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Sustainable development of united territorial communities during the conflict: turning challenges into opportunities

V. Shcherbak[1,*], M. Lyshenko[2], S. Tereshchenko[1], V. Yefanov[1], K. Vzhytynska[3], V. Yatsenko[4], A. Pietukhov[1]

[1] *Department of Economics and Entrepreneurship, Sumy National Agrarian University, Sumy, 40000, Ukraine*

[2] *Department of Marketing and Logistics, Faculty of Economics and Management, Sumy National Agrarian University, Sumy, 40000, Ukraine*

[3] *Department of Trade Enterprise and Logistics, State University of Trade and Economics, Kyiv National University of Trade and Economics, Kyiv, 02156, Ukraine*

[4] *Department of History and Socio-Economic Disciplines, Faculty of Social and Pedagogical Sciences and Foreign Philology, Municipal establishment "Kharkiv Humanitarian-Pedagogical Academy" of the Kharkiv regional council, Kharkiv, 61000, Ukraine*

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ABSTRACT

BACKGROUND AND OBJECTIVES: In the context of global challenges and local conflicts, the sustainable development of united territorial communities took on special importance. Amid military conflict, united territorial communities encountered numerous economic, social, and environmental problems. This research builds on resilience and sustainable development theories. It proposes that with appropriate support, united territorial communities can evolve into hubs of innovation and entrepreneurship even under conditions of conflict. The study necessitated the creation of strategies and programs for sustainable development and adaptation to new conditions, positing that united territorial communities, with proper development and support, could harness these challenges to foster significant entrepreneurial and innovative activities. The study's objective was to analyze the potential of united territorial communities for innovation and sustainable development in conflict conditions and to develop recommendations for supporting entrepreneurship and infrastructure development.
METHODS: To achieve the objective, a variety of methods were utilized, including multi-regression, multifactor, correlational, and comparative analysis. All analyses were carried out using STATISTICA software (version 13).
FINDINGS: The research results confirmed the hypotheses, indicating the significant potential of united territorial communities for initiating innovative projects and developing entrepreneurial initiatives. Specifically, it was discovered that the level of institutional capability and sustainable development could increase by 43.7% with the integration of effective support programs. Crucial elements impacting sustainability were pinpointed, with investments in environmental projects showing an 85% variance, socio-demographic stability exhibiting a 92.8% variance, and the development and implementation of programs for small and medium-sized business development reflecting a 92.9% variance. This demonstrated the potential for enhancing the budget efficiency of territorial communities by up to 56.4%, representing a substantial incentive for recovery and progress in the post-conflict period.
CONCLUSION: Recommendations included developing targeted programs to support innovations in the agricultural sector, tourism, and eco-initiatives, which could catalyze attracting investments and improve the quality of life in territorial communities. The importance of integrating modern technologies, supporting local entrepreneurship, and developing infrastructure were key elements for the sustainable development of united territorial communities in conflict conditions. The developed recommendations could facilitate the formation of effective development strategies for territorial communities.

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*Corresponding Author:
Email: *valeriia.shcherbak@snau.edu.ua*
Phone: +380999687135
ORCID: 0000-0002-7918-6033

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NTRODUCTION

In the context of global challenges and local conflicts, the sustainable development of United Territorial Communities (UTCs) becomes particularly significant for ensuring food security, employment, and the preservation of natural resources. This study draws upon resilience and sustainable development theories, particularly those discussed by Folke et al. (2010), Walker (2002), and Hansen (2014), to explore how UTCs can transform adversities from military conflicts into opportunities for innovation and entrepreneurship. Despite the potential threats to sustainability posed by wartime conditions, which can jeopardize the growth of these communities through the destruction of infrastructure and natural resources, and loss of livelihoods, UTCs have shown resilience. Historically, numerous countries experiencing armed conflicts have seen their territorial communities unite to face these challenges, emerging as hubs of entrepreneurial ventures and sustainable growth. Over recent decades, these conflicts have endangered the livelihoods of residents, leading to employment losses, destruction of infrastructure, degradation of nature, and the halting of agricultural activities. However, wartime conditions can jeopardize the sustainability and growth of these communities. Despite the hurdles posed by military actions, UTCs hold the potential to convert challenges into opportunities for entrepreneurship and sustainable development. Over recent decades, numerous countries have experienced armed conflicts and military actions that have profoundly UTCs. These conflicts endanger the livelihoods of residents, leading to employment losses, destruction of infrastructure, degradation of nature, and the halting of agricultural activities. Yet, despite these obstacles, UTCs can emerge as hubs of innovation, entrepreneurial ventures, and sustainable growth amidst military conflict. This study aims to uncover opportunities and strategies to bolster the sustainable development of UTCs during and after military conflicts. The research zeroes in on analyzing the effects of military actions on the communities in the Sumy region of Ukraine, pinpointing potential growth or recovery areas, and opportunities to support local entrepreneurship. To fulfill the stated objective, the study will undertake the following tasks:

- Analyse the impact of military conflicts on the communities in the Sumy region of Ukraine and their economy;
- Identify opportunities for initiating growth or recovery in these areas;
- Investigate tools and programs that support the sustainable development of communities in the Sumy region of Ukraine under military action conditions.

Based on a literature review and previous studies, the following hypotheses were posited:

H1. Territorial communities can evolve into centers of innovation and entrepreneurship during conflicts with the implementation of effective sustainable development programs.

H2. Efforts to preserve and develop infrastructure in these areas are crucial for the revival and sustainable growth of the communities.

This research seeks to validate these hypotheses and discover avenues to achieve sustainable development goals in the UTCs of the Sumy region of Ukraine amid military conflict.

Literature review

The core concepts of sustainable development in UTCs under conflict include supporting the viability and self-sufficiency of these communities. A key idea is the integration of sustainable development principles into the planning and recovery of UTCs post-conflict. This encompasses the conservation of natural resources, infrastructure recovery, support for local entrepreneurship, and ensuring access to education and healthcare for the residents of UTCs (Raja *et al.,* 2022; Shcherbak *et al.,* 2020a).

