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Peculiarities of the Realization of IT Projects for the Implementation of ERP Systems on the Path of Digitalization of Territorial Communities Activities

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ABSTRACT

This study presents a detailed case analysis focusing on the intricacies involved in preparing a project for implementing an Enterprise Resource Planning (ERP) system, aimed at the comprehensive, phased digitalization of resource management and the operations of territorial communities. The urgency of transitioning to a more effective audit and management system for all types of resources in territorial communities is underscored by the current absence of specialized information systems designed for these specific tasks. The authors demonstrate that deploying ERP systems to manage the diverse activities of territorial communities represents a complex, yet innovative solution. Specifically, a Four-Phase Model for implementing each segment of the project have been adopted. Drawing from the extensive experience of university researchers involved in consulting for numerous territorial communities across Ukraine, this work develops principles for constructing main elements for the project. Special emphasis is placed on the careful selection of software to facilitate project activities.

Keywords: IT Project, ERP implementation, territorial community, Project Management, project lifecycle

1. INTRODUCTION

The reform of the management system in Ukrainian territorial communities (TCs) represents a pivotal pro-European initiative currently in its active phase [1]. This reform ushered in a new era for unified territorial communities, endowing them with authority, access to external resources, and autonomy in managing their resources. These communities bear the responsibility of fostering a comfortable and secure environment for living and working for their residents. To achieve these objectives, competent management, stability, and development are essential, particularly through the integration of information technologies.

In 2023, with backing from international organizations like USAID, Social Boost, the "U-LEAD with Europe" program, and Ukraine's Ministry of Digital Transformation, the "Community 4.0" initiative was launched. Its aim is to roll out diverse digital projects to enhance sustainability, investment appeal, and innovative concepts [2]. The program received 291 applications, reflecting a keen interest among territorial communities in adopting and mastering digital technologies. However, participation was limited, and the program did not encompass all areas, selecting only 50 TCs through a competitive process.

The resilience of Ukraine's IT sector is highly valued by international experts, as it plays a crucial role in national progress through the execution of digital projects tailored to local communities [2]. Consequently, collaborations between communities and a broad spectrum of domestic IT firms show immense future potential. Many publications have documented the outcomes of these successful regional projects. For instance, in study [3], the specifics of establishing dairy processing units within community territories were explored. This study employed simulation modeling, enabling the determination of an optimal product configuration. Authors in [4] highlight the necessity for developing methodologies and tools to manage

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energy production projects from organic waste within communities, aiming to enhance implementation efficiency and stakeholder value. Considering that the majority of territorial communities host agricultural enterprises, study [5] advocates for a unified platform to manage production processes in the crop production sector, aiming to boost their efficiency.

Numerous local self-governing bodies encounter challenges in management efficiency, recognizing the imperative to establish a unified information space encompassing all functional areas. This includes electronic documentation, economic and production operation accounting, budget distribution and oversight, financial analysis, and management of communal enterprises, transportation, and logistics. Therefore, the urgency of transitioning to an advanced level of resource accounting and management for TCs, leveraging digital technologies, is palpable. This need is further underscored by the current absence of specialized information systems tailored to these tasks [1].

Articles [6-7] have established the feasibility of implementing ERP Information Systems (IS) to create a unified digital information space for territorial communities. The authors demonstrate that applying ERP systems to manage the multifaceted activities of territorial communities is a sophisticated and forward-looking solution. Historically, such systems were primarily associated with the automation of large manufacturing enterprises and businesses.

The uniqueness of ERP systems lies in their role as universal software capable of integrating various business processes. By amalgamating processes, systems, and data, these systems facilitate analytics, acceleration, and adaptability, essential for initiating optimization in business or managerial processes. The primary focus of ERP management is on information processes, many of which are common in enterprises and organizations across diverse sectors [8]. Modern ERP systems are characterized by a standardized composition: they have evolved into modular structures over time, where modules (or sub-systems) function both independently and in synergy when interfacing with a database [9-10].

The architecture underpinning ERP's unique capabilities centers around a platform that acts as a software environment for all modules and components. The platform's code is proprietary to its developer. This architecture includes the database and methodologies for data storage and interpretation. Modules, which plug into the platform as needed and operate using a unified database, contribute to the system's scalability and functional flexibility [11]. All modules integrate smoothly and swiftly with the platform, underscoring the primary advantage of using ERP systems over integrating multiple disparate products, which often require additional modifications and extensions. Additionally, ERPs can integrate with other products if necessary, such as with different document management systems or CRM solutions [12].

In study [13], research findings on the constraints and factors contributing to the successful implementation of ERP systems in small and medium-sized enterprises are presented. The study emphasizes the increasing adaptability of ERP systems, noting that developers of renowned software products, like Microsoft or SAP, are now also considering the needs of smaller businesses. The project of implementing an ERP system for a territorial community is explored here for the first time.

