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Olga A. Kozak [1]

Measuring food losses and waste in Ukraine: A review [1]

Abstract: Global challenges, including the COVID-19 pandemic, climate change, economic crises, and conflicts, have exacerbated food insecurity, with an estimated 733 million people facing hunger in 2023. Simultaneously, approximately one-fifth of food produced is lost or wasted annually, contributing to greenhouse gas emissions, resource depletion, and economic costs estimated at $1 trillion globally. Alongside Sustainable Development Goals and EU integration objectives, Ukraine has made strides in addressing food loss and waste through legislative initiatives and national strategies. However, challenges persist due to limited data, outdated methodologies, and insufficient integration of FLW-specific policies. This study aims to provide an overview of FLW measurements in Ukraine and outline conceptual steps for achieving a sustainable food future, analyzing the regulatory framework, existing research, and consumer behaviors that influence FLW. The findings highlight gaps in data collection, the need for methodologies tailored to Ukraine's agricultural and cultural context, and the lack of centralized food waste management systems. Ukrainian households, contributing significantly to agricultural production, face losses due to manual practices, inadequate storage, and traditional consumption behaviors. The study underscores the importance of developing robust national strategies, improving data collection mechanisms, and fostering collaboration among policymakers, researchers, and stakeholders to address FLW. By enhancing monitoring and implementing targeted interventions, Ukraine can reduce FLW, contributing to global food security and environmental sustainability.

Keywords: food losses and waste, agri-food chain, consumers, policy, Ukraine.

Abbreviations:

FLW is food loss and waste,

SDG is Sustainable Development Goal.

Introduction

Global shocks and stresses such as COVID-19, climate variabilities and extremes, economic slowdowns and downturns, and wars in various parts of the world have negatively impacted food security. The number of people facing hunger was estimated at 733 million in 2023, an increase of approximately 152 million compared to 2019 (*The state…, 2024*). At the same time, one-fifth of food produced for human consumption is lost or wasted globally each year (*Food waste…, 2024*), amounting to 132 kilograms per capita in 2022 (*Food waste…, 2024*).

Food losses refer to the decrease in edible food mass throughout the supply chain (from harvest and retail) that does not reenter any other utilization, such as animal feed, industrial use, etc. (*Global food…, 2011*). Food waste occurs at the end of the food chain (retail and final consumption) and is linked to the behaviors of retailers and consumers (*Parfitt et al., 2010*). The total cost of FLW to the global economy is estimated at roughly one trillion dollars US (*Addressing…, 2020*). In addition to exacerbating food insecurity and causing significant economic challenges, FLW is responsible for an estimated 8-10 percent of global greenhouse gas emissions and is a significant methane hotspot, impacting climate change and environmental sustainability (*Food losses…, 2013*). As a result, reducing FLW is a critical component of the 17 SDGs. Specifically, SDG 12 (Responsible Consumption and Production), Target 3, commits to

halving per capita global food waste at the retail and consumer levels and reducing food losses along production and supply chains by 2030 (*Transforming…, 2015*). Additionally, Target 16 of the Kunming-Montreal Global Biodiversity Framework addresses "halving global food waste by 2030." (*Food waste…, 2022*)

In Ukraine, food is lost at all stages of the value chain, from production to final consumption by households (*Assessment…, 2024*). Given the national economic development trajectory aimed at EU integration and the global significance of addressing food loss and waste, Ukraine has incorporated this issue into several legislative documents. In particular, following the other UN Member States, Ukraine joined the global sustainable development process. During the comprehensive adaptation of the SDGs in 2016-2017, each global goal was revised to account for national development specifics and to identify priorities up to 2030. In September 2017, the baseline National Report "Sustainable Development Goals: Ukraine" was approved.

In 2019, the President Decree "On the Sustainable Development Goals for Ukraine up to 2030" established that "the SDGs for the period up to 2030 are benchmarks for drafting forecast and program documents, as well as regulatory legal acts to ensure the balanced development of the economic, social, and environmental dimensions of Ukraine's sustainable development" (*On the Sustainable…, 2019*). Ukraine also developed mechanisms to monitor the implementation of the defined 86 SDG targets and 183 indicators annually. Addressing FLW is included under SDG 12, "Sustainable Consumption and Production," with Target 2 aiming to reduce FLW along production and marketing chains.

Several key documents guide the current policy of FLW in Ukraine. In November 2017, the Cabinet of Ministers of Ukraine approved the "National Waste Management Strategy for Ukraine until 2030" by Resolution No. 820-r. In February 2019, the Cabinet of Ministers of Ukraine approved the "National Waste Management Plan until 2030," developed in line with the national strategy by Order No. 117-r. Both documents are based on European directives, which Ukraine must implement under the EU-Ukraine agreements. A special section of the strategy focuses on agricultural waste, including crop waste, livestock and poultry waste, biowaste (animal and poultry carcasses), residual fertilizers, chemical and biological plant protection products, and veterinary drugs. However, food waste is not classified as a separate category but is addressed within the broader context of food industry waste, categorized as part of industrial waste. "On Waste Management," the Law of Ukraine No. 2320, dated June 20, 2022, focuses on the procedural aspects of preparing and approving waste management plans. However, this law and related regulations do not provide a comprehensive or detailed plan for food waste management. Critical issues, such as food waste across all stages of production and retail, as well as food losses, remain unaddressed in current legislative frameworks.

The most common waste management practice in Ukraine is landfilling, which accounts for about 95% of the total waste generated. On average, each Ukrainian generates about 1-1.5 kilograms of waste daily, 40-70% of which consists of food or packaging waste (*Korbut et al., 2022*). Before the Russian invasion in 2022, the volume of household waste in Ukraine was 1.5 times higher than the European average (*Filippov et al., 2023*).

For decades, Ukraine has faced significant challenges related to waste generation, storage, processing, recycling, and disposal. The country has not established a centralized system for collecting household food waste. When food waste is mixed with other waste in landfills, it

produces methane – a greenhouse gas highly detrimental to the environment and a contributor to climate change. Reducing FLW is a critical step toward conserving resources and mitigating environmental impacts. This is a priority for countries worldwide, including Ukraine.

This study aims to provide an overview of FLW measurements in Ukraine and outline conceptual steps for achieving a sustainable food future.

Methods and Materials

We employed a literature review method (*Snyder, 2019*) in this article, providing an approach for examining existing research on FLW measurements in Ukraine. The review aims to summarize and evaluate a body of literature on our specific topic: FLW measurements in Ukraine. Articles were selected using the Google Scholar academic database. Given that this area of study is relatively new in Ukraine and the number of available articles is limited, we considered scientific literature in both English and Ukrainian and grey literature (non-peer-reviewed publications). Our search keywords were food losses, food waste, and Ukraine. To identify relevant studies, we followed these steps:

(1) conducting keywords search in the selected database;
(2) selecting publications that met the inclusion criteria;
(3) scrolling the article to identify those relevant to our research;
(4) reading and analyzing the full text of selected publications.

We identified 21 references through database searches. We found nine studies after excluding records that did not meet our requirements. Among the selected publications, a series of articles authored under O. Kotykova's leadership was included. However, since all these publications followed the same methodology, we included in the table only one article out of six found, which we deemed most relevant to this study (*Table 1*).

Results

To ensure that national efforts to tackle food waste are based on robust evidence and facilitate the sharing of innovation and global best practices, reliable quantification of food waste levels is essential. One of the most comprehensive studies on FLW in Ukraine was conducted by the FAO in 2013 in Ukraine (*Food wastage…, 2013*). The study analyzed five priority agri-food chains to identify critical points of losses and waste across five stages: agricultural production, post-harvest handling and storage, processing and packaging, distribution, and consumption. The summary assessment expresses the findings as weight percentages of FLW, revealing a range from 1% to 40% depending on the agri-food chain, producer category, and supply chain stage.

In 2019, FAO launched a pilot project under the SAVE FOOD Initiative on Food Loss and Waste Reduction in two Ukrainian cities: Kyiv and Lviv. The project aimed to assist the Ukrainian government in improving municipal food waste management (*Cutting food…, 2021*). The study found that the average Ukrainian generates 230-300 kilograms of waste per year, with up to 60% of solid municipal waste consisting of organic waste, including food waste.

The Ukrainian scientific community began addressing the issue of FLW relatively recently; as a result, the number of studies in this area remains limited. The table (*Table 1*) summarizes publications by Ukrainian scientists on measuring FLW over the past decade. Among the

researchers, a group of authors under the leadership of O. Kotykova stands out for their systematic work on the issue of FLW from 2019 to 2024. This group examined various aspects of FLW in Ukraine in a series of studies. They assessed the extent of FLW, analyzed the degree of impact at different stages of the food chain (*Kotykova et al., 2020b*), summarized the causes of FLW (*Kotykova et al., 2020a*), calculated the economic damage and lost revenue resulting from FLW (*Kotykova & Babych, 2019*). Additional studies by this group further highlighted the economic, environmental, and social consequences of FLW, demonstrating that reducing food losses and waste can yield positive environmental and social outcomes (*Kotykova et al., 2021*; *Kotykova et al., 2023*; *Kotykova et al., 2024*). Their research found that approximately one out of every ten calories produced for human consumption in Ukraine is ultimately not consumed (*Kotykova et al., 2020b*). To measure FLW, the authors relied on weight percentages calculated by the FAO for various commodity groups (cereals, roots and tubers, oilseeds and pulses, fruits and vegetables, meat, fish and seafood, and milk) along the value chain – agricultural production, post-harvest handling and storage, processing and packaging, distribution, supermarkets, retail, and consumption in Europe (*Global food…, 2011*). However, the group led by O. Kotykova noted that some coefficients provided by the FAO might be insufficiently relevant for Ukraine, given the wide range of countries (42 European nations) for which the same coefficients were proposed. They argue that these coefficients require adjustment better to reflect the specific conditions and context of Ukraine.

O. O. Varchenko (*2022*) calculated the amount of FLW across various products, including meat, milk, eggs, grains and legumes, potatoes, vegetables, and fruits. These losses were analyzed at different stages: cultivation, harvesting, storage, and transportation from producer to consumer. For this purpose, the author utilized data from official statistics, specifically the report "Balances and Consumption of the Main Food Products by the Population of Ukraine." (*2020*) Additionally, a survey was conducted among managers of small, medium, and large enterprises to gather further insights.

O. V. Kovalenko and L. O. Yaschchenko (*2022*) highlight that, according to state statistics, Ukraine produces more than 250 kg of food waste per person yearly, 1.4 times higher than the average food waste generated in European countries. The authors stress that the total food waste generated annually in European countries, including Ukraine, exceeds 100 million tons. The highest volumes are recorded in the UK (15.9 million tons), Ukraine (11 million tons), and Germany (12.4 million tons).

All the reviewed studies noted a significant lack of data on FLW in Ukraine. This information gap poses a major obstacle to developing an effective national program, policy, or strategy for reducing FLW in the country.

Discussion

The absence of a national strategy on FLW in Ukraine creates challenges for the country in implementing practical approaches and practices to reduce food loss and waste at every stage of the food chain.

According to the UN Food Waste Index Report 2024, food waste in Ukrainian households is estimated at approximately 2,758,037 tons per year, or 69 kg per capita per year in 2022 (*Food*

waste…, 2024). However, these figures are provided with a "low confidence" rating, indicating that the reliability of the data is relatively low.

The FAO coefficients (*Global food…, 2011*) proposed for European countries for calculating FLW must also be revised. First, over the more than ten years since their development, changes have occurred in Ukraine's food system. Second, these coefficients are quite generalized, whereas Ukraine has specific national characteristics in food production, storage, transportation, and consumption. Although there is data from official state statistics on food losses during production, storage, and transportation for some types of products, consumers lack information on food waste. Let us now focus on some aspects of the food behavior of Ukrainian consumers that are worth considering in future assessments of FLW.

1. Ukrainian consumers spend a significant portion of their income on food, not due to an increased desire to eat but because of low incomes. In 2022, the share of consumer expenditure on food was 42.7% (*Share…, 2022*). This figure was 11.8% in Germany, 13.6% in France, 19.4% in Poland, 6.7% in the USA, 10.4% in Australia, and 20.1% in China. It can be assumed that food losses will be lower or minimal for the poorer segment of the population in Ukraine.
2. A large number of Ukrainians produce food for the needs of their families. In 2022, approximately 4 million households produced agricultural products in Ukraine. The share of households in the total production of certain products exceeded 90% (*Figure 1*). Such a significant share of household production can lead to greater losses at the production stage due to outdated, predominantly manual methods of planting, tending crops, harvesting, and caring for animals. Household products are used for their consumption, sold at local markets, or given to intermediaries. An important cultural tradition is giving food to children, relatives, or neighbors. During the war, another channel emerged, with food being donated to the military and refugees.
3. Ukrainian consumers tend to stock up on food. Purchasing large quantities of products for storage and canning home-produced goods is a traditional practice among Ukrainians. Losses can occur due to improper storage at home or expiration. The unpredictability of the food supply situation during the war has further exacerbated this tendency.
4. Ukrainians often prepare large amounts of food for celebrations. This food may go uneaten, and leftovers are sometimes thrown away (*Assessment…, 2024*). Additionally, respecting guests is an important part of the culture, sometimes leading to excessive food preparation that ultimately goes unused.

Conclusions

After analyzing the available literature and regulatory framework regarding FLW in Ukraine, several conclusions can be drawn:

1. Although the regulatory framework on FLW in Ukraine is generally satisfactory, it lacks a dedicated section on FLW, creating challenges for implementing approaches and practices to reduce FLW.
2. Data on the extent of FLW in the country is lacking, making it difficult to set specific targets for its reduction and monitor progress. Furthermore, virtually no scientific studies offer methodologies adapted to Ukrainian realities. Therefore, a mechanism for generating data

to monitor and assess the achievement of sustainable development goals is needed to address this gap.

3. Since the State Statistics Service of Ukraine is the main body responsible for recording FLW volumes, it would be beneficial to include questions on food waste at the consumer level in the existing household survey, "Expenditure and Resources of Households of Ukraine" based on a sample survey of living conditions of households in Ukraine. This would provide policymakers with representative data and allow scientists to analyze and make recommendations to those interested in reducing food waste. When formulating questions for this survey, it is essential to consider the unique eating behaviors of Ukrainians and the respondents' cultural traditions, age, and education levels.

Conflict of interest

The author declares that there is no conflict of interest.

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Appendix

Table 1. Studies on measuring food losses and waste in Ukraine

Author(s)	Study specific	Methods	Results of measurement
FAO, 2013	Identifying critical points and patterns of FLW along selected food chains in Ukraine	Methodology established by FAO and the Swedish Institute for Food and Biotechnology. Data sources: statistical data,	FLW on the stage of agricultural production range from 2.5% (large producers of wheat) to 40% (medium producers of wheat);

		existing research, key informant interviews. The five priority agri-food chain are: cereals (wheat), roots and tubers (potato), fruits and vegetables (apple), meat (pork), and milk. Stages analyzed: agricultural production, postharvest handling and storage, processing and packaging, distribution and consumption.	postharvest handling and storage accordingly from 0.5% (large producers of wheat) to 40% (small producers of apples), processing and packaging from 1% (modern producers of pork) to 30% (home processing of milk); distribution from 1% (apple processors) to 20% (small apple producers); consumption from 2% (pork) to 20% (potato).
Kotykova et al., 2020a	Determining the amount of FLW by product and region in Ukraine at each stage of the food chain (grain, potatoes, vegetables, fruits, milk, and meat), including the creation of additional product value in terms of physical volume and kilocalories in 2016	The FAO methodology (*Global food…, 2011*) utilized a mass flow model for each commodity group to account for FLW at each stage of the commodity's food supply chain	In 2016, the level of FLW in Ukraine was 18,365.8 million kcal, which accounted for 8% of the total production of the estimated products. The volume of FLW included 2,548.9 thousand tons of grain (4.9% of total grain production), 4,645.4 thousand tons of potatoes (21.4%), 3,155.3 thousand tons of vegetables (31.6%), 984.8 thousand tons of fruits and vegetables (41.3%), 816.9 thousand tons of meat (35.2%), and 1,715.3 thousand tons of milk (16.5%)
Kovalenko & Yaschchenko, 2022	Studying trends in waste management and losses in the production of raw materials and food products	Calculating the losses during the production and storage of grains and pulses (the authors' method was not described)	The share of losses in grain and pulse production in 2020 was 1.7% of total production. The share of storage losses at enterprises in 2020 was 0.6% of total production.
Varchenko, 2022	Identifying FLW along the supply chain (meat, milk, eggs, grain and legumes, potato, vegetables, fruits)	To determine the FLW, the balances of the main food products were utilized Questionnaires for managers of small, medium, and large agricultural enterprises were used	In 2020, potato losses accounted 18.1% of total produced volume, vegetables for 12-2%, fruits for 10%, grain and legumes for 1.65%, eggs for 0.32%, meat for 0.2%, milk 0.1% Based on the survey, average losses during the harvest stage of crop production range from 3% to 12%. In small and medium-sized agricultural enterprises, losses at the harvesting stage can, in some cases, reach as high as 38% of the total potential output. At the milking and transportation stage, 3% to 9% of milk is declared unfit for processing.

Source: Compiled by the author.

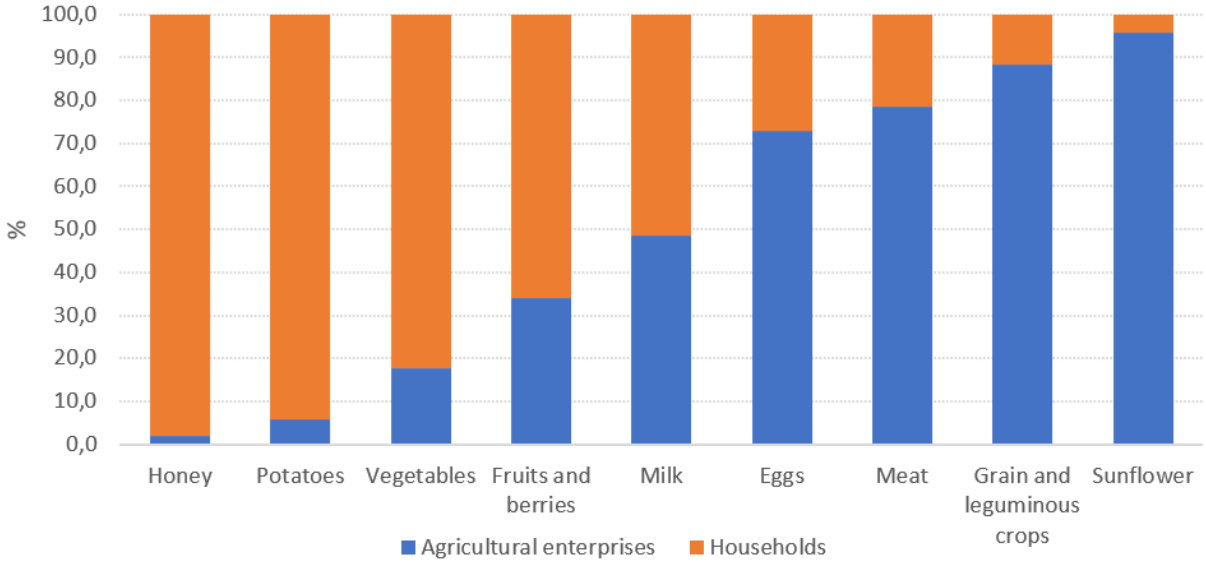

Figure 1. Figure. Share of agricultural enterprises and households in total agricultural production of Ukraine, 2022.
Source: Calculated by the author based on SSSU (*Agriculture…, 2023*)

Yaroslav M. Kostyuchenko [2]

European economic support for Ukraine: From stabilisation to recovery [2]

Abstract: The article examines Ukraine's economic recovery and integration into the European Union in the context of current geopolitical challenges. It analyses key structural obstacles, investment strategies, and policy recommendations to promote sustainable economic resilience. The study examines the role of the European Union in supporting Ukraine through macro-financial assistance, trade preferences, and regulatory harmonization. Particular attention is paid to adapting the legislative framework, the strategic use of international sanctions, and the mobilization of foreign investment. The study uses comparative analysis, systematic research, legal interpretation, and policy evaluation to assess the effectiveness of integration mechanisms and economic recovery strategies. The results contribute to understanding the long-term trajectory of Ukraine's economic alignment with the EU and global finance.

Keywords: Ukraine, European Union, economic recovery, financial assistance, integration, foreign investment, regulatory harmonization, structural reforms, international sanction.

Introduction

The European Union is one of the largest financial donors to Ukraine, providing funds both within the framework of macro-financial assistance and through unique mechanisms aimed at fostering business development. In 2023, the EU launched the *Ukraine Facility*, a €50 billion program designed to ensure macroeconomic stability, recovery, and long-term development of Ukraine from 2024-2027 (*The World Bank, 2024*). A crucial element of this program is supporting small and medium-sized enterprises (SMEs), offering accessible loans, and grant funding for innovative projects.

Furthermore, in October 2024, the EU and the Group of Seven (G7) countries agreed to jointly provide $50 billion, combining loans to support Ukraine's budget, military needs, and reconstruction efforts. This financing is sourced from the proceeds of *frozen Russian assets*, with the EU contributing $20 billion, of which the first $3.2 billion was disbursed in January 2025 (*International Finance Corporation…, 2023*).

Ukraine has significant potential for attracting foreign capital, particularly in regions without severe destruction. The western regions, which remain relatively stable, continue to be a hub of investment activity. In response, the EU is expanding its business support programs, offering grant funding for enterprise modernization and adaptation to European market standards.

At the same time, access to financing remains a serious challenge for Ukrainian companies. The share of financial aid directed toward the private sector accounts for only 5% of international funding (*Foreign direct investment…, 2024*). This creates significant obstacles for SMEs, requiring additional recovery and growth resources.

Thus, EU support during wartime is crucial for Ukraine's future economic stability. Practical international assistance should cover budgetary needs facilitate entrepreneurship, stimulate investment, and improve access to financial resources. Financial innovations, business insurance mechanisms, and increased grant support from the EU play a key role in this process, serving as essential conditions for sustainable economic recovery in Ukraine.

Materials and methods

A number of general scientific and legal research methods will be applied to comprehensively analyze Ukraine's economic recovery and integration into the European Union.

The comparative analysis method will be used to identify similarities and differences between Ukraine's national regulatory framework and EU legislation and assess the effectiveness of integration processes.

A systematic analysis will study Ukraine's economic recovery as a complex legal, economic, and political system. This approach will allow for a deeper understanding of the interdependence between institutional reforms, investment policy, and international partnerships.

Analyzing regulatory documents will contribute to an in-depth review of legislative acts, policies, and strategic agreements shaping Ukraine's economic development within the EU. This method will help assess the compliance of national policies with European legal standards.

In addition, legal interpretation will be used to ensure the correct understanding and application of European and Ukrainian legal norms, particularly in areas related to financial assistance, investment protection, and economic governance.

Together, these methods will provide a structured and objective approach to assessing Ukraine's integration into the EU, allowing for a thorough assessment of progress, challenges, and the trajectory of economic and legal harmonization.

Results

The Ukrainian business sector faces numerous challenges that significantly complicate its operations, particularly under wartime conditions with no clear political resolution. The most critical issues include a shortage of accessible financing, limited access to credit resources, low equity investments, and dysfunction within the insurance market. Mechanisms such as life and health insurance in combat zones, stringent safety requirements for construction projects – including the mandatory establishment of bomb shelters – and substantial security-related expenses impose additional financial pressure on enterprises.