Core concepts and approaches to sustainable development in UTCs

This section delves into the essential principles and diverse theoretical-practical approaches to sustainable development in UTCs, particularly in conflict contexts. It underscores the importance of embedding sustainable development principles into the planning and recovery processes, focusing on conserving natural resources, developing infrastructure, and bolstering local entrepreneurship and access to crucial services. In contemporary theory and practice, at least seven theoretical-practical approaches to sustainable development in UTCs have been identified (Shkoda *et al.,* 2023):

The first approach

Sustainable development concepts for UTCs. The Food and Agriculture Organization (FAO) study emphasizes the necessity of incorporating sustainable development principles into the planning and recovery of UTCs post-conflict (Acunzo and Vertiz, 2014).

The second approach

Sustainability strategies for UTCs. Advocates of this theory (Roldan *et al.,* 2023), examining ecological, social, and economic aspects of sustainability in these communities, highlight their crucial role in achieving balanced regional development.

The third approach

Interaction between UTCs and urban areas for sustainability. This approach explores the potential for global sustainability through the interaction between UTC and urban processes, considering various urbanization aspects and the rural-urban relationship in sustainable development (Gutierrez-Velez *et al.,* 2022).

The fourth approach

Environmental sustainability in UTCs defines this as the outcome of rural-urban interactions, employing methods and strategies to enhance the environmental situation, especially in water resources, land restoration, waste management, and renewable energy use, based on various indicators and policy recommendations (Ilina and Shpyliova, 2021).

The fifth approach

Social inclusion in UTC development is predicated on social engagement in UTC development and addressing the issue of social participation misperception, resulting in some groups being undervalued and considered socially excluded due to confusion over "social inclusion," (Shcherbak *et al.,* 2024) "social capital," and "civic activity" (Shortall, 2008; Shcherbak *et al.,* 2020b).

The sixth approach

Tourism and sustainable development in UTCs focus on the relationship between tourism and sustainable development, promoting tourism as a catalyst for their balanced and sustainable economic, social, and environmental development (Hussain *et al.,* 2023; Rodríguez-Darias and Díaz-Rodríguez, 2023; Mwesiumo *et al.,* 2022).

The seventh approach

Resource management in UTCs emphasizes effective natural and human resource management to achieve sustainable development and optimal resource utilization to support agriculture and other activities (Leder, 2022; Harrington, 2016; Emtage and Herbohn, 2012; Walker, 2002; Loevinsohn *et al., 2002;* Higgins and Lockie, 2002).

Sustainable development goals and strategies for UTCs in conflict

This subsection explores specific goals and strategies for achieving sustainable development in UTCs during and after conflicts (Kumar, 2018). It reviews prior studies and theoretical frameworks, emphasizing the significance of safety, resilience, economic activity, environmental sustainability, social inclusion, education, healthcare, and infrastructure recovery as vital elements for the sustainable advancement of UTCs amidst adversities. Previous research in transforming UTCs under conflict has demonstrated that sustainable development goals can still be pursued during wartime (Pereira *et al.,* 2022; Beckmann and Reimer, 2014). These goals focus on ensuring the sustainability and progress of UTCs in military conflict contexts. Potential sustainable development goals for UTCs in wartime may include: Ensuring safety and resilience a primary and crucial goal in providing security for residents of UTCs. This may encompass measures for protection against military threats and delivering humanitarian aid to affected individuals (Kajus *et al.,* 2022). Conserving natural resources is essential as UTCs often serve as hubs for agricultural activities and are rich in natural resources. Promoting sustainable usage of these resources and preventing their destruction and facilitating their recovery after conflicts are vital objectives (Petrescu-Mag *et al.,* 2018; Shan *et al.,* 2017). Supporting local entrepreneurship by facilitating conditions for its development can preserve employment (Jahanshahi *et al.,* 2020) and ensure economic resilience in UTCs (Lee, 2023; Stevanović, 2016; Bruton *et al.,* 2021). Entrepreneurship plays a key role in the sustainable development of UTCs, as initiating new businesses and fostering existing

ones can provide employment, enhance economic activity, and ensure social stability. Supporting local entrepreneurship is a critical element of a sustainable development strategy. Ensuring access to education and healthcare. Maintaining operational educational and medical facilities is crucial during wars or other crisis force majeure situations (pandemic, natural disasters, etc.) to ensure population development and health (Beyene *et al.,* 2023; Shcherbak *et al.,* 2021). Preserving the cultural heritage and traditions of UTCs is an important goal to support their resilience and identity (Denton, 2017; Zhu *et al.,* 2021). Engaging international humanitarian aid, donors, and humanitarian organizations *is* crucial for providing necessary resources and assistance to UTCs in challenging times (Solana-Solana, 2010). Reintegration and recovery of UTCs, including the restoration of infrastructure, economy, and social services, become crucial after the conflict's end (Gignoux and Menéndez, 2016). Conflict can significantly impact UTCs, leading to infrastructure destruction, job losses, and economic changes. Analyzing the conflict's impact on various aspects of community life is essential to develop recovery and support strategies. These studies underline the importance of reintegration and recovery of UTCs' post-conflict, including infrastructure, economy, and social services restoration, and provide recommendations for achieving this sustainable development goal. The study, addressing the tasks of analyzing the impact of military conflicts on UTCs and their economy, identifying opportunities for growth or recovery, and investigating supportive tools and programs for sustainable development under conflict conditions, was conducted in the Sumy region of Ukraine from January to June 2023.

MATERIALS AND METHODS

Research methodology

To test the hypothesis for validity, a methodological approach consisting of the following steps is proposed:

• **Step 1** involves a detailed case study analysis of UTCs that have experienced military conflicts to uncover innovative and entrepreneurial activities initiated during these challenging times. We analyze existing support programs and infrastructure development projects to understand their roles in the recovery and sustainable development of these communities. Primary data collection is carried out through surveys among representatives from the UTCs, experts in sustainability and innovation, and participants in various support programs.

• **Step 2** leverages statistical methods to analyze the collected data, aiming to establish correlations between the presence of innovative and entrepreneurial activity in UTCs and the implementation of support programs and infrastructure projects. This step is crucial for understanding the direct impacts of these initiatives on sustainable development outcomes.

• **Step 3** focuses on synthesizing insights from the data analysis to formulate concrete recommendations for enhancing the effectiveness of future development initiatives, particularly in post-conflict recovery scenarios within UTCs. This involves proposing targeted support measures that can address identified gaps and leverage opportunities for growth and sustainability.

