STUDY OF CRITICAL FACTORS OF SOCIAL TENSION IN REGIONAL SYSTEMS

Nataliia Gavkalova¹, Nataliia Stepanenko², Oleksandr Ponomarenko³

Abstract. Purpose. The purpose of the study is to identify and study critical factors of social tension in different economic regions of Ukraine using a modern set of models for analysis and assessment of the level of social tension in conditions of transformation of the structure of modern society for timely prevention and avoidance of social disparities and uneven development. The main stages of measuring the level of social tension are highlighted: analysis and determination of a set of parameters for assessing social tension, their classification according to their impact on society, formation of a set of initial data, calculation of group integral indicators, construction of a general integral indicator of social tension. The main stages of the study of regions by the level of social tension are defined: a graphic representation of the levels of tension in the regions, the study of the dynamics of the formation of the levels of social tension, the establishment of the main factors of its formation in the regional dimension, the classification of objects by the level of social tension. Value/originality. Theoretical analysis of the content and role of social tension in the economic system was conducted, the main indicators and criteria of social tension were considered, a set of models for analysis and evaluation of social tension in various economic regions of the world and in Ukraine in particular was proposed and implemented. The thesis proposes a conceptual research model divided into two main modules: Module 1 – Assessment and analysis of social tensions; Module 2 – Building a regional development programme. Within the first module, assumptions about the criteria and indicators of social tensions are made, the boundaries of the system are determined, the external environment is described, its essential elements are highlighted and described. The selection of the criteria of social tension was carried out according to the following groups of factors: economic, demographic, political and social, the demarcation of substitutes and those that were included in the model and those that were not analysed by the researcher was carried out. Results. Multiple regression models have been constructed and the most significant variables that have the strongest influence on the resulting criterion have been selected. The second module defines the directions of development of the regions, based on all the data and models obtained previously. The main factors that are indicators of social tensions are identified, namely: the number of people with at least a school education; gross domestic product; total population; average length of study. Practical implications. With the help of economic and mathematical tools, the most important indicators of social tension were formed and determined for each region of Ukraine and the country as a whole, among which the level of income and education are the most critical. The results of the study can be put into practice to normalise the social balance in the country, to overcome the disparities in the development of different segments of the population.

Key words: social tension, population development disparity, social balance, human development index, model, analysis, assessment.

JEL Classification: B55, P23, J24

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1. Introduction

In the conditions of global political and economic crises, social tension is the most important characteristic of the diagnosis of the socio-economic system. The phenomenon of social tension can be of short or long duration. In any case, the consequence of social tension is the emergence of social conflicts, which can lead to the violation of social and national security as a whole. Permanent control over the factors of social tension, timely reaction to them and minimisation of threats arising from their occurrence are the main components of effective provision of national security.

The comprehensive and complete understanding of the nature of the phenomenon of social tension requires the definition and assessment of the parameters of its formation according to certain spheres of influence: the level of material security, tension in the sphere of employment, medical and demographic situation, living conditions.

Therefore, the relevance of the conducted research is conditioned by the need to: clarify theoretical and methodological principles of sociological analysis of social tension; identify factors, criteria and indicators of social tension in modern society; determine the nature of the impact of transformation of the social structure on the level of social tension; develop measures for comprehensive state regulation of the level of social tension.

The aim of the research is to identify critical factors of social tension in different economic regions in order to prevent social inequalities and uneven development.

2. Literature Review

A complete socio-psychological analysis of the phenomenon of social tension is provided in the monograph (Sidelnikova, Novosolova, Dmytriv, 2019), the authors of which conducted a comprehensive study of social tension that characterises a society in crisis, identified its key elements, reflected the image of social tension in public consciousness, and determined the connection between social tension and the potential of social protest.