The objective of this study is to develop methodological approaches for designing and implementing complex projects in the resource management and all activities of territorial communities. The study employs case methodology, empirical, quantitative, and qualitative analyses of applied software based on surveys of professionals in TCs of a Ukrainian region. Real project data, along with economic and technical specifications of the ERP system "Universal 9," are available on Soft.Pro's (developer and distributor of IS in Ukraine) official website [14]. Subsequent sections of the paper present results on developing the project structure, life cycle model, work planning, project team selection, and a review of the software for project support.

2. IDENTIFYING THE NEEDS OF LOCAL COMMUNITIES IN THE DEVELOPMENT OF INFORMATION INFRASTRUCTURE, ANALYZING PROJECT CONSTRAINTS AND SUCCESS FACTORS

The initial concept of implementing an ERP system to create a unified information space in territorial community management emerged from field seminars and numerous consultations by researchers at the Poltava State Agrarian University (PSAU) in over 25 territorial communities. An analysis of the organizations' (TC) activities, conducted with key specialists, helped identify common challenges that require a unified management system solution [5,7]. The following sections provide summarized results, confirming the feasibility of using ERP systems in TCs as a unified database platform and management system.

The study initially examined the organizational structure of over 20 territorial communities. Executive committees of city or village councils manage departments addressing issues like document circulation, land resources, and communal enterprises (schools, libraries, leisure centers, archives, sports facilities, medical institutions, etc.). Territories of these communities also host private business enterprises, contributing to the community budgets. Thus, each territorial community exhibits a typically complex and branched structure (Figure 1).

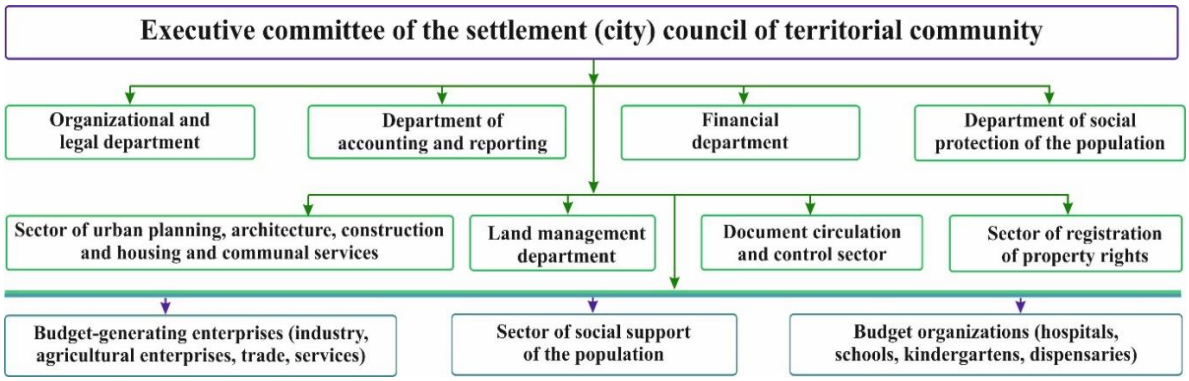

Figure 1. Organizational structure of a territorial community managed by the executive committee of a settlement or city council

In practical scenarios, the work of individual departments and community enterprises is often found to be uncoordinated, as per their own evaluations. Making decisions requires processing a substantial amount of information, and document flow is typically inefficient, often characterized by routine, repetitive data processing. Analyzing the effectiveness of individual enterprises, which influences the planning and allocation of the community's budget, among other aspects, is also challenging. Consequently, executive committees of territorial communities need to foster cooperation between different departments and business enterprises, eliminate barriers, and establish effective communication. In such contexts, it is advisable to leverage one of the key strengths of ERP systems, which can diminish departmental boundaries by facilitating corporate access to a centralized, unified database within a single software environment.

During the project's initiation phase, the responses of leading specialists from several communities, each with a population of up to 30,000 inhabitants, were analyzed. An analytical report was compiled on the existing, commonly used software slated for replacement and integration of data into the modules of the ERP system. The results from monitoring the types of software used by business entities in territorial communities are summarized in Table 1. It represents data from only one territorial community, yet it is quite typical. The list encompasses around 30 different accounting, financial, and production programs, which are often uncoordinated with each other.

The same data is frequently entered into multiple systems, leading to time wastage and reduced efficiency. Organizational heterogeneity manifests in the diversity and variety of the information systems and software deployed. This heterogeneity is evident in both technical aspects (hardware platforms, operating systems, etc.) and conceptual elements (data models, database management). The solution lies in standardizing data, processes, and roles based on a ready-made solution. We have thus developed a project to transition to a single ERP-based information space.

