ISSN 2413-9610, E-ISSN 2663-2365 Journal homepage: https://devma.com.ua/en

DEVELOPMENT MANAGEMENT

UDC 351.72:336.143:004.738.5(477)
DOI: 10.63341/devt/4.2025.08

Vol. 24, No. 4. 2025

E-budgeting model in the architecture of financial resilience of territorial communities during the full-scale war

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Abstract. The aim of the study was to develop an adaptive model of e-budgeting that would contribute to strengthening the financial resilience of territorial communities amid wartime and other crisis challenges. The research methodology was based on the mix of systems, comparative and structural-functional analysis, as well as on the best international practices, in particular, the Finnish OmaStadi system and the Ukrainian E-DEM platform. The results of the study demonstrated that effective implementation of e-budgeting has a positive impact on the transparency of governance processes, increases public participation and the optimal allocation of public resources. The analysis revealed key issues hindering the implementation of digital budgeting tools in Ukraine, including: low levels of digital literacy, insufficient infrastructure, weak engagement of vulnerable population groups in participatory budgeting processes and the absence of integrated mobile services. To enhance the financial resilience of territorial communities in the face of crisis and wartime challenges, a multi-level model for improving the e-budgeting system is proposed. This model encompasses directions for improving participatory budgeting practices, a system for their evaluation, expected outcomes from model implementation and its impact on key components of financial resilience. The proposed model for improving the implementation of electronic budgeting systems in support of the financial resilience of territorial communities has a potential to illustrate how areas for improvement influence the criteria of electronic budgeting systems, leading to qualitative outcomes. The practical significance of the study lies in the possible application of the adaptive e-budgeting model by local self-government bodies, civil society organisations, analytical centres and state institutions that monitor the financial activities of territorial communities

Keywords: public administration; participatory budgeting; digital platform; transparency; local community

INTRODUCTION

In the context of ongoing economic and political challenges, particularly amid full-scale war, the financial resilience of Ukraine's territorial communities has become a key element of endurance, as well as national recovery and sustainable development. Ensuring effective budget management, transparent allocation of funds and citizen engagement in decision-making processes has become not only a tool of effective public governance but also a factor in societal consolidation and support for local financial resilience. One of the promising mechanisms contributing to resilience is e-budgeting, which leverages digital platforms to enhance public participation in budgetary processes.

Article's History: Received: 23.06.2025; Revised: 28.10.2025; Accepted: 23.12.2025; Published: 12.01.2026

Suggested Citation:
Gordiienko, L., & Kunitsyn, O. (2025). E-budgeting model in the architecture of financial resilience of territorial communities during the full-scale war. *Development Management*, 24(4), 8-19. DOI: 10.63341/devt/4.2025.08.

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E-budgeting enables citizens to influence the allocation of local financial resources, thereby promoting transparency, accountability and efficiency in the management of public finances. The potential implementation of e-budgeting represents a fundamental shift in the interaction between local authorities and community members. By integrating digital tools into budget planning, execution and monitoring, territorial communities not only increase citizen involvement in governance decisions but also strengthen trust in local self-government bodies.

The relevance of research in the field of e-governance, including the digitalisation of budgeting processes, is widely recognised within the Ukrainian academic discourse. Studies of digital governance and e-budgeting in Ukraine emphasise the promise of participatory budgeting for community development. For example, Ye.V. Maliarevskyi & V.O. Barannik (2021) examined participatory budgets in Ukraine. They concluded that empowering residents through local budget initiatives could drive social and territorial development. O.P. Basyuk (2022) analysed international experiences of digital budget optimisation. The researcher found that automating budget processes and embedding strong financial controls is crucial. A conceptual model for Ukraine's public finance digital transformation was subsequently proposed. N.Ye. Skorobohatova *et al*. (2024) investigated how accounting for wartime expenditures affects community budgets. Their research highlighted challenges in tracking and financing essential services under martial conditions, and proposed the ways to manage those challenges. M.M. Pityulich *et al*. (2023) identified key socio-economic determinants of community development. In their research they showed, how such factors affect the financial resilience of territorial communities. V. Kruhlov & D. Tereshchenko (2024) explored adaptive budgeting under crisis. They argued that digital tools could enable more responsive public financial management during emergencies.

J. Davies *et al*. (2022) used qualitative fieldwork in Scottish local councils to study embedding digital participatory budgeting. They found that formal adoption of digital participatory budgeting requires well-trained mediators and adequate resources, otherwise entrenched bureaucratic practices can stall innovations. K.S. Wackowski & L.Yu. Gordiienko (2025) analysed digitalisation of public services drawing on Poland's experience. In their paper, they noted that while digital platforms can improve service delivery, they must be tailored to local institutional contexts. However, it should be noted that existing studies pay insufficient attention to the local level, specifically, territorial communities, instead examining e-budgeting, participatory exercises and digitalisation of finance primarily at the national scale. Furthermore, there is a near-complete lack of publications analysing the impact of full-scale war as the most critical shock factor on the financial resilience of territorial communities. Financial resilience is defined as the ability of a territorial community to effectively manage its resources, maintain a balance between revenues and expenditures and proactively respond to economic shocks (Kunitsyn & Melnyk, 2025). Its significance has increased considerably in the context of full-scale armed aggression, which has confronted communities with existential challenges, including the need to mobilise resources and ensure the provision of essential functions under martial law. E-budgeting is aimed at supporting these functional capacities by improving spending transparency and enhancing the level of public oversight. Despite its advantages, the implementation of e-budgeting in Ukraine faces several challenges. These include limited digital infrastructure in some communities, low levels of digital literacy among citizens and resistance to change from entrenched budgeting practices. Overcoming these barriers requires targeted investments in technological capacity, public education and institutional preparedness.