In his research, O.V. Kredentser makes a theoretical analysis of the concept of "social tension" in the context of interdisciplinary research. The concept of "social tension" is analysed in relation to sociology, sociology of work, economics, management, social philosophy, political science and psychology, social psychology and personality psychology. The results show that this topic has been developed mainly in sociology and psychology. The study of "social tension" in terms of psychological knowledge has its own characteristics and is studied at the level of society, organisations or individuals (Kredentser, Lahodzinska, Kovalchuk 2016). A similar study of the peculiarities of the emergence of social tension at
The analysis of literature revealed a rather important problem – the selection of factors and indicators of social tension, which differ from author to author. The existing scientific studies on social tension in society allowed to identify the main stages of measuring the level of social tension: analysis and determination of a set of parameters for assessing social tension, their classification according to their impact on society, formation of a set of initial data, calculation of group integral indicators, construction of a general integral indicator of social tension. Based on this, the main stages of the study of objects (for example, regions) according to the level of social tension should be the following: a graphic representation of the levels of tension in regions, the study of the dynamics of the formation of social tension levels by regions, the establishment of the main factors of its formation in the regional dimension, the classification of objects according to the level of social tension.

Various indicators are used to measure the effectiveness of social policies. For example, the most important international indicator – quality of life – is measured by the Human Development Index, which is calculated on the basis of three indicators: life expectancy, educational attainment and standard of living, measured by GDP per capita.

The greatest attention in the research is paid to the detailed analysis and assessment of the socio-economic state of Ukrainian society. At the same time, however, it must be remembered that the problem of social tensions needs to be solved comprehensively.

The Human Development Index (HDI) is a composite indicator that characterises human development in countries and regions of the world. It is calculated annually by experts from the United Nations Development Programme (UNDP), together with a group of independent international experts, using statistical data from national institutes and international organisations and analytical developments.

According to the United Nations Development Programme (UNDP) Human Development Report ranking, Ukraine was ranked 74th on the Human Development Index in 2020. According to the data, Ukraine’s Human Development Index was 0.779 (out of a maximum of 1.000). At the same time, the values of its components were equal: the expected life expectancy in Ukraine is 72.1 years, the education index, which analyses the average duration of education of citizens, is 11.4 years, and the expected duration of education of the population is 15.1 years (Zlobina, Shulha, Bezenko, 2019).

The main reasons for the low standard of living of the population in Ukraine are: the lack of paid work for a part of the working population, low wages for working citizens, the existence of certain wage disparities, difficult working conditions, unemployment. The reasons for the high mortality rate of the population are: deterioration of health, unhealthy lifestyle, concomitant diseases, irrational nutrition, worsened environmental conditions, stress, worsened working conditions, frequent death from external causes, high number of domestic and industrial
accidents, etc. These and other negative trends associated with demographic processes are the causes of premature ageing of the population and increasing economic burden on the working population. Such crises of demographic processes provoke real and potential losses of labour force and, as a result, deformations of its sex-age structure.

The analysis of individual parameters of social tension indicates the existence of serious problems in the sphere of socio-economic development of the regions. However, a general understanding of the current situation allows for a comprehensive assessment. That is why it is necessary to bear in mind that the solution to the problem of social tensions must be systemic.

The analysis made it possible to draw conclusions about the need to use economic-mathematical methods and models to study such a problem as social tensions in society.

3. Materials and Methods
Solving such a complex and multilevel task as analysing and assessing the level of social tension requires a comprehensive and systematic approach. The conceptual model of the study consists of two fundamental modules (Figure 1).

The main objective of the first module is the analysis of research on the problem and its aggregation. On the basis of this block assumptions about the optimal and the most important criteria and indicators of social tension are made. During the formation of the mass media sphere, the system boundaries are determined, the external environment is described, the essential elements are distinguished and their description is given. It is at this stage that all further steps of the research are formed, so it is very important that this block reveals the essence of the problem to be solved as broadly as possible. Block of selection of

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**Figure 1. Conceptual model of the study "Modelling indicators of social tension"

*Source: developed by the authors*
social tension criteria: groups of factors can be divided as follows: economic, demographic, political and social. At this stage, a distinction is made between substitutes included in the model and those not analysed by the researcher. The choice of factors is subjective and may depend either on the researcher’s point of view or on the statistical information available. This block is also devoted to the construction of multiple regression models to select the most significant substitutes that have the strongest influence on the resulting criterion.