Table 1. The results of monitoring the types of software in territorial communities

Name and type of the territorial community enterprise (Department)	Number of employees	Sources of external information, name	What accounting and other IS are used?	Number of software types
Department of Education, Youth and Sports of the District City Council	638	"M.e.Doc"	TiS-Zarplata, 1C, «M.e.Doc.K_Files», IAC«LOGICA»	5
Municipal institution "District labour archive"	2	Privatbank, Treasury client	The Treasury's client is the Treasury", "E-reporting", FreeZvit, Zoom	4
Municipal enterprise "City Medical Care Centre"	135	"M.e.Doc", Privatbank	K-Files, "E-reporting", E-date, Helsi, Treasury's client	4
Financial Department of the City Council	7	Client-bank Privatbank	"Sonata" IAS "Logica"	2
City Production Department of Housing and Communal Services	82	Client-bank Privatbank, "M.e.Doc", GPS monitoring	ERP 1C	3
Municipal institution "CNSP"	73	"M.e.Doc", "E-reporting"	ERP IS-Pro (Budget, module "Payroll accounting for up to 200 personal accounts")	4
Municipal enterprise "Novator Company"	39	Client-bank Privatbank, "M.e.Doc",	ERP BAS, module for utility accounting	3
Department of Culture and Tourism of the District City Council	79	Client-bank Privatbank	ERP 1C: Enterprise,(budget module, PKI Local Budget, SDO Reporting)	4

The analysis of the organization's activities, initiated by the leadership, was conducted in collaboration with key community specialists and representatives of the software development company. This helped identify not only internal issues requiring resolution through the adoption of a unified management system. During the communication process and through completing specialized questionnaires in each community subdivision, the types, volumes, and timeframes of data requiring transfer to a unified ERP database were ascertained. Categories of data identified include:

1) Reference materials for balance sheet formation.
2) Payroll information over 12 months.
3) Records of assets, non-current assets, and commodity-material values for the current year.
4) Directories of counterparties, balances, employee data, balance control of budget programs, and others.

In the project initiation phase, developing a concept that impacts the project's success is crucial. The project concept encompassed these elements:

1) Relevance (understanding the situation necessitating change).
2) Problem definition (identifying the problem's source, scale, characteristics).
3) Formulating the project's goal (planning and outlining the desired outcome).
4) Establishing tasks and selecting methods for project execution.

Ultimately, project goals were defined following the SMART criteria. Preliminary plans are mandatorily discussed with the community's management personnel and key specialists who will utilize the new software. During discussion panels, major limitations in accepting the new idea from department and business unit representatives were uncovered, presenting distinct challenges. To summarize, the primary limiting factors (considerations) are highlighted before beginning the development of a project to implement a unified system.

1) A major constraint is the insufficient transparency (visualization) of business processes in the ERP system, coupled with the anticipation of disrupting conventional data management, reporting, and documentation practices. This poses significant barriers for individuals who are not IT specialists.
2) The entry barrier to ERP is high, marked by limited modularity (with additional internal dependencies within modules) and an excess of functionality, leading to high implementation costs due to the absence of adequately adapted processes.
3) Another challenge is the lack of compatibility with other existing programs (such as specialized industry systems like medical or educational) or those that may be implemented later as needed.

Therefore, we have identified three of the most pertinent and common limiting factors impacting the project's success. The list of challenges to be aware of is potentially much broader [15]. Adequate flexibility is essential to ensure the software can adapt to evolving business and management process needs in a timely manner while continuing to deliver value.

Most technical and methodological constraints were significantly mitigated by selecting the appropriate ERP and its implementation method. The sequential steps involved in choosing a system are illustrated in Figure 2.

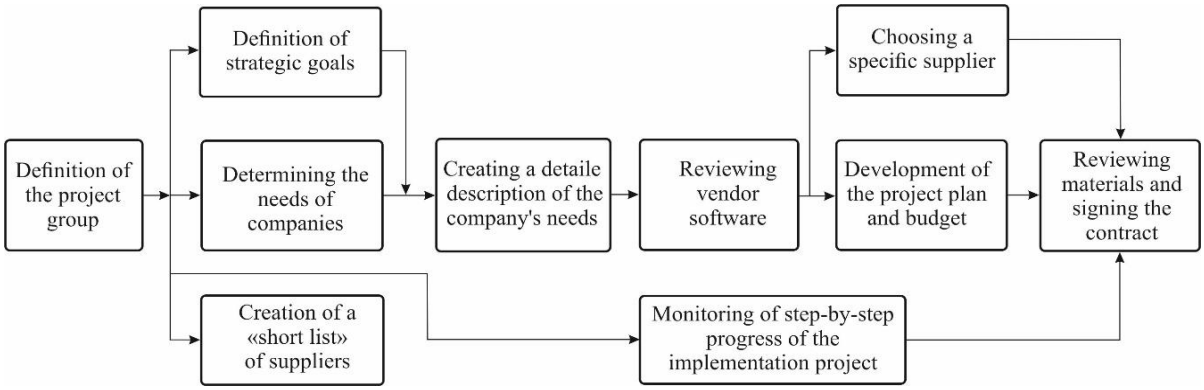

Figure 2. Procedure and content of actions when selecting a system for implementation