The situation is challenging for small and medium-sized enterprises (SMEs) with limited access to capital and struggle to secure credit under viable conditions. Most international financial aid is directed toward supporting large companies that had resource access before the full-scale invasion. This constrains the banking sector, reducing the pool of viable borrowers. Furthermore, many Ukrainian enterprises lack access to medium – and long-term credit, further complicating their operations amid ongoing instability.

Following the outbreak of full-scale war, the European Union has become a key partner of Ukraine, providing substantial financial and economic assistance. One of the most significant decisions was the introduction of temporary trade preferences in 2022, allowing Ukrainian producers duty-free access to the EU market. Additionally, Ukraine receives macro-financial assistance through loans and grants to maintain macroeconomic stability, restore critical infrastructure, and strengthen economic resilience (*Dalevska & Boiko, 2022*).

Ukraine is actively harmonizing its legislation according to EU standards as part of the European integration process. This includes implementing European sanitary and phytosanitary

control regulations, industrial regulation, energy security, and consumer protection. These measures enhance the competitiveness of Ukrainian goods in the European market and create the foundation for further integration into the EU economic space.

The free trade area between Ukraine and the EU, which has been in effect since 2016, has significantly intensified during the war (*Doing Business…, 2022*). Export growth has been particularly notable in the agricultural sector, where key export products include grain, oilseeds, and processed agricultural goods. However, the war has led to the destruction of logistical routes, mainly due to the blockade of Black Sea ports, forcing Ukraine to expand alternative supply channels via railway and road corridors along its western borders (*Boiko, 2024*).

One of the key challenges remains the destruction of transport and energy infrastructure, complicating the stable operation of industrial enterprises and freight transportation. Ukraine has been compelled to adapt production to new conditions, diversify exports, and invest in infrastructure recovery.

The EU has imposed extensive sanctions against Russia, including restrictions on trade, financial transactions, the energy sector, and the export of critical technologies. These measures have weakened Russia's economic capacity and impacted the structure of Ukraine's economy, as specific sectors were previously dependent on trade with Russia. The sanctions policy has driven Ukraine to diversify its external economic relations actively and develop alternative energy sources (*Budiachenko, 2025*).

The EU and international financial institutions actively mobilize investments for Ukraine's economic recovery. Funding is allocated to projects related to infrastructure modernization, energy restoration, digitalization of the economy, and the development of green energy. Particular attention is given to supporting small and medium-sized enterprises as the foundation for future economic growth.

Ukraine's agricultural sector remains strategically vital to its economy, as it is one of the world's largest exporters of grain and oilseeds. The blockade of Black Sea ports has forced the EU and Ukraine to seek alternative transport solutions, leading to "grain corridors" that enable the export of agricultural products via rail and Danube ports. These measures have helped stabilize global food markets and maintain Ukraine's role as a crucial supplier of agricultural goods.

We support E. Kaka's recommendations that the EU should better adapt its investment support to the wartime situation. The European Commission (EC) could simplify and accelerate the procedures for allocating funds to infrastructure projects, particularly in the energy sector. To enhance the capacity of the Ukrainian administration at the regional level, it would be advisable to subsidize the development of teams of officials responsible for investment projects and provide them with training in areas such as strategic planning and project management.

In the private sector, the EC could further increase the availability of war risk insurance. Financial institutions implementing EU assistance could expand their advisory services for Ukrainian companies on project preparation and implementation while increasing the presence of their representatives on the ground.

To ensure Ukraine's efforts to improve the regulatory environment for business, the EC should strictly apply the conditionality mechanism for reforms in the rule of law sector and work towards a smooth negotiation process for accession. Additionally, the Ukrainian

authorities and the European Commission could facilitate effective communication with foreign investors regarding the progress of reforms in Ukraine (*Kaka, 2024*).

The EU's financial assistance consists of highly concessional loans financed through joint borrowing, utilizing the debt management infrastructure established for funding the recovery mechanism under NextGenerationEU and backed by the EU budget. The EU's decision to lend money rather than donate it directly, as the US did until July 2024, is particularly notable in this context. In the short term, unlike those provided by the IMF, EU loans do not impose an immediate financial burden on the Ukrainian government. Loan repayments will not begin before 2033, and the EU has exceptionally agreed to cover Ukraine's interest payments and other associated loan costs. Additionally, the repayment period extends over 35 years, reducing the annual financial obligations. These highly favorable conditions, alongside the unprecedented volume of funding allocated to a non-EU country, reflect significant political efforts to leverage the EU's financial capabilities in line with geopolitical considerations.

In this regard, L. Spielberg's observation that EU support for Ukraine since 2022 has been crucial is particularly relevant. While the EU has not agreed on large-scale budgetary grants, it has used its new borrowing powers to finance most international financial aid to Ukraine. It has offered exceptionally favorable loan conditions and introduced a new budget guarantee framework to support third countries on an unprecedented scale. At first glance, the EU's lending approach carries risks for the EU budget, and political-economic factors make it unlikely that member states will proactively cancel Ukraine's debt obligations. Nevertheless, the EU has various alternatives to outright debt forgiveness, both technical and political, that could mitigate the impact of its loans on Ukraine's public finances. The European Commission's recent proposal to allocate revenues from sanctioned Russian assets to finance another emergency loan for Ukraine underscores the EU's central role in ensuring international financial support (*Spielberg, 2024*).

In conclusion, our research highlights the following key areas shaping Ukraine's future strategic relationship with the European Union:

1. Economic challenges and structural barriers

The Ukrainian business sector faces profound structural challenges exacerbated by the ongoing war, with no immediate resolution. The most pressing issues include a lack of accessible financing, limited credit availability, and an underdeveloped insurance market. These factors disproportionately impact small and medium-sized enterprises (SMEs), restricting their ability to secure necessary capital for sustainability and growth. While large corporations' benefit from international financial aid, SMEs remain vulnerable due to their constrained access to credit, which impedes economic diversification and resilience.

The destruction of critical infrastructure, particularly in the transport and energy sectors, presents another significant barrier to economic stability. The blockade of Black Sea ports and the need for alternative supply chains have forced Ukraine to adapt its logistics, further straining resources rapidly. These challenges highlight the necessity for targeted economic policies that promote business continuity and foster new avenues for trade and investment.

2. The role of the European Union in Ukraine's economic resilience

The European Union has emerged as Ukraine's primary economic partner, offering substantial financial support through concessional loans and macro-financial assistance. The

introduction of temporary trade preferences in 2022, which granted Ukrainian businesses duty-free access to EU markets, played a crucial role in maintaining trade flows. Furthermore, the EU's commitment to harmonizing Ukrainian legislation with European standards accelerates the country's long-term economic integration with the bloc.

Despite these efforts, concerns remain regarding the sustainability of financial assistance. The EU's preference for issuing loans rather than grants contrasts with the U.S. approach, which focused on direct financial aid until mid-2024. While these loans offer highly favorable terms – such as a 35-year repayment period and deferred interest payments – their long-term impact on Ukraine's fiscal health requires careful consideration. Effective debt management strategies will be essential to prevent future economic burdens and ensure the viability of Ukraine's post-war recovery.

3. The necessity for strategic investment attraction

Attracting foreign investment remains a critical priority for Ukraine's economic recovery. However, the perception of high risk among international investors limits large-scale capital inflows. Many foreign businesses view economic activity in Ukraine as a form of humanitarian aid rather than a profitable venture. To counter this, Ukraine must enhance its investment climate by:

- Ensuring regulatory transparency – Strengthening legal protections for investors and streamlining bureaucratic processes.
- Showcasing successful investment cases – Highlighting foreign companies that have successfully navigated Ukraine's economic environment.
- Expanding risk insurance mechanisms – Encouraging the EU to broaden insurance coverage for enterprises operating in high-risk conditions (*Transparency International Ukraine, 2020*).

Combined with EU-driven financial support, these measures will enhance investor confidence and stimulate new business ventures in key sectors such as energy, infrastructure, and digital industries.

4. The strategic use of sanctions and confiscated Russian assets

The EU's imposition of wide-ranging sanctions against Russia has significantly impacted both economies, restricting trade, financial transactions, and access to critical technologies. While these sanctions have weakened Russia's economic capacity, their effectiveness in supporting Ukraine depends on long-term enforcement and strategic utilization.

The proposal to repurpose revenues from frozen Russian assets to finance Ukraine's reconstruction demonstrates a shift in EU policy toward leveraging economic measures for geopolitical stability. This approach strengthens Ukraine's fiscal position and sets a precedent for future international financial interventions in post-war rebuilding efforts.

5. Policy recommendations for sustained economic recovery

To ensure sustainable economic growth and integration into global markets, Ukraine and its international partners must adopt a multifaceted approach:

- Accelerating EU investment adaptation – To accelerate post-war recovery, the European Commission should streamline funding allocation procedures, particularly in the infrastructure and energy sectors.

- Enhancing public-private collaboration – Strengthening partnerships between government institutions, financial entities, and businesses will facilitate targeted investment strategies.
- Improving economic governance – Enforcing anti-corruption policies and aligning Ukraine's business environment with international best practices will foster long-term economic stability (*Skorik, 2024*).

Ukraine's economic resilience depends on a balanced strategy integrating immediate financial support with long-term structural reforms. The collaboration between Ukraine, the EU, and international financial institutions must remain adaptive to evolving geopolitical and economic conditions to ensure sustained recovery and future prosperity.

Conclusion

Strategies for supporting Ukrainian businesses and attracting investments

Implementing innovative and flexible approaches to supporting Ukrainian businesses is crucial to addressing the challenges caused by the war and stimulating economic recovery both during the conflict and in the post-war period. A coordinated effort between international financial institutions, development organizations, Ukrainian state institutions, and the private sector can establish optimal support mechanisms.

Short-term measures to support businesses:

- Providing financial assistance for working capital;
- Offering risk insurance for enterprises operating in war conditions;
- Expanding access to international markets through trade facilitation measures;
- Providing consulting and mentoring support for entrepreneurs navigating the crisis.

Medium-term initiatives to attract investments:

- Creating a favorable investment environment with stable regulatory policies;
- Stimulating technological innovations and modernizing production facilities;
- Developing critical infrastructure, including transportation and logistics networks.

Despite the ongoing war, Ukraine remains an attractive market for investors due to several key advantages:

- *European integration and access to European markets*: Simplified trade procedures and enhanced economic cooperation with the EU facilitate smoother cross-border transactions.
- *Resource potential*: Abundant deposits of raw materials with strong global demand.
- *A sizable consumer base*: Over 40 million potential consumers.
- *A skilled and competitive workforce*: Strong capabilities in high-tech industries and engineering sectors.

However, some investors perceive Ukraine as a high-risk market, viewing economic engagement as humanitarian assistance rather than a commercially viable opportunity. To shift this perception, the following actions are necessary:

Ensuring transparency and predictability of economic policy:

- Strengthening legal frameworks to provide clear regulations for investors;
- Establishing transparent business practices and simplifying bureaucratic procedures;

- Enhancing anti-corruption measures to foster a more secure investment climate.

Demonstrating successful investment cases:

- Showcasing international companies that are successfully operating in Ukraine;
- Launching incentive programs to support new investors entering the Ukrainian market.

Engaging with global investors:

- Effectively communicating the long-term benefits of investing in Ukraine;
- Building trust through strategic international partnerships and comprehensive risk insurance mechanisms.

Sustainable support for the private sector, both during and after the war, depends on implementing comprehensive financial mechanisms. The key steps include:

- *Structural reforms*: Improving the business climate and aligning Ukrainian legislation with EU standards.
- *Strengthening international financial assistance*: Expanding business grant programs and investment mechanisms.
- *Utilizing frozen Russian assets*: Leveraging international legal frameworks to redirect confiscated assets toward Ukraine's economic recovery.

These initiatives require international coordination, a balanced approach, and careful consideration of legal, economic, and political factors. Only through such measures can Ukraine establish a stable economic foundation for post-war recovery and ensure deeper integration into the global economic system.

Conflict of interest

The author declares that there is no conflict of interest.

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Maksym S. Mudryi [3]

The paradigm of partnership relations as the basis for the emergence and development of cross-cluster partnership [3]

Abstract: The need to study the signs and characteristics of cross-cluster partnership because of the factors of the emergence of this phenomenon and the regularities of its development led to the analysis of the concepts of "partnership" and "cluster." The study aims to analyze the scientific achievements of scientists regarding the concept of "partnership." The article considers the existing scientific doctrine of "partnership." The key signs and characteristics of partnership are analyzed. The economic capabilities of clusters and the features of their internal development and functioning are summarized. The author used scientific research methods such as dialectical, system analysis, analysis and synthesis, and generalization. Based on the study results, the author concluded regarding the desire of clusters to cooperate in the form of macro-cluster formations, which are characterized by signs of partnership. The presence of standard features between the scientifically studied concept of "partnership" and the joint activities of clusters in the form of macro-cluster formations gives grounds to assert the partnership factor, which leads to the emergence of macro-cluster formations.

Keywords: cluster, connectivity, cross-cluster partnership, intercluster partnership, interregional cooperation.

Introduction

The lack of a normative and scientific definition of the concept of "cross-cluster partnership," considering the stimulating factors of this phenomenon's emergence and the regularities of its development, determines the relevance of the analysis of the existing scientific doctrine regarding the concepts of "partnership" and "cluster."

The study aims to analyze scientists' scientific achievements regarding the concept of "partnership," its features, and its characteristics. It also investigates the manifestation of partnership in cluster management and the influence of the partnership factor on the cooperation of clusters within macro cluster formations.

Based on the purpose, the following tasks were solved:

- analyze internal content and characteristics of the concept of partnership;
- analyze the content of the business partnership as a special form of partnership;
- present concentration of business partnership as a factor in a new form of partnership.

The author used scientific research methods such as dialectical, system analysis, analysis and synthesis, and generalization.

Scientists such as M. Porter, M. Enright, S. Rosenfeld, M. Storper, P. Maskell, J. Kortright, O. Solwell, G. Lindqvist, K. Ketels, M. Voinarenko, V. Dubnytsky, S. Sokolenko, O. Amosha, N. Trushkina, V. Shiposha, M. Gudz, O. Zadoya, G. Pyatnytska, O. Samborsky, etc. have studied issues related to the development of economic clusters.

Despite the wide range of research in Ukrainian science on cluster topics and the characteristics of business communities, some issues require further consideration. Among them is the determination of the characteristics of cross-cluster partnership as a modern and effective form of economic recovery of Ukraine in the post-war period. The relevance of this

issue and its problems determines the direction of the author's scientific research and its goal and objectives.

Results

Internal content and characteristics of the concept of partnership

When studying the history of forming partnerships in business relations, it is worth paying attention to the origin of this concept. The term "partnership" comes from the English word "part."

Plato wrote, "A city, in my opinion, is born when each of us is insufficient for himself and needs many." From this, it follows that the basis of partnership is the unification of people's activities through joint participation to ensure effective joint activity.

Michael Porter considered partnerships to be "commercial relations" and "legal rules of competition," and he emphasized that the further development of the economy depends on "strengthening the role of contracts and agreements." (*Porter, 2020*)

In the monograph, N. Chukhray and Ya. Kryvoruchko state that when establishing partnership relations, in addition to suppliers, manufacturers, intermediaries, and consumers, attention should be paid to the relations of the enterprise with other institutions. According to these researchers, the main areas of partnership relations are worth dividing into five areas, and the most important are the relations of the enterprise with subjects of the internal and external environment. In particular, relations with subjects of the internal environment involve establishing relations with the enterprise's personnel, organizational units, and shareholders. Relations with the external environment include business partnerships with relevant intermediaries, end consumers, customers, influential institutions, suppliers of resources, and service providers (*Ganushchak-Efimenko et al., 2018*).

In the broadest sense, partnership is a form of organization of social life that aims to create balanced relations between people and recognize and support their autonomy and self-sufficiency to achieve mutually beneficial results.

Partnership has several characteristic features that distinguish it from other forms of relations:

(1) Horizontal orientation of social interaction. Potential partners should take an equal part in forming joint social activity.
(2) Individualistic approach of the relationship participants. The partnership participants maintain a distance from the other side of the dialogue, which contributes to the priority consideration of their own interests.
(3) Interdependence in achieving the desired results.
(4) Contractual nature of decision-making.
(5) Consensus orientation in the formation of social relations.

Thus, the study of the economic essence of partnership relations provides grounds for identifying their common characteristics, among which the following are of particular importance: the voluntary and contractual nature of the relationship, the common goal of the activity, unity of interests, joint responsibility, and risks. Based on these aspects, a business partnership can be considered as a set of various types of interactions performed based on

voluntary contractual relations aimed at combining or distributing resources, joint responsibility, and risks to protect and strengthen the competitive position in the market and achieve positive results of activity (*Krekhovskaya, 2014*).

The content of the business partnership as a special form of partnership

The theory of cluster economic management emerged as a theory that studies the formation and development of economic competitiveness. Its peculiarity is that it defines a new structural element – a cluster – in the set of competitive entities. The cluster is a new tool for organizing the economy, promoting its dynamic development, and being the principle of implementing state policy in the regions. This theory is widely used in different countries.

The term "cluster" means a group, accumulation, or gathering (e.g., people, objects) or very close elements; it can also mean a bee swarm. That is, the term "cluster" has many meanings, but the main essential feature of its essence is the union of individual elements (particles) so that they form a single whole to perform a certain function or achieve a specific goal (*Mulyar, 2014*).

According to N.M. Vnukova, a modern cluster is a voluntary partnership association based on territorial grounds of goods producers with suppliers and other institutions, aimed at obtaining aggregate economic benefits based on the comprehensive satisfaction of their production requirements and consumer requests (*Vnukova, 2007*).

According to domestic cluster participants, a cluster is not just a group of companies but goes much further. This helps expand opportunities for business development and self-development. The cluster provides joint communication within the group and with the outside world, authorities, and educational institutions. It also offers the opportunity to gain new knowledge, skills, and other benefits.

According to research and calculations, companies operating in a cluster automatically occupy a more advantageous position than independent businesses. Clusters provide the following opportunities:

(1) Strengthen the specialization and division of labor processes between participants.
(2) Attract a wider range of customers through close interaction between producers and consumers of services.
(3) Reduce the cost of services and products manufactured and sold based on joint activities.
(4) Strengthen the flow of ideas and information between participants.
(5) Increase the level of innovation in the production of services.
(6) Use local natural resources more effectively.
(7) Create healthy social capital and balance market efficiency and social harmony.

According to scientists A.V. Karpenko and N.M. Karpenko, competition in an economic cluster has a "soft" nature, which means that the rivalry between its participants is based on the principles of partnership and complementarity. This contributes to establishing mutually beneficial relations, characterized as competitive interaction. In this process, participants in an economic cluster unite on the principles of competition and partnership, jointly create added value, and agree on its distribution to achieve mutual benefit (*Karpenko & Karpenko, 2023*).

Studying the world experience of economic clusters, it is worth considering that the cluster strategy requires significant time to achieve actual results. A successful cluster can flourish no earlier than 5-6 years after its creation. This is explained by several factors: it is necessary to

ensure mutual trust between the partners, establish effective communications for exchanging knowledge and innovations, and develop an effective organizational and economic mechanism for cooperation (*Grebeshkova & Gaivoronskaya, 2012*).

According to H. Mazur, initially, greater productivity of cluster participants is achieved through the use of natural, geographical, and historical advantages inherent in a specific territory and its resources (e.g., land, mining, human or recreational). However, these advantages alone cannot be used without establishing effective and high-quality production of goods or a set of services. This is necessary to create direct and permanent trusting relationships between participants in the technological process based on their mutual interest in joint activities. At the same time, the effect of scale is manifested in increasing production volumes and reducing transaction costs. Therefore, the cluster development organization aims to improve business competitiveness (*Mazur, 2022*).

Thus, research shows that a cluster, as a sustainable partnership of enterprises, organizations, and individuals, has excellent potential that exceeds the simple sum of the potentials of individual components. This increase occurs due to the effective use of opportunities and long-term cooperation of partners, a combination of collaboration and competition. Practically speaking, we can talk about a specific synergistic effect that clusters create (*Sovershenna, 2017*).

Concentration of business partnership as a factor in a new form of partnership

Cluster partnerships constitute a significant part of the industrial landscape in Europe. They are dynamic geographical concentrations of interconnected firms and economic entities that have reached a sufficient scale to develop specialized expertise, services, resources, suppliers, and skills. According to the European Cluster Collaboration Platform, such cluster partnerships comprise various participants, including business companies, research institutions, science and technology parks, financial service providers, non-profit organizations, etc. (*Shkoda, 2022*)

Investigating the issue of cluster partnerships, M.S. Shkoda notes that the role of cluster partnerships in the EU is to solve the following tasks:

- providing strategic guidance on recovery and other systemic problems;
- developing and implementing industrial policy using multi-level governance;
- ensuring communication between entities from different EU Member States, regions, and their industrial ecosystems;
- managing the process of entrepreneurship development within the framework of smart specialization strategies;
- active participation in retraining and upskilling;
- expanding international markets for non-EU countries;
- directing EU public funding to support small and medium-sized businesses;
- creating its potential to promote cooperation, capital development, and dissemination of technological and market information and provide specialized services (*Shkoda, 2022*).

Thus, cooperation between clusters can form a consortium characterized by short-term ties. Experience shows that the most effective collaboration is between 3-5 clusters of a grouping. This size of the consortium allows for specific actions and cooperation and simplifies the

achievement of a common understanding for coordinating a single international strategy (*Ganushchak-Efimenko, 2018*).

Conclusion

Clusters strive to cooperate in the form of macro-cluster formations, which, by their nature, are characterized by partnership features. Thus, participants in micro-cluster formations directly engage in joint actions to solve systemic problems in the economic sector. In contrast, thanks to multi-level management, each participant retains the individualism of their interests. The interdependence of participants in achieving a specific goal and their desire to find consensus on multi-level management of regions and ecosystems leads to the coordination of a single strategy. The presence of standard features between the scientifically researched concept of "partnership" and the joint activities of clusters in macro cluster formations gives grounds to assert the partnership factor as one that leads to cross-cluster partnerships.

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Anna Yu. Munko [4]

Formation of a conceptual framework for interaction between local self-government bodies and non-governmental organizations in Ukraine [4]

Abstract: Non-governmental organizations in Ukraine, as subjects of public administration on the one hand and part of civil society on the other, play an essential role in supporting social, economic, and environmental initiatives, as well as in shaping policy and influencing management processes through mechanisms of public consultations and participation in the development of legislation. The article aims to substantiate modern forms and mechanisms of interaction between local councils and non-governmental organizations in the context of overcoming the humanitarian crisis, as well as recommendations for optimizing this cooperation to increase the social resilience of communities. To achieve this goal, methods of analysis and synthesis, comparative analysis, content analysis, modeling, case studies, and a systemic approach were used. The concept of "integration symbiosis" is proposed, forming an innovative model of cooperation between local councils and non-governmental organizations through integrating European standards, using local innovations, and the involvement of citizens in management processes. The main components of the concept – the Three Ps institutional model, the civic innovation accelerator, the digital hub, the adaptive democracy model, and the partnership trust fund – are aimed at strengthening the capacity of non-governmental organizations, transparent distribution of tasks, motivating civic participation and preventing corruption. The expected results include increasing trust among all participants, introducing innovations to solve local problems, accelerating integration with the EU, and strengthening civil society. At the same time, the emphasis on digital technologies, open platforms, and transparency mechanisms creates prospects for the sustainable development of local communities in Ukraine.

Keywords: public management and administration, local self-government, local councils, non-governmental organizations, martial law, post-war reconstruction of territories, integration symbiosis, project approach.