The goal was to create an adaptive e-budgeting model that would help territorial communities increase their financial resilience in the face of war and other crises. To achieve this aim, the following objectives were set: to analyse existing e-budgeting platforms in Ukraine and abroad, identifying their advantages and disadvantages; to assess the effectiveness of implementing e-budgeting practices based on examples of Ukrainian territorial communities affected to varying degrees by the full-scale war; to propose a multi-level model for improving the implementation of the e-budgeting system as part of supporting the financial resilience of territorial communities. The novelty of the study lies in the attempt to integrate principles of digital budget resource management under conditions of high uncertainty, resource scarcity and risks characteristic of wartime.

MATERIALS AND METHODS

The research is based on a combination of comparative analysis of e-budgeting systems functioning in various territorial communities of Ukraine and a theoretical-conceptual analysis of the most effective e-budgeting models in global practice. This approach enabled a comprehensive examination of existing management practices in the field of e-budgeting, revealing both the advantages and shortcomings of the respective systems. The research proceeded through a structured multi-stage methodology. Literature review of Ukrainian and international studies on e-budgeting, participatory budgeting and local financial resilience was conducted. Then analysis of the next Ukrainian e-budgeting tools was done: E-DEM (Ukrainian e-democracy portal, 2021), Public Project (BePart, 2022) and The Interactive Community Budget (Cost Ukraine, 2025). The prepared analysis is based on the mix of systems, comparative and structural-functional analysis, to define the most used, which prove its effectiveness, system in-use in territorial communities. The next step is the similar analysis done for the most well-known foreign e-budgeting tools: OmaStadi from Finland (Mainiotech, 2021); Decide Madrid from Spain (Faster Capital, 2025); Go Vocal (2024) from Canada; Maptionnaire (2022) from Poland and Dalyvaujamasis biudžetas from Lithuania (EEA and Norway Grants, 2025). This informed the selection of analytical frameworks and identified best practices to examine in depth. Comparison of its advantages and disadvantages gave a possibility to empirically choose the most applicable one, to make a deeper structural analysis with the Ukrainian cases. The next step was purposive sampling that performed a case selection: two Ukrainian territorial communities

with contrasting wartime conditions were chosen. They are Novoiavorivsk territorial community in Lviv region and Kherson City, which was liberated from Russian occupation in autumn 2022. Novoiavorivsk territorial community is digitally advanced and largely untouched by conflict, while Kherson has been heavily impacted by the full-scale invasion. This allowed comparison of e-budgeting under divergent shock exposures. Data were gathered for the years 2021-2024, drawing on e-participation platform usage reports (Maptionnaire, 2022; Go Vocal, 2024; Faster Capital, 2025), qualitative information from territorial community websites (City of Helsinki, 2024; Novoiavorivsk City Council, 2024a), news and organisations releases (BePart, 2022; Decentralization portal, 2024; EEA and Norway Grants, 2025).

Based on the mentioned above, the study applied a combination of analytical methods. Comparative analysis component was used to identify differences in functionality and engagement possibilities of e-budgeting systems. This method was justified by the need to systematically contrast varied contexts and digital platforms itself. Structural-functional analysis component supported to examine system's components and their contributions to budgeting processes under stress. This highlighted how elements like mobile apps or transparency methods applied in each setting. Systems and contextual analysis component placed these findings among legal, social and technological environments. In particular, there was reviewed how Ukrainian financial regulations and digital literacy levels influence outcomes. Content analysis of platform helped characterise the intended features of each tool. Finally, model synthesis was used to integrate insights and propose an adaptive multi-level e-budgeting model for crisis resilience, drawing parallels with systems thinking. The mixed approach of combining qualitative review and case comparison ensures both breadth and depth. The methodology enabled a comprehensive examination of e-budgeting tools and their impact on community financial resilience under varying pressures caused by a full-scale invasion.

RESULTS AND DISCUSSION

Analysis of Ukrainian e-budgeting tools

Ukrainian scholars, including O.P. Basyuk (2022), define e-budgeting as the process of digital transformation of the budgeting system, which involves the use of information and communication technologies to automate budget procedures, enhance transparency, improve financial management efficiency and ensure open access to budget indicators and decision-making processes. E-budgeting tools are understood as software solutions that enable the automation of budget planning, control and analysis, integration of financial data, generation of electronic reporting and support of managerial decision-making (Popov *et al.*, 2023). The use of such tools contributes to increased transparency, accountability and active citizen engagement in local decision-making. Further development and enhancement of these platforms can strengthen democratic processes and improve the financial resilience of territorial communities through a more flexible and adaptive system for forming local budgets. Particular importance is the participatory budget (also known as the public budget or participatory budgeting), which, according to I.I. Bozhuk & U.O. Fomenko (2020), is an instrument that allows residents of territorial communities to directly influence the allocation of a portion of the local budget by submitting project proposals and participating in the voting process for their implementation.

It is worth agreeing with A.M. Oriol (2024), who argues that there is currently no universal e-budgeting system that fully meets the needs of both territorial communities and central authorities. At the same time, existing systems are capable of covering a wide range of tasks and generally shape the e-budgeting process. Their development can be observed both in Ukraine and internationally. Table 1 presents a comparison of the most widely used e-budgeting systems currently implemented in Ukrainian territorial communities (The EGAP Program, 2022; Council for the development of communities and territories, 2023; Decentralization portal, 2024).