The second module is the development of a regional development programme based on all the data and models previously obtained. This block is a simulation and an answer to the questions, tasks and purpose of the research.

4. Research Results

Consider the results of implementing the proposed model using the Python programming language and regression analysis methods.

Based on the assumptions about the most important criteria and indicators of social tension, a model for assessing and analysing the human development index of countries will be built. The Human Development Index (HDI) will be the initial variable. The following indicators provided by the United Nations (Human Development Report, 2022) will be used as exogenous factors:

\[
\begin{align*}
X_0 & \quad \text{number of elderly people (65 years and older) per 100 people (aged 15 to 64 years);} \\
X_1 & \quad \text{population aged 15-64 years (million people);} \\
X_2 & \quad \text{population older than 65 years (million people);} \\
X_3 & \quad \text{total population (thousands of people);} \\
X_4 & \quad \text{population with at least school certificate (% ages 25 and older);} \\
X_5 & \quad \text{average duration of education (years);} \\
X_6 & \quad \text{gender development index;} \\
X_7 & \quad \text{life expectancy index at birth (years);} \\
X_8 & \quad \text{gross domestic product (billion US dollars).}
\end{align*}
\]

The factors that have the greatest impact on the performance indicator were selected. First, an exploratory data analysis was carried out. It includes: 1) Checking the data for the presence of all values, the absence of empty rows and columns that provide information about indices (in this case, countries), the number of observations in the data frame, the presence of empty values, and the type of data used; 2) determination of descriptive statistics (number of observations, mean, standard deviation, minimum and maximum values, as well as information by quartiles), which is clearly seen in Figure 2.

The factors that have the greatest impact on the performance indicator were selected. The most important factors were selected by building a tree, which helped to assess the importance of each factor. The result is shown in Figure 3.

Figure 3 shows that the most important factors are \(X_4\) – population with at least school education; \(X_8\) – gross domestic product; \(X_3\) – total population; \(X_5\) – average years of schooling.

Therefore, the new model was built with only these factors. The analysis of the impact of each factor on the dependent variable is presented in the form of graphs in Figure 4.

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**Table 1**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Min</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDI</td>
<td>Human Development Index</td>
<td>0.706507</td>
<td>0.031445</td>
<td>0.661000</td>
<td>0.678500</td>
<td>0.705500</td>
<td>0.734250</td>
<td>0.751000</td>
</tr>
<tr>
<td>Population, ages 65 and older (millions)</td>
<td>Population, ages 65 and older (millions)</td>
<td>6.925000</td>
<td>2.953040</td>
<td>2.953040</td>
<td>2.953040</td>
<td>2.953040</td>
<td>2.953040</td>
<td>2.953040</td>
</tr>
<tr>
<td>Mean years of schooling (years)</td>
<td>Mean years of schooling (years)</td>
<td>10.660714</td>
<td>2.547828</td>
<td>2.547828</td>
<td>2.547828</td>
<td>2.547828</td>
<td>2.547828</td>
<td>2.547828</td>
</tr>
<tr>
<td>Gender Development Index</td>
<td>Gender Development Index</td>
<td>0.997004</td>
<td>0.695136</td>
<td>0.695136</td>
<td>0.695136</td>
<td>0.695136</td>
<td>0.695136</td>
<td>0.695136</td>
</tr>
<tr>
<td>Life expectancy index at birth (years)</td>
<td>Life expectancy index at birth (years)</td>
<td>68.857143</td>
<td>5.132665</td>
<td>5.132665</td>
<td>5.132665</td>
<td>5.132665</td>
<td>5.132665</td>
<td>5.132665</td>
</tr>
</tbody>
</table>

