Method of the main components in comparative analysis of job satisfaction

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Abstract. The article presents a comparative analysis of employees’ satisfaction with the main components’ method of work. The research was carried out on the example of personnel of Stavropol State Agrarian University. The estimation of satisfaction of scientific and pedagogical workers with the work was carried out by a method of the anonymous questionnaire. A total of 629 people took part in it. The statistical analysis was conducted in SPSS Statistics (version 21). It is shown that the personnel are the main driving force of all production processes in the organisation with a client. By the example of the university personnel involved in the primary processes - educational and scientific, the specifics of work with the staff are described. The importance of implementation of permanent procedures for maintaining motivation and efficiency of employees and ensuring the optimisation of human resources potential of the organisation is emphasised. In this connection, the question of available mathematical tools and algorithms of estimation of satisfaction of the personnel with work is actual. As the tested algorithm the method of principal components and construction of a model of satisfaction with work of the staff on an example of age groups are offered: “under 30 years” - young scientific-pedagogical workers and ”51-60 years” - mature scientific-pedagogical workers. The differences in the complex of labour satisfaction factors of these categories of workers and strategic approaches in the regulation of human resources potential of the organisation are shown.

1. Introduction

The actuality of search of modern tools and algorithms of modelling of personnel processes is confirmed in scientific discussion of scientists from different countries of the world [1, 2, 3, 4, 5]. Researchers Karakhan A.A., Gambatse J., Simmons D.R. offer the tool of an estimation of stability of the workforce of the enterprises of building branch [6]. Authors based on complex application of methods of the analysis of the literature, semistructured interviews and versatile expert interrogation convincingly prove that development of labour potential provides stability of the building
organisations. The undoubted advantage of the development is the final aggregate assessment, which shows the level of stability of the labour force.

Questions of modelling of personnel processes are not only for industrial branches of the economy but also for the public administration system. Authors Gökalp E., Demirörs O., Eren P.E. suggest using the tested model for estimation of possibilities of the process of management of the state personnel [7].

For client-consuming organisations in the sphere of services and business, the vector of achieving competitiveness through personnel is relevant [8, 9, 10, 11]. The conclusions made on the example of commercial structures can be successfully applied to organisations providing educational services. Besides, it is essential to use the opinion of consumers of products and services to define the essential characteristics of personnel in modelling personnel processes [12]. This allows making a timely decision about the requirements to personnel competence and to prepare them for changes in time, providing flexibility and stability of the organisation [13].

The multifactor evaluation of labour activity plays an essential role in the modelling of personnel processes. Researchers Kirkendall C.D., Nye C.D., Rounds J. have established that correspondence between the interests of a person and his or her labour activity is positively connected with the work performed. Based on empirical data, the strategies of personnel appointment based on the professional interest of employees have been proposed [14]. In addition to this approach to the modelling of personnel processes, it is possible to use the method of author Ortiz-Vilarelle L., proposed in the publication "Academic career construction: personnel documents as personal documents. Life Writing" [15].

2. Materials and methods
The modelling of personnel processes in the organisation was carried out on the example of staff of the Stavropol State Agrarian University. The factor analysis of the results of the satisfaction of the personnel with work has been used as a method of research. The satisfaction of academic staff with the work was assessed by an anonymous survey method. A total of 629 people took part in it. The factor model was constructed using the SPSS Statistics package (version 21). The modelling was based on the evaluation of 19 indicators of job satisfaction on a scale from -5 to +5 points: 2 age groups of survey participants were identified as an independent variable: "under 30 years" - young researchers and "51-60 years" - mature researchers. The differences in the factor model of these categories of workers determine the strategic approaches to regulating the human resource potential of the organisation.

3. Building factor models of staff satisfaction with work
Factor analysis of the research database was conducted in SPSS Statistics (version 21), which made it possible to group the listed satisfaction indicators and to distinguish the enlarged groups of factors separately by age groups of the personnel: "under 30 years old" - young academic staff and "51-60 years old" - mature academic staff.

The listed 19 labour satisfaction characteristics for the category of academic staff "under 30 years" as a result of factor analysis performed by Rotation Method: Varimax with Kaiser Normalization (Rotation converged into seven iterations) were grouped into five factors.

