Application of statistical software SPSS to study the professional profile of engineers

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Abstract: *The paper represents the statistic results of empirical examination for the identification of the vocational profile structure of the full-study graduates for Bachelor's degree in Heat Engineering degree programme in Technical University of Sofia, and the indication of the modern tendencies in their training. The quantitative examination of the vocational competence is a premise for the application of effective pedagogical methods of approach in the teaching, successful realization and vocational mobility of the future engineers.*

Key words: *a vocational competence, frequencies statistics, factor analysis.*

The European Union is faced with growing competition, which imposes a reguidance of resources to activities in the field of climate, effective using of resources and row materials, pure energetics. The programme "Horizon 2020" foresees a development of science and key industrial technologies. The innovations in education and our incorporation in the European education space are a resource for the achievement of the set purpose.

The integral structure of the concept vocational competence, reflecting the expectations/requirements of the future specialists in Heat Engineering is deduced as a unity of theoretical and practical readiness for the fulfilment of the vocational functions in this study. For the identification of the basic competences representing the originality of the engineering activity in energetics and the peculiarities of its object is done a theoretical analysis. The examination methods applied are as follows: a) theoretical analysis; b) inquiring; c) frequency analysis for the characterization of the distribution; d) factor analysis for the determination of the vocational competence.

Two hundreds and eight respondents take place in this investigation, as all of them had filled in the offered check-list containing 25 items. They were evaluated by the seven-degree scale of Likert: especially insignificant; insignificant; rather insignificant than significant; as much significant as insignificant; rather significant

than insignificant; significant , and much significant, marked with 1, 2, 3, 4, 5, 6, and 7. The data obtained are introduced and analyzed by means of the computer programme **A Statistical Package for Social Sciences (SPSS) Statistics 19.0.**

The objective group of examined persons consists of 35 employers from Heating Plant "Maritza-East 2" and "Heat-and-power-supply Sliven, Ltd", 34 university teachers and 139 students studying to graduate in Bachelor's degree in Heat Engineering in Technical University of Sofia in its branches in Sliven and Plovdiv, or the total number of the inquired persons is 208. The participants are requested to give information about their sex, degree of education, and vocational experience divided in three groups: up to 10 years; from 11 to 20 years, and above 20 years.

A variational analysis is applied for the calculation of: **a**) an indicator for an average level, mean value (X_{mean}), minimum (X_{min}), and maximum (X_{max}); **b**) measurements of variations, range (*R*), standard derivation (*S*), and coefficient of variation (*V%*); **c**) categories for the determination of distribution type – a grouping round the normal Gaussian curve (coefficient of asymmetry, *As*), and curve bevel, (excess, *Ex*). The results of the analysis are presented on Table 1.

Table 1. A descriptive statistics of the total results

N	*R*	X_{min}	X_{max}	X_{mean}	*S*	*V%*	As_{emp}	As_{tab} $p<0,05$	Ex_{emp}	Ex_{tab} $p<0,05$
208	*91,00*	*78,00*	*167,00*	*131,61*	*18,23*	*13,85*	*- 0,39*	*0,280*	*- 0,069*	*0,823*

The empirical distribution of the obtained common values of significance of the 25 vocational competences is shown in Figure 1.

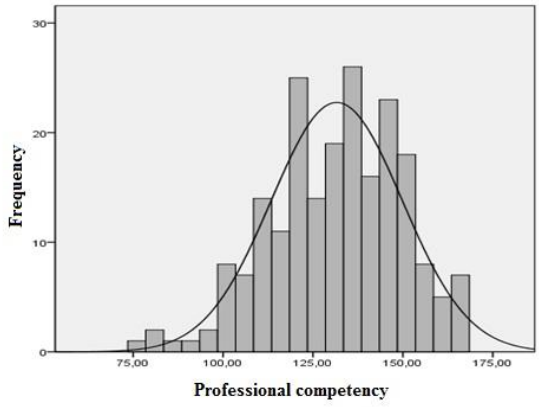

Figure 1. An empirical distribution of the common values

The empirical coefficient of asymetry is As_{emp}= - 0,39, the mean is lower than the mode and the median. The tabular value of the asymmetry criterion (As_{tab}) at expert volume (208) and level of significance (0,05) is 0,280, and $As_{emp}<As_{tab}$. Therefore, the distribution of the empirical data is symmetric. The calculated value of the empirical coefficient of excess is $Ex_{emp.}$= - 0,069. The tabular value of the criterion at expert volume (208) and level of significance (0,05) is Ex_{tab}= 0, 823 and $Ex_{emp}<<Ex_{tab}$, i. e. the distribution of the empirical data has a normal excess.

The obtained distribution inclines to the normal, which is decisive for the choice of the check criterion. For the characterization of the concept vocational competence is relative the application of the statistic method of approach and factor analysis.

The factor analysis is a method for multidimensional statistical analysis of the features variations which allows to be found open their latent outside not observed combinations, regularities of their interrelations and different hiden factors effecting the studied object (Ivanov, 2006). Some authors define the factor analysis as a procedure of the data (Kaplan and Sakuzo, 2013; Palland, 2011:181). In the software package SPSS it is included as a method for the generalization of the data with the help of a little number of factors/components. It is carried out through the search of groups among the interrelations of the number of variables, as a full description of the studied phenomenon is reached. The analysis operates with the basic concept factorial weight determine the correlation between the initial items and the factors (Sidorenko, 2000). The variables with high weights in respect to a given factor define the factor, and allow its meanings to be interpreted.