Conducting a case study analysis of UTCs affected by military conflict

The selection of the research method involves using a combination of quantitative and qualitative methods for data collection and analysis, including surveys of UTCs, observations on the implementation of programs, and analysis of available statistical data. Sources of information for this study include official reports from the Express Releases Publication Calendar (2023) Main Statistical Office in Sumy Oblast, scientific articles (Prohorovs, 2022; Akimov, 2022), and interviews with experts and representatives of UTCs. The scope of the study includes the analysis of implemented development programs, statistical data on UTCs, and the study of the impact of conflict on the economy and infrastructure of UTCs. The evaluation of methods and tools for analysis was conducted with consideration of their effectiveness and the ability to identify connections between different factors. Data collection and processing include statistical analysis, content analysis, and categorization of information for further comparison and conclusions regarding the impact of support programs on the sustainable development of UTCs after the end of the conflict. To enhance the methodological rigor of the case study analysis on UTCs affected by military conflict, it is crucial to specify the sample size and selection criteria. The study engaged a sample size of approximately 400 respondents, representative of the Sumy region's demographic and

Table 1: System of indicators influencing the sustainable development of UTCs in the Sumy region

Indicators	Conventional designation
Gross Product of the United Territorial Community, million UAH.	$x_{1.1}$
Infrastructure losses, million UAH.	$x_{1.2}$
The share of wages in the expenditures of the general fund, %.	$x_{1.3}$
The revenues of the general fund per capita, UAH. (financial potential of UTC)	$x_{1.4}$
Expenditures of the general fund per capita, UAH.	$x_{1.5}$
Capital expenditures per capita (UAH).	$x_{1.6}$
The share of capital expenditures in the total amount of expenditures, %.	$x_{1.7}$
Some entrepreneurship entities.	$x_{1.8}$
Some individual entrepreneurs.	$x_{1.9}$
Individual entrepreneurs, led by women, share in % of the total number.	$x_{1.10}$
Population as of 01.01.2023, people.	$x_{2.1}$
Some general secondary education institutions.	$x_{3.1}$
Some cultural and educational institutions.	$x_{3.2}$
Some recreational facilities.	$x_{3.3}$
Some restaurant businesses.	$x_{3.4}$
Some cultural-national heritage sites.	$x_{3.5}$
Losses in agriculture and land resources, million UAH.	$x_{4.1}$
Losses of the forest fund, million UAH.	$x_{4.2}$
A rating of institutional capacity and sustainable development.	$x_{5.1}$
A presence of SME development programs.	$x_{5.2}$
Budget efficiency of UTC.	$x_{5.3}$

socio-economic diversity. Respondents were selected using a purposive sampling technique to include a wide range of impacted stakeholders such as local business owners, government officials, and residents directly affected by the conflict. Data sources were comprehensive, including not only official reports but also scientific articles and firsthand interviews with these stakeholders. This approach ensured a balanced view of the impacts across different social and economic layers within the community, providing a robust basis for analyzing the effectiveness of development programs and the broader economic and infrastructural impacts.

Collection and preliminary processing of statistical data

Statistical data that can impact the achievement of sustainable development goals in UTCs during wartime include:

Economic data: Gross Regional Product (GRP), unemployment rate, market opportunities, economic structure (agriculture, industry, services), and other data regarding the economic situation. These data indicate the economic impact of the conflict on UTCs and their recovery opportunities.

Demographic data: population size, age group distribution, population structure (male, female, children), migration level (displacement), and ethnic composition. This data helps assess the war's impact on the population of UTCs and identify the need for social programs and services.

Social data: education level, access to medical services, poverty level, and security. This data helps identify the social needs of residents in UTCs and develop social support programs.

Environmental data: environmental condition, pollution level, access to natural resources. These data are important for ensuring sustainability and environmental protection in UTCs, especially during war.

Political data: the impact of political factors, including the presence of conflict, political stability, and governance, on UTCs and their ability to implement sustainable development programs.

All these initial data were collected and normalized. Conditional indicators were previously collected to determine their impact on the sustainable development of UTCs (Table 1).

Evaluation of analysis methods and tools

The initial data collected are normalized to ensure comparability across different scales and measures. This normalization involves converting all indicators into a dimensionless form, allowing for more accurate

Table 2: Results of factor analysis on the impact of individual indicators on the sustainable development level of UTCs (STATISTICA 13 listing)

Variable	Factor Loadings (Unrotated) (data). Extraction: Principal components. Marked loadings are >0,700000			
	Factor 1	Factor 2	Factor 3	Factor 4
$X_{1.1}$	0,733	-0,306	0,041	-0,004
$X_{1.2}$	-0,829	-0,371	-0,315	-0,170
$X_{1.3}$	0,153	0,256	0,364	0,173
$X_{1.4}$	0,757	-0,393	-0,268	0,051
$X_{1.5}$	-0,791	-0,350	-0,086	-0,080
$X_{1.6}$	-0,228	-0,346	-0,447	0,469
$X_{1.7}$	0,099	-0,019	-0,489	0,134
$X_{1.8}$	0,918	-0,259	0,150	0,066
$X_{1.9}$	0,929	-0,254	0,167	0,009
$X_{1.10}$	-0,129	-0,176	-0,124	-0,597
$X_{2.1}$	-0,234	0,928	0,191	-0,132
$X_{3.1}$	0,120	-0,112	0,968	0,008
$X_{3.2}$	-0,417	0,427	0,098	0,087
$X_{3.3}$	0,109	0,059	0,702	0,307
$X_{3.4}$	0,014	-0,110	0,873	-0,098
$X_{3.5}$	-0,172	0,167	0,032	0,112
$X_{4.1}$	-0,356	-0,108	-0,291	-0,855
$X_{4.2}$	-0,364	-0,093	-0,286	-0,849
Exp.Var	5,541	3,151	2,177	1,367
Prp.Totl	0,388	0,275	0,181	0,076

statistical analyses such as factor analysis, regression analysis, and cluster analysis. These methods help identify key factors influencing sustainability and pinpoint specific areas for intervention. Normalization of the initial data involves converting all indicators into a dimensionless form using Eq. 1:

$$z_{ij} = \frac{x_{ij} - \overline{x}_j}{S_j} \quad (1)$$

where x_{ij} – *is* the *j-th* indicator of the state of the *i-th* UTC; x_j – is the average value of this indicator for all UTCs; S_j – the standard deviation of this indicator for all UTCs.

