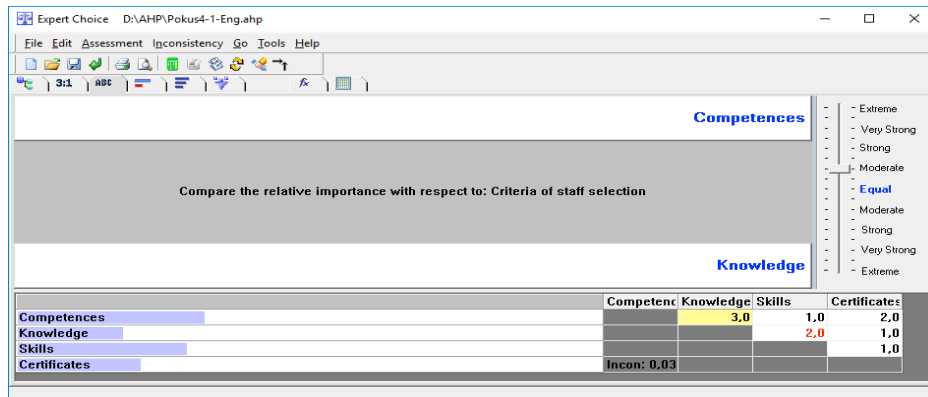


Figure 4. Importance of individual basic criteria expressed as weight

Criterion (individual attribute), which is most important from the viewpoint of execution of work position in connection to the work position, has been assigned the higher weight (numerical value). If a number is displayed in red color, it means that the criterion in lower part is more important than the criterion on the upper part. When the number is black, it means that the criterion in upper part is more important than criterion in lower part.

Meaning and order of individual criteria based on assigned weight is shown in Figure 5.

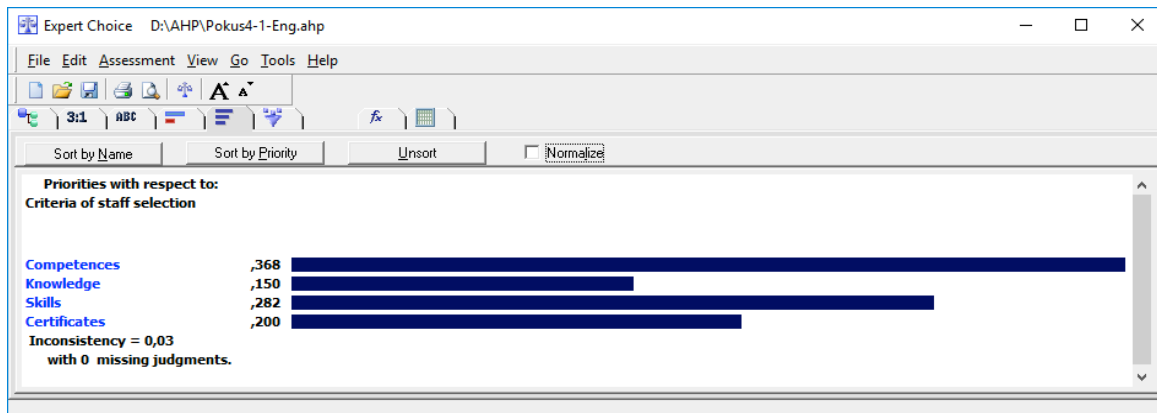


Figure 5. Rank of importance of individual criteria based on assigned weights

Ratio of discrepancy (inconsistency) between the weights of criteria is consistent (≤ 0.1). Inconsistency thus represents acceptable value (0.03).

All selected applicants possessed required general competencies. The differences consisted mainly of their level (mainly elementary, advanced and high). It has been thus necessary to identify mutual relationship between concerned required general competencies from the viewpoint of their importance. Specifically following competencies were examined: digital literacy, financial and economic literacy, dealing with people, and communication in foreign language.

Partial differences were identified via selection interviews at individual applicants also in the sphere of professional knowledge, specifically: legal basis for security activities, risk management, management for entrepreneurs. In sphere of vocational skills the differences mainly concerned these areas: analysis of needs in sphere of training of security employees, ensuring realization of business relations and contracts, representation of organization in negotiations with offices and institutions. In addition to the professional competence certificate type “P” required by the law, some of the applicants possessed also other certificates or licenses: security technician, firearms license, certificate of IT skills.

Inconsistency between the weights of sub-criteria moves within the range of 0.00 – 0.07 what means that the ratio is consistent (≤ 0.1).