The "Universal 9" system was selected during the project concept discussion and recommended for implementation based on its successful deployment in over 500 diverse enterprises and organizations in Ukraine in previous years. Positive feedback about the product and the developer, SoftPro Ltd, which already had experience working with territorial communities, was taken into consideration.

The presence of all types of enterprises, including manufacturing, service, legal, and budgetary institutions, among the clients of the "Universal 9" system, attests to its high flexibility and genuine universality. The system's key advantages include a cloud solution, adaptability to state legislative requirements and standards, a standard set of modules, and an advanced three-tier client-server architecture. It features a new productive interface built on modern web technologies and supports popular browsers. Access for professionals is also provided through a browser.

Clients can select the necessary modules (eliminating unnecessary functions and reducing costs) with the option for further functional scaling. The ERP is flexibly configurable and integrates with other systems like CRM, document management, etc., and provides mobile access. Its architecture allows for the collection of "field" data through peripheral devices in specific modules. A notable advantage is the company's collaboration with universities in training personnel for such systems, participation in scientific research, and providing access to software for education and course delivery [16]. Thus, the issue of staff training during the transition to a new system can be addressed with the support of the university's educational infrastructure.

When transitioning to ERP, organizations decide on the implementation approaches. Options include phased implementation, immediate purchase of the full software version, or a hybrid approach. Research indicates that large companies often prefer a phased approach (about 30%) for complex product implementation [17]. Similarly, in territorial communities, a considered phased (project-based) approach based on the project is necessary.

Following the system presentation and project goal alignment, an initial list of tasks (primary works) required for the project implementation was compiled. The sequence of planned works is as follows:

1) Survey the subject area (activities of structural divisions, enterprises) subject to automation, outline the information flow scheme, and refine the project plan.
2) Choose approaches for system implementation, including types and sequence of module implementation for phased approaches.
3) Research existing communication systems and develop the solution architecture.
4) Begin software delivery and installation, transfer data into the system.
5) Refine and modify the standard solution, adapt it to the enterprise, and develop additional modules if needed.
6) Train staff to use each module and the system, and form a unified data processing system.
7) Test the information system and transition it to ongoing operation.
8) Provide ongoing support and technical assistance.

To achieve rapid results, the project can be divided into sub-projects focused on the most critical functionalities. A practical and logical starting point is the implementation of the accounting module, as accounting activities are common to both budgetary and commercial organizations. Subsequent phases could include personnel accounting and payroll management. This approach facilitates the establishment of a structured database and a corporate structure for operational and final accounting. The preliminary cost and timeline of the project are determined after a thorough review of the set objectives.

3. METHODOLOGICAL APPROACHES TO THE DEVELOPMENT OF THE MAIN ELEMENTS OF THE ERP SYSTEM IMPLEMENTATION PROJECT

In the collaborative process with ERP development company's project managers and through the analysis of the implementation subject, several key perspectives on the project and its execution were formulated:

An ERP implementation project is not a typical IT project. It is more appropriately considered as a standard project with a defined start and end, or a closed cycle with various stages, rather than as software development. This approach entails a series of actions from the initial moment to a predetermined end point. The Critical Path Method (CPM) can be employed to calculate project duration. The Critical Path in project management is the longest sequence of activities needed to complete a project within set timelines. The Program Evaluation and Review Technique (PERT) is another tool for managing programs and projects that involve a series of activities along the critical path.

The project doesn't conclude with the ERP system becoming operational. Planning for technical support throughout the product's lifecycle is essential to maintain the connection between the business (customer) and IT.

The implementation of an ERP system requires focus on both organizational and operational factors, with organizational aspects playing a more crucial role in the success of the implementation.

The project involves two teams: the developer's team and the customer's team. The developer's team (in our case, ERP supplier SoftPro) consists of a project manager (PM), programmers, testers, engineers, marketers, system administrators, technical support, and other specialists as per the work plan. The customer's team includes heads of leading departments in the territorial community, the executive committee chair of the city or village council or their deputy, as well as key specialists from various organizations and communal enterprises who will be using the software and understand the essence of the organization's management or business processes. This approach facilitates the optimal adaptation of the system and the development of a data structure that maximizes organizational efficiency during implementation. University researchers have served as consultants in the IT company's team, offering their software solution and ready to commence project activities.