In terms of the content of the grouped characteristics, it can be said that the set of variables determines the first factor: good relations with team members (factor load factor 0.833); respect from colleagues (factor load factor 0.803); favourable working conditions (factor load factor 0.796); interest and pleasure in work (0.660 and 0.636 respectively). Thus, the first factor can be interpreted as psychologically comfortable working conditions.

The set of variables determines the second factor is determined by the desire to do more qualified work (0.797); professional achievements and management attention to these achievements (0.702 and 0.641 respectively); professional knowledge development (0.560); setting and achieving professional
goals (0.528). Thus, the second factor can be interpreted as professional improvement and promotion under the guidance of senior mentors.

The set of variables determines the third factor: job satisfaction is more important than high earnings (0.812); dedication to work in the organisation (0.762); attracts the opportunity to learn something new (0.600). Thus, the third factor can be interpreted as the prevalence of the working interest and devotion to the organisation over material remuneration for work.

The set of variables determines the fourth factor is determined by a set of variables: high functional load in the workplace (0.800); rare job rewards (0.630); work disagreements (0.561); and failure to match a position with the ability (0.448). Thus, the fourth factor can be interpreted as a mismatch between a high functional workload in work processes and rewards for successful performance, including career progression.

The set of variables determines the fifth factor is determined by the set of variables: not satisfied with the organisation of work in the team (0.834); frequent situations of misunderstanding by the direct supervisor (0.766). Thus, the fifth factor can be interpreted as an imperfection of labour organisation and functionality at the workplace.

| Component | Initial eigenvalues % | Sums of extraction load squares % | Sums of rotation load squares % |
|-----------|-----------------------|----------------------------------|---------------------------------|
| 1         | 6.207 32.670          | 6.207 32.670                     | 3.791 19.954                    |
| 2         | 2.187 11.510          | 2.187 11.510                     | 2.705 14.235                    |
| 3         | 1.601 8.426           | 1.601 8.426                      | 2.041 10.744                    |
| 4         | 1.366 7.187           | 1.366 7.187                      | 1.978 10.412                    |
| 5         | 1.070 5.631           | 1.070 5.631                      | 1.915 10.079                    |
| 6         | 0.880 4.630           | 0.880 4.630                      | 0.705 4.212                     |
| 7         | 0.800 4.212           | 0.800 4.212                      | 0.727 4.765                     |
| 8         | 0.750 3.950           | 0.750 3.950                      | 0.734 4.885                     |
| 9         | 0.719 3.783           | 0.719 3.783                      | 0.742 4.968                     |
| 10        | 0.647 3.406           | 0.647 3.406                      | 0.750 5.043                     |
| 11        | 0.582 3.065           | 0.582 3.065                      | 0.758 5.131                     |
| 12        | 0.470 2.471           | 0.470 2.471                      | 0.775 5.288                     |
| 13        | 0.412 2.171           | 0.412 2.171                      | 0.792 5.445                     |
| 14        | 0.350 1.844           | 0.350 1.844                      | 0.809 5.599                     |
| 15        | 0.281 1.481           | 0.281 1.481                      | 0.826 5.756                     |
| 16        | 0.245 1.289           | 0.245 1.289                      | 0.843 5.914                     |
| 17        | 0.204 1.071           | 0.204 1.071                      | 0.860 6.068                     |
| 18        | 0.140 0.737           | 0.140 0.737                      | 0.877 6.225                     |
| 19        | 0.089 0.468           | 0.089 0.468                      | 0.894 6.382                     |
Table 2. Matrix of rotating components for the category of academic staff "under 30 years"