Application of statistical methods for data analysis

Statistical analysis is conducted using the STATISTICA software package, applying techniques such as factor analysis to determine which indicators most significantly impact the sustainable development levels of UTCs. The results of this factor analysis help clarify the relationships among various factors and guide the development of targeted interventions. During the initial phase of data analysis, it was identified which indicators influence the sustainable development level of UTCs. This was done using factor analysis with the application of the Statistica software package. The results of this analysis are presented in Table 2.

The results of the factor analysis are interpreted as follows: the indicators that have an impact on the process are highlighted by the program in red, while those that do not have an impact are in black. Thus, Table 2 indicates that not all indicators have an impact on the sustainable development level of UTCs. Specifically, the share of wages in the expenditures of the general fund ($x_{1.3}$); capital expenditures per capita ($x_{1.6}$); the share of capital expenditures in the total amount of expenditures ($x_{1.7}$); individual entrepreneurs who are women ($x_{1.10}$); the number of cultural and educational institutions ($x_{3.2}$); the number of objects of cultural-national heritage ($x_{3.5}$) do not affect the level of sustainable development of UTCs. To address the need for a detailed discussion on how military conflicts specifically affect various dimensions of sustainability, it is crucial to recognize that conflict not only disrupts infrastructure, as indicated by the substantial factor loading of -0.829 but also significantly impacts social and economic stability. This manifests through direct damage to physical assets, disruptions in local economies, and strains on social services, all of which compound the challenges faced by united territorial communities in maintaining sustainable development. These disruptions require targeted recovery strategies that not only focus on physical rebuilding but also on restoring the social fabric and economic vitality

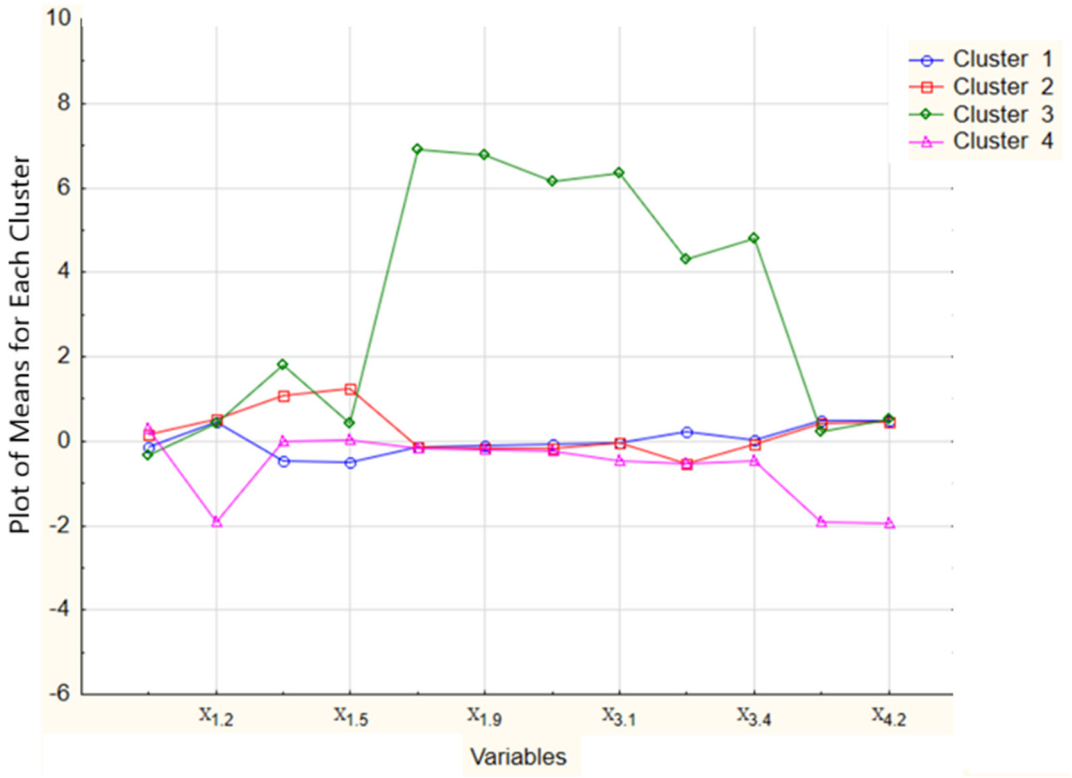

Fig. 1: The average values of the indicators of the state of UTCs in Sumy region. STATISTICA 13 listing

of these communities. Cluster analysis was used to determine how many clusters of different levels of sustainable development of UTCs were obtained and which communities entered each cluster. The construction of clusters was carried out by minimizing the root mean square deviation of all indicators (Eq. 2):

$$min\ [\sum_{i=1}^{k}\sum x(j)\in S_i \left\| x^{(j)} - \mu \right\|^2] \quad (2)$$

where $x^{(j)} \in R^n$; $\mu_i \in R^n$; μ_i – the centroid (center) of cluster R_i. Next, the centroid R_i of the cluster is determined by the principle of minimizing the root mean square deviations of indicators from the cluster centroid using Eq. 3:

$$\mu_i = \frac{1}{S_i}\sum_{x^{(j)}\in S_i} x^i \quad (3)$$

The recalculation is completed when the μ_i values do not change, which is done using Eq. 4:

$$\mu_i^{step\ t} = \mu_i^{step\ t+1} \quad (4)$$

where *step t* – is the previous iteration, and *step t+1* – is the current iteration. Discriminant analysis is used to determine potential growth points and development vectors of each cluster using Eq. 5:

$$K_i = \sum_{i=1}^{n} b_i \times a_{ij} \rightarrow max \quad (5)$$

where *i* – is the cluster number; *n* – is the number of clusters; a_{ij} – the specific weight of the impact of indices. Regression analysis is used to confirm or refute hypotheses. Statistical tests such as the t-test and F-test (analysis of variance) are used to assess the statistical significance of each regression coefficient and the model as a whole. If the p-value is less than the set significance level (usually 0.05), the hypothesis can be accepted. By integrating a robust

methodological approach with detailed data analysis, this research aims to provide actionable insights and practical recommendations for enhancing the sustainability of UTCs in post-conflict scenarios, thereby contributing to their long-term resilience and development.