Communication plays a vital role in the project. To facilitate communication at the project's outset (pre-investment phase), groups can be created on popular messaging platforms like Viber or WhatsApp for exchanging operational data, questionnaires, and addressing short-term tasks. During the investment phase, it's beneficial to incorporate special project support software for visualizing types, sequences, duration of works, creating diagrams, and controlling and reporting on the project.

These principles align with recommendations from the renowned analytical company Gartner regarding the success factors of projects or portfolios [20]. A four-phase model of the project lifecycle was selected for the implementation of the ERP system, as illustrated in Figure 3.

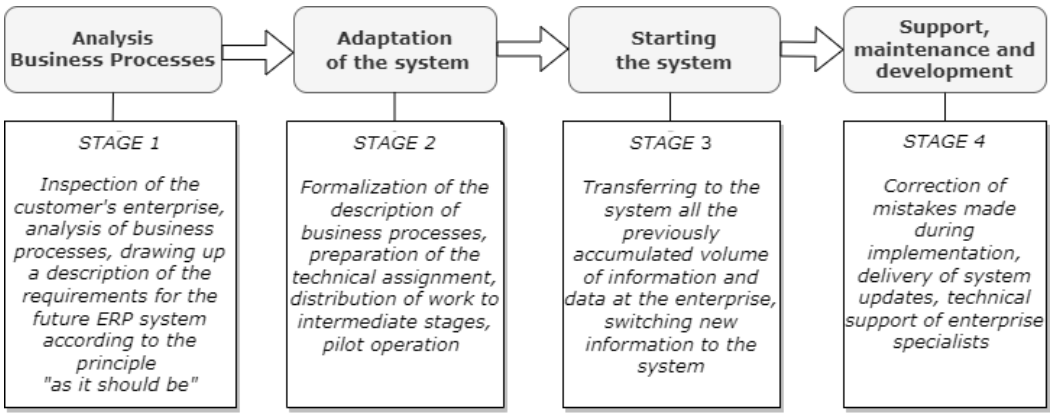

Figure 3. Stages of the ERP implementation project life cycle in territorial communities

Throughout the cooperative process and discussions with the ERP development company's project managers, and from studying the implementation object, several key views on the project's features and its implementation were formulated.

First Stage: an ERP implementation project differs from typical IT projects. It is better approached as a standard project with a clear start and end, encompassing various stages. This involves algorithmic descriptions of information flows, interrelationships, business rules, and evaluation criteria at this initial stage. It includes designing not only document flow but also system ergonomics and user interfaces. Together with the customer's representatives, decisions are made on "how it should be," leading to the creation of the project's technical specifications (TS). Building the system's architecture based on the client-server model is also crucial.

Second Stage: this involves identifying flaws in the TS formation and simulating the system's performance in various production scenarios, preparing for the system's launch and usage.

Third Stage: information that exists in the enterprise, already formalized and used in previous systems, is transferred with a

focus on data preservation. New operational information is directly entered into the "Universal" platform. This stage is intense but relatively brief, according to expert assessments.
Fourth Stage: the role of the development company (or project executor) diminishes, shifting the focus to technical support, future system updates, and staff training.
The main project phases are broken down into stages forming the hierarchical structure of works (WBS), meaning the project is divided into specific outcomes needed to achieve the project's overall goals. The implementation of the project across all stages is supported by appropriate software designed to enhance the efficiency of project activities.

4. ANALYSIS OF SPECIAL SOFTWARE SUPPORTING PROJECT ACTIVITIES

Special attention was given to selecting software for project activities. The significant number of project management systems (PMS) available, from classic MS Project to well-known agile teamwork support systems like Trello, Wrike, Jira, etc., demonstrates the relevance of software support for IT projects. Table 2 presents a comparative analysis of the functionality of these systems and provides recommendations for their use in relation to project tasks and methods.

Table 2. Characteristics of project management methods and types of software

An element of the project management model	Content and characteristics of methods in project management	Type of software for performing the relevant work
Goals, project initiation The instrument is a contract, a technical task	The requirements for the project are determined in terms of volumes, costs, time, etc., and it is also determined which of them dominates	MS Office, CorelDraw, Draw.oi, Lucidchart, SmartDraw
What shall we do? The tool is WBS	Work processes are determined through the development of the hierarchical structure of the project using flowcharts / diagrams	CorelDraw, Draw.oi, Lucidchart, SmartDraw, Creately, Visio, Cacoo, Apple iWork, SureTrak
Who performs? (command) Tool is OBS	A manager is appointed and a project team is formed using the organizational structure (OBS)	Jira, Trello, Smartsheet, Asana
Who does what? The tool is the responsibility matrix	A matrix of responsibility is created, in which works are assigned to performers with the determination of the degree of responsibility	Asana, Jira, Trello MS Project, Project 365, Project Manager, Wrike and Teamwork
How? Project management tools – Gantt charts, resource charts	Plans for the implementation of the project are agreed with regard to the established goals and relationships of work elements	Trello, Jira, MS Project, Asana, Project 365, SureTrak Project Manager, Smartsheet
Time, Costs (control) Tool - analytical and informational reports, adjusted budget method	Documents are selected that contain information for control regarding terms, volumes, budget by the method of determining deviations from the plan	Asana, Jira, Trello Jira, MS Project, Project 365, SureTrak Project Manager