Abbreviations:

LGB is local self-government bodies,

NGO is a non-governmental organization.

Introduction

Military actions accompanied by large-scale population displacements, destruction of infrastructure, and deterioration of the socio-economic situation require a prompt and coordinated response at the local level. In this context, the interaction of LGBs with NGOs becomes a key tool for ensuring stability, social support, and effective resource use.

Martial law creates additional legal and administrative barriers that affect the cooperation mechanisms between LGBs and NGOs. The relevance is reinforced by the fact that practical cooperation in such conditions can contribute to increasing the resilience of communities, strengthening social capital, and improving crisis management. In addition, international experience shows that the participation of NGOs in overcoming the consequences of crises is a crucial component of decentralized management systems. The experience of the European Union, particularly of countries that have faced large-scale crises, demonstrates that cooperation

between LGBs and NGOs can provide short-term assistance and contribute to long-term recovery.

The study object is cooperation processes between public administration bodies and non-governmental organizations.

The study aims to substantiate modern forms and mechanisms of interaction between LGBs and NGOs in the context of overcoming the crisis and the consequences of a full-scale war, as well as recommendations for optimizing this cooperation to increase the social stability of communities.

The study's objectives are:

– generalize theoretical research on the issue of interaction between LGBs and NGOs;
– substantiate the organizational and legal mechanisms of interaction between LGBs and NGOs in Ukraine;
– develop recommendations for strengthening cooperation between local councils of Ukraine and non-governmental organizations through their conceptualization.

The following scientific methods were used during the study:

- analysis and synthesis to study the theoretical and regulatory framework;
- a systemic approach to consider the interaction of LGBs and NGOs as a single system in which each element performs a specific role;
- comparative analysis to study the best practices of cooperation between authorities and the public sector in EU countries;
- content analysis to analyze reports, programs, agreements, and other documents that regulate the interaction of LGBs and NGOs;
- modeling to develop a conceptual model of cooperation that considers the specifics of Ukrainian conditions and international experience;
- case studies to analyze specific examples of successful or unsuccessful interaction between LGBs and NGOs in overcoming humanitarian and social crises.

Another vital aspect is Ukraine's theoretical and regulatory framework, which regulates the interaction between LGBs and NGOs. The studies mainly focus on such areas as:

- democratization of governance and the role of NGOs in public policy (E. Afonin, Ya. Berezhnyi, O. Valevskyi, N. Kravchuk, V. Rebkalo, O. Shumilo, etc.) (*Existing…, 2016*; *Shumylo & Kravchuk, 2018*);
- cooperation with international NGOs (A. Viremeychyk, I. Ivzhenko, L. Kozak, G. Komarnytska, Kryvachuk, M. Lakhyzha, E. Pozhydayev, V. Soloshenko, etc.) (*Komarnytska et al., 2021*; *Kryvachuk, 2010*; *Lakhizha & Shkurin, 2024*; *Pozhydayev, 2007*);
- legal support for cooperation, problems of corruption and bureaucratization (V. Manko, A. Munko, O. Sychenko, O. Khokhba, M. Yatsyna, etc.) (*Manko, 2015*; *Munko & Khokhba, 2022*; *Munko, 2020*; *Sychenko, 2012*; *Iatsyna, 2022*);
- innovative approaches and digitalization (O. Matveeva, A. Munko, M. Treshchov, etc.) (*Matveieva, & Munko, 2023*; *Treshchov, 2023*).

The authors draw attention to the insufficient implementation of innovative solutions, such as digitalization of management or eco-innovation. Despite a significant number of relevant works, researchers can talk about the lack of research on local specifics and an emphasis on

financial aspects; in particular, the interaction of LGBs with NGOs is often considered in a general context without considering the specifics of territorial communities, the effectiveness of financing non-governmental organizations through local budgets, especially in conditions of limited resources, has been studied superficially. Also, existing research does not fully consider modern challenges associated with the humanitarian crisis and military operations. In general, it can be stated that although significant achievements have been made in Ukraine in cooperation between authorities and NGOs, research on interaction at the level of LGBs, especially in the context of modern challenges, remains insufficient. A comprehensive study of these aspects will contribute to optimizing cooperation mechanisms, developing civil society, and ensuring the sustainable development of territorial communities in Ukraine.

Results

Identification of NGOs as subjects of public administration in Ukraine

Since the beginning of the full-scale invasion of the Russian Federation, LGBs have taken on the lion's share of primarily unusual functions, particularly in the security sphere, including social and humanitarian security. This requires transforming LGBs' role not only as a management tool but also as a platform for activating the participation of the non-state sector. The level of transparency, accountability, and involvement of representatives of the non-state sector in the decision-making process determines their effectiveness.

That is, we see the fundamental role of LGBs. At the same time, we understand the strengthening of NGOs' role in state building and the importance of their joint efforts to ensure Ukraine's restoration and further sustainable development.

It is worth noting that the concept of "non-governmental organization" is borrowed from foreign practice in the domestic theoretical and legal fields. These trends are due to the widespread use of this term in international regulatory acts. Referring to the origins of this concept, namely English philology, "non-governmental organization" is "an organization that helps people, protects the environment, etc., and is not under the control of the government or state structures" (*Longman…, 2024*); "organizations created and managed by citizens without any formal intervention of the state, which serves as a counterweight to the state and the market." (*Lewis, 2001, p. 2*)

In the EU, the concept of NGO was first officially encountered in the European Convention "On the Recognition of the Legal Personality of International Non-Governmental Organizations and on the Desirability of an Increase in the Number of Its Contracting Parties," adopted on April 24, 1986 (*European Convention…, 1986*) covering activities that go beyond the territory of one country.

Foreign researchers emphasize the intermediary role of NGOs, which can influence the authorities "by protecting the civil rights of certain social, professional, national and other groups of the population or associations of citizens, non-governmental organizations are primarily." (*Iatsyna, 2019*)

Already in the domestic scientific space, NGOs are interpreted as "local, national or international associations of people whose activities are performed on the initiative of citizens, and not on the sanction or instruction of the government, and are not aimed at making a profit."

(*Avdeenko et al., 2005, p. 567*) Such organizations implement many different functions, ranging from global ones, such as research and educational activities, protection of human rights, and support for refugees, to specific ones, such as the fight for disarmament.

A review of the Ukrainian legal field has shown the absence of a separate definition of "non-governmental organization." However, it is repeatedly mentioned in individual regulatory legal acts that regulate various industries and spheres. At the same time, NGOs are mentioned in those documents that specifically refer to organizations of foreign origin. For example, "institutions of different years of the Central Election Commission in the part that related to the activities of foreign observers during the elections in Ukraine." (*Iatsyna, 2019*)

Therefore, it is possible to state the application of this concept in the Ukrainian legislative sphere without defining the content of this term as such in the current legislation. This, in turn, creates additional obstacles in regulating the participation of NGOs in the public administration sphere. It also controls the organization of their interaction with authorities of various levels, which is an integral part of modern public administration and local self-government. We define NGOs as key stakeholders in forming and implementing public administration decisions in democratic governance.

NGOs in Ukraine are important elements of civil society. They act as intermediaries between citizens and the authorities and contribute to solving key social, economic, and environmental challenges.

Having analyzed the legal framework, we conclude that in Ukraine, they can operate in the following forms:

- public associations (with or without the right of a legal entity);
- charitable organizations (funds, societies, or institutions);
- other non-profit entities (trade unions, creative associations, or employers' organizations).

Referring to European practice, the author will list the features of the legal status of NGOs in the EU countries, in particular the following:

- shall include associations or organizations established by both individuals and groups of such individuals (*Manko, 2015, p. 94*);
- may be both informal associations and organizations with legal personality;
- may be national and international in terms of composition and scope of activity;
- must have the right to free expression of their views, as well as other rights and freedoms guaranteed by international or regional agreements that may apply to such entities;
- actions or inaction of public authorities affecting non-governmental organizations shall be subject to administrative appeal and free appeal by non-governmental organizations to an independent and impartial court with appropriate jurisdiction (*Manko, 2015, p. 95*).

That is, generalizing the study of the genesis of the definition of the borrowed concept of "non-governmental organization," the author can conclude that it is somewhat identical to the domestic term "civil organization." This is indicated by the provisions of the Law of Ukraine "On Public Associations" (*On Public Associations, 2012*) and certain international acts.

At the same time, it is worth noting that, in particular, the content of the concept of NGO in the Council of Europe acts is already broader than the concept of "civil organization" fixed in national legislation.

These organizations can function at the national and local levels, focusing efforts on solving the problems of individual communities or influencing national policy.

NGOs' primary areas of activity in Ukraine cover a wide range of areas, including the protection of human rights, support for vulnerable population groups, educational activities, development of local communities, environmental protection, promotion of cultural development, education, and science. It is worth noting their participation in implementing reforms, particularly in decentralization, anti-corruption policy, digitalization, and modernization of social services.

NGOs have a non-commercial nature, and their functions are conventionally divided into two groups: financial and economic, as well as social and labor.

Financial and economic include:

- filling economic niches that are not effective enough for business and are inappropriate for the state;
- lobbying the interests of individual socio-economic groups;
- fulfilling the role of objects of domestic and foreign investments (*Sychenko, 2012, p. 89*).

Among the social and labor functions, the following are distinguished:

- functioning as a source of social innovations;
- ensuring employment of the population;
- representing the interests of various groups of society;
- ensuring the effectiveness of collective actions;
- creating social capital;
- influencing the formation of socio-economic policy;
- expressing social partnership;
- increasing the efficiency of the use of labor resources;
- creating a service infrastructure for the poor part of society (*Sychenko, 2012, p. 89*).

One of the crucial roles of NGOs is participation in the processes of forming state policy and legislation. According to the Law of Ukraine, "On Access to Public Information," they have the right "to participate in public consultations, submit their proposals for draft laws, and also to be involved in the work of public councils under state bodies." (*On Access to Public Information, 2011*) This mechanism allows organizations to represent the interests of citizens and influence decision-making at the level of government bodies.

Transparency and accountability are integral aspects of NGOs' work. Organizations are required to keep financial records, publish information on funding sources and expenditure areas, and submit reports to tax authorities. Transparency increases citizens' and donors' trust in NGOs and helps attract new partners and resources.

At the same time, NGOs in Ukraine face many challenges:

- many NGOs are dependent on funding from international donors, which makes their activities vulnerable to changes in politics and the economy;
- bureaucratic obstacles and insufficient support from the authorities are observed;
- there are risks of political pressure on NGOs dealing with sensitive issues, such as fighting corruption or monitoring the authorities' activities.

Despite this, NGOs in Ukraine demonstrate high efficiency in implementing socially significant projects and contributing to the development of civil society. To strengthen their role, it is necessary to improve legislation, promote the development of partnerships between NGOs and authorities, and ensure the stability of funding through state support programs. This will allow such organizations to contribute even more actively to social progress, the protection of citizens' rights, and the sustainable development of Ukraine.

Organizational and legal mechanisms of interaction between LGBs and NGOs in Ukraine

Interaction between LGBs and NGOs is a key element in ensuring democratic governance, public involvement in decision-making, and the implementation of socially significant projects. Let us describe the main mechanisms of the interaction studied.

According to Article 26 of the Law of Ukraine, "On Local Self-Government in Ukraine," (*On Local Self-Government in Ukraine, 1997*) LGBs have the right to initiate cooperation with NGOs to solve local problems through public hearings, the creation of consultative and advisory bodies, and the discussion of regional development programs.

In turn, the Law of Ukraine "On Access to Public Information" provisions oblige LGBs to ensure transparency in the decision-making process, creating the prerequisites for NGOs' active participation.

LGBs can provide financial support to NGOs for the implementation of projects that meet the priorities of local communities, the provisions of the Budget Code of Ukraine, and the decisions of local councils. This support can include the allocation of grants, the ordering of social services, and financing the participation of NGOs in project competitions.

Interaction between local councils and NGOs can be carried out through public-private partnership models. The Law of Ukraine, "On Public-Private Partnership" (*On Public-Private Partnership, 2010*), provides for the possibility of involving public organizations in the implementation of joint initiatives in the fields of education, healthcare, social protection, and ecology.

LGBs must also ensure that NGOs have access to information about their activities, including publishing reports on using budget funds, informing about public events, project competitions, and grant programs, and creating conditions for consultations with the public.

NGOs can become executors of local programs or partners in implementing socially important initiatives. This applies to education, healthcare, assistance to vulnerable groups of the population, infrastructure development, and ecology.

The Cabinet of Ministers of Ukraine regulates the activities of public councils under executive authorities (*On Ensuring Public Participation…, 2010*). Such councils can also be created under local self-government bodies to involve NGOs in consultations on important local development issues.

High-quality implementation of comprehensive interaction between LGBs and NGOs has many advantages, among which the author emphasizes the following:

- increasing the efficiency of management because the involvement of NGOs allows LGBs to receive additional ideas, resources, and expert support, which contributes to solving complex social problems;

- transparency and accountability through the participation of NGOs in the decision-making process of LGBs contributing to trust from the community;
- resource mobilization because, thanks to partnerships with NGOs, LGBs can attract additional funding, including international technical assistance, for the implementation of development projects;
- expanding citizen participation where NGOs act as intermediaries between the community and LGBs, ensuring more active inclusion of the population in management processes.

At the same time, the analysis of the mechanisms of interaction between LGBs and NGOs in Ukraine and the relevant regulatory and legal framework indicates many shortcomings and challenges, namely:

- lack of funding in local budgets, which may limit the possibilities of supporting NGOs;
- low level of trust between local governments and NGOs due to insufficient transparency or lack of dialogue (not everywhere, but in many cases);
- insufficient legal certainty as the legislation contains general provisions that do not always specify cooperation mechanisms, which complicates their practical application;
- the bureaucratic obstacles to NGOs' access to participation in programs or project competitions may be due to their excessive complexity, which reduces their effectiveness.

It is worth examining international technical assistance separately as a way of interaction between the authorities and NGOs. It is essential for supporting reforms, increasing institutional capacity, and developing key sectors of the Ukrainian economy. The provision of international technical assistance in Ukraine is performed according to international agreements concluded between Ukraine and donor countries or international organizations. Such agreements determine the volumes, areas of use, conditions, and principles of assisting.

Another notable area of interaction between LGBs and NGOs is humanitarian assistance, which is an essential tool for overcoming crises in Ukraine, particularly during armed conflicts, natural disasters, or socio-economic shocks. The mechanism for receiving humanitarian assistance in Ukraine is regulated, particularly by the Law of Ukraine "On Humanitarian Assistance" (*On Humanitarian Aid, 1999*) and relevant subordinate regulatory legal acts. Currently, national legislation creates mechanisms that minimize the risk of corruption or misuse of assistance. Reporting and control requirements contribute to increasing donor confidence in Ukraine. Exemption from taxes and customs duties encourages international organizations to cooperate with Ukrainian partners. And clear rules for the distribution of humanitarian aid ensure it reaches those who need it most.

We would also like to highlight the shortcomings of the humanitarian aid system in Ukraine:

- recognizing a shipment as humanitarian aid requires significant time and effort due to complex bureaucratic procedures, which can delay the provision of assistance in critical situations;
- despite control, especially at the local level, which may include misuse or misappropriation of aid;
- small volunteer organizations often face difficulties in procedurally processing aid due to a lack of resources or experience.

We also draw attention to ways to maximize the positive results of involving NGOs in the provision of social services based on the experience of European countries in particular:

- establishing and strengthening intersectoral cooperation between the non-governmental sector and local and national authorities so that the activities of NGOs in social services are visualized and comply with current standards;
- integrating NGOs into the system of social services should be performed based on partnership and complementarity rather than replacement and unjustified duplication;
- providing organizational and financial support to NGOs from international donors and local councils (*Lomonosova et al., 2024*).

We conclude that the interaction between LGBs and NGOs is essential for developing local communities. To improve, it is necessary to implement the following measures, which we summarized based on a previous analysis of the shortcomings of organizational and legal mechanisms of interaction:

- develop precise mechanisms for involving NGOs in the decision-making process;
- introduce transparent procedures for the distribution of funding;
- develop training programs for representatives of LGBs and NGOs on partnership work;
- promote the digitalization of communication and reporting processes.

Conceptualization of the interaction between LGBs and NGOs taking under the challenges of war and European integration progress

Given the shortcomings and problems of interaction between LGBs and NGOs in Ukraine identified during the research, we believe that the fundamental step in improving such interaction should be its conceptualization. This will determine the basic framework of such interaction and allow LGBs and other authorities to better organize the processes of cooperation with NGOs.

The author proposes an original interaction concept between LGBs and NGOs in Ukraine under European integration.

The key idea of the concept is integration symbiosis.

Within the framework of the integration symbiosis concept, the author proposes a new model of interaction based on the principles of joint development through the synchronization of each subject's interests and capabilities. This model combines strategic adaptation to European standards with the introduction of local innovations for effective solutions to local problems.

The author offers to define and describe the key components of the concept.

1. Institutional constructor "Three Ps": Progression, Partition, Performance.

Progression: development and implementation of capacity-building programs for NGOs, ensuring their integration into management processes at the local level. For this, regular training modules are envisaged, focusing on European participation practices and innovative management.

It is assumed that this will work through creating an infrastructure for training, e.g., regional training centers for employees of LGBs and NGOs. Based on the centers, it is advisable to organize training on project management, fundraising, and work with digital platforms, as well

as transparency and accountability practices. It is also possible to implement mentoring programs when experienced NGOs that have successfully implemented projects according to EU standards take on the role of mentors for less experienced organizations. Creating a database of active public figures ready to join local governance is possible. This will become a kind of "human resource reserve" for NGOs to form the perspective of institutional strengthening of civil society, which is often lacking in the Ukrainian context.

Partition: Introduce a mechanism for the transparent distribution of competencies and tasks between LGBs and NGOs through "maps of partnership areas of responsibility," which can be created as interactive digital tools. For example, NGOs are engaged in public monitoring of environmental projects and councils – in implementing infrastructure initiatives. Joint meetings held at regular intervals to adjust areas of responsibility depending on changes in community priorities can be effective.

Performance: each project or initiative is assessed according to performance indicators (social impact, citizen involvement, resource efficiency). The following indicators are included in the performance metrics: the number of citizens involved, the project cost compared to analogs, and social impact (assessed through a citizen survey). It is essential to ensure regular reporting when LGBs and NGOs publish joint reports on each project.

A new approach for LGBs in Ukraine combines the principle of partnership responsibility distribution with the use of "maps of responsibility zones." This tool integrates digital technologies into management practices, which is lacking in many existing models.

2. Civic innovation accelerator, which involves the creation of platforms for joint idea generation between LGBs and NGOs. That is, the LGBs open "challenges" for the community (e.g., restoring buildings destroyed by Russian attacks and creating an inclusive environment for IDPs). NGOs offer innovative solutions competing for grants. As a result, the winning NGOs receive funding, and local councils have access to progressive ideas. The format of "challenges" open to citizens and NGOs is innovative for national practice as it combines a competitive basis with the direct participation of the local community. This approach is unique compared to traditional grant programs. The emphasis on technical and social innovations in the context of the local community needs to be integrated into cooperation with LGBs, which is not widespread enough in Ukraine.

3. A single digital hub that will unite LGBs, NGOs, and international partners to search for joint projects and publish information on implemented initiatives. Such a hub is worth integrating with the "Diya" portal to access community information and citizen involvement in processes. The idea of creating a single digital space that not only accumulates information but also offers training, participation, and reporting tools has not yet been fully implemented in Ukraine. Integration with "Diya" to include citizens in the governance process is a step forward from the usual electronic services already provided through this platform.

4. The adaptive democracy model stimulates citizen participation through the use of such innovative tools for Ukrainian practice as:

- local referendums on a smartphone, where the council, together with NGOs, determines the most pressing issues that are put to electronic polls;
- "neighborhood assemblies" as regular meetings of residents and NGO representatives for joint analysis of the results of council decisions;

- gamification of participation, when residents who participate in decisions receive symbolic rewards (discounts on utility services or other incentives).

The "gamification of participation" format is an innovative tool for stimulating civic activism. Using rewards as a motivational factor creates a new level of involvement. "Neighborhood assemblies" are an adaptation of classic democratic tools to the local context, focusing on solving specific community problems through direct communication.

5. A partnership trust fund that can be formed at the expense of local budgets, EU grants, and private businesses to co-finance social initiatives of NGOs. The fund's feature is joint management by council representatives, NGOs, and citizens. This minimizes the risks of corruption and guarantees fair distribution of funds. It is advisable to manage the fund through a committee of representatives of local councils, NGOs, and independent experts (e.g., lawyers or economists). All applications for project financing are considered publicly, with the community's involvement in discussions and transactions with the fund reflected in real time on an interactive platform. It is advisable to conduct an independent audit every year.

The format of "joint management" of the fund, with the involvement of various stakeholders, minimizes the risks of corruption and strengthens community control over the distribution of funds. However, using the mechanism of open audit in real-time is not yet a common practice in Ukrainian local financial structures.

Among the expected results of the proposed concept of integration symbiosis of interaction between LGBs and NGOs, we identify the following:

- stimulating citizen participation through new cooperation mechanisms;
- increasing trust between citizens, local councils, and NGOs;
- accelerating adaptation to EU standards through local innovations;
- reducing corruption risks through transparent digital mechanisms;
- strengthening civil society and trust in local self-government;
- integrating Ukrainian local policies into the European environment;
- implementing innovative solutions to local problems.

Discussion

In a crisis, a full-scale invasion, as evidenced by the results of our study on the escalation of the situation and the features of cooperation between LGBs and NGOs, traditional mechanisms of bureaucratic vertical interaction no longer work properly. It is necessary to transform existing mechanisms, based on the proposed concept of integration symbiosis supplemented with specific tools specific to increasing the effectiveness of interaction between LGBs and NGOs under war to overcome the consequences of the social and humanitarian crisis.

Conclusion

The concept of integration symbiosis aims to make the interaction between LGBs and NGOs not just a coordination but a multi-level partnership that generates new values for the community. This approach allows building a more sustainable model of local self-government that meets the challenges of European integration and modernity.

This detailed concept considers the unique needs of Ukrainian communities and creates an integration mechanism that works effectively at the local government level. It is worth noting that the proposed concept is original in the sense that it is based on the rethinking and adaptation of modern managerial and social practices in the context of Ukraine's specific conditions and its European integration course.

The presented ideas are a synthesis of the best European practices and their original adaptation to modern conditions in Ukraine and consider such specific aspects as the weakness of institutions, the low level of trust in the authorities, the relevance of digitalization, the insufficient development of project management skills among employees of local councils, the ongoing full-scale conflict with the Russian Federation and the permanent humanitarian crisis in Ukraine. At the same time, like any concept, it is general. It requires further specification that is supplementation with specific tools considering the current conditions of martial law in Ukraine and the specifics of the crisis.

Conflict of interest

The author declares that there is no conflict of interest.