RESULTS AND DISCUSSION

Analysis of the condition of UTCs in conflict situations

To analyze the condition of UTCs in conflict situations, the method of cluster analysis was applied, and clusters of UTCs were calculated. For each cluster, a chart was created, displaying the average values of the indicators for the UTCs. The chart highlights the main indicators, and each cluster is represented by a different color or symbol for visual identification (Fig. 1).

The list of clusters included in each of the four clusters is presented in Tables 3-6. The composition of the first cluster of UTCs in the Sumy region is shown in Table 3. The composition of the second cluster of UTCs in the Sumy region is shown in Table 4. The composition of the third cluster of UTCs in the Sumy region is shown in Table 5. The composition of the fourth cluster of AUTCs in the Sumy region is shown in Table 6.

Visualization of the results of the condition of UTCs in conflict situations

Visualization of the location of each territorial community by its level of development in the coordinate system: Economic-Environmental Development Level / Socio-Demographic Development Level is presented in Fig. 2.

Analysis of the obtained results allows for the comparison of the condition and characteristics of

Table 3: Composition of the first cluster (STATISTICA 13 listing)

Members of Cluster Number 1 (Data nor) and Distances from Respective Cluster Center. A cluster contains 29 cases			
Case No.	Distance	Case No.	Distance
UTC1	0,386	UTC27	0,335
UTC2	0,645	UTC28	0,553
UTC5	0,867	UTC29	0,309
UTC7	0,498	UTC30	0,439
UTC9	0,403	UTC32	0,507
UTC10	0,322	UTC34	0,284
UTC12	0,262	UTC35	0,335
UTC13	0,456	UTC38	0,337
UTC14	0,371	UTC39	0,460
UTC15	0,398	UTC41	0,400
UTC18	0,346	UTC43	0,425
UTC20	0,981	UTC47	0,534
UTC21	0,463	UTC48	0,348
UTC24	1,127	UTC49	1,669
UTC26	0,321		

Table 4: Composition of the second cluster (STATISTICA 13 listing)

Members of Cluster Number 2 (Data nor) and Distances from Respective Cluster Center. A cluster contains 11 cases			
Case No.	Distance	Case No.	Distance
UTC4	0,336	UTC37	0,263
UTC6	0,300	UTC40	0,385
UTC19	1,234	UTC44	0,219
UTC25	0,259	UTC46	0,434
UTC33	0,439	UTC51	0,343
UTC36	0,615		

Table 5: Composition of the third cluster (STATISTICA 13 listing)

Members of cluster number 3 (data nor) and distances from respective cluster center cluster contains 1 case	
Case No.	Distance
UTC42	0,00

Table 6: Composition of the fourth cluster (STATISTICA 13 listing)

Members of cluster number 4 (data nor) and distances from respective cluster center. A cluster contains 10 cases			
Case No.	Distance	Case No.	Distance
UTC3	0,362	UTC22	0,398
UTC8	0,363	UTC23	0,823
UTC11	0,564	UTC31	0,351
UTC16	0,681	UTC45	0,395
UTC17	0,216	UTC50	0,350

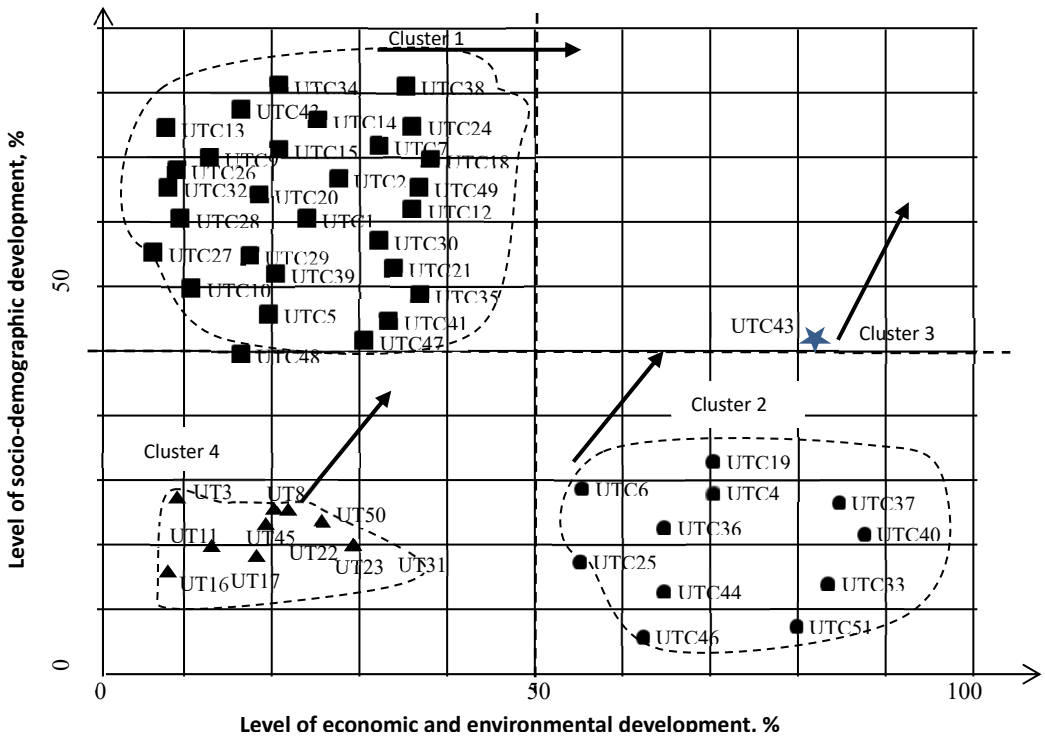

Fig. 2: Matrix for assessing the current state of UTCs in the Sumy region

UTCs in each cluster, identifying which clusters have similar characteristics and which are distinct (Table 7).

Analysis of the data in Table 7 helps to identify the main trends and issues in the condition of UTCs under conflict conditions. Such analysis enables an understanding of the diversity of UTCs and isolates the main features of each cluster for further refinement of development strategies and crisis management.