As indicated in Table 2, for executing the principal stages of the project, one or several types of modern software can be employed. These will be used for various purposes:

1) For drafting project documents, MS Office is utilized.
2) For visualization of descriptions and preparation of presentation materials, as well as technical specifications, software such as CorelDraw, Draw.oi, Figma, and other graphic systems are employed.
3) To form the project team, assign tasks, and monitor their execution, tools like Asana, Jira, Trello, and similar are used.

According to analytical research, as of the beginning of 2023, the most popular project management systems are Jira and Microsoft Project. Other less popular but notable systems include Asana, Trello, and Smartsheet, as shown in Figure 4.

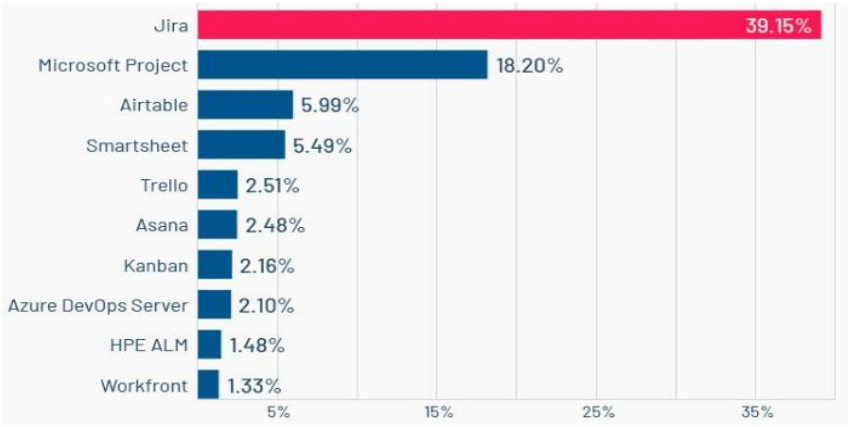

Figure 4. Statistics of the use of project management systems as of the beginning of 2023 (according to [22])

When selecting a project management system, it is crucial to consider the team size, project duration, task complexity, and the chosen methodology. Each system has unique features, making it essential to find the one that best suits your team and projects. Typically, these systems enable users to create and edit a project, a calendar, and its contents, such as tasks and responsibility distribution. Almost all PMSs include a Gantt chart. Beyond these basic functions, each system may offer special features not found in its competitors and vary in interface complexity and user-friendliness. A detailed analysis of each system is necessary to identify their strengths and weaknesses and to establish selection criteria [23].

In the project management systems under consideration, each has its advantages and disadvantages. Jira and MS Project are powerful and functional systems that allow for detailed project planning and control but may be complex and time-consuming to use. Their popularity is well-justified. The main difference lies in their approach to project methodologies. MS Project is ideal for cascade models in long-term projects and offers advanced tools for resource accounting, distribution, and control. Jira suits complex projects in a flexible model where visualizing the team's work status and sprints can be challenging.

Asana, Worksection, and Trello offer less functionality (missing some basic features) but are based on boards and cards, allowing for organizing projects into convenient task lists (Figure 5). They are suitable for Agile management and small teams [24].