Table 1. E-Budgeting tools in Ukrainian territorial communities

Platform	Developer / Foundation	The main functions	Territorial communities, which are using the system
E-DEM (Ukrainian e-democracy portal, 2021)	EGAP / East Europe Foundation	participatory budgeting; open public consultations; creation of local-level petitions; school participatory budgeting	For December 2024, the system is in-use in 546 communities across Ukraine
Public Project (BePart, 2022)	SocialBoost	the system ensures a full-cycle process of participatory budgeting	For December 2024, the system is in-use in more than 200 communities across Ukraine
The Interactive Community Budget (Cost Ukraine, 2025)	CASE Ukraine / USAID	community revenue and expenditure analysis; budget modelling; proposals for infrastructure projects	Usage statistics are not collected by the developer or external organisations

Source: created by the authors

The E-DEM platform, as rightly emphasised in Ukrainian e-democracy portal (2021), is the most widespread e-democracy tool in Ukraine, integrating key services for citizen engagement with local self-government bodies. One of the core functionalities is a participatory budgeting, which in fact is a tool that enables residents to submit their own initiatives and apply for funding from the local budget. In addition, important function is local petitions creation and management availability. It is a service for submitting electronic petitions aimed at drawing the attention of authorities to important community issues. A core function allowing users to report local problems using an interactive map usually called as "open community". It is also important, that platform has possibility to organise public consultations, which acts as a mechanism for gathering public opinion on pressing issues. School Participatory

Budgeting is quite an interesting educational initiative for students aimed at developing civic engagement skills through the design and implementation of projects, which is also available on E-DEM platform. Important to note that, to date, the E-DEM platform is the most widely used e-budgeting tool in Ukraine, implemented under the EGAP project of the East Europe Foundation (Ukrainian e-democracy portal, 2021).

Public Project (Table 1) is another widely used digital tool that automates the entire participatory budgeting cycle, from project submission to voting and reporting. Its main advantages include transparency, ensuring openness at every stage of the process, by requirements of detailed description of each step of decision-making, and making available this information accessible for community members. In addition, this tool has intuitive interface and easy navigation among services and section. Public Project has a hybrid identification system for authentication: via BankID, digital signature or a specific resident card, if the system is implemented in a community. The toll uses integration with social networks, email newsletters and communication tools for increasing engagement of community members. Since 2016, over 5 million users have visited the Public Project platform and the total value of implemented initiatives has exceeded 1 billion UAH (BePart, 2022).

The Interactive Community Budget platform is a tool developed by the analytical centre CASE Ukraine with support from the USAID programme. It allows citizens to explore, analyse and model local budgets in a convenient and visualised format. The tools provide an access to detailed information on budget items, which allow to make a revenue and expenditure Analysis. In addition, the tool allows users to create budget allocation scenarios, to make comparative analysis and determine the best possible option. Except this, internal function supports communication between users, enabling public engagement in discussions and voting. It is important to note that, unlike E-DEM and Public Project, The Interactive Community Budget is not a direct e-budgeting tool. Rather, it serves a supporting function, like enhancing awareness among citizens and local authorities about the principles and potential of participatory budgeting and preparing them for the implementation of full-fledged digital e-budgeting systems (Cost Ukraine, 2025).

As rightly noted by H.I. Jeakalo *et al*. (2020), e-budgeting serves as a powerful tool for engaging citizens in the processes of formulating and allocating public finances, offering a range of significant advantages. First and foremost, it enhances the transparency of budgeting processes by providing open access to information on revenues, expenditures and funding priorities. Such openness strengthens citizens' trust in government institutions, which is particularly important in the context of post-conflict recovery and democratic progress. In addition, e-budgeting stimulates active civic participation by enabling residents to directly influence decision-making, sets development priorities for their communities and implements projects that address real public needs. This contributes to an improved quality of life, as initiatives with tangible value for local communities are brought to fruition.

Analysis of foreign e-budgeting tools

Table 2 represents the most well-known e-budgeting tools that have been implemented in territorial communities abroad (OECD Observatory of Public Sector Innovation, 2015; Maptionnaire, 2022; City of Helsinki, 2025a), as well as in the countries and cities (communities) whose public administration systems have adopted e-budgeting. The table outlines the advantages and disadvantages of these solutions.

Table 2. International e-budgeting tools

Platform	Developer	City / Country of Use	Advantages	Disadvantages
OmaStadi (Mainiotech, 2021)	Decidim	Helsinki, Finland	Combines online tools with offline events (e.g., OmaStadi Expo) to foster citizen engagement. Budget of approximately €8.8 million. Innovative methods like a card game for co-design promote participation and understanding.	The platform proved to be complex for some users, leading to reduced activity in online discussions.
Decide Madrid (Faster Capital, 2025)	CONSUL	Madrid, Spain	High participation: over 400,000 registered users and a budget of €100 million. Offers both online and physical voting options.	Lack of detailed citizen-to-citizen discussions may limit the quality of decisions. Limited feedback on project implementation.
Go Vocal (2024)	In-house development	Toronto, Canada	Mobile app allows citizens to quickly submit proposals and vote. Integrated with social media for broader outreach.	Limited information on the platform's influence on decision-making and project implementation.
Maptionnaire (2022)	Maptionnaire	Warsaw, Poland	Interactive maps allow citizens to mark specific locations for improvement. User-friendly interface for proposal visualisation.	Focus on geospatial data may limit the range of topics discussed. Fewer opportunities for deep discussion and collaboration among users.
Dalyvaujamasis biudžetas (EEA and Norway Grants, 2025)	In-house development	Vilnius, Lithuania	Simple platform for submitting and voting on proposals. Focus on local initiatives and community projects.	Limited information on integration with other platforms or discussion tools. Potential functional limitations compared to more advanced systems.