After the weight comparison of mutual significance of basic criteria and sub-criteria the three selected applicants were compared with each other for each individual criterion (Figure 6).

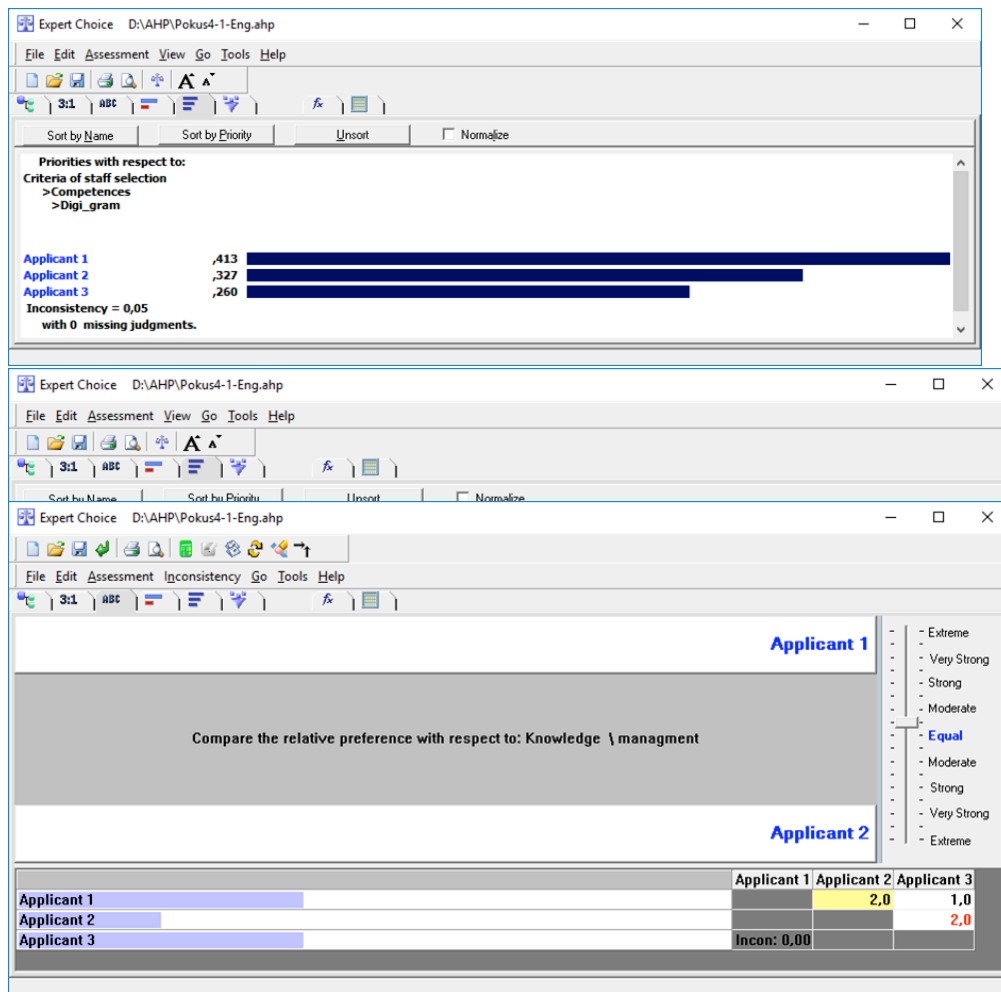


Figure 6. Illustrative results of comparison of success of applicants according to selected criteria

Results of the comparison and subsequent synthesis revealed that the best suited applicant is no. 3. It is a relative valuation of variants using distributive mode (variants were compared together analogically as well as the criteria and resultant valuation is represented in the interval $<0, 1>$ in such way, their sum equals 1). Inconsistency value represents acceptable 0.04 (Figure 7).