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Inna Yu. Yurova [5]

Topographical poetry by M. Syngayivsky in the context of the literature of the Sixtiers [5]

Abstract: Mykola Syngayivsky is a little-studied Ukrainian writer of the Sixties. It is difficult to call him little-known because his poetic lyrics are songs that, without exaggeration, are known and sung by the whole of Ukraine and all Ukrainians both on the territory of the national state and in exile. The study aims to analyse the landscape lyrics of M. Syngayivsky. Its tasks are to characterise the features of implementing the landscape genre in the work of M. Syngayivsky, determine the specificity of the author's writing style and outline a special type of lyrical hero. M. Syngayivsky turns to the genre of classical landscape. In this way, he demonstrates his difference from the majority of the sixties, who actively turn to related genres of philosophical, love, patriotic and other lyrics. Instead, M. Syngayivsky escapes from the scientific, social, political present in the timeless Ukrainian national landscape with its traditional rural elements. According to the creative concept of M. Syngayivsky, a person is inscribed in the world of nature, consonant with it. Nature helps us know, analyse, and discover additional levels in the human consciousness, cultivating the best feelings in it. The author emphasises separately that the vast majority of the writer's landscape lyrics are connected with the village, rural landscapes and localities as a component of a certain Eden. In this ideal space, a person feels protected. The guiding principle of M. Syngayivsky's creative manner is the simplicity of poetry, the play on parallelisms, comparisons, well-known, recognisable images. The author does not seek to confuse the reader or pose overly complex philosophical questions to him. Still, through simple images and well-known words, he conveys crucial thoughts to the audience, reminds them of universal human values, emphasises the beauty and value of our life, and proves the need to look into the details. The writer emphasises visual images in most of his landscape lyrics, but some poems also appeal to auditory images.

Keywords: topographical poetry, sixtiers, theme, issues, genre, text, context, fiction, author.

Introduction

Mykola Syngayivsky is a little-studied Ukrainian writer of the Sixties. It is difficult to call him little-known, because his poetic lyrics are written songs that, without exaggeration, are known and sung by the whole of Ukraine and all Ukrainians both on the territory of the national state and in exile: "Chornobrivtsy," "Immortelle," "Polisyanochka," "In the Land of Childhood," "The Sun in the Palms," "Our Field Has Spread Out", etc. The artist's imaginative, poetic, patriotic lyrics deeply sink into the soul and remain in the memory for a long time. At the same time, scientific works devoted to the work of M. Syngayivsky as a separate author are not so much, despite all the prospects of research on this topic. This is primarily because the generation of artists of the sixties was highly gifted and polyphonic, against the background of a large number of artists of this level, the creative figure of M. Syngayivsky is lost. It does not cause either great resonance or broad scientific interest.

As already noted, M. Syngayivsky belonged to the generation of the Sixties, respectively, the subject and problems of his work are connected with this literary direction. The corresponding direction determines the presence of humanistic tendencies, environmental problems, love for Man, nature, and the native land in M. Syngayivsky's poetry. The artist spent most of his creative life working under strict censorship, which led to a limited theme of his work. At the same time, the powerful use of the genre of landscape lyrics, active singing of the

beauty of the native land, falling in love with the Ukrainian nature become for the writer a way to demonstrate love for the native land and Ukraine, a way to foster patriotic feelings among readers of different generations. The Soviet ability to read and write between the lines is fully realised in the poetry of M. Syngayivsky.

The study aims to analyse the landscape lyrics of M. Syngayivsky. According to the purpose, the study has the following tasks:

- characterise the features of the implementation of the landscape genre in the work of M. Syngayivsky;
- determine the specifics of the author's writing style;
- outline a special type of lyrical hero.

Materials and Methods

The Sixtiers as a general artistic movement has been studied quite thoroughly in the Ukrainian scientific field. The works of scientists are devoted to the analysis of the phenomenon as a whole, as well as the study of individual figures of writers, their defining texts, and creativity in general. Among the most famous works are the scientific developments of A. Pakhlevskaya, B. Kravtsev, I. Koshelovets, A. Bazhan and many others. The study of this literary phenomenon took place both in Ukraine and in emigration science, and the latter lack of censorship and external pressure allowed us to start talking about this phenomenon immediately, boldly and sharply. While in Ukraine itself, the actual study of the work of the Sixties began only after the country gained independence. During the study of the Sixties, many different types of works were written: general cultural, historical, with political accents, and so on. The Sixtiers were interpreted very broadly, from a general philosophical phenomenon ("invisible spiritual supports, philosophers who gave this phenomenon a semantic dimension" (*Pakhlevskaya, 2000, p. 67*)) to a revolt against the Empire of living people with their destinies and characters (*Mokrik, 2003, p. 12*).

The very same work of M. Singaevsky came to the attention of a few researchers. First, contemporary artists reacted approvingly to his work: Mikhail Stelmakh, Dmitry Pavlychko, Ivan Dzyuba, etc. Ukrainian dissident human rights activist, literary critic and translator Valery Marchenko even received a verdict, including for considering the work of M. Singaevsky. Separately, we can distinguish several critical and analytical works, with a general assessment of the life and work of the writer, as well as his influence on the development of Ukrainian literature and culture in general.

The author uses comparative, biographical, historical and cultural, problem-thematic, and typological methods of comparison, among other methods. These methods allow us to see the author's work in the context of the era, the work of contemporaries, the general totality of the writer's works, and so on.

Results

Although landscape lyrics or landscape verse are defined as "a lyrical genre, the works of which depict aesthetic experiences of humanised, animated or Spiritualized, mostly personified nature," (*Landscape poem…, 2007, p. 193*) many sources, presenting the definition, immediately specify that it is a mistake to reduce landscape lyrics exclusively to depicting nature, since writers

always try to put a little more into their texts, expressing their views, beliefs, feelings, thoughts, etc.: "landscape lyrics are not limited to mimetic sketches of the environment or a reflection of the inner state of the lyrical hero, they can acquire intimate, civil, sacred motives. Often the image of nature is combined with a psychological portrait. or identified with the soul of the lyrical subject." (*Landscape lyrics, 2007*) For some authors, even the landscape may fade into the background, obeying a different goal.

The genre of landscape lyrics has been widespread in Ukrainian poetry since its formation. A special place in the landscape lyrics of Ukrainian fiction is occupied not just by depicting nature, but by depicting rural areas. Love for the native village, perception of it as an ideal space, a carrier of extraordinary beauty, a place of strength and peace for the Ukrainian begins with Taras Shevchenko: "The village! And the heart will rest. // Village in our Ukraine – / / like a pysanka village!" (*Shevchenko, 1939, p. 7*) The established tradition allows writers of the 20th century to return to depicting the village as a Lost Paradise, an unattainable paradise or a conditional paradise that can at least temporarily lead out of the problems of the present.

For the Sixtiers, landscape poetry becomes one of the defining genres, as it makes it possible to discuss various important problems of the humanistic direction. Thus, the genre becomes complex and combined, acquiring features of other genres.

In his work, M. Syngayivsky adheres to the classical landscape genre as much as possible, which demonstrates a certain escapism from the scientific, social, and political present to the timelessness of the Ukrainian national landscape with its traditional rural elements.

In his poetry, the author demonstrates to readers such a concept of the world and Man, where man is wholly inscribed in the world of nature, consonant with it. The natural world helps analyse and discover additional levels in the human mind, and brings up the best feelings. Man in the poetry of M. Syngayivsky is inscribed in the world of nature, both living and inanimate.

Separately, the author would like to emphasise that most of the writer's landscape lyrics are associated with the village, rural landscapes and localities as components of a confident Eden, an ideal space where a person feels protected. Poetry's philosophical and patriotic nature is light and unobtrusive, without pressure on the reader, the need to make difficult choices, and sympathy with suffering.

The apparent simplicity of poetry, when writers use the simplest parallelisms and comparisons, well-known, recognisable images, does not seek to confuse the reader or put super-complex philosophical questions in front of him, allows M. Syngayivsky to convey essential thoughts to the audience, remind universal values, emphasise the beauty and value of our lives, and prove the need to look into details.

In the vast majority of texts of his landscape lyrics, the writer focuses on bright and familiar visual images of the Ukrainian eye. However, some poems also appeal to auditory images. As an example of such a text, we can call the poem "Voice of Nature." The text contrasts the plant and bird world. Plants have voices of different timbres and colours: "every tree in the forest // has its voice," (*Syngayivsky, 2024l*) forming a real Polyphony together. The voice of each plant depends on its character. Aspen obeys the wind-conductor and has a voice like an alarm: "tremble like an alarm, // aspen leaf." (*Syngayivsky, 2024l*) However, the mighty oak does not obey, resists the wind: "only the wind is against // the oak, like a giant, becomes." (*Syngayivsky, 2024l*) Accordingly, his voice has an entirely different intonation and timbre: "velvet voice //

dark leaf gives." (*Syngayivsky, 2024l*) The voices of birds are compared with musical instruments, in particular, the thrush correlates with the flute: "and it will play in silence // the gentle flute of the thrush." (*Syngayivsky, 2024l*)

The writer depicts the seasons through direct naming, description of leading features, and a certain philosophical, psychological characteristic. They emphasise the consonance of human feelings and landscapes of their native land, showing their interdependence. Appealing to traditional images of the seasons makes it easier for a character to express their feelings and thoughts.

Winter, mentioned in the rhyme "and the garden fell asleep," is conveyed through the image of a garden that sleeps under the snow: "and the garden fell asleep, // as if submerged in snow." (*Syngayivsky, 2024a*) At the same time, Winter is not depicted as an element, without negative connotations, the author emphasises that winter is a time of peace: "under the snow, silence warms up silence." (*Syngayivsky, 2024a*) Behind this external calm, life continues: "but the eternal cycle has not stopped: // everything born grows and matures." (*Syngayivsky, 2024a*) Winter Sleep is traditionally considered a time of fading, death, emptiness, etc. Syngayivsky interprets as a favourable time of change or preparation for them: "and we grow with lust and good, // and tomorrow our growth will arrive." (*Syngayivsky, 2024a*) Such winter becomes a time of inner growth for a person: "Winter enchants the garden with a frosty dream, // and in dreams both gardens and people are more generous." (*Syngayivsky, 2024a*)

In the rhyme "Rainbow in the Snow," the writer also refers to the image of winter but interprets it more ambivalently. On the one hand, winter in this text is already presented as a difficult, cold time that causes unpleasant feelings in a person: "Snow hurts the eyes, // Light is like a tear. // The Frost-Scarecrow will dry up and burn." (*Syngayivsky, 2024f*) Adhering to the tradition of his style, the lyrical hero compares such winter freezing with an undesirable celebration of the soul: "I care // when the soul becomes callous." (*Syngayivsky, 2024f*) At the same time, the lyrical hero offers a recipe for preventing such harmful and undesirable changes. The way out is to observe the world, its knowledge, love for it: "I greedily absorb // the white world, // and, as myself, I must know it." (*Syngayivsky, 2024f*) Accordingly, a conclusion is drawn about the need to live, feel, seek, experience: "you live as long as you are on earth – your footprint. // You live as long as the pain permeates the soul." (*Syngayivsky, 2024f*)

The rhyme "Thyme Land" immediately plays on the contrast of expectation and reality. Seeing the name, the reader immediately expects summer landscapes, warmth and other relevant elements and associations. However, M. Singaevsky again draws us to winter. The author again returns to the associative series "winter" – "dream" but in a different emotional and logical context. Winter is shown in an ideal, picturesque plan: "snow-covered windows are kissed by tits, // and silver branches breathe Frost. // And you can hear how easily the wells sigh." (*Syngayivsky, 2024k*) Its purpose is to give time to rest, to gain strength: "The father's land is gaining strength." (*Syngayivsky, 2024k*) Along with the Earth, a person should also gain strength from the Earth: "and I was courageous here, // I did not wander in roundabout ways, // and I absorbed the juices of the Earth drop by drop." (*Syngayivsky, 2024k*) The unity of Man and the Earth helps to bring spring closer, awaken the Earth and the soul: "it will also warm thyme from under the snow // and confuse the soul with herbal infusions." (*Syngayivsky, 2024k*)

In the rhyme "March dreamed", he continues to use the motif of sleep as a premonition of warmth and change: "March dreamed: // he is still in the Birches, / still under the bark // the juices are asleep." A detailed spring landscape with a list of all future changes, a premonition of a new time, the writer simultaneously saturates the desire for movement: "I want to take // the path by the hand // and lead, / / like a child, to the grove." (*Syngayivsky, 2024d*) The author does not ignore the contemplative element: "stand in the birches // and listen longer, // as the Ant talked // with Spring." (*Syngayivsky, 2024d*)

The poem "It Was an Eloquent Day…" also addresses the theme of parallelism between man and nature. The anticipation of positive changes in the world around us coincides with the author receiving pleasant news. Creating the appropriate mood, M. Singaevsky first describes nature, among which events take place: "there was an eloquent day, // colourful, // hops from the fragrance of Spring." (*Syngayivsky, 2024e*) And then, through parallelism, he proceeds to describe the joy of the news received, while comparing the news received with birds that are symbols of Spring: "good news has come to me, // like the early swallows of spring." (*Syngayivsky, 2024e*) The situation of double spring, when the joy of the awakening of nature coincides with the joy of the news received, enhances the feelings of the lyrical hero, hints at the great joy that awakens the lyrical hero: "and everything that has long been a slogan in the heart, // instantly stirred up, // bloomed…" (*Syngayivsky, 2024e*)

The author refers to spring in his rhyme "White Cherries Walked in the Garden." Poetry about spring is written according to the same scheme as texts about winter. At first, the author describes a beautiful spring landscape, cherry blossoms at night: "white cherries walked around the garden, // and the night bloomed under the cherry crowns." (*Syngayivsky, 2024m*) After that, he proceeds to describe the inner state and thoughts of the lyrical hero. His inner happiness is due to his connection with his native land: "I thought a happy thought then, // that it was in this land that I could have been born." (*Syngayivsky, 2024m*) From the spring that takes place on his native land, the soul of the lyrical hero also blooms: "and my soul aspired to bloom, // as if on a holiday, with its love." (*Syngayivsky, 2024m*) Accordingly, the moment of the highest happiness comes when Joy and spring from outside and inside intersect and are combined in one feeling: "what else can I wish for when I // merged with you, my beloved land." (*Syngayivsky, 2024m*)

Autumn is also mentioned in M. Syngayivsky's poetry. This is a sad time of year for both the Earth and man. Their consonant feelings become a general reflection of what is happening around them. Thus, in the poem "Autumn," the lyrical hero, having enjoyed the sad autumn landscape, merging with his native land, feels that he has fallen leaves in his heart: "I still walk with autumn sadness, // as if I move leaves in my heart." (*Syngayivsky, 2024b*) However, sad feelings can be contrasted with the feeling of the arrival of spring, the joy of waiting for the awakening of nature: "to be spring again // and complete everything started // in time." (*Syngayivsky, 2024b*)

M. Syngayivsky's poetry has a rich figurative range of plants, especially flowers. They are part of the landscape, part of the soul of the lyrical hero. Flowers act as symbols of life, love, and memory, embodying thoughts and hopes in material things. So, for example, in the rhyme "The Sun Stood in Warm Sunflowers," the main image is the poppy. Beautiful, but delicate and fragile, the poppy gets a certain chance for longevity in the hands of its mother, who turns it

into patterns: "the mother removed the patterns from the poppies, // the colour, like a flame, // played in her hands." (*Syngayivsky, 2024i*) Then these patterns are transferred to towels and become part of the Material Memory of a person: "and the poppy stars bloomed, // embroidered by the mother on towels." (*Syngayivsky, 2024i*)

In the rhyme "Chornobrivtsy" flowers become an association of native home, Childhood, mother, homeland, which accompany the lyrical hero all his life: "as I look at those Chornobrivtsy, // I see my old mother, // I see your hands, my mother, // I hear your affection, dear." (*Syngayivsky, 2024c*) And the poem "Song in the Dew" offers a meadow chamomile, which is familiar to the lyrical hero from childhood, I accompany him all my life, although in my memory as part of a happy childhood, as a loyal girlfriend: "that chamomile-zhurlivka, // that she looked at the meadow. // That I was rewarded // until autumn bloomed, // foreshadowed the weather, // as a harbinger of summer." (*Syngayivsky, 2024g*)

The lyrical hero is inscribed in nature, consonant with it. However, the author never details landscapes. It dispenses with small details, general descriptions, hints, and appeals to feelings. It does not put pressure on the reader, allowing them to reproduce pictures as each person imagines them, based on their personal experience.

Discussion

The lack of research on Mykola Syngayivsky's poetic works requires further study of his texts as an independent artistic unit. In the context of the literature of the Sixtiers and Ukrainian literature in general, since the writer is a continuation of the traditions that were laid down in our national literature from the moment of its formation, in his legacy he preserved and developed the traditions of Ukrainian writing.

The writer's landscape and intimate lyrics can be compared with those of other Ukrainian authors who have worked in the relevant genres. In particular, comparative analysis can be performed with the works of such authors as Lina Kostenko, Vasily Simonenko, Vasily Stus, Dmitry Pavlychko, Alexander Oles, Viktor Cherednichenko, Nikolai Vorobyov, Vladimir Sosyura, Nikolai Vingranovsky, Maxim Rylsky, Andrey Malyshko, Nikolai Lukov, etc.

Special attention can also be paid to analysing tropes and various language tools used by M. Singaevsky since the artist's lyrics are quite poetic and song-like, full of various artistic decorations and vivid poetic images.

Thus, despite its wide recognition, M. Syngayivsky's poetry has significant research prospects and is worthy re-evaluating as a significant component of Ukrainian literature.

Conclusion

Mykola Syngayivsky occupies a significant place in Ukrainian literature. This writer, during the Times of strict Soviet censorship, managed to find ways to affix his native land, foster love for it, and portray its beauty and wealth. The leading place in his work belongs to the genre of landscape lyrics. This genre direction is primarily because the writer wrote during the time of strict Soviet censorship, respectively, he had to look for ways to cover complex topics of patriotism, love for his native land and people.

M. Syngayivsky's poetry is rich in visual and auditory images, with the help of nature in landscape lyrics, which gives the lyrics sound and embodiment. The writer creates a special type

of lyrical hero who is consonant with the nature of his native land and connected with it on many levels. Nature helps him express and experience his feelings and visualise emotions.

Conflict of interest

The author declares that there is no conflict of interest.

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Dmitriy V. Shvets [6]

Investigation of software simulators for modeling combinational circuits in microprocessor technology [6]

Abstract: This article examines the use of virtual laboratories and simulators for modeling combinational circuits in microprocessor systems. The research focuses on how students at universities and other educational institutions learn circuit design and the methodologies for developing combinational circuits in microprocessor technology. This work aims to explore existing virtual laboratories and simulators for modeling combinational circuits in microprocessor technology, analyze their advantages and disadvantages, and study their functional capabilities and educational potential. The primary research methods include analyzing literary sources and online resources to identify software simulators for modeling combinational circuits in microprocessor technology and comparing their characteristics and capabilities in terms of their applicability for educational purposes. The research findings indicate that the Electronic Workbench is the most suitable for the basic study of simple combinational circuits due to its ease of use among all the reviewed simulators. NI Multisim offers a broader range of features and allows integration with hardware platforms. Proteus is applicable for studying embedded systems and working with firmware. Future research directions may include exploring new simulators for modeling combinational circuits in microprocessor systems and developing a new simulator that combines the advantages of the tools discussed in this article.

Keywords: virtual laboratories, simulator, microprocessor technology, circuit design, combinational circuits, education.

Abbreviations:

EWB is an electronic workbench.

Introduction

Today, virtual laboratories are widely used as an effective tool in the educational process at universities and other academic institutions (*Nolan et al., 2016*; *Shen & Bian, 2022*; *Üstünel, 2019*). Developing such laboratories requires competencies in various fields, such as programming, UI development, and pedagogical qualifications. Such software is created by teams representing various groups, including educational, research, and industrial sectors. Virtual laboratories are being developed and applicable to a wide range of fields (*Ahmad et al., 2017*; *Peidró et al., 2015*; *Chao et al., 2015*; *Erdem et al., 2016*). Among them are simulators for modeling combinational circuits of microprocessor technology (*Makarenko & Spivak, 2016*; *Mafudi & Handhika, 2021*; *Connor et al., 2018*; *Moura & Moura, 2016*).

Three types of laboratory work can be distinguished for students when studying physical processes or electronic circuits. The first type involves working in a traditional laboratory with the necessary equipment, stands, and laboratory setups, which requires students' physical presence and direct interaction with the equipment. The second type involves virtual laboratories based on actual equipment, accessed remotely through dedicated software (*Trnka et al., 2016*). Thus, students work remotely but use physical equipment, which requires adherence to a schedule for conducting work and a stable internet connection between the laboratory and the students. The third type of virtual laboratory is software that fully simulates the physical

equipment used in traditional laboratories. This software can be installed on a student's computer, allowing them to conduct experiments at any convenient time and from any location.

Using software that simulates the processes being analyzed and enables experiments without needing to visit an educational institution is undoubtedly a significant advantage, especially in distance learning.

Several scientific works that explore the use of virtual laboratories and simulators in the educational process can be cited. The work (*Ersoy et al., 2022*) discusses a developed virtual laboratory for conducting applied courses in formal and distance education. It includes working with user-programmable logic matrices and application programming interfaces. Researchers compared the two groups' performances using a virtual laboratory and traditional teaching methods. The research results showed that the developed virtual laboratory was more effective than conducting experiments using conventional techniques, and it allowed students to create combinatorial schemes more quickly.

The research (*Susilawati et al., 2021*) examines a comparison of two simulators for modeling combinational circuit schematics. Students were also divided into two groups and performed laboratory work in one of the virtual laboratories. The tasks included building simple circuits with resistors and capacitors, constructing an RLC circuit, and studying Kirchhoff's law. The studies that were conducted demonstrated the effectiveness of using both simulators.

The study (*Islahudin & Soeharto, 2020*) aimed to investigate the understanding of digital circuits using electronic circuit-building simulators among students in the physics education program. The sample included 14 students studying the course "Fundamentals of Electronics". The study was conducted in two cycles. Each cycle consists of four stages. They included planning, action, observation, and reflection. Data analysis was performed to determine the improvement in concept comprehension in cycles one and two using the t-test formula. The research results indicated that the passing score in the first cycle was 57.14%, while in the second cycle, it was 85.71%. Based on the obtained research results, the authors concluded that using an electronic circuit simulation tool can enhance students' understanding of digital circuit concepts.

Results

As demonstrated above, virtual laboratories and simulators provide the opportunity to overcome the limitations of traditional laboratories and enable the conduct of classes for a more significant number of students in more comfortable spatial and temporal conditions. Using simulators can also track students' academic progress and receive feedback on material comprehension and any issues that arise (*Budai & Kuczmann, 2018*). Significant advantages include working remotely at a convenient time for students. Moreover, with simulators, students cannot damage the equipment or injure themselves when conducting experiments incorrectly. Therefore, using such an educational tool reduces the responsibility placed on the instructor concerning student safety and the preservation of laboratory equipment.

Integrating simulators into the educational process is associated with significantly lower costs, eliminating the need for laboratory setups with expensive electronic equipment. Virtual equipment in the simulator does not age or wear out like actual equipment and does not require maintenance expenses. Additionally, modeling new experimental tools using simulators does

not require material resources, unlike working with physical equipment. An important advantage of simulators is their ability to model scenarios that are difficult to replicate in actual conditions. For instance, it is possible to make significant changes to the system configuration of equipment or alter the values of several system parameters. Such changes are typically challenging to implement with actual equipment. Simulators also enable students to learn from mistakes without consequences, providing a safe environment for conducting various tests and experiments that would be difficult or risky to perform on actual equipment (*Aliev et al., 2024*).

Thus, with the increasing complexity of electronic devices, traditional teaching methods based solely on theoretical analysis and physical experimentation are becoming insufficient for training qualified specialists. Simulation software, including tools for modeling combinational circuits in microprocessor technology, offers capabilities that cannot be fully achieved in traditional laboratory settings.