**Figure 2.** Descriptive statistics of the model

*Source: calculated by the authors using the Python programming language and regression analysis methods*
Figure 3. Weight of each exogenous factor
Source: calculated by the authors using the Python programming language and regression analysis methods

Figure 4. Graphical representation of the relationship between factors
Source: calculated by the authors using the Python programming language and regression analysis methods
Figure 4 shows that there is a link between the influencing factors and the performance indicator. Let’s analyse the data in the form of a box-and-whisker plot. This type of chart conveniently shows the median, lower and upper quartiles, minimum and maximum sample values, and outliers. Such squares are displayed side by side to visually compare one distribution with another. The distances between different parts of the field make it possible to determine the degree of scattering (dispersion) and asymmetry of the data.

Figures 5 to 8 show the box-and-whiskers diagrams for each indicator.

The following is a multivariate linear regression model based on these factors (Figure 9).

The built model has the form (1):

\[ Y = 0.447 + 0.0028 X_4 + 0.0003 X_8 - 0.003 X_3 + 0.008 X_5 \]  

(1)

Next, the obtained model values of \( Y \) will be compared with the real ones using a distribution graph (Figure 10).

As can be seen in Figure 10 clearly shows the diagonal distribution of the results, which indicates a fairly high quality of the model. To test this hypothesis, the error value, coefficient of determination, and p-value for the parameters of the model are calculated (Figure 11).

The obtained coefficient of determination is very high and equals 0.95, which indicates a very high quality of the model. Also, general indicators of model validity were calculated, the main of which is MAE – the average absolute error, which was 0.005%.

As can be seen, the p-value for the model coefficients is very small, which means that all selected factors are statistically significant.

For a more detailed analysis of the most influential factors of social tension in Ukraine, the authors will also conduct a regression analysis by region of the country. As a dependent variable, the gross regional product per capita will be used.

The basic data for building the model are statistical information on an annual basis (2008–2019).
according to the following indicators: gross regional product (UAH million); gross regional product per person (UAH); economic activity of the population (thousands of people); employed population (thousands of people); unemployed population (according to ILO methodology) (thousands of people); average monthly wage for the period since the beginning of the year (UAH); income of the population (million hryvnias); disposable income per person (UAH); wage arrears (million hryvnias); employers’ need for labour (thousands of persons); consumer price index (%) (Serhiienko, Baranova, Yakymenko-Tereshchenko, Volosnikova, 2021).

To select the most influential factors affecting GDP, the method of stepwise inclusion of factors in the model is used. The essence of the inclusion method is to consistently include variables in the model until the regression model meets the previously established quality criteria. The order of inclusion is determined by private correlation coefficients: variables with a higher private correlation coefficient in relation to the indicator under study are included in the regression equation first. The results of modelling, the most critical factors influencing social tensions and the coefficient of determination (which indicates the quality of the built model) for Ukraine as a whole and by regions are presented in Table 1.

Based on the modelling results, the most critical indicators of social tension in Ukraine are those related to wages and incomes. That is why it is necessary to start by eliminating the negative effects of these factors.

5. Discussion

The results of the study proved that the main factors in the formation of social tensions in Ukrainian society are the level of wages, the available income per person and the level of unemployment. The situation
Figure 11. Quality indicators of linear regression and coefficients with exogenous model parameters

Source: calculated by the authors using the Python programming language and regression analysis methods