Source: created by the authors

The comparative analysis of the international e-budgeting tools presented in Table 2, conducted to identify the potentially most functional model suitable for adaptation to Ukrainian realities, reveals the following. The OmaStadi platform in Helsinki, built on the open-source Decidim framework, exemplifies a robust model for digital participatory budgeting that fosters institutional transparency, inclusivity, and scalability. Launched in 2018, Decidim was selected for its modularity and democratic design, which Helsinki has since extended with approximately 20 custom modules and integrations aimed at enhancing usability, accessibility, and inclusive participation across device types and user groups (Decidim, 2022). OmaStadi operates on a biennial cycle: in the first year, citizens propose ideas, which are screened, co-developed with city experts in both online and offline workshops, and ultimately voted on by residents aged 12 and older; in the second year, the winning proposals are implemented (Shin *et al.*, 2022). Inclusivity is central to OmaStadi: the platform allows Helsinki residents to propose and vote, with interfaces available in seven languages and support facilitated through libraries, community centres and digital channels to reach diverse linguistic and cultural groups. Notably, younger residents participate actively: during one round, 29% of comprehensive-school-aged children voted – far exceeding turnout figures among older age groups (City of Helsinki, 2022). Transparency is institutionally embedded in the process: all stages, from proposal submission and cost assessments to iterative co-development and implementation tracking, are made publicly accessible via the OmaStadi website, ensuring accountability and city-citizen dialogue (City of Helsinki, 2025b).The OmaStadi platform also incorporated elements of gamification with a specially designed card game that functioned as a participatory tool to stimulate creativity, idea generation and collaborative brainstorming among residents. By transforming the often abstract and technical task of project ideation into an engaging, game-like activity, the platform succeeded in lowering barriers to entry, making participation more accessible and enjoyable, particularly for younger or less experienced contributors (Participedia, n.d.). Decidim's open, flexible architecture offers a scalable foundation for local participatory budgeting platforms, capable of integrating tailored modules, multilingual accessibility, transparent decision-making and engagement innovations to enhance democratic inclusion and responsiveness (Mainiotech, 2021).

The Decide Madrid platform is noteworthy as an example of a continuously functioning system for proposals and voting on civic initiatives funded by the city budget. The use of mechanisms for direct citizen initiatives, through petitions and voting, has ensured the system's stable operation, with more than 400 projects implemented. Ukrainian communities, especially in cities with a high level of digitalisation, should consider this model as a best practice that combines transparency, efficiency and social impact. It is essential to establish a regulatory framework enabling direct citizen initiatives in budget processes (Faster Capital, 2025). The Canadian approach to e-budgeting, illustrated by the case of Toronto, is suitable for adaptation at the district administration level in large Ukrainian cities. District-level budgets (approximately 750,000 Canadian dollars), project submission via interactive maps and mandatory voting are mechanisms that could be integrated in Ukraine. This decentralised model is particularly well-suited for communities with high population density and multi-level infrastructure (Go Vocal, 2024). Warsaw's experience with the use of interactive maps that allow citizens to pinpoint specific locations for improvement demonstrates the sustainability of participatory budgeting and the importance of a regular budgeting cycle. Annual participatory budgeting events, a high volume of proposals and the implementation of approximately 80% of selected projects point to an effective organisational model. As recommended by Maptionnaire (2022), annual participatory budgeting cycles should be implemented as a mandatory practice, with clearly defined procedures and key performance indicators for monitoring. For Ukraine, this provides a strong example of how systematic approaches and transparent communication with residents can foster trust in local authorities. The Lithuanian model demonstrates the benefits of scaling participatory budgeting nationwide. Given that over 70% of Lithuania's municipalities have implemented participatory budgeting using a unified digital platform, Ukraine could consider a scenario involving a centralised e-budgeting system capable of adapting to various community types. As highlighted in EEA and Norway Grants (2025), such a solution has the potential to reduce local development costs and ensure standardised approaches to public reporting and oversight.

The comparative analysis of e-budgeting tools (Table 2) confirms that, globally, governments are increasingly implementing e-budgeting systems to enhance transparency, efficiency and accountability in public financial management. According to a study by the European parliamentary research service (2015), e-budgeting involves the digitalisation of budget procedures, the dissemination of budget information in open formats and the use of big data to support policy-making. This reflects the widespread adoption of such practices in many countries, although it does not allow for the identification of a single dominant system. A World Bank report (The World Bank Blogs, 2022) also notes the global rise in cashless transactions, indicating a general trend toward the digitalisation of financial processes. While this trend is not synonymous with e-budgeting, it reflects the gradual emergence of a digital financial environment in which such systems can operate effectively. However, as current research shows, there is no unified international statistical record that would allow the identification of a single most widely used e-budgeting system globally. Based on the comparative analysis of leading international e-budgeting cases, the OmaStadi system in Helsinki was found to be the most effective. It is distinguished by its innovative approach to citizen engagement, process transparency and high efficiency in participatory budget formation. Thus, e-budgeting serves as a powerful instrument for the democratisation of financial governance, combining significant potential with the necessity of overcoming structural and social barriers. Based on the data and findings presented, the next section of this article will propose a model for improving the implementation of the e-budgeting system in the context of strengthening the financial resilience of territorial communities in Ukraine.

Comparative analysis on implementation of E-DEM and OmaStadi platforms

The one of the previous sections established that the most widely used e-budgeting platform in Ukraine is the E-DEM system. One of the most successful examples of E-DEM implementation is demonstrated by the Novoiavorivsk territorial community in Lviv Region. In 2024, this community ranked among the top 100 communities in terms of digital transformation, according to the Digital Transformation Index developed by Ukraine's Ministry of Digital Transformation (Novoiavorivsk City Council, 2024b). This indicates a high level of integration of digital tools into the community's public administration system, particularly the E-DEM platform. However, the experience of the Novoiavorivsk community is not fully representative for assessing the effectiveness of E-DEM under wartime conditions, as this community has not been significantly affected by the shock factors associated with the full-scale invasion. To obtain a more relevant picture of the functioning of the e-budgeting system under martial law, it is appropriate to analyse the experience of the Kherson territorial community. This community experienced russian occupation in 2022 and continues to suffer from intense shelling by the occupying forces, being located near the front line. This case allows for a deeper evaluation of the resilience, adaptability and potential of the E-DEM system under extreme conditions. Table 3 presents the results of a comparative analysis between the OmaStadi system (Helsinki) and the E-DEM system (Novoiavorivsk and Kherson territorial communities), aiming to identify directions for improving e-budgeting systems in Ukrainian territorial communities under full-scale war conditions.