Modeling electronic circuits requires focus, attentiveness, and precision. Software simulators enable students to work with virtual circuit models that closely resemble real ones, significantly accelerating the process of mastering complex circuit design concepts. Furthermore, simulators provide immediate feedback, which is crucial for a deep understanding of the principles of microprocessor technology. It makes the learning process more interactive and visual, eliminating barriers previously caused by limited access to equipment or the inability to study rare or expensive components.

The specified tools contribute to developing students' systems thinking and analytical skills, which are crucial for solving engineering problems. Modeling complex combinational circuits using software products helps students study device operation and allows them to practice their optimization.

The author offers to consider some of today's popular tools for modeling combinational circuits in microprocessor technology.

EWB is software for modeling and analyzing electronic circuits (*Electronic Workbench, 2024*). At its emergence, it was one of the most intuitive and accessible programs for studying the fundamentals of circuit design and digital circuit engineering. EWB allows users to design electronic circuits in a virtual environment and analyze their behavior using built-in tools such as oscilloscopes, multimeters, and signal generators.

Several factors drive using EWB in education, particularly in microprocessor technology and combinational circuit design. The software enables students without working experience with hardware to learn theory through practice. This is accomplished through a simple interface, various components, and analysis tools. For beginner specialists, observing how specific elements interact is crucial. EWB provides visualization capabilities without requiring work with physical circuits, thereby simplifying the learning process.

At the same time, using EWB in teaching has its limitations. One such nuance is the simplified component library, which includes standard elements of circuit design (resistors, capacitors, transistors) and basic microprocessor modules. It makes the software less suitable for modern microprocessor systems, requiring a more complex modeling and analysis approach. However, for studying combinational circuits such as logic gates, multiplexers, and decoders, the software remains an effective tool, especially at the basic level.

Another important aspect is the limited integration of EWB with real hardware. Modern engineering education requirements involve modeling and testing the created solutions on physical devices.

However, despite the mentioned limitations, the EWB remains helpful in teaching the fundamental aspects of circuit design and introducing microprocessor technology. The software provides a convenient environment for conducting laboratory work, developing simple projects, and studying electronic circuit component interaction fundamentals. Its use can be especially beneficial in the early stages of learning when students need to focus on understanding theoretical principles rather than the complexity of working with physical equipment.

Another popular simulator is NI Multisim (*Multisim, 2024*). This powerful software for modeling electronic circuits significantly surpasses EWB's capabilities and functionality. It is designed to meet the needs of both educational processes and professional engineering practices. Multisim combines an intuitive interface, an extensive component library, and modern simulation tools, making it an effective tool for studying and designing electronics.

Multisim's main advantage is its extensive component library, which includes essential circuit elements and complex digital devices, microcontrollers, processor cores, communication modules, and specialized integrated circuits. This makes it ideal for working with microprocessor technology, where interactions between analog and digital components and the modeling of complex combinational circuits are crucial.

Multisim integrates with hardware platforms such as Arduino, allowing students to transition from virtual modeling to real-world testing. This enables learners to study theoretical aspects and verify the functionality of their circuits on physical equipment. An additional advantage is the presence of powerful analysis tools, including frequency response analysis, transient analysis, parametric analysis, and noise analysis.

However, NI Multisim has several drawbacks that should be considered for educational purposes. First, the high cost of the license can be a significant limitation for educational institutions, especially when access needs to be provided to many students. Second, the abundance of features and the complexity of the interface may pose challenges for beginners. Students without sufficient foundational knowledge may struggle to master the software, requiring additional instructor guidance.

Another disadvantage is its high demand for computing resources. Multisim requires powerful hardware to handle complex circuits, which can be problematic when using low-performance computers.

Thus, Multisim's capabilities may be excessive for the initial learning stage, where the interface's simplicity and limited functionality are required. However, the advanced stage of studying electronics and designing microprocessor systems offers unparalleled opportunities for learning and practice. It is well-suited for in-depth study of digital and analog systems for senior students with foundational circuit design knowledge.

Proteus should also be mentioned in the context of circuit simulation software. Its key features are its ability to simulate programmed microcontrollers and microprocessors (*Proteus, 2024*). Unlike EWB and NI Multisim, Proteus allows actual binary firmware files to be uploaded and tested into virtual microcontrollers. This makes the software indispensable for studying

areas of microprocessor technology where both hardware and software components are important.

Proteus also offers extensive capabilities for simulating peripheral devices such as LCDs, keyboards, sensors, motors, and other components used in control systems. This enables students to study combinational circuits and design and debug complex embedded electronic systems, including smart devices and IoT solutions.

The program's interface integrates hardware and software components, making Proteus an ideal tool for projects requiring microcontrollers to interact with external devices. Another significant advantage of Proteus is its visualization capabilities. The software allows the creation of interactive projects where the operation of virtual displays, motors, and other elements is shown in real time. It dramatically reduces the difficulty of working with abstract circuit designs.

However, Proteus has a high entry threshold, requires substantial student preparation, and has a high cost for user licenses. Additionally, its circuit analysis tools – such as noise analysis, frequency response, and other specialized methods – are less developed than NI Multisim's.

In summary, Proteus may be too complex for beginners in circuit design, and its analytical tools may be insufficient for deep circuit analysis. However, it is one of the best tools available for advanced studies of microcontrollers and their programming, including working with real firmware.

Conclusion

Using software simulators to teach circuit design and microprocessor technology allows students to master complex concepts and develop practical skills. These tools ensure the accessibility of experimentation without expensive equipment, allow students to study intricate processes in a safe virtual environment, and make the learning process more interactive and visually engaging.

Each of the reviewed programs has its optimal use cases. EWB is the simplest to use and is ideal for acquiring fundamental knowledge of circuit design. NI Multisim offers a wide range of analysis tools and enables the simulation of both analog and digital circuits. It stands out for its robust functionality and integration with hardware platforms, making it suitable for studying more complex systems. Proteus is distinguished by its ability to simulate microprocessors and work with firmware, making it the optimal choice for studying embedded systems. Selecting the appropriate tool should be based on the specific educational objectives and the student's level of preparation.

Integrating software simulators into the educational process accelerates learning, simplifies the process, and enhances the students' experience. Thus, software simulators are key tools for improving the quality of engineering education and training highly qualified specialists.

Conflict of interest

The author declares that there is no conflict of interest.

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Dynamic updating of association rules in intelligent e-commerce recommendation systems [7]

Abstract: The accumulation of large volumes of digital content in e-commerce necessitates implementing intelligent recommendation systems in their web platforms, which contribute to increasing financial profits by enhancing the efficiency of e-commerce. Among the methods used for generating forecasts in recommendation systems, Association Rule Mining (ARM) is widely applied. ARM uncovers hidden relationships between objects in large datasets. Many algorithms have been proposed for updating association rules in recommendation systems using incremental association rule mining. This approach involves rerunning the search algorithm on a modified transaction database instead of the entire database. However, dynamic updating of association rules in e-commerce systems remains an unsolved task that requires further development. The study object is the process of updating association rules in e-commerce recommendation systems. The study aims to develop and describe a method for dynamically updating association rules in an e-commerce recommendation system, which is implemented using the Apriori algorithm. The Apriori algorithm is based on finding association rules for frequent itemsets and is static and highly complex. In this work, dynamic updating of found association rules to ensure their relevance is proposed through periodic scanning of a portion of the database that contains transaction records from the past three months. The database is updated by adding new products and removing those that have been discontinued during this period. The proposed approach was implemented in actual operational conditions in an e-commerce system engaged in the retail sale of animal supplements. The study of the effectiveness of the developed intelligent recommendation system showed that its use was accompanied by an increase in the number of products sold, the average purchase value, and the conversion rate.

Keywords: e-commerce system, intelligent recommendation system, association rule, support, confidence, Apriori algorithm, dynamic update of associative rules, incremental association rule mining.

Abbreviations:
ARM is Association Rule Mining,
DELI is Difference Estimation for Large Item sets,
FUP is Fast Update,
IncA is Incremental Apriori,
UWEP is Update with Early Pruning.

Introduction

The high pace of informatization in modern society is accompanied by the accumulation of large volumes of digital content in e-commerce. This complicates the satisfaction of users' needs for obtaining necessary information about available products and services and drives the development of technologies related to searching and providing personalized recommendations. Implementing intelligent recommendation systems in the operations of online stores significantly enhances the effectiveness of commercial activities in the online sales sector. It contributes to increasing customer loyalty by saving time and providing a personalized approach to product recommendations (*Naresh & Suguna, 2021*).

For developing an intelligent e-commerce recommendation system that generates personalized recommendations for users when making product selection decisions, the choice of methods aimed at selecting products to ensure optimal forecasting is crucial. Collaborative, content-based, and hybrid filtering methods are distinguished among the main approaches used for forecasting in recommendation systems (*Falk, 2019*; *Boliubash & Zheltobriukhov, 2024*). However, the algorithms that implement these methods have many issues: cold start, sparsity of the user-item matrix, scalability, and changes in user interests (*Fayyaz et al., 2020*; *Jannach, 2022*).

Recommendation provision based on association rule mining uses a fundamentally different approach. An association rule $X \rightarrow Y$ is an implication of the form "if X," then Y", where X is the selected product or products (condition, an antecedent in the form of itemsets), and Y is the product or products that customers typically purchase together with the selected one (a consequence in the form of itemsets). Based on association rule mining, recommendation generation is performed when selecting a product for the cart based on analyzing a database of transactions previously made by other customers (*Lobur et al., 2017*). Well-known algorithms for Association Rule Mining include Apriori and its modifications, Eclat, DHP, AprioriTID, McEclat, and MsApriori (*Satyavathi et al., 2019*). The Apriori algorithm is based on two processes:

(1) discovering frequent itemsets whose support is more significant than a predefined threshold value;
(2) generating strong association rules from the discovered frequent itemsets whose confidence exceeds a predefined threshold value.

However, the Apriori algorithm is static. Therefore, in e-commerce systems, there is an issue with updating the discovered rules, which has not yet been fully resolved.

The study object is the process of updating association rules in e-commerce recommendation systems.

The implementation of recommendation systems among large retailers is one of the factors driving the rapid growth of global online sales. However, this approach is not sufficiently represented in smaller online retail stores, and the existing recommendation algorithms do not always meet users' needs, which requires further improvement.

The study aims to enhance the effectiveness of e-commerce in the product sales sector by developing a recommendation system for an online store. It incorporates effective methods for searching and dynamically updates association rules to generate personalized recommendations for users using the Apriori algorithm.

Dynamic updating of already discovered association rules is very complex because the range of products available for sale changes over time. Reapplying the Apriori algorithm results in the discovery of rules, some of which may no longer be relevant. Another issue with updating association rules in e-commerce systems is the increasing computational complexity of their search caused by the accumulation of many transactions. There are various approaches to dynamically updating the transaction database during the lifecycle of recommendation systems, aimed at generating rules based on newly added transactions and updating existing rules in a shorter time frame (*Naresh & Suguna, 2021*; *Satyavathi et al., 2019*). Incremental approaches, in particular, are worth noting, as they involve updating association rules by scanning only a

portion of the transaction database rather than the entire dataset. However, their implementation in e-commerce systems has not been sufficiently researched and requires further development.

Overview of information sources

Thanks to significant improvements in the ARM process, practical algorithms have recently emerged that demonstrate the automatic updating of generated association rules. Most proposed algorithms focus on minimizing database scanning and incremental association rule mining (*Satyavathi et al., 2019*; *Santoso, 2021*). The proposed approaches use variable threshold values for support and confidence (*Aqra et al., 2019*). This also addresses the issue of re-scanning previously mined databases and allows for acquiring knowledge that meets several thresholds without restarting the process, thereby reducing processing time.

Incremental association rule mining updates already mined rules using newly added transaction records in the database (*Figure 1*). The analysis of incremental association rule mining revealed the following approaches.

The FUP algorithm updates rules gradually based on changes to the database (when new transactions are added), generating a candidate set on each iteration subordinated to frequent itemsets already mined in previous iterations (*Han et al., 2022*). The FUP2 algorithm is an extension of the FUP algorithm, which supports incremental ARM for new record insertions and deletions of existing records.

The DELI algorithm, when updating the database, uses a sampling method to decide whether a new set of association rules needs to be generated or not (*Satyavathi et al., 2019*). If the evaluation is low, it considers the old rule set a good approximation of the new set. It waits for additional changes to be made to the database and applies the DELI algorithm again. If the evaluation is high, the FUP2 algorithm is applied to generate a new set of rules. DELI is more efficient than FUP2.

The algorithm utilizing negative borders improves the performance of algorithms based on FUP by using the concept of negative borders (*Thomas et al., 1997*). When generating frequent itemsets related to database growth, it scans the entire database only when the itemsets is beyond the hostile border.

The UWEP algorithm is another type of incremental ARM based on early pruning (*Ayan et al., 1999*). Early pruning helps avoid unnecessary processing of certain records by focusing only on incremental updates. The IncA algorithm is a new version of the Apriori algorithm, which scans incoming transactions and updates itemsets based on this data (*Driff & Drias, 2017*). This saves time and memory.

The MAAP and PELICAN algorithms generate large, frequent item sets based on previously mined frequent itemsets (*Satyavathi et al., 2019*). These algorithms are similar to FUP2 but focus on maintaining minimal frequent itemsets, as the database is periodically updated. MAAP computes the most frequent itemsets using the Apriori property, while PELICAN uses a decomposition grid and a vertical database format.

Thus, the analysis of incremental ARM algorithms showed that for dynamic updating of association rules in e-commerce systems, it is advisable to apply approaches that scan only part

of the transaction database rather than the entire dataset. This reduces the algorithm's computational complexity and decreases the time required for rule updates.

Materials and methods

For developing the server-side part of the e-commerce recommendation system, the MongoDB database management system, the open-source platform Node.js, the JavaScript library Mongoose, and the cloud hosting service Digital Ocean with an Ubuntu server were used. Nginx and SSL were configured on the server. HTML, CSS, JavaScript, the Vue.js framework, the Shopify e-commerce platform, and the Liquid templating language were used to develop the user interface.

The developed intelligent recommendation system was implemented into a company's web application specializing in the online sale of animal feed additives designed to help combat specific diseases. The recommendation system's main tasks are finding feed additives for animals with particular health issues and recommending their selection to customers.

A transaction database was prepared for generating and searching association rules (*Figure 2*). Scanning the entire transaction database has high computational complexity. To reduce the search space, the Apriori algorithm was chosen. However, it is static, and in real-world commercial systems, the discovered association rules must remain relevant. Recommended products are periodically removed, new ones are added, and advertised in different ways. Therefore, to solve the problem of generating up-to-date association rules and their optimal updating, the Apriori algorithm-based association rule mining was used, which allows reducing the search space by setting threshold values for support $S_{min}(X \to Y)$ and confidence $C_{min}(X \to Y)$ and searching for rules among frequent itemsets using incremental association rule mining.

The system includes the calculation of the following association rule metrics (*Boliubash, 2023*):

1) *Support* – is the ratio of the number of transactions containing both the condition and the consequence to the total number of transactions in the database:

$$S(X \to Y) = P(X \to Y), \quad (1)$$

where $P(X \to Y)$ is the probability of the joint occurrence of the condition and consequence;

2) *Confidence* – is a measure of the rule's accuracy and is defined as the ratio of the number of transactions containing both the condition and the consequence to the number of transactions containing only the condition:

$$C(X \to Y) = \frac{S(X \cup Y)}{S(X)}, \quad (2)$$

3) *Lift* – is the ratio of the confidence of the rule to its expected confidence, which is determined by the frequency of the consequence's appearance in the overall database (the support of the consequence of the rule):

$$L(X \to Y) = \frac{C(X \to Y)}{S(Y)}, \quad (3)$$

4) *Conviction* – compares the probability that condition X will appear in a transaction without consequence Y, assuming they are independent, to the actual frequency of X appearing without Y:

$$Conv(X \rightarrow Y) = \frac{1-S(Y)}{1-C(X \rightarrow Y)} = \frac{P(X) \times P(\overline{Y})}{P(X \cup \overline{Y})}, \quad (4)$$

where $P(\overline{Y})$ is the probability that Y will not appear in a transaction.

Discovered by the Apriori algorithm, the rules were sorted according to their lift and conviction values in the developed e-commerce system. The determination of lift $L(X \rightarrow Y)$ and conviction $Conv(X \rightarrow Y)$ metrics allows for more accurate identification of relevant rules by detecting their non-randomness, which enhances the understanding of the discovered patterns. The calculation of lift helps exclude false rules that are not frequent itemsets: rules with lift values greater than 1 are considered significant. The calculation of conviction $Conv(X \rightarrow Y)$ helps identify the condition X and consequence Y, where the relationship is random if the value is close to 1. If the conviction is greater than 1, the relationship between the condition and consequence of the association rule is not random.

To dynamically update the discovered association rules to maintain their relevance and reduce the algorithm's computational complexity, it was decided to periodically scan the transaction database, including only transactions within the most recent time interval. The size of this interval was empirically determined by scanning the actual transaction database with different intervals. Accordingly, the association rules discovered by the Apriori algorithm will be updated at a period equal to the selected interval.

Results

The recommendation system, developed using the approaches described above, was implemented in the operation of the e-commerce system for selling animal feed additives. The threshold values for support and confidence were selected so that the company could promote new products to the market.

The developed intelligent recommendation system generates association rules by selecting products that are frequently bought together, based on the set threshold values for support $S_{min}(X \rightarrow Y)$ and confidence $C_{min}(X \rightarrow Y)$ (*Figure 3*). The metrics for the generated association rules are calculated (*Figure 4*). Based on association rule mining, recommendations are generated when selecting items for the shopping cart based on the analysis of transaction data from previous purchases made by other customers.

Scanning the transaction database with different intervals showed that the most optimal update period for the association rules is every three months. Therefore, to generate the rules, it was decided to consider only the most recent transactions from the last three months. Subsequently, new transactions will be considered, and new association rules will be generated every three months. Implementing this approach significantly reduced the computational complexity of the algorithm and considerably shortened the time needed to search and update the association rules.

In the recommendation system, custom events were set up to track how many times a product appeared in the recommendations, how many purchases were made, and how many users showed interest in the product. The Figure 5 (*Figure 5*) shows information about each product added to the cart via the recommendation system. Monitoring the operation of the recommendation system revealed that its implementation led to an increase in revenue

generated from sales due to the more significant number of company products purchased through the provided recommendations.

Custom events were also set up to track how many times each product was displayed in the recommendations, how many purchases were made, and how many users were interested in the product (*Figure 6*, *Figure 7*). This allows for tracking sales conversion and making decisions regarding optimizing the company's marketing strategy based on the analysis conducted. An analysis of the impact of the recommendations on customer product selection showed that 55% of the recommended products were chosen and purchased by the customers (*Figure 8*).

Thus, applying the described approaches to the dynamic update of association rules in the e-commerce recommendation system has enhanced and improved customer service, expanded the customer's shopping cart, stimulated online sales in the e-commerce platform, and ensured high conversion rates for the online store.

Discussion

Providing personalized recommendations in the context of rapid growth in digital content volume requires identifying methods that offer high forecasting accuracy regarding users' intentions and preferences and optimal flexibility in their interaction with the recommendation system. The research has shown that incremental ARM algorithms can be used in real-time applications, ensuring automatic rule updates without the need to rescan the entire database. The incremental database is sufficient for creating new rules and updating the existing ones that have been generated. However, the ability of these algorithms to work with data with Big Data's characteristics remains unexplored. There are also incremental mining algorithms based on patterns. This highlights the need for further development in researching the effectiveness of their application in electronic commerce systems.

Conclusion

The analysis of recommendation provision in electronic commerce systems showed that the widely used method for forecasting users' potential preferences when selecting products is the search for association rules using the Apriori algorithm. It was found that dynamic updating of association rules in e-commerce systems is a problem that has not yet been fully resolved, as the algorithm is static and highly complex. In contrast, the product and service assortment in e-commerce systems changes over time.

The research established that incremental association rule mining algorithms significantly reduce rule update time and computational complexity by scanning only a part of the database related to new transaction records rather than the entire database.

To improve the commercial activity of a company engaged in the online sale of animal feed additives, an intelligent recommendation system was developed based on the Apriori algorithm using incremental ARM. Recommendations were provided based on association rules generated by the Apriori algorithm, sorting according to lift and conviction values. The recommendation system scans the transaction database every three months for dynamic updating of association rules. To reduce computational complexity and find up-to-date rules, the new scan covers only transactions made during the new three-month period, not the entire database. Implementing the developed intelligent recommendation system in the company's web application was

accompanied by an increase in profit due to a rise in the number of products sold through the provided recommendations.

Thus, the research revealed that implementing an intelligent recommendation system based on the Apriori algorithm, using Incremental Association Rule Mining, significantly enhances the effectiveness of commercial activities in online sales.

Conflict of interest

The authors declare that there is no conflict of interest.