| Rotated Component Matrix | Component |
|--------------------------|-----------|
|                          | 1         | 2         | 3         | 4         | 5         |
| 1. What I do at work interests me. | 0.660     | 0.376     | 0.290     | -0.026    | -0.110    |
| 2. In recent years, I have made (achieved) success in my profession | 0.149     | 0.702     | 0.102     | -0.226    | -0.152    |
| 3. I have a good relationship with our team members. | 0.833     | 0.086     | 0.045     | -0.236    | -0.117    |
| 4. Work satisfaction is more important than high earnings. | 0.260     | -0.032    | 0.812     | -0.215    | 0.124     |
| 5. The position I occupy does not match my abilities. | -0.398    | -0.223    | 0.132     | 0.448     | 0.107     |
| 6. In my work, I'm primarily attracted to the opportunity to learn something new... | 0.190     | 0.027     | 0.600     | 0.362     | -0.312    |
| 7. Every year, I feel my professional knowledge grow. | 0.354     | 0.560     | 0.100     | -0.018    | -0.231    |
| 8. The people who I work with respect me... | 0.803     | 0.238     | 0.022     | -0.011    | -0.142    |
| 9. There are often situations in life when it is not possible to do all the work you have been entrusted with. | 0.116     | -0.031    | -0.053    | 0.800     | 0.007     |
| 10. Recently, management has repeatedly expressed satisfaction with my work. | 0.200     | 0.641     | -0.008    | 0.056     | -0.007    |
| 11. The work I do cannot be done by a person with lower qualifications. | 0.041     | 0.797     | 0.110     | 0.078     | 0.118     |
| 12. It's a pleasure to work: | 0.636     | 0.158     | 0.452     | 0.139     | -0.373    |
| 13. I am not satisfied with the organization of work in our team. | -0.120    | -0.133    | -0.081    | 0.165     | 0.834     |
| 14. I often have disagreements with my workmates... | -0.402    | 0.243     | 0.009     | 0.561     | 0.246     |
| 15. I'm rarely rewarded for my work. | -0.144    | -0.106    | -0.114    | 0.630     | 0.348     |
| 16. Even if I were offered a higher salary, I wouldn't change jobs. | -0.010    | 0.386     | 0.762     | -0.081    | -0.078    |
| 17. My direct supervisor often doesn't understand or doesn't want to understand me. | -0.326    | 0.008     | -0.006    | 0.207     | 0.766     |
| 18. Favourable working conditions have been created in the team | 0.796     | 0.230     | 0.225     | -0.005    | -0.155    |
| 19. In my work, I set and achieve goals | 0.460     | 0.528     | 0.169     | -0.187    | -0.146    |

Table 3. Conversion matrix component for the academic staff category "under 30 years"

| Component | 1   | 2   | 3   | 4   | 5   |
|-----------|-----|-----|-----|-----|-----|
| 1         | 0.711 | 0.458 | 0.334 | -0.211 | -0.360 |
| 2         | -0.109 | 0.526 | 0.341 | 0.675 | 0.373 |
| 3         | 0.261 | -0.686 | 0.454 | 0.461 | -0.207 |
| 4         | 0.513 | -0.015 | -0.737 | 0.437 | 0.055 |
| 5         | 0.389 | -0.208 | 0.154 | -0.310 | 0.828 |
Table 4 shows the full explained dispersion for the academic staff category "51-60 years". The full explained dispersion is 70.3% and is determined by six components.

The listed 19 labour satisfaction characteristics for the academic staff category "51-60 years" as a result of factor analysis performed by Rotation Method: Varimax with Kaiser Normalization (Rotation converged into seven iterations) were grouped into six factors.

According to the content of the grouped characteristics, we can say that a set of variables determines the first factor: lack of understanding or unwillingness to understand on the part of the direct supervisor (0.801), can not perform all the work assigned to you (0.703), the lack of good relations with team members (-0.681), frequent disagreements with team members (0.663), lack of correspondence of the position held by the ability (0.593), rare rewards for work (0.508). Thus, the first factor can be interpreted as dissatisfaction with the working relationship with the immediate supervisor and the team.

The set of variables determines the second factor: professional achievements and management's attention to these achievements (0.757 and 0.750 respectively); a desire to do more skilled work (0.730); reluctance to change jobs even because of higher earnings (0.705). Thus, the second factor can be interpreted as support for the professional achievements of the staff by management.

The set of variables determines the third factor is determined by a set of variables: not satisfied with the organisation of work in our team (0.805); no favourable working conditions (-0.865). Thus, the third factor can be interpreted as unrealised opportunities to improve the organisation and working conditions.

The set of variables determines the fourth factor: setting and achieving professional goals (0.817); growth of professional knowledge (0.773); high interest in work (0.679). Thus, the fourth factor can be interpreted as professional self-realisation and interest in work.
The set of variables determines the fifth factor is determined by a set of variables: respect of colleagues (0.879); extensive opportunities to learn something new (0.706). Thus, the fifth factor can be interpreted as a research activity in creative teams.