Validation of hypotheses

The evaluation of the two proposed hypotheses was conducted using multi-regression analysis.

Validation of H1

The results of the multi-regression analysis with a correlation coefficient of Multiple R = 0.66138664 and an F-value = 2.462285 at a p-value of 0.017270 indicate the statistical significance of the model for predicting the rating of institutional capability and sustainable development (dependent variable $X_{5.1}$). The R^2 value of 0.43743229 shows that approximately 43.74% of the variability of the dependent variable can be explained by the variability of the independent variables in the model. Among the significant coefficients, $X_{3.1}$ (b* = 1.02) for the number of general secondary education institutions and $X_{3.4}$ (b* = 0.831)

Table 7: Results of cluster analysis. Determining the composition of UTC clusters in Sumy region (STATISTICA 13 listing)

United Territorial Communities (UTCs) of the Sumy region	Cluster number / Number of UTCs	Identification of the level of sustainability of UTCs
Andriyashivska (UTC1); Bezdrytska (UTC2); Boromlianska (UTC5); Burynska (UTC7); Verkhni Syrovatska (UTC9); Vilshanska (UTC10); Hlukhivska (UTC12); Hrunska (UTC13); Druzhbivska (UTC14); Duboviazivska (UTC15); Kyrykivska (UTC18); Konotopska (UTC20); Korovynska (UTC21); Lebedynska (UTC24); Mykolaivska (Bilopilskyi district) (UTC26); Mykolaivska (UTC27); Myropilska (UTC28); Nedryhailivska (UTC29); Nyzhniosyrovatska (UTC30); Okhtyrska (UTC32); Putivlska (UTC34); Richkivska (UTC35); Sveska (UTC38); Seredyno-Budska (UTC39); Stepanivska (UTC41); Trostianetska (UTC43); Chupakhivska (UTC47)$ Shalyhinska (UTC48); Shostkinska (UTC49)	1 /29	Low level of economic and environmental development High level of socio-demographic development
Berezivska (UTC4); Bochechkivska (UTC6); Komyshanska (UTC19); Lypovodolynska (UTC25); Popivska (UTC33); Romenska (UTC36); Sadivska (UTC37); Synivska (UTC40); Khmelivska (UTC44); Chernechchynska (UTC46); Krolevetska (UTC51)	2 /11	High level of economic and environmental development Low level of socio-demographic development
Sumyskaya (UTC42)	3/1	High level of economic and environmental development High level of socio-demographic development
Bilopilska (UTC3); Velykopysarivska (UTC8); Vorozhbianska (UTC11); Esmanska (UTC16); Znob-Novhorodska (UTC17); Krasnopilska (UTC22); Yampilska (UTC23); Novoslobidska (UTC31); Khotynska (UTC45); Yunakivska (UTC50)	4/10	Low level of economic and environmental development Low level of socio-demographic development

Table 8: Validation of H1 through multi-regression analysis of the development level in UTCs in the Sumy region

N=51	Regression Summary for Dependent Variable: $X_{5.1}$ (Data nor) R= 0,66138664 R? = 0,43743229 Adjusted R? = 0,25977932 F(12,38)=2,4623 p<0,01727 St. Error of estimate: 0,86036					
	b*	Std.Err. of b*	b	Std. Err. of b	t(30)	p-value
Intercept			0,000	0,120	0,000	1,000
$X_{1.1}$	0,223	0,182	0,223	0,182	1,225	0,228
$X_{1.2}$	0,399	0,508	0,399	0,508	0,784	0,438
$X_{1.4}$	0,049	0,260	0,049	0,260	0,186	0,853
$X_{1.5}$	-0,100	0,272	-0,100	0,272	-0,366	0,716
$X_{1.8}$	-0,620	2,003	-0,620	2,003	-0,310	0,759
$X_{1.9}$	-0,026	2,779	-0,026	2,779	-0,009	0,993
$X_{2.1}$	-0,769	1,201	-0,769	1,201	-0,640	0,526
$X_{3.1}$	1,022	0,687	1,022	0,687	1,488	0,145
$X_{3.3}$	-0,315	0,173	-0,315	0,173	-1,819	0,077
$X_{3.4}$	0,831	0,307	0,831	0,307	2,713	0,010
$X_{4.1}$	-0,408	0,455	-0,408	0,455	-0,896	0,376
$X_{4.2}$	-0,234	0,442	-0,234	0,442	-0,530	0,599

for the number of restaurant establishments indicate their significant positive impact on the rating of institutional capability and sustainable development. Also important are $X_{1.1}$ (b* = 0.223) for the gross product of the community and $X_{1.2}$ (b* = 0.399) for infrastructure losses, highlighting the importance of economic and infrastructure factors (Table 8).

Data in Table 8 confirm H1, suggesting that UTCs can transform into centres of innovation and entrepreneurial activity during a conflict if effective sustainable development programs are implemented. Special attention should be given to the development of educational and restaurant infrastructure as key factors in enhancing institutional capability and sustainable development. Based on these results, it is recommended to focus on the development and implementation of comprehensive programs that include support for educational initiatives,

development of the restaurant business, and infrastructure restoration to promote sustainable development of UTCs in the Sumy region, even in the context of military conflict.

Validation of H2

Results of the multi-regression analysis with a high correlation coefficient (Multiple R = 0.75154353) and significant F-statistic level (F = 4.109977) at a p-value of 0.000408 indicate the statistical significance of the model for predicting the budget efficiency of the community (dependent variable $X_{5.3}$). The determination coefficient (R^2 = 0.56481768) suggests that the model explains approximately 56.48% of the variability of the dependent variable, which is relatively high. Significant coefficients in the model, such as $X_{1.4}$ (b* = 1.28) on general fund income per capita, $X_{3.1}$ (b* = 0.497) on the number of general secondary education institutions, and $X_{4.2}$ (b* = 0.280) on forest fund losses, indicate their positive impact on the budget efficiency of the community. Negative coefficients, such as $X_{1.5}$ (b* = -0.84) on general fund expenditures per capita and $X_{2.1}$ (b* = -0.35) on population size, may suggest that high expenditures and a decrease in population size negatively affect budget efficiency (Table 9).