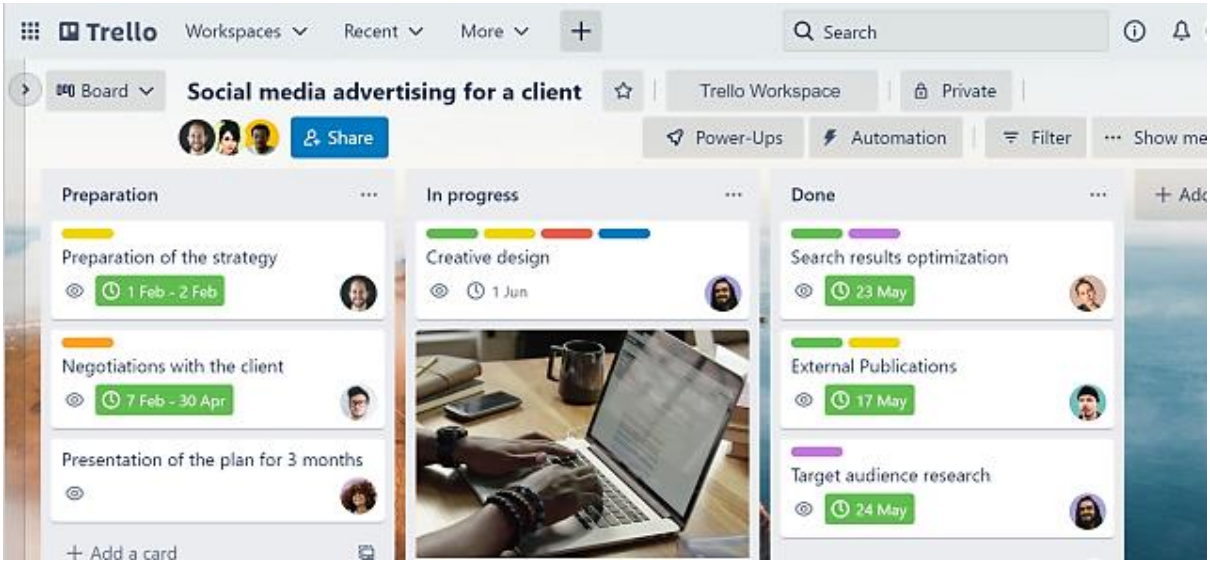

Figure 5. A fragment of the Trello Kanban board interface

For the ERP implementation project, we propose dividing the functions among teams and utilizing a user-friendly cloud resource like Trello for setting up and monitoring operational tasks and ensuring compatible communications. For the IT company, it is also advisable to use a system equipped with resource allocation, critical path analysis, Gantt charts, calendars, and other necessary tools. Suitable options include Jira or MS Project.

5. CONCLUSIONS

This paper has illuminated the key aspects of preparing and executing projects for implementing ERP class information systems to automate the management activities of territorial communities, based on a practical case constructed from real-life situations.

The findings of this work can serve as a foundation in many similar scenarios for implementing comparable projects with analogous objectives and various elements. The project management theory itself is enhanced with unique examples and algorithms for addressing complex tasks in the field of IS implementation. This case study is utilized in the "Management of Information Systems Projects" course within the master's program.

The generalized conclusions and recommendations outlined in this study are designed to be adaptable to similar projects that seek to enhance resource management through the implementation of ERP systems. Moreover, these insights have the potential to assist others in similar endeavors, thereby opening up further opportunities for methodological innovation in this field.

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7. REFERENCES

[1] Communities. URL: https://decentralization.gov.ua/en/newgromada [accessed 2024/26/01].

[2] Hromada 4.0. SocialBoost. URL: https://www.socialboost.ua/projects/hromada-4-0 [accessed 2024/26/01].

[3] A. Tryhuba and O. Bashynsky, "Coordination of dairy workshops projects on the community territory and their project environment," *2019 IEEE 14th International Conference on Computer Sciences and Information Technologies (CSIT)*, Lviv, Ukraine, 2019, pp. 51-54, doi: 10.1109/STC-CSIT.2019.8929816.

[4] A. Tryhuba, V. Boyarchuk, I. Tryhuba, O. Ftoma, V. Tymochko and S. Bondarchuk, "Model of Assessment of the Risk of Investing in the Projects of Production of Biofuel Raw Materials," *2020 IEEE 15th International Conference on Computer Sciences and Information Technologies (CSIT)*, Zbarazh, Ukraine, 2020, pp. 151-154, doi: 10.1109/CSIT49958.2020.9322024.

[5] Kopishynska, O., Utkin, Y., Makhmudov, K., Kalashnik, O., Moroz, S., Somych, M. (2023). Digital Transformation of Resource Management of Territorial Communities Based on the Cloud ERP System in the Concept of Industry 4.0. *Proceedings of the 17th International Multi-Conference on Society, Cybernetics and Informatics: IMSCI 2023*, pp. 13-20. International Institute of Informatics and Cybernetics. https://doi.org/10.54808/IMSCI2023.01.13.

[6] O. Kopishynska, Y. Utkin, O. Galych, M. Marenych and I. Sliusar, "Main Aspects of the Creation of Managing Information System at the Implementation of Precision Farming," *2020 IEEE 11th International Conference on Dependable Systems, Services and Technologies (DESSERT)*, Kyiv, Ukraine, 2020, pp. 404-410, doi: 10.1109/DESSERT50317.2020.9125072.

[7] Kopishynska O, Utkin Y, Sliusar I, Muravlov V, Makhmudov K., Chip L., "Application of Modern Enterprise Resource Planning Systems for Agri-Food Supply Chains as a Strategy for Reaching the Level of Industry 4.0 for Non-Manufacturing Organizations", **Engineering Proceedings**, 2023, 40(1):15. https://doi.org/10.3390/engproc2023040015.