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Appendix

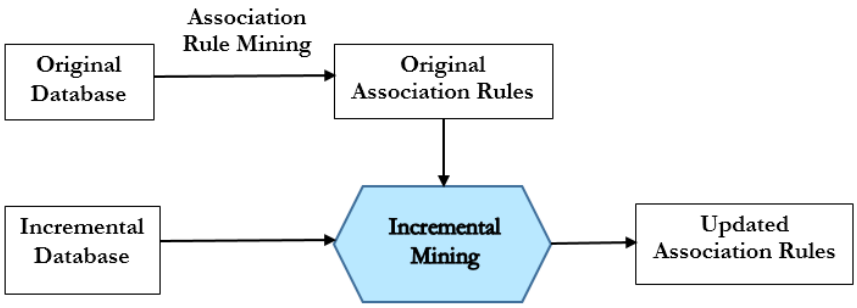


Figure 1. Process of Incremental Mining

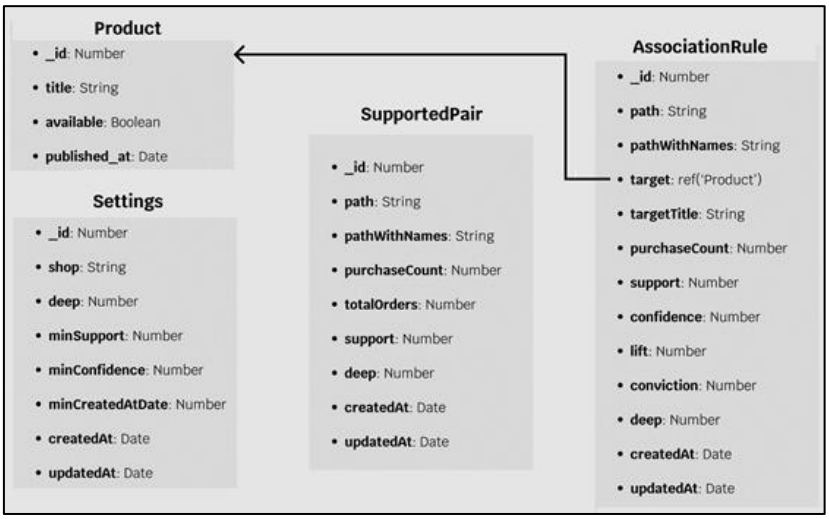


Figure 2. Architecture of the transaction database

Deep	Minimal support	Minimal confidence
2	0.40	0.55

Supported Pairs

Items set	Deep	Support
Lucky Belly	1	0.62224493557
Relax Time	1	0.84451045138
Fresh Smile	1	0.12363502326
Happy Hips	1	0.71974935110

Figure 3. Calculation of support for single-item sets

Association Rules

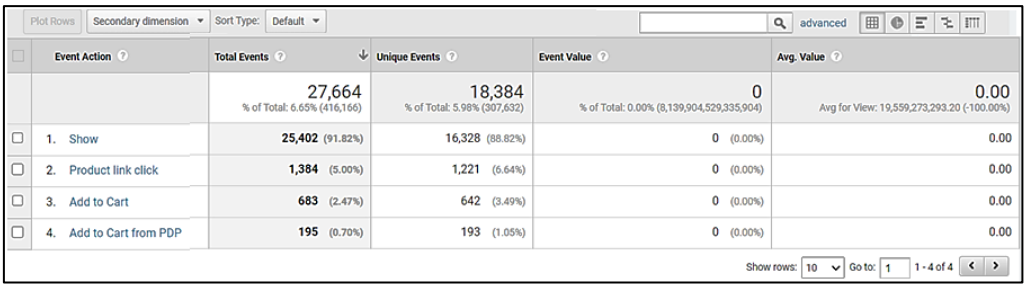
Deep	Minimal support	Minimal confidence
2	0.40	0.55

Items set	K	Confidence	Lift	Conviction
Easy Fresh -> Fresh Smile+	2	0.8435145869691682	8.747077774819811	1.0599619226450465
Easy Fresh -> Flavor Bundle	2	0.8231937172774869	2.931496303428662	1.0411289277060174
Easy Fresh -> Lucky Belly+	2	0.77545908667830134	2.4865983684815864	1.0314847517964587
Easy Fresh -> Fresh Smile	2	0.5997673072774869	2.3714454814477577	1.2398941522653337

Figure 4. Calculation of association rule evaluations at the stage of their formation

Назва продукту	Всього покупок	Ціна продукту	Загальна сума
Easy Fresh (50% Rabatt)	232	17.49	4,057.68 €
Lucky Belly Akut (40% Rabatt)	211	17.99	3,795.89 €
Fresh Smile Probe	83	4.99	414.17 €
Lucky Belly	65	39.99	2,599.35 €
Flavor Bundle	72	19.99	1,439.28 €
Pure Genius	43	39.99	1,719.57 €
Immu Push	31	39.99	1,239.69 €
Lucky Belly+	37	49.99	1,849.63 €
Fresh Smile+	24	49.99	1,199.76 €
Easy Protect (50% Rabatt)	11	17.49	192.39 €
Forever Young	10	39.99	399.90 €
Super Protect	14	39.99	559.86 €
Lucky Belly Probe	8	4.99	39.92 €
Fresh Smile	7	39.99	279.93 €
Happy Hips	7	39.99	279.93 €
Lucky Belly Akut	5	29.99	149.95 €
Easy Fresh	2	34.99	69.98 €
Happy Hips+	1	49.99	49.99 €
Relax Time	1	39.99	39.99 €
Shiny Hair	1	39.99	39.99 €
Приблизна загальна сума доданих в кошик продуктів			20,416.85 €
Приблизна загальна сума куплених продуктів (-55%)			11,229.27 €

Figure 5. Products added to the cart via the recommendation system



Event Action	Total Events	Unique Events	Event Value	Avg. Value
	27,664 % of Total: 6.65% (416,166)	18,384 % of Total: 5.98% (307,632)	0 % of Total: 0.00% (8,139,904,529,335,904)	0.00 Avg for View: 19,559,273,293.20 (-100.00%)
1. Show	25,402 (91.82%)	16,328 (88.82%)	0 (0.00%)	0.00
2. Product link click	1,384 (5.00%)	1,221 (6.64%)	0 (0.00%)	0.00
3. Add to Cart	683 (2.47%)	642 (3.49%)	0 (0.00%)	0.00
4. Add to Cart from PDP	195 (0.70%)	193 (1.05%)	0 (0.00%)	0.00

Figure 6. Custom recommendation events in analytics

Назва події	Всього подій	Всього унікальних подій	Відсоток подій	Відсоток унікальних подій
Відображеннь продукту в секції рекомендацій	25,402	16,328	100%	100%
Відриття продукту через секцію рекомендацій	1,384	1,221	5.45%	7.48%
Додавання продукту в кошик через секцію рекомендацій	683	642	2.69%	3.93%
Додавання продукту в кошик зі сторінки продукта, якщо на неї перейшли через секцію рекомендацій	195	193	0.77%	1.18%
Усього додавань в кошик за допомогою рекомендацій	878	835	3.46%	5.11%

Figure 7. Generalized data of custom events

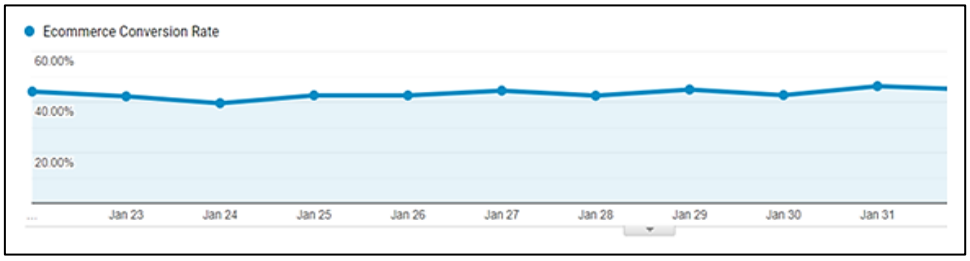


Figure 8. Analysis of the dynamics of recommended product purchases

Olena V. Borysiak [9]

Prerequisites for developing an information support system for freight transportation of agricultural waste [8]

Abstract: Developing the agricultural sector is essential for ensuring food security. The modernisation of freight logistics by applying innovative measures to the organisation of such transportation is of particular importance. The study aims to analyse and systematise the prerequisites for developing an information support system for transporting agricultural waste. The article considers the requirements for developing an information support system for freight transportation of agricultural waste. The specifics of agricultural waste transportation in terms of determining their safety level are highlighted. The ways to improve the efficiency of freight transportation are considered. Information and communication measures have been formed to enhance the efficiency of freight transportation of agricultural waste, including thoughtful freight planning and digital solutions to improve the efficiency of the vehicle fleet. Prospects for further research include studying the issue of the safety of freight transportation of agricultural waste.

Keywords: information technologies, freight logistics, transport safety, agricultural enterprises, agricultural products, vegetable oil production waste, smart freight planning, circular economy, digitalisation, automobile transport.

Introduction

Environmental responsibility in the context of agricultural development is based on the rational use of natural resources. This process includes the supply of raw materials and the production and marketing of finished agricultural products. Of particular importance in this process is the storage, transportation, and disposal of agricultural waste.

Today, information technology is used to optimise any business process. The effective use of information support by agricultural enterprises directly depends on the level of assessment of the organisational and economic conditions for its use. Because of this, an analysis of the prerequisites for developing an information support system for freight transportation of agricultural waste is an urgent issue.

The study aims to analyse and systematise the prerequisites for developing an information support system for transporting agricultural waste.

Aspects of improving freight transportation efficiency and using innovative approaches to forming supply chains based on digitalisation are the scientific community's subject of discussion and research. In particular, A. Kuzmenko, E. Komarov, I. Zhyr, I. Lesnikova, N. Khalipova and O. Shapovalov (*2023*), A. Fonseca, R. Oliveira and R. Lima (*2013*), and others analyse the optimisation of routes for the freight transportation of agricultural products by automobile transport. The use of GIS technologies for optimisation of reverse logistics routes is studied by O. Bakulich (*2022*), V. Dembitsky (*2022*), Lisandra Quintana, Marcos A. Coronado, José R. Ayala, Daniela G. Montes and Laura J. Pérez (*2023*), Taknaz Alsadat Banihashemi, Jiangang Fei and Peggy Shu-Ling Chen (*2019*), etc.

The analysis of the scientific achievements of domestic and foreign scientists shows the relevance of freight transportation in general and automobile transport in particular. Most studies focus on analysing the conditions and developing recommendations for optimising

logistics flows, modelling supply chains, and improving the supply chain management system. At the same time, the study of the prerequisites for integrating information technology into the transportation system of dangerous goods in the agricultural sector remains an open issue.

Methods

The methodological basis of the study is the following general and special methods:

- analysis, comparison, and synthesis to consider ways to improve the efficiency of freight transportation;
- induction and deduction to identify the specifics of transporting agricultural waste in terms of determining the level of their safety;
- dialectical cognition to study information and communication measures to improve the efficiency of freight transportation of agricultural waste, including smart cargo planning and digital solutions to improve the efficiency of vehicle fleets.

Results

Automobile transport is considered to be the most convenient type of transport for short-distance freight transportation. In terms of production in the agricultural sector, it is of particular importance to ensure a waste-free production process, which also includes issues related to minimising the negative impact on the environment during freight transportation and disposal of agricultural waste. In general, the following types of waste are distinguished: industrial waste, hazardous waste, medical waste, household waste, agricultural waste (containers for pesticides, agrochemicals, herbicides; pesticides and agrochemicals; herbicides; poisoned and spoiled grain; seeds; cake; vegetable oil; elevator waste; animal feed) (*Edible…, 2024*), etc.

In particular, vegetable oil production waste is classified as agricultural waste. According to the National Waste List, approved by the Resolution of the Cabinet of Ministers of Ukraine No. 1102 dated October 20, 2023, waste classifiers "20 01 25 – Edible Oils and Fats" and "20 01 26 – Oil and Fats" other than those specified in code "20 01 25" are distinguished. The type of waste as edible oils and fats also includes vegetable oil waste, which, according to the classification, is classified as vegetable oil production waste in Section 14, "Secondary Raw Materials; Municipal and Other Waste: Group 14.2 Other Waste and Secondary Raw Materials".

In Annex 3, "vegetable oil waste is included in the waste classification by hazard. In particular, vegetable oil production waste has such a dangerous property as ecotoxicity. Such waste is toxic to water and soil resources" (*On Approval of the Waste…, 2023*) and requires special conditions for transportation and utilisation. This necessitates compliance with environmental standards and, as a result, an increase in the efficiency of freight transportation of vegetable oil production waste. "Among the requirements is that vegetable oil waste is not worth releasing into the environment." (*On Approval of the Classification…, 2014*)

"Synchronisation of Ukraine's transport logistics system with the European transport logistics system is to optimise the transport system by addressing issues related to the modernisation of roads, creating a network of multimodal transport and logistics centres, increasing containerised cargo transportation, renewing the vehicle fleet, increasing the use of environmentally friendly and energy-efficient transport, equipping vehicles with software that

minimises downtime, reduces congestion and reduces the number of vehicles per route." (*Sustainable…, 2024*)

Among the ways to solve the issue of modernising the transport logistics of freight transportation are "drawing up a route that involves collecting freight from several points; using modern vehicles; transition to the transportation of groupage freight; optimisation of loading and unloading processes." (*Boychenko, 2018*) Among the ways to improve the efficiency of freight transportation is multimodal transportation, which is "performed by two or more modes of transport, but by a single operator. Multimodal transportation includes intermodal transportation, a distinctive feature of which is the absence of a single operator responsible for transporting goods." (*Chaika-Petegirich, 2020*)

In the context of ensuring the climate neutrality of freight transportation, in particular by automobile transport, another effective method of freight transportation (especially in international transportation) used in the European Union is the interaction of automobile transport with railway transport through counter-railway connections.

Improving the efficiency of freight transportation of agricultural waste necessitates an integrated approach to analysing organisational and economic factors. An open issue is ensuring the interaction of automobile transport with vehicles by type on the route. Among such problems are "cargo safety, unloading, and work with terminal operators." (*Bolzhelarsky et al., 2022*)

Considering the issue of increasing the efficiency of freight transportation of vegetable oil production waste, among the organisational components, and the choice of vehicle and vehicle interaction, the direct method of forming a logistics route (ring, pendulum, delivery and collection) is essential. For long-distance transport of goods by road, "pendulum routes are used. The use of these routes is due to the need to simultaneously send goods to customers located in different cities of the country. The main disadvantage of this type of route is empty runs during the return journey, which significantly increase the cost of the transportation process." (*Chaika-Petegirich, 2020*) As a result, it is economically feasible to use the pendulum route, provided that the freight is loaded on the way back.

Because of this, it is proposed, as an alternative to the pendulum route, to use a "distribution and collection route, which allows achieving an economic effect by reducing the number of rolling stock units and reducing the total mileage per trip in both directions of the transport company's trucks. The use of a distribution and collection route is characterised by the fact that other freight is loaded simultaneously at the same points when unloading freight. It is a combination of the two above routes." (*Litvinona & Baranovskyi, 2020*)

The tasks related to developing the road network in terms of harmonising conditions for international transport, namely "harmonisation with European standards of road transport" (*National Transport Strategy…, 2018*), are of great importance for agricultural enterprises.

In this context, to improve the efficiency of freight transport in Ukraine, it is of particular importance to apply the global practice of transition to multimodal transport as a component of sustainable mobility. The European Union has developed White Papers (the first in 1996, the second in 2001, and the third in 2011) to formulate a standard transport policy.

Because of this, one of the ways to improve the efficiency of freight transportation of agricultural waste is to use multimodal transportation, which involves container transport. The

organisational and economic prerequisites for the feasibility of using such transport by the company are based on the analysis of the provisions of the National Transport Strategy of Ukraine for the period up to 2030, which identifies the expansion of the multimodal transport network as one of the priority areas for reforming the transport sector of Ukraine.

"The interaction of vehicles (automobile and railway) determines the possibility of forming optimal supply chains in domestic and international traffic. Formation of supply chains based on the interaction of automobile and railway transport minimises transport costs and creates conditions for further development of supply chains and transport technology systems." (*Shramenko et al., 2021*) As a result, the global trend in freight transportation is to increase the role of multimodal freight transportation, considering organisational and economic factors to improve the efficiency of freight transportation of agricultural waste. The characteristic features of multimodal freight transportation that are worth considering by an enterprise are "the use of two or more vehicles, a unified tariff rate, and the presence of a single operator responsible for the entire process of transportation to the final destination." (*Pron, 2021*)

On this path, "the formation of an innovative transport policy by considering modern requirements for the transport of goods is promising." (*Pron, 2021*) Another challenge is "limited resources of transport modes and transport safety." (*Pysarchuk & Konrad, 2020*) Because of this, the urgent tasks for agricultural enterprises are to ensure the most favourable conditions for introducing multimodal freight transportation by considering the factors of influence of martial law in Ukraine and the need for decarbonisation of transport.

In turn, implementing sustainable development principles and transitioning to carbon neutrality requires innovative approaches to producing and supplying agricultural raw materials and direct production, storage, transportation, and marketing of farm products. Such approaches should be based on circular resource use and digitalisation principles. Scientists (*Optimizing cargo delivery…, 2024*) highlight the importance of using GIS technologies to form reverse routes. The table presents information and communication measures to improve the freight transportation process of agricultural waste (*Table 1*).

In the context of considering the issue of organising the working conditions of a logistician at an agricultural enterprise, it is valuable to consider the possibilities of using TIP Insight Digital Services, which increases "the competitiveness of transport companies through online monitoring, which will provide improved decision-making and connected work, namely:

- FleetRadar is TIP's interactive self-service fleet management platform for all our customers;
- FleetConnected is a telematics system for live visibility and connectivity;
- FleetAdmin is TIP's customer registration software;
- TIP Vehicle Inspection is a mobile application for damage management." (*TIP…, 2024*)

To prevent climate change, more and more logistics companies worldwide are implementing environmental solutions to preserve biodiversity and prevent climate change. To improve the efficiency of freight transportation of agricultural waste, it is valuable to consider the international experience in improving logistics services in the context of the transition to climate neutrality.

Among the measures to reduce carbon emissions, the Chinese logistics company SF focuses on reducing energy consumption in transport through intelligent planning of transport

routes, promoting electronic delivery confirmation (POD), photo uploading and paperless document management, increasing the construction of photovoltaic equipment in green industrial parks and increasing the share of clean energy use, diversifying green transport, and establishing the "SF carbon-neutral forest", for offset carbon emissions and the use of green packaging.

"As a pioneer of environmental and low-carbon transformation in the industry, SF has established a digital intelligent carbon management platform, which consists of carbon accounting, carbon targets, asset management and other parts covering packaging, transportation, transit, delivery and other processes, with a total of more than 120 indicators in more than 60 typical scenarios. The platform can calculate the end-to-end carbon footprint of businesses in real-time, enabling real-time monitoring of carbon targets. The four main functional sections of "identifying emission sources, setting emission factors, quantifying greenhouse gas emissions, and reducing emissions" are complete, reasonable, and accurate. Thus, it can perfectly meet SF's greenhouse gas inventory needs." (*2022 S.F., 2023*)

Conclusion

Today, the use of services and goods is viewed through the prism of the speed of their delivery directly to the end consumer, namely, effective supply chain management. In this regard, the assessment of cargo safety, selection of vehicles, ensuring interaction between them and determining the most efficient route for the transportation of agricultural raw materials and finished agricultural products, as well as agricultural waste, are particularly important for the agriculture sector.

Automobile transport is the most common type of vehicle used to transport various goods. In the production logistics of the agricultural sector, special attention is paid to transport support for the uninterrupted supply of raw materials, delivery of finished products to the end consumer, and the transportation of agricultural waste. An urgent issue is improving the efficiency of freight transport of agrarian waste by road based on information technology. This involves applying an integrated approach to forming a logistics system, including an analysis of the characteristics of the cargo, including determining the level of its safety for transportation, selecting the most economically and environmentally feasible types of vehicles, ensuring a harmonious interaction between them to reduce downtime during unloading and loading operations, and directly forming the optimal logistics route, considering road conditions.

Thus, transporting agricultural waste requires consideration of a set of conditions for its safety. Information support for freight transportation of agrarian waste is significant for the prompt collection, analysis, systematisation of factors and effective decision-making. This necessitates further research to focus on the issue of the safety of freight transportation of agricultural waste in general and automobile transport in particular as the most common way of transporting goods within Ukraine during military operations.

Conflict of interest

The author declares that there is no conflict of interest.

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Appendix

Table 1. Information and communication measures to improve the efficiency of freight transportation of agricultural waste

Event Name	Characteristics of the Event
Smart freight planning	Before any freight is shipped, plans must be made. A review of the destination and route of the shipment helps companies assess potential difficulties that may arise during transport. This includes possible road closures, traffic jams, or bad weather. By planning ahead, e.g., adjusting delivery times, using alternative routes or taking extra security measures, businesses can be well prepared for disruptions and ensure on-time delivery.
Digital solutions to improve vehicle fleet efficiency	Digital solutions can help ensure smooth deliveries and inform companies about their loads. Trailer telematics uses technology and software linked wirelessly to sensors on trailers to generate data that allows fleet managers to maximise ROI and uptime and minimise the total cost of trailer ownership. Trailer telematics data gives operators more information so they can make better decisions. It also provides greater real-time transparency into all aspects of the trailer, from the condition of its mechanical components and the need for preventive maintenance to its journey and the freight it carries as it moves through the supply chain to final delivery.

Source: based on (*Optimizing…, 2024*).

Oleksandr H. Haiduchok [10]

Mathematical model for synergistic purification in portable water device [9]

Abstract: The article considers the urgent problem of ensuring safe drinking water in global crises, anthropogenic impacts, and military conflicts. The topic's relevance is due to the growth of water pollution, which poses serious threats to public health and contributes to the emergence of epidemics. The study object is water purification processes using mobile autonomous devices that integrate mechanical filtration, ozonation, and ultraviolet disinfection. The study subject is a mathematical model of synergistic water purification processes, including analyzing hydraulic characteristics (using the Darcy equation), ozonation kinetics (first-order reaction model), and logarithmic kinetics of UV disinfection. The study aims to develop a mathematical model of the synergistic effect of these processes, which allows optimizing the operation of the device with minimal energy consumption. The study's objectives are to analyze the principles of operation of each purification stage and develop the mathematical models (using the Darcy equation for filtration, the pseudo-first-order model for ozonation, and logarithmic kinetics for ultraviolet disinfection). The main research methods are theoretical analysis and mathematical modeling. The results indicate the effectiveness of an integrated approach that removes mechanical, chemical, and biological contaminants, making the technology promising for use in emergencies and hard-to-reach regions.

Keywords: drinking water, portable water purification device, mathematical modeling, filtration, ozonation, UV disinfection.

Abbreviations:

DNA is deoxyribonucleic acid,

MF is microfiltration,

NF is nanofiltration,

RNA is ribonucleic acid,

UF is ultrafiltration,

UV is ultraviolet radiation,

WHO is World Health Organization.

Introduction

Nowadays, the problem with drinking water remains a critical global challenge. Every year, people from different continents and countries are deprived of safe water due to natural disaster or their isolation from centralized supply systems. Extensive research by the *WHO* reveals a critical crisis: nearly one-third of the global population lacks access to reliable, safe drinking water (*Environment…, 2023*). In many areas burdened by industrial waste, dangerous heavy metals like lead and mercury soar to ten times above the recommended limits. Additionally, military operations, especially in active conflict zones, intensify the contamination of surface water sources by introducing hazardous substances such as fuel, organic residues, and various heavy metals (*Shestopalov et al., 2024*).

The consequences of poor water quality extend deeply into public health. Contaminated water has been closely linked to illnesses, including cholera, dysentery, typhoid, and hepatitis A. The *WHO* estimates inadequate water, sanitation, and hygiene contribute to around 485,000

diarrheal deaths yearly. The risk of waterborne diseases escalates further in conflict zones where disruptions to sanitation and water supply systems are common (*Trembitska et al., 2024*). Moreover, long-term exposure to polluted water can lead to chronic conditions such as cardiovascular disease, kidney impairment, and neurological disorders, with children being particularly at risk – poor water quality being a major contributor to child mortality in low- and middle-income countries (*Strokal et al., 2023*).

The problem of obtaining drinking water could be solved by modernizing water treatment facilities and measures to curb anthropogenic challenges. The modernization strategy includes portable treatment devices or facilities to ensure safe drinking water even in emergency conditions.

In the previous research (*Tomashevskyi et al., 2024*; *Trembitska et al., 2024*), a mobile portable drinking water device (*Figure 1*) was developed to satisfy the needs of consumers in safe drinking water for areas of combat or extreme conditions. This work aims to develop a mathematical model that describes the operation of a water purification device through the synergistic use of three sequential processes: filtration, ozonation, and *UV* disinfection. This will allow for optimizing the device's operating parameters and achieving high purification efficiency with minimal energy consumption, critically essential in crisis situations.

The study object is water purification processes using mobile autonomous devices that integrate various treatment stages from primary mechanical filtration to ozonation and final *UV* disinfection.

The study subject is a mathematical model of synergistic water purification processes, including analyzing hydraulic characteristics (using the Darcy equation), ozonation kinetics (first-order reaction model), and logarithmic kinetics of *UV* disinfection.

To achieve the purpose of the study, the following tasks must be performed:

– determine the basic principles and technological scheme of water purification in mobile autonomous devices using sequential processes: filtration, ozonation, and *UV* disinfection;
– develop a mathematical model that describes the dynamics of each purification stage, using the Darcy equation to describe the filtration process, pseudo-first-order to model ozonation, and logarithmic kinetics to assess the effectiveness of *UV* disinfection.

Results

The technological design of the portable water purification device

Innovative mobile water treatment solutions, which combine filtration, ozonation, and ultraviolet light radiation, provide a robust method for achieving exceptional water purification under even the most demanding conditions.

Key filtration principles include (*Chen et al., 2024*; *Epoyan et al., 2018*):

- *mechanical filters* – retain large and microscopic particles using screens of varying densities;
- *carbon filters* – adsorb organic impurities, unpleasant odors, chlorine, and specific chemical contaminants;
- *membrane filters* – provide deep molecular-level cleaning, removing up to 99% of bacteria, viruses, and other pathogens.