The set of variables determines the sixth factor: satisfaction with work is more important than high earnings (0.734); pleasure with the work process (0.549). Thus, the fifth factor can be interpreted as satisfaction with the work process.

**Table 5.** Conversion matrix component for the academic staff category «51-60 years old»

| Component | 1     | 2     | 3     | 4     | 5     | 6     |
|-----------|-------|-------|-------|-------|-------|-------|
| 1         | -0.664| 0.310 | -0.545| 0.329 | 0.079 | 0.225 |
| 2         | 0.425 | **0.719** | 0.245 | 0.441 | 0.146 | 0.160 |
| 3         | 0.146 | -0.486| -0.101| 0.605 | 0.561 | -0.226|
| 4         | -0.246| 0.042 | 0.341 | **-0.394** | 0.732 | 0.360 |
| 5         | 0.437 | 0.200 | -0.689| -0.411| **0.314** | -0.161|
| 6         | 0.323 | -0.328| -0.205| 0.080 | -0.150| **0.847** |

The article [16] comments regression to the main components. Here the situation is similar. If we follow the tradition of regression analysis, we will get regression on factor loads, which does not sound very nice. This equation has the form

\[ x_i = \bar{x}_i + \sum_{j=1}^{k} l_{ij} f_j + \epsilon_i \quad (i=1, 2, \ldots, m), \]

\(x_i\) – research result on \(i\)-issue; \(\bar{x}_i\) – arithmetic mean for the \(i\)-th issue, calculated for the investigated group; \(l_{ij}\) – factor load of research result \(i\)-th issue on \(j\)-th factor; \(f_j\) – the value of the \(j\)-th factor; \(\epsilon_i\) – error of reproduction by factors of result on the \(i\)-th issue; \(m\) – number of issues (\(m=19\)), \(k\) – number of factors (\(k=5\)).

In matrix form, this equation is written down as follows

\[ x = \bar{x} + Lf + \epsilon, \]

where \(x\), \(\bar{x}\) and \(\epsilon\) – columns of dimension \(m\); \(f\) – column of dimension \(k\); \(L\) – matrix of factor loadings of dimension \(m \times k\), elements of which for the first group up to 30 years are in Table 2, i.e. Table 2 is a table of factor loadings. All factors (elements of column \(f\)) have a single dispersion (variation). However, the factors are not independent (uncorrelated), and the columns of the factor loadings matrix are not normalized and mutually orthogonal.

**Principal component analysis equation.** Looking at the regression to the principal components, in matrix form, as well as inline style, we do not find any external differences, indeed,

\[ x = \bar{x} + Pz + \epsilon. \]

All elements of this matrix equation of principle component analysis have the same dimensions as in the equation of factor analysis. However, the columns of matrix \(P\) are mutually orthogonal and normalized, i.e. equality \(P^\top P = I\) is performed, where \(T\) is the transposition operator, and \(I\) is a unit matrix (identity matrix). However, in this case, the elements of the column of principle components \(z\) are independent. They have different values of dispersion (variation), which for the first group up to 30 years stand in Table 1 in the second column (first five values).

Matrix \(P\) and \(L\) are linked by equality

\[ P = LW^\top \Lambda^{-1/2} \quad \text{and} \quad L = \Lambda^{1/2} W, \]
where $W$ is an orthogonal matrix of rotation of dimensional factors $5 \times 5$ (see Table 3), $\Lambda$—diagonal matrix with dispersions of principle components on the diagonal (see the previous paragraph).

Table 6. Basis vectors (columns) of principal components

|    | 0,314 | 0,112 | 0,045 | 0,087 | 0,135 |
|----|-------|-------|-------|-------|-------|
| 0,226 | 0,121 | -0,371 | -0,100 | -0,124 |
| 0,296 | -0,158 | 0,074 | 0,242 | 0,280 |
| 0,177 | 0,090 | 0,264 | -0,472 | 0,389 |
| -0,190 | 0,212 | 0,232 | -0,083 | -0,134 |
| 0,154 | 0,221 | 0,423 | -0,175 | -0,203 |
| 0,252 | 0,130 | -0,163 | 0,068 | -0,144 |
| 0,297 | -0,010 | 0,064 | 0,325 | 0,147 |
| -0,048 | 0,335 | 0,312 | 0,384 | -0,192 |
| 0,170 | 0,235 | -0,288 | 0,105 | -0,077 |
| 0,149 | 0,371 | -0,375 | -0,027 | -0,057 |
| 0,313 | 0,083 | 0,319 | 0,027 | -0,066 |
| -0,204 | 0,229 | -0,058 | 0,101 | 0,588 |
| -0,152 | 0,436 | -0,047 | 0,036 | -0,170 |
| -0,179 | 0,322 | 0,159 | 0,262 | 0,040 |
| 0,188 | 0,257 | 0,045 | -0,524 | -0,006 |
| -0,220 | 0,313 | -0,124 | -0,026 | 0,426 |
| 0,322 | 0,034 | 0,144 | 0,195 | 0,164 |
| 0,288 | 0,071 | -0,175 | 0,012 | 0,031 |