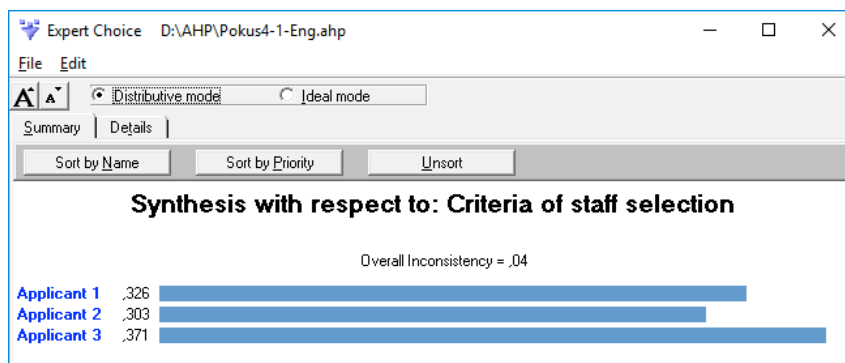


Figure 7. Results of success of applicants according to selected criteria

Sensitivity analysis can be seen on following graph (Figure 8).

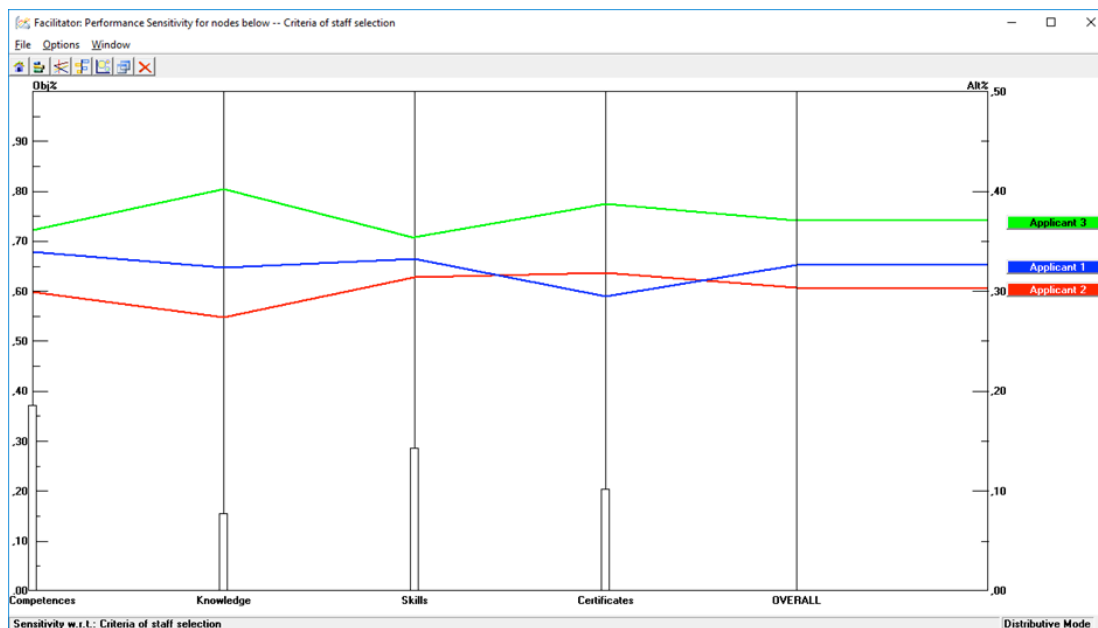


Figure 8. Sensitivity analysis (authors)

4. Conclusion

Quality of university educators shall depend on new methods of education, as well as of teaching conditions, new approaches to evaluation, renewal of curriculum defined in terms of competences, and of education of the university pedagogues for the purpose of acquiring required pedagogical qualities (Paul, 2003). It is necessary to view the role of university educators from the perspective of highly-qualified profession, which is mostly understood as mission. A teacher is a bearer of education and protector of humanitarian and ethical values. He has to cultivate the student as multi-layered personality (Slavík et al, 2012, s. 73).

The focus of this article was, among other things, also to inform professional public about the possibility and feasibility of use of the method of continual simulation of virtual company for training of students, or management employees. Part of their practical preparation has been also the personal selection of staff of the company, as the indispensable condition of its operation and sustainability. Using the analysis of work position (in newly defined content and scope), students were able to define (create) optimal model of employee that covers different requirements resulting from specific work position, type position, character and location of the workplace. Efficiency of AHP method using Expert Choice software has been proven within the decision-making process of staff selection. The program allows definition of hierarchically structured criteria and their priorities to individual valuated variants. It combines hierarchical priorities to overall priorities of all valuated variants of the evaluated issue. Sensitivity analysis simultaneously allows determining the impact of change on overall result caused by potential change in priorities while selecting variants.

Method, which was used for training of students, deepens not only students' theoretical knowledge but also professional habits in setting up a company and its staffing. Businesses in the private security sector, which are potential employers of students of FSE positively, accepted this approach.

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