Table 3. Comparative analysis of OmaStadi (Helsinki) and E-DEM (Novoiavorivsk and Kherson Territorial Communities) platforms

Criterion	OmaStadi (Helsinki)	E-DEM (Novoiavorivsk Community)	E-DEM (Kherson Community)
Inclusiveness	Active involvement of community members aged 12 and older	Participation is available to all community residents. A mobile application has been implemented for convenient access to services	No information found regarding specific measures to ensure inclusiveness
Citizen Participation Mechanisms	The process includes idea submission, co-development with experts, voting and implementation	Citizens can submit projects, vote and monitor implementation. The Novoiavorivsk community has introduced the "Novoiavorivsk SMART" mobile app, integrating E-DEM and other digital services	Local petition services, public consultations, participatory budgeting and "Open City" are integrated
Gamification	Game-based mechanisms are used to engage participants	Not available	Not available
Process Transparency	A high level of transparency is ensured through open access to information at all process stages	A basic level of transparency is provided through publication of information on the platform and in the mobile app	No information found regarding measures to ensure process transparency
Challenges and Limitations	The need to further engage all community groups and improve discussion processes	Low awareness among residents about the platform and the need for adaptation to wartime conditions	Low awareness among residents about the platform and the need for adaptation to wartime conditions

Source: created by the authors

A comparative analysis of the characteristics of the OmaStadi system (Helsinki) and E-DEM (Novoiavorivsk and Kherson territorial communities), presented in Table 3, revealed a number of gaps in the implementation of e-budgeting systems in Ukrainian territorial communities. Novoiavorivsk, being a relatively peaceful and well-resourced city, implemented advanced e-budgeting features, for example, a dedicated "Novoiavorivsk SMART" mobile app (Novoiavorivsk City Council, 2024a) that integrates the E-DEM platform. Its residents can submit projects, vote on them and monitor implementation conveniently via this app and open data portal. This has led to relatively higher engagement among local citizens. In contrast, Kherson's e-budgeting relies on the standard E-DEM system without such enhancements, and its participatory budget process lacks any mobile integration. Kherson's platform version shows no specific inclusion or transparency measures, like neither multi-channel access nor detailed public dashboards, reflecting both infrastructural constraints and the disruptions of a full-scale war (Kherson City Council, n.d.). Consequently, citizen awareness and involvement in Kherson's participatory budgeting process remain low, exacerbated by ongoing military actions.

Both communities shared certain weaknesses. Neither Novoiavorivsk nor Kherson currently uses gamification elements, unlike Helsinki's OmaStadi, which actively engages youth through game-like features. Additionally, both reported low overall awareness of participatory budgeting opportunities among residents. In sum, Novoiavorivsk leveraged better digital tools, mobile app and wider criteria of participation, to involve more citizens, whereas Kherson suffered from limited adoption and outreach under wartime conditions. These contrasts imply several causal insights and lessons. The first one is that infrastructure and stability matter. Novoiavorivsk's infrastructure investments and absence of direct conflict enabled smoother e-budgeting implementation. In Kherson, conflict-related resource diversion and population displacement hindered similar progress. The next one is that technology alone is not enough. Even with E-DEM in place, both communities face low engagement, indicating that without active promotion and support, digital tools underperform. In addition, it is the

fact that transition of best practices requires adaptation. Features like gamification or mobile access (inherited from the Helsinki model) could improve outcomes, but must be tailored for ongoing wartime conditions, so, for example taking into account power outages or displacement.

Based on the conducted analysis, the following directions for improving participatory and e-budgeting can be proposed. There should be enhancing inclusiveness by ensuring the participation of all population groups, including youth, persons with disabilities and internally displaced persons, through targeted programmes and initiatives. In addition, it is important to improve community engagement in project development by strengthening cooperation with experts and local authorities. This can be facilitated by integrating e-budgeting systems with mobile applications, thereby expanding functionality and improving access to key information (Gavkalova & Kunitsyn, 2024). It can be effective to make an introduction of gamification practices, drawing from the Helsinki model, to attract young people to e-budgeting processes. This could enhance the system's effectiveness by leveraging game-based mechanisms. The next is highly important increasing of transparency at all stages of the budgeting process to improve public trust in the culture of participatory budgeting and digital fiscal systems (Barida *et al.*, 2024). Finally, implementation of embed rapid response mechanisms within the budgeting process to provide timely support to communities during emergencies.

Proposal model for improving the implementation of e-budgeting systems

Based on the identified gaps and proposed improvement directions for implementing e-budgeting systems in Ukrainian territorial communities, the following points should also be considered. The effectiveness of implementation can be achieved through the synergy of all proposed improvement directions. Adaptability to wartime conditions should be viewed as a key success factor in the current context of full-scale war. Evaluation of improvement efforts in e-budgeting implementation should be based on financial indicators that demonstrate a high level of financial resilience in the community. In addition to the above and taking into account the experience of Ukrainian communities in adapting e-budgeting systems to such extraordinary challenges as full-scale war (Lobodina *et al.*, 2022), it is reasonable to recommend that international territorial communities consider adopting the positive practices of Ukrainian communities. To strengthen the financial resilience of Ukrainian territorial communities under wartime conditions, this study developed a model for improving the implementation of e-budgeting systems as an informational tool (Fig. 1).