The error vector in both equations, both factor analysis and principal component analysis, has the same value. Usually, it is assumed that the elements of this vector are independent and have the same dispersion. It follows that the matrix of mutual covariances of this vector has the form $V_c = \sigma^2 I$. The unbiased estimate $\sigma^2$, according to the results of [16], provided the full spectrum is equal to $\sigma^2 = \frac{n - 1}{(n - k - 1)(m - k)} \sum_{i=k+1}^{m} \lambda_i$, where $\lambda_i (i = k+1, \ldots, m)$ at our values $k = 5$, $m = 19$, there are elements of the second column of Table 1 from 6 to 19 (dispersions of discarded principal components). Thus, for both equations we have: $n=95$, $k=5$, $m=19$, the sum is equal to 6,569, the error dispersion is equal to $\sigma^2 = 0,496$, and the standard deviation is equal to $\sigma = 0,704$, which is not bad for the share of the explained variance of 64%.

Note: As can be seen from the comparison of the factor load matrix (Table 2) and the basis of the main components (Table 6), both methods are distinguished as the most significant same elements (the first columns of these tables, in bold).

4. Conclusion
Thus, the conducted research shows fundamental differences in the models of job satisfaction of young scientific and pedagogical workers and representatives of older generations.

19 characteristics of work satisfaction for the academic staff category "under 30 years" as a result of factor analysis performed by Rotation Method: Varimax with Kaiser Normalization (Rotation converged into seven iterations) were grouped into five factors:

- psychologically comfortable working conditions;
- professional improvement and promotion under the guidance of senior mentors;
- the predominance of working interest and dedication to the organisation over material remuneration for work;
- a mismatch between high functional load in work processes and rewards for successful work, including career progression;
- the imperfection of work organisation and functionality in the workplace.

Nineteen characteristics of work satisfaction for the academic staff category "51-60 years" as a result of factor analysis performed by Rotation Method: Varimax with Kaiser Normalization (Rotation converged into seven iterations) were grouped into six factors.
- dissatisfaction with the working relationship with the direct supervisor and the team;
- support for professional achievements of staff by management;
- untapped opportunities to improve the organisation and working conditions;
- professional self-realisation and interest in work;
- research activity in creative teams;
- satisfaction with the work process.

Comparative analysis of factor models of satisfaction of categories of personnel "under 30 years" and "51-60 years" shows the presence of similar and distinctive features.

Similar features are a distinct reflection on the imperfection of the labour organization; high interest in the labour process and desire for professional self-realisation; waiting for support from leaders and senior mentors.

Distinctive features are the assessment of the psychological microclimate (favourable in the model of satisfaction with the work of the academic staff "under 30 years" and negative in the workers of "51-60 years") and the need to continually stimulate the achievements of the academic staff category "under 30 years".

Use of the factor analysis in the modelling of personnel processes of the organisation allowed allocating areas for improvement in work with the personnel and development of its potential. These are:
1. Maintenance of high interest to the labour process and aspiration for professional self-realisation of the personnel.
2. The organisation of staff support from leaders and senior mentors.
3. Continuous encouragement of achievements of scientific and pedagogical workers of the category "up to 30 years".
4. The increasing motivation of "51-60 years old" employees in search of research activities.
5. Consolidation of interdisciplinary, multi-age project groups for participation in contests and grants.

Thus, the method of the main components and construction of the model of satisfaction with the work of the personnel on the example of different age groups are offered as the tested algorithm. The differences in the complex of labour satisfaction factors of these categories of workers and strategic approaches in regulating the organisation's human resources potential are shown.

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