The results (Table 9) confirm H2, which posits that measures for the preservation and development of infrastructure in UTCs can be key to their recovery and sustainable development. Particularly important is the positive impact of the financial potential of the community ($X_{1.4}$) and the development of educational infrastructure ($X_{3.1}$), indicating the need for investments in these areas to enhance the efficiency and sustainable development of UTCs. Based on these results, to achieve greater budget efficiency and sustainable development of UTCs in the Sumy region, it is recommended to focus on developing and implementing programs aimed at increasing general fund income per capita, developing educational infrastructure, as well as reducing general fund expenditures per capita and increasing attention to the preservation of natural resources.

Development of directions and programs for the development and recovery of UTCs in the Sumy region

For each of the four clusters of united territorial communities in the Sumy region, the following directions and programs for development and recovery can be proposed (Table 10).

To enhance recommendations and specify steps that local authorities or organizations can take to implement them, including policy changes, specific program development, or partnership opportunities, the following actions can be proposed:

Cluster 1: Encouraging economic activity may include developing support policies for small and medium-sized businesses in agriculture through tax incentives or subsidies, and partnerships with agrotechnology companies to implement innovative agricultural technologies.

Cluster 2: Attracting youth and professionals could involve creating municipal scholarship and grant programs for education and internships, and

Table 9: Validation of H2 through multi-regression analysis of the development level in UTCs in the Sumy region

N=51	Regression Summary for Dependent Variable: $X_{5.3}$ (Data nor) R= 0,75154353 R? = 0,56481768 Adjusted R? = 0,42739169 F (12,38) =4,1100 p<0,00041 St. Error of estimate: 0,75671					
	b*	Std.Err. of b*	b	Std. Err. of b	t(30)	p-value
Intercept			0,000	0,106	0,000	1,000
$X_{1.1}$	0,148	0,160	0,148	0,160	0,927	0,360
$X_{1.2}$	-0,156	0,447	-0,156	0,447	-0,348	0,730
$X_{1.4}$	1,284	0,229	1,284	0,229	5,609	0,000
$X_{1.5}$	-0,843	0,239	-0,843	0,239	-3,522	0,001
$X_{1.8}$	-0,277	1,762	-0,277	1,762	-0,157	0,876
$X_{1.9}$	0,109	2,444	0,109	2,444	0,045	0,965
$X_{2.1}$	-0,351	1,057	-0,351	1,057	-0,333	0,741
$X_{3.1}$	0,497	0,604	0,497	0,604	0,824	0,415
$X_{3.3}$	0,064	0,152	0,064	0,152	0,422	0,675
$X_{3.4}$	-0,074	0,270	-0,074	0,270	-0,274	0,785
$X_{4.1}$	0,032	0,400	0,032	0,400	0,080	0,937
$X_{4.2}$	0,280	0,389	0,280	0,389	0,721	0,475

Table 10: Development directions and recovery programs for territorial communities of the Sumy region

Cluster	Development directions			Recovery Programs	
Cluster 1: Low level of economic-ecological development, high level of socio-demographic development	Stimulating economic activity, and support for SMEs in agriculture. *Technologies*: Crop yield optimization software and precision farming.	Implementing environmental projects, focusing on resource conservation and green tourism development. *Technologies*: Precision agriculture for sustainable farming, eco-tourism apps.	Developing infrastructure, modernizing roads and communications to enhance accessibility and attract investments. *Technologies*: Smart transportation systems, high-speed fiber-optic networks.	Improving agricultural and environmental skills through courses and seminars. *Technologies*: Online training platforms and VR simulations for education	Creating loan and grant programs for innovation and environmental projects. *Technologies*: Blockchain for transparent funding and mobile banking apps.
Cluster 2: High level of economic-ecological development, low level of socio-demographic development	Empowering youth and professionals. *Technologies*: Online job portals and AI for talent acquisition; e-learning and teleconferencing for expanded connectivity.	Enhancing educational infrastructure with new institutions and distance learning. *Technologies*: E-learning platforms and teleconferencing for virtual classrooms.	Enhancing healthcare and wellness services *Technologies*: Telehealth platforms and wearable health devices.	Developing public health with new medical centers and preventive programs. *Technologies*: Telemedicine for remote consultations and health monitoring wearables.	Establishing cultural and sports centers to boost community engagement. *Technologies*: Online platforms for virtual events and fitness apps for sports challenges
Cluster 3: High level of both economic-ecological and socio-demographic development	Integrating with global economies to access new markets. *Technologies*: E-commerce platforms and blockchain for secure transactions.	Integrating advanced technologies to enhance community life. *Technologies*: Smart city solutions and IoT devices for efficiency	Enhancing global connectivity and trade. *Technologies*: Advanced e-commerce and blockchain	Securing international aid for infrastructure. *Technologies*: Cloud-based project management and GIS mapping tools.	Enhancing social protection and support for young families. *Technologies*: Social welfare systems and online counseling services
Cluster 4: Low level of both economic-ecological and socio-demographic development	Emergency programs for infrastructure recovery and meeting basic needs. *Technologies*: Mobile clinics for remote healthcare, solar water purification.	Boosting local governance and public participation. *Technologies*: E-government platforms and mobile voting apps.	Enhancing local governance and public engagement. *Technologies*: E-government platforms and mobile voting apps	Assisting vulnerable populations with local and international resources. *Technologies*: Crowdfunding platforms and AI-driven resource allocation.	Enhancing economic, ecological, and management literacy. *Technologies*: Online learning platforms and educational apps for financial skills.

collaborating with technology startups to develop remote work platforms, which will improve socio-demographic development.

Cluster 3: Integration with European and international economic structures might include creating specialized economic zones that attract foreign investments and improve access to international markets through digital trade platforms.

Cluster 4: Developing infrastructure in emergencies may involve government programs for infrastructure restoration and renewal, using international aid, and partnerships with nonprofit organizations to provide necessary services to the population, as well as implementing technologies to improve access to medical and educational services in remote areas.

These actions will help not only in the recovery and development of communities after conflicts but

also in creating sustainable and viable conditions for their long-term growth.