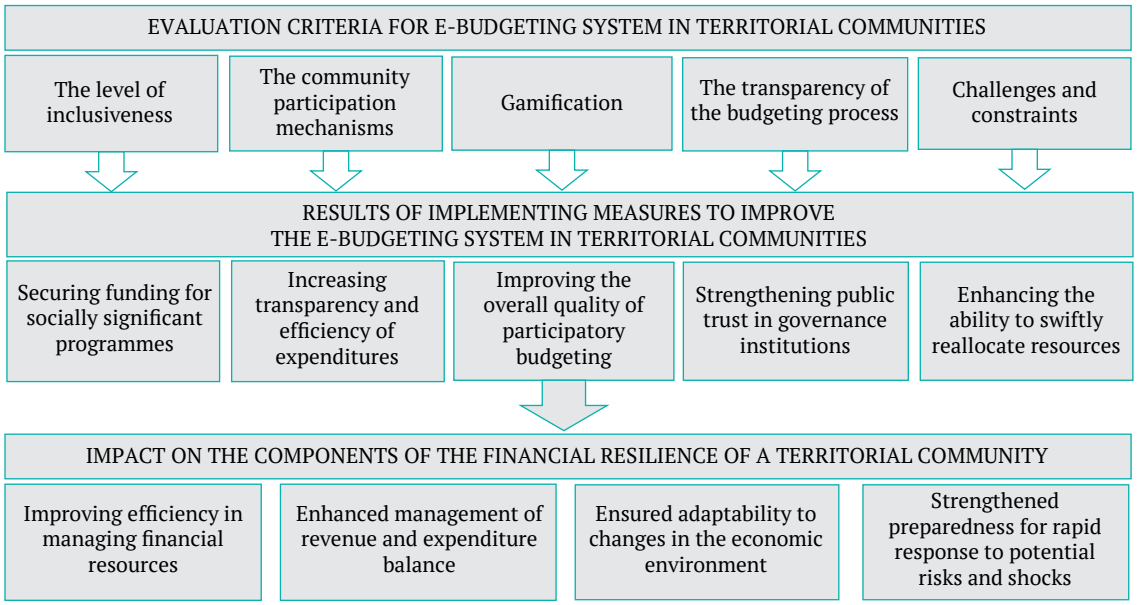

Figure 1. A model for enhancing the implementation of e-budgeting system to support the financial resilience of Ukraine's territorial communities

Source: created by the authors

The model shown in Figure 1 is structured as a multi-level analytical framework. This model should be read as a theory-of-change for how targeted improvements to e-budgeting translate into measurable process performance, near-term governance outcomes and ultimately into the capacities of financial resilience of a territorial community. Structurally, it links four levels: strategic directions for improving the implementation of e-budgeting; a system of criteria to assess the effectiveness of the implemented improvements; the expected outcomes of implementation; and the impact of the proposed measures on the key components of the financial resilience of territorial communities. In the Ukrainian wartime context, the model functions as an informational and managerial tool to align scarce administrative effort with the largest resilience gains, consistent with the study's definition of financial resilience as the ability to manage resources, maintain budgetary balance and respond proactively to shocks.

At the first level of the model, five strategic directions for improving the implementation of e-budgeting are defined. Enhancing inclusiveness is not only about open access, since it requires targeted design for hard-to-reach groups, for example internally displaced persons, persons with disabilities, elderly and the youth. Operational measures include multi-channel participation, accessibility compliance, multilingual interfaces (Ukrainian, Crimean Tatar, English, Polish, Romanian, Slovakian, Hungarian), and assisted submission points via social service centres. In war-affected communities, inclusiveness also entails flexible identity verification for residents with damaged documents and temporary residence. Active citizen engagement in project development shifts participation upstream from voting to co-design. Effective practices include budget-literacy micro-courses and moderated deliberation that reduces elite capture and aligns projects to legal/engineering standards. Embedding these practices in the e-budgeting workflow increases the share of implementable proposals while reducing downstream procurement bottlenecks. Gamification of participatory budgeting is treated as a means, not an end. Appropriate use involves short "quests" that mirror the real process, for example completing a needs-assessment quiz to unlock a project-draft template, transparent badges for constructive behaviours, like peer-review or evidence provision, and community-level leader boards tied to non-monetary recognition, thereby avoiding perverse incentives. Properly tuned, gamification raises engagement from younger cohorts without diluting deliberative quality. Ensuring transparency across the budgeting cycle means having an easy-way accessibility to all the stages of budgeting cycle for community member. It means that community member should have an access to detailed information about project idea, its technical review, costed shortlist, contract details, implementation flow, and be able to participate in post audit. In addition, it is important to highlight, that linking e-budgeting data to procurement and treasury events creates traceability from vote to expenditure, which also has a potential to increase transparency. Providing a rapid response to community needs embeds agility in the platform: emergency tranches with shorter cycles, delegated thresholds for micro-allocations, geo-tagged incident reporting integrated with civil protection and pre-approved "shelf projects" ready for immediate launch are good to have for an effective e-budgeting system. In frontline or de-occupied communities, this reduces the latency from community signal to budgetary action.

The second level of the model presents a system of criteria to assess the effectiveness of the implemented improvements. Each direction is mapped to observable, auditable indicators that can be tracked within the platform and through administrative data. The level of inclusiveness can be measured via coverage ratios, for example, share of active users among eligible residents or participation rates by different dimension based on provided users' personal information. In addition, accessibility metrics like share of submissions via assistive channels or completion rates on mobile vs. desktop can be also useful to properly determine the level of inclusiveness in territorial community. Citizen participation mechanisms are assessed by process quality: conversion rates as percentage of ideas, which turned to real proposals, average review time, number and completion of co-design sessions or proportion of successful proposals with documented evidence, like photos or cost sheets. Gamification could be evaluated using engagement depth, like median session length and repeated participation across cycles. Also, contribution quality, which is measure by peer-review helpfulness scores, and drop-off analysis to ensure that "points" do not crowd out deliberation, can be helpful to properly measure gamification's level of implementation. Transparency can be measured by presence of itemised costs and contracts, which are evidence of each step in a pipeline. Challenges and constraints could be explicitly recorded: platform uptime, cyber-incidents, staff hours per cycle, legal exceptions used and energy/connectivity disruptions. These indicators enable a diagnostic dashboard and support the construction of a composite performance index using normalised scores with transparent weights calibrated to community priorities.