During the carried out unvestigation of the interrelations between the competences the factor analysis is especially selected, because it allows witout relying on criteria to be revealed if the analized concept has a complicated structure. With a view of the large number included items (25) and respondents (208) the application of the factor analysis leads to the reduction of the gathered information and revealing of subscales through the grouping of the variables in “natural way”.

A statistical analysis for the control of the factorial validity and the scales internal coordination is realized, as before that in accordance with the requirements described by J. Palland (Palland, 2011) the strenght of the mutual correlation between the items is evaluated. The factor analysis is not suitable during correlations lower than 0,3 or a little above this value. In the obtained correlation matrix for the check of the mutual correlations between the items all coefficients has values significantly higher than 0,5.

The suitability of the empirical data for a factor analysis is evaluated by the statistic measurements of Kaiser-Mayer-Olkin (KMO) indicator for the adequacy of the expert, and also by the test of Bartlet for sphericity. It is necessary the KMO's indicator to be in the range from 0 to 1, as the minimum acceptable value is 0,6, and the Bartlet's test for sphericity has to be with significance ($p<0,05$) (Eskandari & Ebrahimi, 2013: 271). The obtained by us KMO's indicator is 0,856, and the result of the Bartlet's test for sphericity is below 0.05, which proves that the gathered empirical data can be subject to a factor analysis. The factor analysis is done by the method of the basic components with a consecutive rotation through the method *varimax*, and four orthogonal factors (Figure 2) which most precisely and completely represent the concept vocational competence are derived. The four factors explain 14,47 % (factor 1); 14,45 % (factor 2); 9,70 % (factor3) and 8,32 % (factor 4) from the dispersion of the initial variables, respectively.

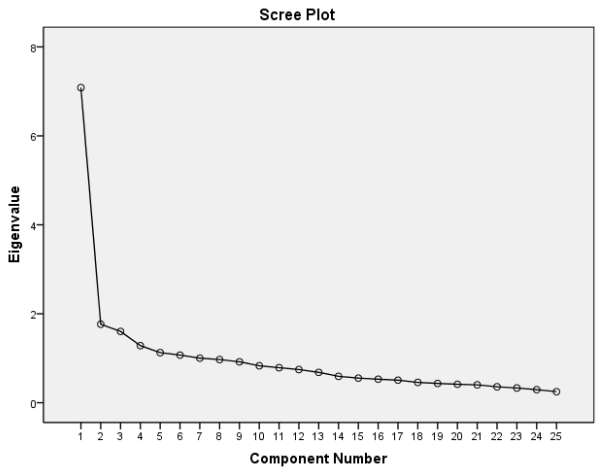

Figure 2. Principal Component Analysis

The obtained factors weights representing the coefficients of regression of the observed variables and the group of factors have positive values according the corresponding factor (F), and are given on Table 2.

Table 2. Factors weights after rotation

Items	***Factors weights***			
	F1	**F2**	**F3**	**F4**
Planning of Vocational Activity	.669			
Motivation for Reaching of Goals	.663			
Vocational Ethics and Honestly	.579			
Readiness for Solution of Problems	.562			
Systematic and Critical Thinking	.558			
Lifelong Learning	.551			
Mobility and Adaptation	.519			
Constructive Communication	.500			
Understanding of European Ecological Legislation		.715		
Skills on Carbon Market		.676		
Design of Low-Carbon Technologies		.615		
Responsibility to Environment		.610		
Practical Skills for Monitoring		.599		
Application of Research Methods		.509		
Application of Natural Sciences Perspectives in Engineering Activity		.496		
Analysis of Technological Data		.442		
Exploitation of Modern Equipment			.651	
Readiness for Design and Using of New Information Technologies			.648	
Practical Skills for Execution of Projects			.556	
Expertise Thinking			.535	
Readiness for Assimilation of New Problems			.401	
Skills for Management of New Resource-effective Economics				.468
Readiness for Team Working				.677
Searching for Information				.542
Enterprise and Initiative Activity				.396

In investigation of Eskandari and Ebrahimi (Eskandari & Ebrahimi, 2013) is recommended the items with factors weights lower than 0,4 (marked as limited) to be eliminated. From Table 2 is evident that only the competence “Enterprise and Initiative Activity” has a lower but close to the value of 0,4 factor weight (0,396),

thus we assume all items in the scale to remain. During the consecutive analysis for the internal consistence it is proved that there is no items which removing leads to the increase of reliability.

The vocational profile of the engineer in energetics has four-factor integral structure which components have to be interpreted.

Conclusions

- The derived model allows the requirements for the successful vocational realization of the engineer in energetics to be determined.
- To the desired qualities can be related the following: planning of the carrier; ability for the generalization of information; analyzing of technological data, as well as consecutive prognoses.
- The designed scale allows information to be periodically gathered, and the dynamics of the real needs of labour market to be watched closely.

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