<table>
<thead>
<tr>
<th>predictor</th>
<th>coef</th>
<th>pvalue</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 intercept</td>
<td>0.322301</td>
<td>3.229651e-02</td>
</tr>
<tr>
<td>1 X4</td>
<td>0.003807</td>
<td>7.647797e-02</td>
</tr>
<tr>
<td>2 X8</td>
<td>0.000274</td>
<td>9.643131e-11</td>
</tr>
<tr>
<td>3 X3</td>
<td>-0.001998</td>
<td>1.652090e-01</td>
</tr>
<tr>
<td>4 X5</td>
<td>0.004840</td>
<td>6.888454e-01</td>
</tr>
</tbody>
</table>

varies from oblast to oblast. In the industrial regions, the first of the three factors mentioned is the most important – the level of wages; in the oblasts where agriculture and light industry are more developed, for example, the available income and the level of unemployment of the population take the first place in terms of influence. The obtained conclusions are closely connected with the results of the scientists who studied the processes of formation of ‘social tension’ at the level of society, organisation or an individual (Klebanova, Kizim, Guryanova, Nikiforova, Sergienko, 2011).

The research methodology proposed in the article develops and improves the tools for studying social tensions in Ukraine, based on the use of mathematical modelling and programming methods. A detailed analysis of correlations allowed to identify the root cause of social tensions in the regions of Ukraine – dissatisfaction with even the most basic needs of the population. This study confirms the opinion of other scientists that the lack of financial and resource support for normal life is a global problem that requires in-depth study and elaboration in order to find an effective way for the regions to get out of the socio-economic crisis.

6. Conclusions

The conducted study of the peculiarities of the formation of social tension in society allowed to identify the main stages of the measurement of the level of social tension: analysis and determination of a set of parameters for the assessment of social tension, their classification according to the impact on society, formation of a set of initial data, calculation of group integral indicators, construction of a general integral indicator of social tension.

The analysis of individual parameters of social tension indicates the existence of serious problems in the sphere of socio-economic development of the oblasts. However, a general understanding of the actual situation makes it possible to form a comprehensive assessment of it. Therefore, it should be borne in mind that the solution to the problem of social tension should be of a systemic nature. The analysis carried out allowed to draw conclusions about the necessity of using economic-mathematical methods and models for studying such a problem as social tension in society, which requires a complex and systematic approach.

The classification of variables, the construction of multiple regression models, the selection of the most significant variables that have the greatest influence on the resulting criterion were carried out using correlation analysis. On the basis of the selected factors, a multivariate linear regression model was constructed, the coefficient of determination of which is very high, equal to 0.95, which indicates its high quality. General indicators were also calculated to test the model, which proved its adequacy and statistical significance. Thus, with the help of mathematical methods, indicators of social tension were determined for each region and for the country as a whole, among which the levels of income and education are the most critical.
Table 1
Results of building a multiple regression model by regions of Ukraine