The third level of the model (Fig. 1) focuses on the expected outcomes of implementation. Increasing transparency and efficiency of expenditures translates into fewer off-cycle budget amendments, lower variance between approved and executed project costs and higher audit pass rates. Improving the overall quality of participatory budgeting is seen in a rising share of technically viable proposals, stronger geographic equity of funded projects and higher completion rates on time and on budget. Strengthening public trust is evidenced by repeated participation across cycles and favourable trust-in-local-government survey scores. Securing funding for socially significant programmes is reflected in the proportion of projects aligned with social protection, education, health and basic infrastructure. Enhancing the ability to swiftly reallocate resources becomes visible through shorter cycle times and the successful activation of emergency tranches without breaching fiscal rules. These results are the near-term "transmission belt" that carries process improvements into fiscal resilience effects. At the fourth, the model illustrates the impact of the proposed measures on the key components of the financial resilience of territorial communities. Enhanced management of revenue-expenditure balance arises from better project costing and fewer failed implementations, improving predictability of cash flows and limiting waste. Ensured adaptability to economic changes could be achieved by institutionalising data-driven reprioritisation and emergency micro-cycles that keep service delivery responsive under constrained revenues. Strengthened preparedness for rapid response follows from pre-vetted projects, integrated geo-data and clear mandates for the main responsible actors. Improving efficiency in managing financial resources reflects transaction cost reductions, tighter procurement alignment and evidence-based sequencing of investments. Together, these channels reinforce the credibility of local public finance, facilitate access to intergovernmental transfers and donor funds, and reduce the risk of fiscal distress under wartime volatility.

It is important to note that the proposed model is built upon a logic of step-by-step interaction among its component levels. The improvement directions outlined at the first level serve as prerequisites for the formation of certain qualitative characteristics of electronic budgeting, which are presented at the second level of the model in the form of assessment criteria. The application of the criteria defined

at the second level directly influences the achievement of third-level outcomes, such as increased transparency of expenditures, improved funding of social programmes and strengthened trust in local authorities. These outcomes, in turn, act as transmitters of influence on the financial resilience of territorial communities, which is represented at the fourth level. It should be emphasised that the outcomes achievable at the third level ensure better resource management, revenue-expenditure balance and community preparedness for crisis situations. Thus, the model reveals a cause-and-effect relationship: initiatives at the respective levels of public governance trigger structural shifts in the budgeting process, which ultimately lead to enhanced financial adaptability and resilience of communities, including under wartime and post-war conditions.

Several barriers may hinder the efforts to improve the effectiveness of electronic budgeting systems in Ukraine's territorial communities. As noted by H. Voznyak *et al*. (2024), technical limitations, such as insufficient access to modern technologies and infrastructure, remain a challenge in many regions. Another major issue is the low level of digital literacy, both among citizens and local government representatives. In addition, there is often resistance to innovation, driven by entrenched traditional budgeting practices. To overcome these challenges, H. Voznyak *et al*. suggests implementing the following comprehensive measures. First, invest in the development of digital infrastructure to ensure reliable internet access in every community. Second, organise digital literacy training programmes for both officials and residents. Third, foster cultural change by demonstrating the advantages of digital solutions and involving stakeholders in the implementation process. Fourth, strengthen the legal and regulatory framework to ensure transparency, accountability and citizen participation in the budgeting process. These measures aim to overcome the outlined barriers and enhance the implementation of electronic budgeting systems.

Therefore, electronic budgeting should be viewed not only as a technical and economic tool but also as a critical mechanism for democratising governance, increasing public finance transparency and strengthening the financial sustainability of communities. This is especially relevant in the context of Ukraine's reconstruction, where the effectiveness of local self-governance determines not only the quality of life of citizens but also the long-term stability of the country as a whole. Electronic budgeting systems can form the foundation for a new culture of interaction between the state and citizens, one that reflects the real needs of communities and supports their sustainable development. The proposed model not only enables a structured assessment of the current state of electronic budgeting in a community but also provides practical guidance for its improvement. It integrates technological, economic and social components, offering a systemic vision of the interconnection between digital participation tools, the quality of the budgeting process and the long-term financial capacity of the community. This is particularly relevant in the context of high uncertainty and limited resources caused by the ongoing full-scale war and represents a novel, flexible approach to public administration. Obtained results resonated with and extend recent international research on digital participatory budgeting, community resilience and e-budgeting. B. Shin *et al*. (2024) catalogued digital participation tools and found that many e-budgeting platforms facilitate citizen-to-government information flow, but suffer from limited accountability features. Novoiavorivsk's system provides open data and project tracking for partial transparency, whereas Kherson's platform offers minimal feedback mechanisms – mirroring B. Shin *et al*. conclusion that "prominent deficiencies" remain in showing citizens how decisions are made. Similarly, V.R. Levesque *et al*. (2024) research showed in rural Maine that municipal digital services enhance community resilience during crises. The results of research extended this by demonstrating a concrete fiscal example: communities with more developed e-budgeting tools (Novoiavorivsk territorial community) were better able to engage stakeholders and maintain budget functions, suggesting stronger resilience. V.R. Levesque *et al*. confirm that more extensive digital services (information portals, online transactions, e-democracy) correlate with greater resilience, which aligns with recommendation that robust e-budgeting is a resilience-building strategy.