[8] Oracle. URL: https://www.oracle.com/erp/what-is-erp/?source=mm-v1 [accessed 2024/26/01].

[9] Md. Tareq Hasan, "Impact of ERP System in Business Management", **International Journal of Management Studies**, Vol. 4, No.4, 2021, pp.24-31. DOI: 10.18843/ijms/v5i4(4)/03

[10] H. Hassabelnaby, D. Hwang, M. Vonderembse, "The impact of ERP implementation on organizational capabilities and firm performance", **Benchmarking An International Journal,** Vol. 19, Issue 4/5, 2012, pp. 618 – 633. DOI: 10.1108/14635771211258043

[11] What is ERP Architecture? Benefits & Importance of ERP Architecture. URL: https://erpmeaning.com/erp/erp-architecture/#:~:text=ERP%20architecture%20is%20a%20shared,for%20a%20bunch%20of%20functions [accessed 2024/26/01].

[12] What is the Importance of ERP System in Business? URL: https://erpmeaning.com/importance-of-erp-system-in-business-why-erp-is-used/ [accessed 2024/26/01].

[13] M. Munir Ahmad, Ruben Pinedo Cuenca, Critical success factors for ERP implementation in SMEs, **Robotics and Computer-Integrated Manufacturing**, Volume 29, Issue 3, 2013, Pages 104-111, ISSN 0736-5845, https://doi.org/10.1016/j.rcim.2012.04.019.

[14] Soft Pro. URL: https://softpro.ua/en/home [accessed 2024/26/01].

[15] Sunyaev, A., Dehling, T., Strahringer, S. et al. The Future of Enterprise Information Systems. Bus Inf Syst Eng 65, 731–751 (2023). https://doi.org/10.1007/s12599-023-00839-2

[16] Olena Kopishynska, Yurii Utkin, Ihor Sliusar, Vadym Slyusar, Nadiia Protas, Olha Barabolia, "Professional-oriented training of specialists under implementation of cloud computing information systems in cooperation between universities and IT companies" *Proceedings of The 14th International Multi-Conference on Society, Cybernetics and Informatics (IMSCI 2020), September 13-16, 2020*, pp.17-22. URL: https://www.iiis.org/CDs2020/CD2020Summer/papers/EA790UO.pdf [accessed 2024/26/01].

[17] The 2023 ERP Report. **Panorama-Consulting Group**. URL: https://www.panorama-consulting.com/resource-center/erp-report/ [accessed 2024/26/01].

[18] **A Guide to the Project Management Body of Knowledge (PMBOK® Guide)**. Seventh Edition and The Standard for Project Management. Published by: Project Management Institute, Inc. 14 Campus Boulevard Newtown Square, Pennsylvania 19073-3299 USA, 2021. 274 p.

[19] Bronte van der Hoorn. The Project-space Model: Visualising the enablers and constraints for a given project. **International Journal of Project Management**. Volume 34, Issue 2, 2016, Pages 173-186. ISSN 0263-7863, https://doi.org/10.1016/j.ijproman.2015.10.006.

[20] Ashutosh Gupta. 6 Step Action Plan for Effective Portfolio Management: Article. May 07, 2021. URL: https://www.gartner.com/smarterwithgartner/6-step-action-plan-for-effective-portfolio-management [accessed 2024/26/01].

[21] Kopishynska O., Utkin Y., Galych O., Makhmudov H., Svitlychna A., Lyashenko V., "Features of the Case Method Application in the Study of Disciplines Related to Information Technologies and IT Project Management", *Proceedings of the 25th World Multi-Conference on Systemics, Cybernetics and Informatics: WMSCI 2021, July 18-21, 2021*. Pp. 7-12. URL: https://www.iiis.org/CDs2021/CD2021Summer/papers/SA592PA.pdf [accessed 2024/26/01].

[22] Project Management Statistics. URL: https://99firms.com/blog/project-management-statistics/#gref/ [accessed 2024/26/01].

[23] Project Management Tools Comparsion: Jira vs. Trello vs. MS Project vs. Basecamp vs. Asana vs. Wrike. URL: https://www.toptal.com/project-managers/digital/project-management-software [accessed 2024/26/01].

[24] What Is Work Breakdown Structure in Project Management? URL: https://www.wrike.com/project-management-guide/faq/what-is-work-breakdown-structure-in-project-management/ [accessed 2024/26/01].

[25] Alleman, G.B. (2002). **Agile Project Management Methods for ERP: How to Apply Agile Processes to Complex COTS Projects and Live to Tell about I**t. In: Wells, D., Williams, L. (eds) Extreme Programming and Agile Methods — XP/Agile Universe 2002. XP/Agile Universe 2002. Lecture Notes in Computer Science, vol 2418. Springer, Berlin, Heidelberg. https://doi.org/10.1007/3-540-45672-4_8.