Water can be pre-treated through filtration for subsequent processes (ozonation and *UV* treatment) and protect equipment from mechanical damage and clogging, extending the device's lifespan.

Due to its efficiency and reliability, membrane filtration has gained widespread use in water purification systems. In many countries, large-scale filtration plants are already operational to produce drinking water. However, certain limitations, such as membrane fouling, insufficient removal of soluble organic compounds, disinfection by-products, and algae – impede the full-scale implementation of *UF* and *MF* (*Ahuchaogu et al., 2018*). It has been noted that provided the source water is of high quality (with minimal anthropogenic pollutants), such systems can yield drinking water that meets quality standards.

Experience with ultrafiltration and microfiltration has shown that purification efficiency significantly increases in regions with well-preserved water resources (*Ahuchaogu et al., 2018*; *Gao et al., 2011*). However, impurities such as algae or soluble organic compounds reduce the efficiency of individual membrane processes to levels that do not meet *WHO* requirements for drinking water. This has prompted the development of integrated or hybrid filtration systems (*Trembitska et al., 2024*).

Research on the Taihu River in China (*Gao et al., 2011*) confirmed the effectiveness of combining coagulation with ultrafiltration as an optimal ferric chloride dose as a coagulant-produced water that met national quality standards. Coagulation enhanced the removal of natural organic matter and extended the lifespan of *UF* membranes.

NF is becoming increasingly popular due to its ability to remove fine contaminants, pesticides, and multivalent ions. Unlike *UF*/*MF*, *NF* effectively removes water hardness, retaining over 90% of calcium and magnesium. A successful implementation of *NF* can be observed at a water treatment plant in France (*Chen et al., 2024*), where the membrane process combined with coagulation and filtration provided high water quality despite a high level of organic pollution in the river water.

Pilot studies on groundwater have shown that preliminary deironing, demanganation, and sand filtration with nanofiltration achieves over 95% removal of organic compounds and high efficiency in eliminating calcium and magnesium (*Poliakov & Martynov, 2024*).

Ozonation represents the second "chemical stage" of purification, during which water is saturated with ozone (O_3) to break down microorganisms, effectively destroying bacteria, viruses, and fungi. The principle is based on ozone generated within the device by an ozonator through either corona discharge or *UV* generation. The produced ozone is introduced into the water, reacting with organic and inorganic contaminants. After purification, the ozone decomposes into harmless oxygen (O_3) without leaving harmful by-products (*Autin et al., 2013*). Among its advantages are rapid water disinfection and environmental friendliness.

Ozonation works effectively with filtration and *UV* radiation, preparing the water for the final disinfection stage.

UV rays destroy the *DNA* and *RNA* of microorganisms, rendering them safe for human health.

The combination of filtration, ozonation, and *UV* treatment offers the following advantages:

- *Multi-level protection*: ensures the removal of mechanical, chemical, and biological contaminants.
- *High productivity*: enables the purification of large volumes of water in a short time.
- *Cost-effectiveness*: features minimal energy consumption and autonomous operation.
- *Compactness and mobility:* devices are easily transportable and quickly deployable.
- *Environmental friendliness:* no chemical waste or secondary contamination is produced.

Water purification in a mobile autonomous device can be performed by integrating three key processes – filtration, ozonation, and ultraviolet disinfection – using a specialized technological scheme (*Figure 2*) (*Trembitska et al., 2024*). At the initial stage, contaminated water containing suspended particles and organic impurities is fed to the first stage of purification – coarse filtration. This stage ensures the removal of large mechanical particles and preliminary water clarification.

To achieve maximum efficiency, the system operates in a cyclic mode: water circulates repeatedly in a closed loop that includes a water tank, filter, ozonator, and *UV* chamber. Circulation is supported by a pump, which ensures a constant flow of water through all stages of purification. This approach allows you to achieve a high degree of disinfection even at low ozone concentrations and moderate *UV* radiation intensity.

Thus, processes based on kinetic dependencies, hydraulic characteristics, and chemical dynamics will be considered by developing a mathematical model of a device that uses the synergy of filtration, ozonation, and *UV* radiation.

Mathematical model of the synergistic process of filtration, ozonation and UV disinfection in the portable water device

To develop the mathematical model, the following assumptions will be taken into account:

- the processes proceed sequentially: filtration → ozonation → *UV* radiation;
- the water flow can be described as stationary and laminar;
- the kinetics of pollution removal is exponential and depends on the contact time with reagents/radiation;
- the filtration efficiency depends on the particle size and filter properties
- the ozone concentration and *UV* radiation intensity are adjustable parameters.

Analysis of literature sources (*Chen et al., 2024*; *Epoyan et al., 2018*; *Haiduchok et al., 2020*; *Keshavarzfathy & Taghipour, 2019*; *Livingston et al., 2025*) regarding dependencies that describe a separate purification process shows the following equations:

1. Darcy's filtration equation:

$$Q = \frac{\Delta P \cdot A}{\mu \cdot L} \cdot K_f \quad (1)$$

where

Q is the volumetric water consumption, m^3/s;

ΔP is the pressure drop across filter, Pa;

A is the filter area, m^2;

μ is the dynamic viscosity, Pa·s;

L is the filter layer thickness, m;

K_f is the filter permeability coefficient.

2. The kinetics of suspended particle removal:

$$C_f(t) = C_0 \cdot e^{-k_f \cdot t} \quad (2)$$

where

$C_f(t)$ is the concentration of suspended impurities after time *t*, mg/l;

C_0 is the initial suspended particle concentration, mg/l;

k_f is the filtration rate coefficient, which depends on the type of filter, s^{-1}.

3. Ozonation is based on chemical oxidation, which is described by a pseudo-first-order equation:

$$C_0(t) = C_f \cdot e^{-k_0 \cdot t} \quad (3)$$

where

$C_0(t)$ is the concentration of organic pollutants after ozonation;

k_0 is the ozone reaction rate coefficient (1/s), which depends on ozone concentration, temperature, and pH,

t is the ozone contact time, s;

C_f is the concentration after process.

4. The concentration of ozone in water depends on the mass of ozone fed into the system and the volume of water:

$$C_{O_3} = \frac{m_{O_3}}{V} \quad (4)$$

where

m_{O_3} is the mass of ozone added to water, g;

V is the volume of water, l.

5. The ozonation efficiency coefficient is determined by:

$$E_0 = 1 - e^{-k_0 \cdot t} \quad (5)$$

6. Disinfection by *UV* radiation is described by the kinetics of a logarithmic decrease in the number of microorganisms:

$$N(t) = N_0 \cdot e^{-k_{UV} \cdot I \cdot t} \quad (6)$$

where

$N(t)$ is the number of pathogenic microorganisms after time *t*;

N_0 is the initial number of microorganisms;

k_{UV} is the coefficient of sensitivity of microorganisms to *UV* radiation;

I is the *UV* radiation intensity (mW/sm^2);

t is the irradiation time, s.

7. *UV* disinfection efficiency coefficient:

$$E_{UV} = 1 - e^{-k_{UV} \cdot I \cdot t} \quad (7)$$

Thus, combining each efficiency coefficient of each stage will be the overall efficiency of purification:

$$E_{total} = E_f \cdot E_0 \cdot E_{UV} \quad (8)$$

So, to get the overall efficiency from the synergy of the three processes, are combined each efficiency coefficient of each stage:

To ensure the best efficiency, the system can be optimized according to the following criteria:

- contact time during filtration, ozonation, and *UV* disinfection;
- ozonator power;
- *UV* radiation intensity (*UV* diode power);
- hydraulic characteristics.

Thus, the obtained model allows us to describe the device's operation quantitatively. Our further study will aim at numerical modeling of the process to predict the cleaning efficiency and optimize the operating modes to achieve maximum productivity with minimal energy consumption.

Discussion

One of the key aspects of the discussion is the determination of critical process parameters, such as contact time, ozonator power, and *UV* intensity, which will significantly affect the treatment efficiency. The mathematical model's reliability must also be verified in actual operating conditions since variable hydraulic characteristics and the composition of pollutants can affect the results.

The study also stimulates further discussions on optimizing integrated treatment systems, particularly the possibility of using additional technological solutions, such as alternative energy sources, for the autonomous operation of the devices. The economic feasibility of implementing such systems remains an open question that requires a comprehensive cost-benefit analysis. At the same time, further experimental tests will allow us to refine the model and consider the influence of external factors on the quality of purifying.

Thus, the study's discussion highlights achievements and existing problems in modeling the synergy of water treatment processes, opening new directions for further research. Issues for discussion include expanding the model to consider variable environmental conditions, validating theoretical calculations with experimental data, and investigating the cost-effectiveness of implementing mobile units in different regions. These areas form the basis for further development of technologies that will ensure reliable water supply in emergencies and military conflicts.

Conclusion

The research addresses the problem of ensuring safe drinking water in crisis conditions and the possibility of using mobile autonomous facilities for purification. Particular attention is paid to integrating three technological processes: mechanical filtration, ozonation, and *UV* disinfection, which provides a high level of water purification. The developed model is the basis for further improvement and scaling of the technology, which can be used in extreme conditions to provide drinking water. It is based on the Darcy equation for filtration, pseudo-first order for ozonation, and logarithmic kinetics for *UV* disinfection.

This study provides a comprehensive analysis of the problem of ensuring safe drinking water in conditions of crisis phenomena and anthropogenic impacts, which determines the need for mobile autonomous devices. The introduction examines in detail the scale of the problem,

the negative impact of external factors on the quality of water resources, and the need to use an integrated approach that combines mechanical filtration, ozonation, and UV disinfection to achieve high purification efficiency.

The section "Mathematical Model of the Synergistic Process of Filtration, Ozonation, and *UV* Disinfection in the Portable Water Device" presents the mathematical model that combines all three processes into a single system. Using the Darcy equation to describe the hydraulic characteristics of filtration allowed us to characterize the water flow accurately, and the models of ozonation and *UV* disinfection contributed to the prediction of the purification efficiency. Numerical modeling and experimental tests confirmed the possibility of optimizing the operation of the device with minimal energy consumption, which is important for mobile systems in hard-to-reach regions and emergencies.

Therefore, integrating filtration, ozonation, and *UV* disinfection processes provides a high degree of removal of mechanical, chemical, and biological contaminants. Optimization of parameters such as contact time, ozonator power, and *UV* radiation intensity can significantly affect the efficiency of purification. The developed mathematical model is the basis for further numerical modeling and optimization of autonomous devices and prospective scaling of the technology. Based on the synthesis of theoretical calculations and practical tests, the research demonstrates the competitiveness and environmental safety of the proposed approach, which can become an effective tool for solving water supply problems in crisis conditions.

Conflict of interest

The author declares that there is no conflict of interest.

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Appendix

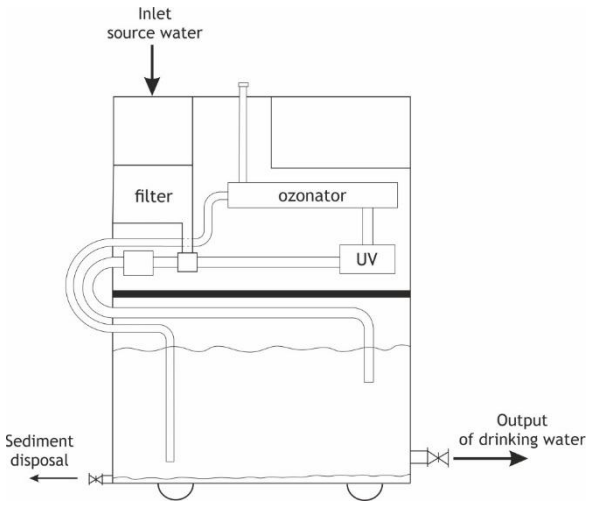

Figure 1. Design of the proposed portable drinking water device

Figure 2. Technological scheme of the proposed portable device

Nataliia O. Ryzhenko [11]

Peculiarities of proof in cases of division of joint marital property [10]

Abstract: The division of the joint property of spouses is always a relevant issue, which has many aspects depending on the type of property to be divided, the method and procedure for division, the features of recognising the property as joint property in the event of its registration under one of the spouses. It is worth noting that the spouses can choose the method of dividing the joint property by concluding a corresponding agreement and its notarial certification. However, this option is possible only if there is no dispute between the spouses. In the event of a dispute about the division of the joint property of the spouses, such a dispute can only be resolved in court. Our study will cover the features of proving the division of certain types of joint property of the spouses. Thus, with developing scientific and technological progress, social networks, and artificial intelligence, new types of civil legal relations appear and, accordingly, new objects of civil ties, which, among other things, can be objects of the right of joint property of the spouses. We will consider the features of the division: credit obligations for loans paid during the marriage, concluded by one of the spouses before the marriage, a car, and real estate that is not registered in the manner prescribed by law. It is also worth noting that dividing the joint property of spouses is always relevant, given the variability of the legal positions of the Supreme Court regarding the division of individual objects of joint property of spouses, which will be discussed in our study. The study object is peculiarities of presenting evidence in cases of division of joint property of spouses, namely, the features of division: credit obligations under loans paid during marriage, concluded by one of the spouses before marriage, a car, real estate that is not registered in the manner prescribed by law will be the object of our study. The study aims to analyse the features of presenting evidence in cases of division of joint property of spouses using the example of individual objects of its division. The task of our study: to determine what evidence is appropriate, admissible, reliable and sufficient for the division of credit obligations under loans paid during marriage, concluded by one of the spouses before marriage, a car, real estate that is not registered in the manner prescribed by law, considering the requirements of procedural legislation and current judicial practice. The methodological basis of the conducted study was general scientific and unique legal methods of cognition. The issue of the specifics of proof in cases of division of joint property of spouses, namely – credit obligations for loans paid during the marriage, concluded by one of the spouses before the marriage, a car, real estate that is not registered in the manner prescribed by law, is poorly studied from a scientific point of view. Regulatory legal acts and judicial practice cover most aspects that reveal this issue. The author concludes that the norms of family law establish the principle of equality of rights and obligations of spouses, in particular, equality of rights in the case of division of marital property and declaration of such division in equal shares. At the same time, based on the principles of reasonableness and justice and to effectively protect the rights of each spouse, modern judicial practice offers us specific options for dividing individual objects of the right of joint property of spouses. The features of the division of credit obligations for loans paid during marriage, concluded by one of the spouses before marriage, a car, or real estate that is not registered in the manner prescribed by law, which we have analysed, give grounds to conclude that the proposed methods of division are effective and aimed at ensuring the interests of each spouse.

Keywords: joint property of spouses, division, evidence, case law.

Abbreviations:

CCC is Civil Court of Cassation of Ukraine,

CPC is Civil Procedure Code of Ukraine,

FC is Family Code of Ukraine,

GC is the Grand Chamber of the Supreme Court,
SC is the Supreme Court.

Introduction

The FC (*Family Code of Ukraine, 2002*) defines that the property acquired by the spouses during the marriage is the common joint property of the spouses and can be divided at any time, even during the period of being in the marriage, and not only in the event of its dissolution. It is also worth noting that the legislation establishes the presumption of equal shares of spouses in common joint ownership. However, one of the spouses did not work because he was engaged in everyday life, took care of children, studied, etc. The legislation also contains provisions that in the event of a significant increase in the value of the property of spouses acquired before marriage due to joint investments in marriage, such property can also be recognised as an object of the right of common joint ownership in court. In our study, the author will consider problematic aspects of proof in cases of separation of individual objects of the right of common joint property of spouses in court, namely credit obligations for loans paid during marriage, concluded by one of the spouses before marriage, a car, real estate that is not registered according to the procedure established by law. The CPC (*Civil Procedure Code of Ukraine, 2004*) defines the requirements for evidence: reliability, admissibility, sufficiency and belonging. Thus, we will analyse which evidence will meet the specified criteria if the right to divide individual objects of the right of common joint property of the spouses mentioned above is proved.

Results

Credit obligations on loans paid during marriage that were concluded by one of the spouses before marriage

It is worth noting that this issue is quite relevant precisely concerning the division of real estate purchased on credit. For example, a person receives a loan before marriage and buys an apartment or other real estate but pays this loan after the marriage is registered.

Recently, the SC, in its decision No. 712/8602/19 dated June 12, 2023 (proceedings 61-14809svo21) (*Resolution…, 2023b*) formed the following legal opinion on the above, namely, "in the case of entering into a loan agreement and receiving money for the purchase of real estate by one of the spouses before marriage, subject to further fulfilment of the loan obligation by the spouses during marriage, the spouse who did not enter into a loan agreement, after the dissolution of the marriage, is entitled to compensation for half of the amounts that were paid for the fulfilment of the loan obligation."

Accordingly, when making claims concerning real estate purchased before marriage on credit, but the credit obligations are fulfilled during the period of marriage, the party that concluded the loan agreement should remember that it does not have the right to make claims for recognition of such real estate as an object of the right of common joint property of the spouses and recognition of ownership of half of such real estate. In this case, the proper way to protect the rights of such a person is to file a claim for recovery from the other spouse of compensation for half of the amounts paid for repayment of the loan.

Proper evidence in such a case can be receipts, payment orders for depositing funds, and certificates from the bank on loan repayment indicating the exact amounts and repayment periods. Suppose the plaintiff is deprived of the opportunity to obtain such evidence in a pre-trial procedure, considering the presumption of the principle of bank secrecy. In that case, the latter can apply to the court for secure evidence or request evidence.

Thus, it can be concluded that real estate purchased on credit before marriage by one of the spouses is not the common joint property of the spouses. However, the funds deposited by the spouses, already during the marriage, to repay the loan obligation received by one of the spouses before the marriage for the purchase of real estate must be compensated to the other spouse for half of the total amount paid. In our opinion, the above position is logical and fair since the funds of the spouses earned in marriage are common, respectively, in the case of division of property, so half of the paid amount should be returned from the spouses who did not apply for a loan.

Division of the car as a common joint property of the spouses

A car purchased in marriage is the common joint property of the spouses and is subject to Division, regardless of who has registered ownership of such a car. At the same time, the vehicle is indivisible, and it is impossible to divide it in kind. Therefore, the spouses' car can either be sold, and the funds between the spouses are divided by ½ each, or one of the spouses owns the vehicle, and the other receives half of its market value. It is the second method of separation that we have analysed.

The GC of the SC in its decision No. 209/3085/20 dated February 08, 2022 (proceedings No. 14-182tss2) (*Resolution…, 2022*) considered the correct conclusion of the courts that the claims for recognition of the defendant's ownership of the car and recovery in favour of the plaintiff of the corresponding monetary compensation is worth considering as a claim for the division of this indivisible thing by allocating it to the defendant's property and collecting compensation from him instead of the plaintiff's share in the right of common joint ownership of the car. In addition, the GC of the SC stated that as a result of its allocation to the ownership of the defendant and such recovery, the right of common joint ownership of the car is terminated. Therefore, a separate requirement to terminate the right of common joint ownership is an ineffective way of protection.

The GC of the SC concluded that the requirements of Parts 4 and 5 of Article 71 of the Criminal Code of Ukraine and Article 365 of the Civil Code of Ukraine, considering the principle of reasonableness, are worth understanding as follows:

(a) the rules on the need for preliminary deposit of funds to the court's deposit account relate to those cases when the plaintiff (one of the spouses or ex-husband, ex-wife) filed a claim for termination of the defendantəs right to a share in common ownership (such funds ensure that the defendant receives monetary compensation);

(b) if the plaintiff (one of the spouses or ex-husband, ex-wife) has not made such a claim (but demands, for example, to divide an indivisible thing by allocating it to the defendant's property and collecting monetary compensation from him instead of the plaintiff's share in the right of common joint ownership of this thing), then there are no grounds for depositing the corresponding amount of funds to the court's deposit account.

The plaintiff did not claim to keep the car for herself, terminating the defendant's right to a share in the right of common joint ownership with compensation to him for this share. On the contrary, she agreed to receive monetary compensation for her share in the right of common joint ownership of the car from the defendant. Therefore, the claim to recover such compensation does not give rise to the defendant's obligation to deposit the corresponding amount in advance to the court's deposit account. The legislation of Ukraine does not require confirmation of the solvency of such a defendant. The fact that the defendant does not have the means to pay compensation to the plaintiff at the same time cannot by itself be a sign of the excess burden of such payment.

The defendant's consent to pay monetary compensation to the plaintiff, whose ownership right to a share in the right of common joint ownership is terminated, is not mandatory. According to the content of Part 4 of Article 71 of the CPC, consent to receive such compensation instead of a share in the right of common joint ownership of property upon its division must be provided by the spouse in whose favour the court awards such compensation. This prescription is consistent with the prescription of Part 2 of Article 364 of the CPC, according to which it is the co-owner who wishes to allocate must consent to receive monetary compensation from other co-owners for the value of his share in an indivisible thing.

The GC of the SC deviated from the conclusion formulated, in particular, in the decisions of the SC of Ukraine No. 6-2811cs15 dated March 30, 2016 (*Resolution…, 2016a*) and the SC No. 559/609/15 dated June 16, 2021, that the court must determine the ideal shares of co-owners in an indivisible thing without its real division and leave the corresponding property in common shared ownership if the defendant has not previously deposited funds to the court's deposit account for the plaintiff's share in the right of common joint ownership of an indivisible thing, and the latter cannot be divided in kind according to shares.

In addition, the GC of the SC deviated from the conclusion formulated, in particular, in the decisions of the SC No. 6-2925tss15 dated January 13, 2016 (*Resolution…, 2016b*) and the CCC of the SC No. 371/1369/15-C dated August 29, 2019, (*Resolution…, 2019*) that to resolve the issue of applying Part 2 of Article 364 of the CPC, the legal significance is whether the co-owner-defendant, who owns and uses common property, pays material compensation to the plaintiff for such possession and use according to Part 3 of art. 358 of the CPC, whether the co-owner-defendant can pay monetary compensation to the co-owner-plaintiff for the value of his share and whether such payment will not be an excessive burden.

Thus, the division of the car as an object of the right of common joint ownership of the spouses in kind is impossible. Instead, the vehicle can be left in the ownership of one of the spouses, and half of its market value must be collected in favour of the other. Proper evidence confirming the actual market value of a car will be a report on determining the market value of a particular vehicle performed by an expert or expert institution on the order of one of the participants in the case or based on a court order.

Real estate that is not registered according to the procedure established by law as an object of division of common joint property of spouses

Quite commonly, private houses are built on land plots that citizens own without appropriate permits, the so-called unauthorised construction. At the same time, when the

spouses diverge and want to divide such a house and other common property, many problems arise. Such a house is not in the State Register of Fundamental Rights to immovable property, i.e., the right of ownership to it is not registered, and, accordingly, it is impossible to recognise it as the object of the right of common joint property of spouses, to divide, to recognise for each of the spouses the right of private ownership to a share of such a house. In 2023, the SC ended this issue and established a mechanism for separating such an object.

In decision No. 511/2303/19 dated April 12, 2023 (*Resolution…, 2023a*), the GC of the SC formed the following legal position:

- before the acceptance of newly created real estate into operation and its state registration, the right of ownership to this newly created real estate as an object of civil turnover does not arise; in this case, the person is the owner of only materials, equipment that was used in the process of this construction (creation of property);
- if it is impossible to separate an unfinished building, the court may recognise the right of the parties to the dispute to the building materials and structural elements of the house or, considering specific circumstances, leave it to one of the parties and award compensation to the other;
- while recognising the ownership of the materials or equipment, the court must specify (name) these materials or equipment in its decision.