Several studies emphasise that governance context and digital divides shape outcomes. For instance, S. Kozaman Aygün & T. İnal Çekiç (2025) made hypothesis that e-participation can widen inequalities if not everyone can engage online. This finding reflected in Kherson's low participation under martial law, where many citizens lack secure Internet connection or digital literacy. The results of research correlated with A.M. Oriol (2024) formulation that "no universal e-budgeting system" exists and solutions must fit local needs, particularly in crisis. H. Voznyak *et al*. (2024) focused on Ukraine's war context and found that well-designed budgetary instruments can largely preserve community resilience. In line with them, there is an observation that neither Kherson nor Novoiavorivsk saw catastrophic budget collapse despite war. Financial stability of these communities was maintained via central transfers and local flexibility. H. Voznyak *et al*. reported that 90% of communities' resilience remained stable when defence-related tax shifts occurred, supporting inference that adaptive budgeting frameworks, like emergency funds, helped shield communities from full disruption. On the other hand, some research highlights challenges not fully addressed by technology alone. M. Bisogno *et al.* (2022) stress that e-participation boosts transparency but must be coupled with accountability frameworks. The research we've done, studied similarly notes that transparency gains from e-budgeting, for example, public visibility of projects, require institutional support to translate into trust and civic action. T.A.N.N. Susanti Oktaviani & C. Kuntadi (2022) emphasised leadership and resources in e-budget adoption, while it was determined, that Novoiavorivsk's proactive leadership, for example, pushing a mobile app and outreach, contrasts with Kherson's more reactive stance. This suggests that capacity-building, which is based on trained officials and funding for tech, is essential. This conclusion echoed in the actual literature. Contributions of this study include a war-time perspective: even under extreme shocks, maintaining participatory budget practices can support resilience, provided they adapt to emergency needs. Globally, the discourse on e-participation and resilience is evolving. Recent works emphasise digital inclusion

and local empowerment. This vision was extended by explicitly linking e-budgeting design to community financial endurance during the deepest kind of crisis. Upon critical reflection it was noted that most scholarship assumes peacetime conditions case highlights that during full-scale conflict, priorities shift and digital tools, like e-budgeting systems, must be agile.

CONCLUSIONS

The conducted study allows to conclude that electronic budgeting is not only a tool for the digital transformation of public administration at the local level, but also one of the mechanisms for ensuring the financial resilience of territorial communities in times of crisis. In examining the digital tools of electronic budgeting in Ukraine's territorial communities, it was found that this domain is not merely a technological innovation but forms part of the broader process of public sector digitalisation under the ongoing decentralisation reform. In the current context, particularly amid full-scale war and the imperative for effective post-war recovery, enhancing the transparency of the budgeting process, engaging citizens in decision-making and fostering trust between government and society are critically important.

An analysis of existing Ukrainian electronic budgeting platforms has shown the gradual introduction of digital solutions into public finance management. Each of these systems has its own specificity, functional features and level of integration with local government bodies. The particular value is the experience of Helsinki, where the OmaStadi platform operates on the open-source software Decidim, offering a flexible setup of citizen participation tools. At the same time, several barriers hinder the full realisation of electronic budgeting potential in Ukraine. These include uneven digital infrastructure development, limited digital literacy in some regions, low levels of trust in government institutions and insufficient integration of e-budgeting platforms with other components of e-governance. Addressing these challenges requires a comprehensive national policy that combines infrastructure investment, digital literacy training programmes, support for local-level innovations and development of open data systems.

The proposed model for improving the implementation of electronic budgeting systems in support of the financial resilience of Ukraine's territorial communities illustrates how areas for improvement influence the criteria of electronic budgeting systems, leading to qualitative outcomes that positively affect the community's financial resilience. Future research should focus on empirically validating the proposed model across a wide range of territorial communities, developing integrated digital budgeting ecosystems and formulating performance indicators that take into account social, economic and security conditions. Another promising direction is the development of recommendations for adapting Ukraine's experience to the needs of other countries facing or potentially facing shock events similar to those experienced by Ukraine.

ACKNOWLEDGEMENTS

None.

FUNDING

None.

CONFLICT OF INTEREST

None.

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Модель електронного бюджетування в архітектурі фінансової стійкості територіальних громад під час повномасштабної війни

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Анотація. Метою дослідження було розроблення адаптивної моделі електронного бюджетування, яка сприятиме зміцненню фінансової стійкості територіальних громад в умовах повномасштабної війни та інших кризових викликів. Методологія дослідження ґрунтувалася на поєднанні системного, порівняльного та структурно-функціонального аналізу, а також на порівнянні міжнародних практик, зокрема фінської системи OmaStadi та української платформи E-DEM. Результати дослідження засвідчили, що ефективна імплементація електронного бюджетування позитивно впливає на прозорість управлінських процесів, підвищує громадську участь та забезпечує оптимальний розподіл публічних ресурсів. Проведений аналіз виявив ключові проблеми, які стримують упровадження цифрових інструментів бюджетування в Україні, серед яких: низький рівень цифрової грамотності, недостатня інфраструктура, слабка залученість вразливих груп населення до процесів партисипативного бюджетування та відсутність інтегрованих мобільних сервісів. Для підвищення фінансової стійкості територіальних громад у кризових та воєнних умовах запропоновано багаторівневу модель удосконалення системи електронного бюджетування. Вона охоплює напрями розвитку практик партисипативного бюджетування, систему їх оцінювання, очікувані результати впровадження моделі та її вплив на ключові складові фінансової стійкості. Запропонована модель удосконалення впровадження систем електронного бюджетування для підтримки фінансової стійкості територіальних має потенціал продемонструвати, як напрями вдосконалення впливають на критерії електронних бюджетних систем, що призводить до якісних результатів. Практичне значення дослідження полягає у можливості застосування адаптивної моделі електронного бюджетування органами місцевого самоврядування, інститутами громадянського суспільства, аналітичними центрами та державними інституціями, які здійснюють моніторинг фінансової діяльності територіальних громад

Ключові слова: публічне управління; партисипативне бюджетування; цифрова платформа; прозорість; місцева громада