Discussion

The results of this research highlight the importance of a comprehensive approach to the sustainable development of UTCs, reflecting previous theoretical and practical developments in this field. In particular, the value of educational initiatives and the development of small and medium enterprises are emphasized, aligning with the conclusions of FAO (Acunzo and Vertiz, 2014), which indicate the necessity of integrating sustainable development principles into territorial community development planning. The analysis of the relationship between rural and urban processes in the context of sustainable development (Gutierrez-Velez *et al.,* 2022) also proved relevant to this study, highlighting the potential of UTCs as centers of innovation and entrepreneurship, even in conflict situations. The importance of environmental sustainability in UTCs is also reflected in the results (Ilina and Shpyliova, 2021), as well as social inclusion (Shcherbak *et al.,* 2020), for achieving balanced development. This indicates the need for the development and implementation of integrated programs that consider economic, social, and environmental aspects of territorial community development. Tourism in UTCs, according to studies by Hussain *et al.,* (2023) and Rodríguez-Darias and Díaz-Rodríguez (2023), is identified as playing a key role in the sustainable development of these communities, as confirmed by the results. Supporting and developing tourism within UTCs can contribute to economic activity and the preservation of the cultural heritage of these communities. Overall, the findings indicate a need for the development of a holistic policy aimed at supporting the sustainable development of UTCs through the integration of economic, environmental, and social strategies. This includes measures to support local entrepreneurship, conserve natural resources, develop education and health care, and attract international support to achieve sustainability and recovery after conflicts. Developing long-term sustainability strategies post-conflict requires a focused commitment to stable support from national and international organizations, which can provide the necessary resources and expertise. Continuous support from such entities plays a critical role in maintaining development and adapting communities to new challenges, fostering their sustainable growth and improving quality of life. Practical steps to ensure ongoing assistance include establishing long-term partnerships with key donors, developing transparent funding mechanisms, and coordinating efforts to implement specific sustainable development projects. The implementation of sustainable development policies should be accompanied by mechanisms for monitoring and evaluating investment effectiveness, ensuring sustainable recovery, and integrating the efforts of all stakeholders into community life.

Limitations and directions for future research

This study is primarily focused on the Sumy region, which limits the generalizability of the findings to the other areas without similar contextual analyses. Future research should aim to replicate this study in various contexts to enhance the robustness and applicability of the results. Additionally, while the research employs quantitative methods, integrating qualitative data could provide deeper insights into the subjective experiences of community members, offering a more comprehensive understanding of the challenges and opportunities in sustainable community development during military conflicts. It is recommended that future studies explore these dimensions to build on the foundational work presented here.

CONCLUSIONS

The research demonstrates significant potential for United Territorial Communities (UTCs) to foster innovation and entrepreneurial activity, even in conditions of military conflict. Hypothesis H1, positing that UTCs can transform into centers of innovation and entrepreneurship by implementing effective sustainable development programs, was confirmed. For instance, the indicator “Gross Product of the United Territorial Community” has a factor loading of 0.733, indicating a significant influence of economic activity on sustainable development. Hypothesis H2, suggesting the importance of measures to preserve and develop infrastructure for the recovery and sustainable development of UTCs after conflict, was also confirmed. The indicator of infrastructure losses shows a high negative factor loading (-0.829), underscoring the critical impact of military actions on infrastructure and the necessity of targeted

recovery strategies. Infrastructure, education, and healthcare investments are key elements ensuring long-term sustainability and development. The research results uncover significant opportunities for UTCs during and after conflicts. It is confirmed that with proper support and the implementation of targeted programs, UTCs are capable of not only withstanding challenges associated with conflicts but also transforming them into opportunities for sustainable development. Future research prospects include expanding the analysis to a broader range of territorial communities, studying the impact of different conflict adaptation strategies, and developing and testing innovative models of support for entrepreneurship and sustainable development in UTCs. An important direction for future research is analyzing the impact of global climate change on the resilience of UTCs and developing adaptive response strategies. The conclusions of this research may contribute to the formation of effective strategies for the sustainable development of UTCs, especially in conditions of military conflicts and global challenges. Although the study primarily focuses on the Sumy region, the findings can also be applied to other regions of Ukraine, particularly those close to active conflict zones, considering similar challenges and conditions. Furthermore, the study demonstrated that to ensure long-term resilience and development of territorial communities, it is crucial to consider not only economic and infrastructure aspects but also to integrate a deeper analysis of psychological and social dimensions of community resilience in conflict zones. This will provide a more holistic view of community needs and their sustainable development. To enhance the understanding and effectiveness of the interventions suggested, future research directions could include conducting longitudinal studies to monitor the long-term impacts and successes of these interventions in the United Territorial Communities. Additionally, expanding the scope of the research to include more regions would help to verify the generalizability of the findings and potentially uncover region-specific variables that could influence the effectiveness of sustainable development strategies. This study's findings are not only relevant to the Sumy region but also provide a methodological framework that can be adapted to investigate similar issues in other regions, offering valuable insights for researchers focusing on community resilience and sustainable development in conflict-affected areas worldwide.

AUTHOR CONTRIBUTIONS

V. Shcherbak led the conceptualization, supervised the project, and administered the project activities. M. Lyshenko was responsible for developing the methodology and drafting the original manuscript. S. Tereshchenko validated the study findings and contributed to the review and editing of the manuscript. V. Yefanov conducted a formal analysis. K. Vzhytynska carried out the investigation and was in charge of visualization. A. Pietukhov managed resources and curated data. V. Yatsenko handled the software aspects of the research.

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. Besides, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

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ABBREVIATIONS (NOMENCLATURE)

%	Percentage
AI	Artificial Intelligence
apps	Applications
E-	Electronic
Eq.	Equation
Expl.Var	Explanatory Variable
FAO	The Food and Agriculture Organization
Fig.	Figures
F-value	Fisher's criterion for testing the null hypothesis fulfillment
GIS	Geographic Information System
GRP	Gross Regional Product
IoT	Internet of Things
Multiple R	The multiple correlation coefficient between three or more variables
Prp.Totl	Percentage of the total variance explained
R^2	Coefficient of determination
SMEs	Small and Medium-sized Enterprises
STATSTICA	Statistical analysis software package
UAH	Hryvnia
UTCs	United Territorial Communities
TC	Territorial Communities
Var	Variable
VR	Virtual reality

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