At the same time, in this decision, the Supreme Court of Ukraine deviated from the conclusion of the Supreme Court of Ukraine, expressed in the decision No. 6-47tss16 dated September 7, 2016, (*Resolution…, 2016c*) that:

- since the disputed object of unfinished construction was built during the marriage for the common funds of the spouses and is the object of common joint property of the spouses,
- its construction is completed, and it is operated for its functional purpose, but is not accepted for operation, and the ownership right to it is not issued due to the fault of the defendant;
- the plaintiff is deprived of the opportunity to perform these actions, which prevents her from exercising her right to divide the specified property acquired during the marriage; there are grounds for recognising the plaintiff's right to a part of the disputed object under construction.

Thus, dividing an object under construction between spouses as real estate is impossible. The court may recognise the parties' ownership of building materials and structural elements of the house or award one of the parties' monetary compensations for half of such building materials, structural elements and equipment. It is worth noting that the cost of building materials, structural elements and equipment can be determined by conducting an expert study and providing such an opinion to the court by one of the parties to the case or performing an expert examination by a specialist institution based on a court order.

Conclusion

Having analysed the above provisions of the legislation and judicial practice regarding the division of individual objects of the right of common joint property of spouses, we came to the following conclusions:

(1) Immovable property acquired on credit before marriage by one of the spouses is not the common joint property of the spouses. However, the funds deposited by the spouses, already during the marriage, to repay the loan obligation received by one of the spouses before the marriage for the purchase of real estate must be compensated to the other spouse for half of the total amount paid. The above position, in our opinion, is logical and fair since the funds of the spouses earned in marriage are common, respectively, in the case of division of property, so half of the paid amount should be returned from the spouses who did not apply for a loan;

(2) The Division of the car as an object of the right of common joint ownership of the spouses in kind is impossible. Instead, the vehicle can be left in the ownership of one of the spouses, and half of its market value must be collected in favour of the other. Proper evidence confirming the actual market value of a car will be a report on determining the market value of a particular vehicle, performed by an expert or expert institution on the order of one of the participants in the case or based on a court order;

(3) Dividing an object under construction between spouses as real estate is impossible. The court may recognise the parties' ownership of building materials and structural elements of the house or award one of the parties' monetary compensations for half of such building materials, structural elements and equipment. It is worth noting that the cost of building materials, structural elements and equipment can be determined by conducting an expert study and providing such an opinion to the court by one of the parties to the case or performing an expert examination by a specialist institution based on a court order.

Conflict of interest

The author declares that there is no conflict of interest.

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Irina S. Pashko [12]

The relevance of problem benchmarks in police activity [11]

Abstract: The article is devoted to analysing the problem-oriented approach in the activities of the National Police of Ukraine. The study is relevant in the context of legal reform and armed aggression, which affect the effectiveness of law enforcement agencies. The study's object is to the forms and methods of police management, while the purpose is to formulate an optimal strategy for assessing law enforcement effectiveness. The research methodology includes system analysis, content analysis, and methods of induction and abstraction. The research is based on the works of Gusarev, Dotsenko, Kubayenko, Hinkle, Weisburd, Itskovich, and other scholars. The results indicate that the SMART model is adequate for assessing police performance, as it identifies key indicators of law enforcement effectiveness and their adaptation to modern conditions. This article is recommended for academics, law enforcement officers, postgraduate students, and anyone interested in the reform of law enforcement as a sector of Ukraine's security and defence.

Keywords: police reform, public monitoring, hot spots, effective strategies, effect size analysis, problem-solving, reducing crime.

Introduction

Problem statement. The wide range of tasks that law enforcement officers have been involved in since the beginning of the 20th century and evaluating the effectiveness of their implementation has become a topic for long discussion. Scientific schools, which emerged as a result of diverse studies of the dichotomy "police" and "coercion" in their collections, looked for alternatives to the criteria for evaluating the activities of police bodies (divisions) that stereotypically functioned in Ukrainian society. The number of registered offences, their disclosure, and demonstration of episodes of investigation of the most high-profile crimes in the media, despite their simplicity, created an image of "crime fighters" for law enforcement officers (*Introduction..., 2009*), which was discordant in the perception of the National Police of Ukraine as a central executive authority with service functions (*On the National Police, 2015*).

Although European countries introduced a problem-oriented approach to policing by the end of the 1990s of the last century, Ukrainian law enforcement officers continued to function as an overly conservative, closed system of the "police state." (*Introduction..., 2009*) The armed aggression of the Russian Federation against Ukraine has become an unprecedented challenge for the activities of law enforcement agencies and the beginning of the transition to a new reform doctrine (*Comprehensive..., 2023*). Replacing traditional guidelines in assessing the effectiveness of law enforcement functions with vectors related to promoting the creation of a safe environment and prompt response determines the need to rethink problematic guidelines in the activities of National Police bodies (divisions) and the relevance of scientific developments in this direction.

The study object is the forms and methods of managerial activity in law enforcement agencies, in particular the bodies (divisions) of the National Police.

The study aims to form a strategy for evaluating the effectiveness of the National Police as a subject of Ukraine's security and defence sector.

The research tasks were defined as follows: to identify determinant vectors in implementing the problem-oriented approach in police activities and to propose an optimal model for assessing the effectiveness and quality of work of National Police bodies and divisions for Specific, Measurable, Achievable, Relevant, and time-limited (SMART) goals.

The study used methods of system analysis to identify factors that affect the specifics of Police Activities, content analysis to take into account the priority areas of its implementation when forming a list of performance criteria, and methods of abstraction and induction to build an optimal assessment model.

There are the works of S.D. Husariev, O.S. Dotsenko, A.V. Kubaienko, Kh.V. Solntseva, V.A. Ahmadov, B. Ariel, O.B. Bodnar-Petrovska, E. Buchnik, N.O. Chudyk, O.M. Dubenko, J.C. Hinkle, E. Itskovich, V.V. Lytvyn, A.V. Novichenko, M.M. Rudenko, A.O. Saparova, V.I. Teremetskyi, A.V. Trembetsky, I.M. Vyhivskyi, N. Wain, C. Weinborn, D. Weisburd used in the study.

The article is intended for scientists, practitioners, applicants for higher education and other specialists whose interests are related to reform and management in law enforcement agencies.

Results

Problem-oriented police activities

The introduction of a problem-based approach to policing in the scientific literature is well considered in the context of the professional and personal development of a police officer (*Dotsenko, 2021*) or the promotion of criminological theories of the search for managerial solutions for the provision of Police Services (*Solntseva, 2021*). Priority in choosing the direction of research a posteriori is determined through determinant vectors, differentiation of the categories "police activity" and "activity of the police," and the choice of a methodological basis for identifying problems, their causes and risk assessment. To develop a model for evaluating the effectiveness of bodies (divisions) of the National Police of Ukraine to ensure the security of the environment at the state, regional and local levels, it is appropriate to apply a systematic approach that takes into account the determinant vectors of problem benchmarks, as well as quantitative and qualitative performance indicators. In this context, it is important to form a system of essential evaluation criteria based on Specific, Measurable, Achievable, Relevant and time-limited goals that would allow an objective assessment of the work of these bodies (divisions) and their application of a problem-oriented approach.

A.V. Kubayenko connects the implementation of a problem-based approach in the activities of the police with the introduction of foreign concepts, strategies and methods of innovative management. Determinant vectors in the choice of role models in this aspect are the current regulatory framework that regulates public relations in law enforcement, foreign policy and internal management factors, which together determine the transformation processes for the structure, strategy and tactics of functioning of police bodies (divisions). Constant changes in the political course of the state under martial law and those that will arise during a unique period require conscious management, intra-departmental interaction, preventive thinking in the direction of work and the priority area of application, careful strategic analysis, planning and

implementation of initiatives in the activities of the subordinate unit (*Kubaienko, 2020, pp. 385-386*).

S.D. Gusarev believes that national and national interests should determine the implementation of a problem-oriented approach. In the context of the armed aggression of the Russian Federation and overcoming its consequences, issues of protection, protection and ensuring a balance between the system of international relations in which Ukraine is involved, the system of values and priorities of legal reality that reigns in Ukrainian society, and the system of familiar, widely used categories of legal realities, which are rethought under the influence of integration, globalisation movements and form a new content of such categories as "police activity" and "activity of police." Due to the constancy of threats to the protection of national sovereignty, functional transformations activate the differentiation of powers in the activities of the police by scope of implementation and subject composition (*Gusariev, 2023, pp. 432, 439*).

V.I. Teremetskyi et al. noted that the problem-oriented approach to police activities is practical in the system of preventive measures, which involves a significant part of civil society. In the formation of ways and mechanisms for organising the security space, providing police services in ensuring public safety and order, and countering offences, the priority is considering the experience of foreign countries, harmonising the selection of candidates for police service and their professional training, strengthening the work of police officers at the local level. Indicators of high efficiency from the use of a problem-oriented approach in the activities of the police are the ability of law enforcement agencies to quickly protect the rights of citizens and take into account the needs of the state and society (*Teremetskyi et al., 2024, pp. 19-20*).

J.C. Hinkle and D. Weisburd point out that the etymological nature of problem-oriented policing is quite variable. Its effectiveness depends on the number and quality of subjects involved and the objects for which it has a target direction. A general relative decrease in the level of committed/committed public order offences is possible due to the use of moderator analysis, the expansion of response measures, the involvement of a significant number of partner departments/groups or more police officers in the programme, as well as the focus on specific types of criminal offences (e.g., criminal offences against property, criminal offences against public safety). Received by J.C. Hinkle and D. Weisburd empirical results allow us to speak of a problem-oriented approach as an effective means of managing the activities of police bodies (divisions) even at the initial stages when the law enforcement agency cannot implement a profound solution to the problem (*Hinkle & Weisburd, 2024*)

According to E. Itskovich et al., the isolation of the problem-based approach and the constant presence of police officers in controlled hot spots does not significantly reduce crime. The results of an empirical study conducted by the authors in south Birmingham (United Kingdom of Great Britain and Northern Ireland) indicate that the concentration of police forces collectively contributes to a decrease in the level of committing offences. However, the indicators obtained are unsustainable and require constant adjustment to consider police reports. This means that the main determinants in the implementation of a problem-oriented approach in police activities are the level of criminogenic situation in a particular territory, the ability of law enforcement agencies to ensure a reasonable concentrated presence of their personnel in hot spots, the presence of a relevant model of rapid response to an event or offence

("treatment-as-assigned" or "treatment-as-delivered") and the smooth reporting between the service links of police units (*Itskovich et al., 2025*).

Thus, implementing a problem-oriented approach in policing is traditionally associated with the imitation of European systems that began in the early 1980s under the influence of hedonistic values of consumer morality of postmodernism to replace the "Puritan asceticism" of industrial, public administration. As a result of the reorganisation processes that took place before the end of the 1990s of the last century, the police department was determined by at least one of the two models produced by "social engineering" or decentralised provision of services.

Identifying problems

Launched in 2014 in the activities of bodies (divisions), the problem-oriented approach provides for close interaction between authorised subjects of law enforcement agencies and the population. This means that the identification of problems, search for the causes of their occurrence, and risk assessment should consider citizens' opinions, their expectations related to creating a safe environment, and the prompt response of law enforcement officers to incidents. Police powers focus on analysing data and information received to understand patterns and trends and identify potential threats and vulnerabilities at the state, regional, and local levels.

I. Vyhivskyi and A. Trembetsky note that the political situation in Ukraine has functionally changed the powers of the National Police bodies (divisions). In the context of the military aggression of the Russian Federation against Ukraine, the list of official tasks of police officers includes countering military threats, maintaining law and order in the de-occupied territories, countering crimes against national security and preventing offences related to the introduction of a legal regime of martial law. Changes made to the national legislation regarding the management of bodies (divisions) of the National Police take into account the peculiarities of the period of martial law, restrictions on the rights and freedoms of citizens defined by the Constitution of Ukraine, the law of Ukraine "on the legal regime of martial law," allow ensuring the effectiveness of police tasks to promote the creation of a safe environment and rapid response to threats and incidents (*Vyhivskyi & Trembetsky, 2024, p. 155*).

New problems in the current conditions are the issues of excessive length of pre-trial investigation due to the overload and inefficiency of individual bodies (divisions) of the National Police, the lack of well-established interaction of police officers with other subjects of the security and defence sector of Ukraine (*Lytvyn & Ahmadov, 2024, p. 58*). The latter is the result of a blurred differentiation of the competence and powers of law enforcement agencies that carry out police activities, duplication of their functions, the presence of corruption risks in making managerial decisions by these subjects of the security and defence sector, imperfect mechanisms for appointment to positions and promotion (*Comprehensive…, 2023*).

Thus, rapid response in the context of the armed aggression of the Russian Federation against Ukraine is a priority way to adapt law enforcement agencies to new challenges and minimise risks. The lack of well-established interaction between the subjects of the security and defence sector of Ukraine, whose competence includes ensuring law enforcement functions, leads to an overload of the work of government personnel, their general inefficiency and slows down the course of the implemented reforms, reducing the level of public confidence.

Causes and risk assessment

V.A. Nekrasov and G.S. Katamadze note that the application of risk assessment measures should be comprehensive and meet the requirements of current legislation. Risk analysis is a tool for studying complex socio-economic systems in conditions of uncertainty, such as potential threats, possible dangers, and harm caused. The subject of such a procedure is the "National Coordinator," fixed in the current regulatory framework (*Nekrasov & Katamadze, 2024, pp. 311, 315*). Establishing the cause of occurrence and assessing risks determines the choice of methods according to the authority of the National Coordinator and provides long-term prospects in the security management system at the state, regional and local levels.

The main criteria for the effectiveness and quality of work of bodies (divisions) of the National Police of Ukraine to ensure environmental security may include the following components:

1. *Quantitative Parameters and Performance of Work*. This indicator determines the number of completed tasks provided for in regulatory legal acts. For example, this may include the number of criminal proceedings investigated and submitted to the court, the number of offences that were prevented (including repeated ones), and the number of preventive measures taken. To this should be added indicators of early detection and neutralisation of threats, which are important factors for the success of law enforcement agencies.

2. *Economic Efficiency*. This criterion concerns the rational use of the body's (Division) resources to perform the tasks assigned to it. It is important to analyse the extent to which the costs of maintaining the national police body (Division) correspond to the results achieved. In particular, the ratio between costs and results of work performed and the economic efficiency of the distribution of human and material resources is evaluated.

3. *Employee Performance*. Assessing the individual performance of employees of the national police body (subdivision) is important in evaluating the body's overall performance. This indicator includes productivity, discipline, compliance with professional ethics standards, and a willingness to improve.

4. *Staff Satisfaction*. Work efficiency largely depends on employee satisfaction with working conditions, organizational culture, and career opportunities. Regular staff surveys can identify problematic aspects of internal communication, excessive workload, or dissatisfaction with service conditions, which can negatively affect the effectiveness of the body's work.

5. *Integrating the Gender Approach and Countering Discrimination*. One of the key criteria of the modern assessment system is compliance with gender equality and effective counteraction to discrimination. This includes indicators relating to women's involvement in all areas of the national police and the availability and effectiveness of mechanisms to prevent discrimination on any grounds.

These key performance indicators are based on the principles of the SMART methodology (Specific, Measurable, Achievable, Relevant, and Time-Bound) and function as a separate element of an integrated system (*Giulmagomedov et al., 2023, p. 560*), according to the requirements of the current legislation, which contains recommendations for implementing an assessment of the effectiveness of law enforcement agencies (*Action Plan…, 2023*).

To specify performance indicators for each of the proposed parameters for evaluating the work of National Police bodies and divisions, the following key indicators can be defined:

1. Quantitative parameters and performance:

- The number of proceedings investigated for a certain period (for example, monthly or quarterly).
- The number of criminal proceedings submitted to the court.
- Percentage of completed criminal proceedings (with notification of a court decision).
- The number of violations in law and order that were prevented.
- Number of preventive measures (lectures, campaigns, public awareness).
- Time spent investigating cases (from receiving the case to submitting it to the court).

2. Economic efficiency:

- Costs per completed production (total costs of the authority divided by the number of completed production).
- The ratio of expenses to income (in the case of organisations that can generate income through fines or other sanctions).
- Percentage of completed tasks with minimal resource consumption.
- The number of productions completed is more than the budget.
- Reduce the cost of auxiliary processes (logistics, technical support, etc.).

3. Employee performance:

- Average number of completed proceedings per employee for a certain period.
- Percentage of over-fulfilment of planned indicators by each employee.
- Assessment of the quality of employees' work (based on internal audits or colleague feedback).
- The number of disciplinary violations or complaints against employees.
- Time spent investigating one case by a particular employee.

4. Staff satisfaction:

- The level of satisfaction of employees with working conditions (based on the survey or questionnaire results).
- Percentage of employees who positively assess working conditions, career opportunities, and the internal climate.
- Staff turnover (the number of layoffs over a certain period).
- The number of vacation days taken due to stress or work overload.
- The level of employee participation in professional development programmes and training.

5. Gender mainstreaming and countering discrimination:

- Percentage of women in senior positions of the body (Division).
- Percentage of women and men in different departments (no gender imbalance).
- Number of programmes or activities aimed at promoting gender equality.
- The number of complaints of gender discrimination and cases resolved.
- Measures to prevent discrimination (training programs, mechanisms for protecting rights) have been implemented.

Each of these indicators should comply with the SMART methodology (concreteness, measurability, reach, relevance, time constraints), which allows them to be evaluated regularly and used to improve the work of law enforcement agencies.

Thus, political instability in Ukraine and legal conflicts in national legislation negatively affect the effectiveness of police activities. The SMART methodology allows you to conduct a

systematic risk assessment, reduce threats by integrating modern technologies, improve personnel policy, and expand interdepartmental interaction. An adequate set of preventive measures and public supervision will also contribute to improving the effectiveness of police activities in this sense.

Optimal evaluation model

The SMART methodology emphasises that goals should be Specific, Measurable, Achievable, Relevant, and Time-Bound. The following qualitative assessment scale adapts these principles to assess the effectiveness of the national police body (Division) based on quantitative parameters and performance, economic efficiency, employee performance, staff satisfaction, gender integration, and countering discrimination.

1. Specific

Definition: clarity of goals and operations.

(1) Bad: Goals are vague and vaguely defined; roles are ambiguous.
(2) Satisfactory: Some goals are clear, but others lack specificity; roles are partially defined.
(3) Good: Most goals are specific and clearly stated; the roles are mostly clear.
(4) Very good: All goals are clearly defined with specific results, and the roles are well understood.
(5) Excellent: The goals are concrete and consistent with the community's needs, and the roles are conveyed and understood by all participants.

2. Measurable

Definition: the ability to qualitatively assess progress and results.

(1) Bad: There are no qualitative indicators for evaluating performance or feedback mechanisms.
(2) Satisfactory: Some quality indicators exist but are not used constantly; reviews are sporadic.
(3) Good: Quality indicators are available and used regularly; reviews are collected but not analysed systematically.
(4) Very good: strong quality indicators guide ratings; regular feedback is collected and analysed for improvement.
(5) Excellent: Comprehensive quality indicators encourage current assessments, and feedback is actively used to inform strategies and operations.

3. Achievable

Definition: realistic goals that can be achieved with available resources.

(1) Bad: The goals set are unrealistic given the available resources, and there has been frequent failure to achieve them.
(2) Satisfactory: Some goals are achievable, but many remain unattainable due to resource constraints.
(3) Good: Most goals are realistic and achievable with available resources; achieving goals can be problematic.
(4) Very good: the goals set are consistently achievable within resources; proactive measures taken to solve problems.
(5) Excellent: All goals are realistic and constantly achieved; strategic resource allocation ensures success.

4. Relevant

Definition: aligning goals with the community's needs and the organisation's mission.

(1) Bad: The goals do not meet the community's needs or the organisation's mission; there is a significant gap.
(2) Satisfactory: Some goals meet the community's needs, but many do not effectively reflect the organisation's mission.
(3) Good: Most goals meet the needs of the community and meet the mission, although there are some gaps.
(4) Very good: The goals are very relevant to the community's needs and are closely related to the organisation's Mission; community contributions are taken into account.
(5) Excellent: All goals are directly related to the community's needs and fully consistent with the organisation's mission; constant interaction with the community informs goal setting.

5. Time-Bound

Definition: a clear time frame for achieving your goals.

(1) Bad: There is no set time frame for achieving goals; uncertain completion dates lead to delays.
(2) Satisfactory: Some goals have a time frame but are not consistently followed or unrealistic.
(3) Good: Most goals have a clear time frame that is usually followed; sometimes, there are delays.
(4) Very good: Deadlines for all purposes are clearly defined and mostly followed; proactive time management is evident.
(5) Excellent: All goals have a well-defined time frame that is strictly followed, and continuous monitoring ensures timely completion.

The form for evaluating the effectiveness of the national police body (Division) is presented in the Appendix (*Table 1*).

Thus, the proposed assessment scale provides a structured approach to evaluating the effectiveness of bodies and divisions of the National Police of Ukraine to promote creating a safe environment and rapid response based on the SMART methodology. By focusing on quality parameters, structural divisions can gain valuable information about their performance and identify areas for improvement. Regular assessment on this scale can help increase public accountability, transparency, and trust in law enforcement agencies.

Discussion

The scientific discussion on problematic guidelines in police activities covers a wide range of issues, particularly the effectiveness of prevention methods in countering crime, the role of high technologies in law enforcement, and optimal models for evaluating effectiveness. The research of Ukrainian and foreign authors reflects various aspects of this problem, namely, from the importance of legislative integration of international norms into national legislation to establishing interaction between the police and society as a key factor in reducing the crime rate.

Integrating a problem-based approach helps reduce crime rates, but it requires significant resources and systematic risk analysis. The smart methodology in modern assessment of the work of law enforcement agencies is quite effective. It allows you to create a transparent system

of performance indicators and contributes to improving the accountability of national police bodies (divisions) and public confidence in them.

Existing scientific discussions indicate the need for a comprehensive approach to assessing the effectiveness of law enforcement agencies, combining legal, organisational, technological, and social factors. The study prospects in this area determine the favourable formation of an optimal model of police activity focused on citizens' needs.

Conclusion

Determinant vectors in the implementation of a problem-oriented approach in the activities of the police, which determine the specifics of the implementation of the concept for imitation, are the target orientation of the political course of the state, the balance of national legislation with international norms, the number, professional motivation and professionalism of authorised subjects of law enforcement agencies, their ability to perform official tasks to ensure respect for human rights, identify problems that require rapid response and the use of preventive measures. Indicators of well-established management processes are highly effective police activity, which is achieved by specifying the causes of problems in the law enforcement sphere, assessing risks to create or promote a safe environment, and quickly responding to the elimination of problems by law enforcement agencies.

The analysis of the problem-oriented approach in police activities indicates the need to improve the management mechanisms of the National Police bodies (divisions). Identification of problems indicates legal and organisational barriers that hinder the effective functioning of law enforcement agencies as subjects of the security and defence sector of Ukraine. The causes of problems and risk assessment prove that the stability of law enforcement depends on resource support, regulatory framework and interdepartmental coordination. The proposed SMART assessment model makes it possible to systematise the activities of the police at the state, regional and local levels and increase the efficiency of decision-making to promote the creation of a safe environment and rapid response.

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Appendix

Table 1. Form for evaluating the effectiveness of the national police body (Division)

Criteria / Evaluation	1 (Bad)	2 (Satisfactory)	3 (Good)	4 (Very good)	5 (Excellent)
Specific					
Measurable					
Achievable					
Relevant					
Time-Bound					

Note. Marks in columns are made using "+"/ "–" signs in black or blue ink (paste). One rating must correspond to one criterion on the scale. Strikethrough or correction is not allowed in the form.

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