<table>
<thead>
<tr>
<th>Oblast</th>
<th>Coefficient of determination</th>
<th>Critical indicators of social tension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ukraine</td>
<td>0.9849</td>
<td>average monthly salary by region since the beginning of the year; disposable income per person, UAH</td>
</tr>
<tr>
<td>Vinnytsia</td>
<td>0.9939</td>
<td>average monthly salary by region since the beginning of the year; salary arrears (million UAH)</td>
</tr>
<tr>
<td>Volyn</td>
<td>0.9982</td>
<td>employed population by region; unemployed population (ILO methodology) by region; average monthly wage by region for the period since the beginning of the year; wage arrears (million UAH)</td>
</tr>
<tr>
<td>Dnipro</td>
<td>0.9732</td>
<td>disposable income per person, UAH; employers' need for employees by region (thousand people)</td>
</tr>
<tr>
<td>Donetsk</td>
<td>0.8846</td>
<td>employed population by region; disposable income per person, UAH</td>
</tr>
<tr>
<td>Zhytomyr</td>
<td>0.99</td>
<td>unemployed population (ILO methodology) by region; average monthly wage by region since the beginning of the year; disposable income per capita, UAH; wage arrears (million UAH)</td>
</tr>
<tr>
<td>Transcarpathia</td>
<td>0.99</td>
<td>employed population by region; unemployed population (ILO methodology) by region; average monthly wage by region for the period since the beginning of the year; disposable income per capita, UAH; wage arrears (million UAH); employers' need for employees by region (thousand people)</td>
</tr>
<tr>
<td>Zaporizhzhia</td>
<td>0.9851</td>
<td>employed population by region; unemployed population (ILO methodology) by region; average monthly wage by region for the period since the beginning of the year; disposable income per capita, UAH; wage arrears (million UAH)</td>
</tr>
<tr>
<td>Ivano-Frankivsk</td>
<td>0.9791</td>
<td>average monthly salary by region since the beginning of the year; disposable income per person, UAH</td>
</tr>
<tr>
<td>Kyiv</td>
<td>0.7893</td>
<td>salary arrears (million UAH)</td>
</tr>
<tr>
<td>Kirovohrad</td>
<td>0.8356</td>
<td>Unemployed population (ILO methodology) by oblast</td>
</tr>
<tr>
<td>Luhansk</td>
<td>0.9498</td>
<td>salary arrears (million UAH)</td>
</tr>
<tr>
<td>Lviv</td>
<td>0.9513</td>
<td>disposable income per person, UAH</td>
</tr>
<tr>
<td>Mykolaiv</td>
<td>0.9802</td>
<td>average monthly salary by oblast since the beginning of the year</td>
</tr>
<tr>
<td>Odesa</td>
<td>0.9529</td>
<td>average monthly salary by oblast since the beginning of the year</td>
</tr>
<tr>
<td>Poltava</td>
<td>0.9965</td>
<td>average monthly salary by oblast since the beginning of the year; wage arrears (million UAH); employers' need for employees by region (thousands of people)</td>
</tr>
<tr>
<td>Rivne</td>
<td>0.9747</td>
<td>average monthly salary by oblast since the beginning of the year</td>
</tr>
<tr>
<td>Sumy</td>
<td>0.9716</td>
<td>average monthly salary by oblast since the beginning of the year</td>
</tr>
<tr>
<td>Ternopil</td>
<td>0.9911</td>
<td>average monthly salary by oblast since the beginning of the year; disposable income per person, UAH</td>
</tr>
<tr>
<td>Kherson</td>
<td>0.9712</td>
<td>average monthly salary by oblast since the beginning of the year</td>
</tr>
<tr>
<td>Khmelnytskyi</td>
<td>0.9794</td>
<td>average monthly salary by oblast since the beginning of the year</td>
</tr>
<tr>
<td>Cherkasy</td>
<td>0.9883</td>
<td>unemployed population (ILO methodology) by region; average monthly wage by oblast for the period since the beginning of the year</td>
</tr>
<tr>
<td>Chernivtsi</td>
<td>0.9933</td>
<td>average monthly salary by oblast since the beginning of the year; disposable income per person, UAH; employers' need for employees by region (thousands of people)</td>
</tr>
<tr>
<td>Chernihiv</td>
<td>0.9807</td>
<td>average monthly salary by oblast since the beginning of the year</td>
</tr>
<tr>
<td>Kyiv (city)</td>
<td>0.996</td>
<td>average monthly salary by oblast since the beginning of the year; disposable income per person, UAH; employers' need for employees by region (thousands of people)</td>
</tr>
</tbody>
</table>

Source: results obtained by the authors in the course of the study, taking into account official statistical information of the Human Development Report (2020), State Statistics Service of Ukraine (2023)

The scientific novelty of the study is the proposed conceptual model of social tension research, which is divided into two modules: the assessment and analysis of social tensions and the construction of the regional development programme.

A promising direction of this research is a more detailed analysis of the causes of the formation of social tensions by regions of Ukraine, for which a regression analysis by regions of the country should be conducted. The dependent variable should be gross regional product per capita. Such an in-depth diagnosis will allow to conduct a study that will point out the most painful points of potential conflict and take the necessary measures in time to prevent social tensions from escalating into a social catastrophe. In the case of a social catastrophe, social processes become uncontrollable and unpredictable, and the consequences are destructive and irreversible.
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