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Automation of Investment and Project Management Based on the Introduction of an Enterprise Resource Planning System in the Power Grid Company

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Abstract

Today, there is no universal software product that can fully cover the need for automation of management in all areas of a large company. The purpose of this study is to consider the automation of the asset management of a power grid company based on the introduction of an Enterprise Resource Planning (ERP) system. The subject of the study is the automation of investment and project management in a power grid company. This study uses abstract-logical and economic-statistical methods of information analysis. The automated system for managing investment activities and capital construction through the ERP system was introduced in the work of Rosseti Lenenergo PJSC. Here, the subsystems for project management and investment programme management are considered. The scientific novelty of the study is the fact that the results of the study provide insights for increasing the efficiency of the assets management processes of the power grid company, that is, the process of managing investment and project activities and the process of managing technical inspections and maintenance through automation based on the introduction of an ERP system. Of practical importance is the new integrated solution developed for the process of managing the investment activities of the power grid company, which takes into account the current requirements for project development. The results obtained show that the system developed involves the most ergonomic user interfaces that meet the requirements for convenience and speed.

Keywords: automation, management process, power grid company, ERP system

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Автоматизация Процесса Управления Инвестиционной и Проектной Деятельностью в Электросетевой Компании на Основе Внедрения Системы Управления Предприятием

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Аннотация

В настоящее время не существует универсального программного продукта, способного полностью покрыть потребности в автоматизации управления не только всех областей деятельности крупной компании, но даже какой-либо одной ее области. Целью настоящего исследования является автоматизация процесса управления активами электросетевой компании на базе внедрения ERP-системы. Предмет исследования - процесс автоматизации бизнес-процесса управления инвестиционной и проектной деятельностью в электросетевой компании. Научная новизна проведенного исследования заключается в повышении эффективности основных процессов управления активами электросетевой компании: процесса управления инвестиционной, проектной деятельностью и процесса управления техническими осмотрами и ремонтами оборудования, посредством автоматизации на базе внедрения ERP-системы. В ходе исследования применялись абстрактно-логический, экономико-статистический методы анализа информации. В ходе исследования была разработана и внедрена в работу ПАО «Россети Ленэнерго» автоматизированная система управления инвестиционной деятельностью и капитальным строительством с помощью ERP-системы, подробно рассмотрены подсистемы управления проектами и управления инвестиционной программой. Практическая значимость проведенного исследования заключается в том, что для процесса управления инвестиционной деятельностью электросетевой компании разработано новое интегрированное решение, в полной мере учитывающее требования современного проектного развития. Полученные результаты показывают, что в созданной системе реализованы максимально эргономичные пользовательские интерфейсы, отвечающие требованиям пользователей к удобству и быстродействию.

Ключевые слова: автоматизация, процесс управления, электросетевая компания, ERP-система.

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1. Introduction

The tasks of boosting the Russian economy and import substitution are associated with an increase in power consumption, the volume of its transmission, and the connection of an increasing number of new consumers to the power grids. The solution to these problems is complicated by a high degree of equipment wear. In the power generation industry, the share of equipment operating for more than 30 years is about 40%; in the grid complex, it is more than 50%. As noted by leading economists, the duration of consumer outages due to accidents will only increase unless decisive measures are taken to improve the reliability of the power grid complex (Hadidi et al., 2020; Kriswanto et al., 2021). The successful implementation of investment programmes and projects, as well as the quality management of equipment maintenance, directly affects the performance of companies and the achievement of their strategic goals. In the current challenging environment, effective investment and maintenance management in power grid companies is no longer possible without special software. The problem is not only selecting the software but also integrating it into the company's business processes, taking into account their specifics.

Studies have indicated that the software used for management should not only meet the requirements of the company's business but should also be an integral part of business processes and ensure their high-quality implementation (Lebedev, 2019; Lin, 2021). Only in this case can the automation of management and the effective use of software with the competitive advantages it creates become possible. Further, companies expect to obtain a customised system that takes into account their requirements and has the most convenient interface. Currently, there are a small number of products of the required quality on the market. Thus, the largest Russian Enterprise Resource Planning (ERP) systems "1C" and "Galaktika ERP," do not have any components for the development of investment portfolios and programmes, although their practical application in various business processes was substantiated in a number of scientific works (Danilczuk, et al., 2020; Roslan. et al., 2017; Wang. et al., 2020).

The study pursued the following goals: the analysis of the current state of the enterprise's business processes, the analysis of the possibility of integrating ERP systems into the business processes of the enterprise, the selection of an ERP system that best meets the strategic goals of the enterprise, the development of design solutions for the implementation of the selected ERP system, and the analysis of the possibility of using the developed universal technical solution for the automation of asset management in power grid companies.

The automation of investment management implies a certain extension of the standard functionality of the SAP PPM system and the use of the functionality of SAP ERP modules already implemented in the company. These systems must be integrated with each other and with BusinessObjects BI, as well as with the technological connection management system (on the 1C platform). The developed subsystems implement the most ergonomic user interfaces that meet the requirements for convenience and speed.

2. Literature Review

We analysed the extent of knowledge concerning the automation of asset management based on the implementation of an ERP system. Most authors consider automation as a process of developing various technical means and mathematical methods aimed at facilitating production, technological, managerial, and other processes, as well as reducing the role of a human worker in these processes and reducing the labour intensity of work performed by human workers (Babkin et al., 2021; Alekseeva et al., 2020). However, most scientists pay attention to the fact that automation is a natural process of enterprise development (Kozlov et al., 2019; Kudryavtseva et al., 2020; Mizanbekova et al., 2020). Automation allows us to optimise management and technological processes and reduce risks by removing human workers from hazardous life and health industries. Thus, it is possible to improve the quality of manufactured products, increase management efficiency, increase labour productivity, and, consequently, increase business productivity (Rudskaia et al., 2017). The introduction of automation systems allows for an increase in sales and profits and strengthens the competitiveness of the company. In recent research,

economists have noted that automation paves the way for business expansion and scaling (Wellmann et al., 2020; Schepinin et al., 2018).

The most effective tool for automating a company's business processes is the introduction of information systems, such as systems in the enterprise resource planning (ERP) class. ERP belongs to the class of accounting and transactional computer enterprise management systems designed to plan and manage all enterprise resources vital for the production, sale, and accounting of products (Locatelli et al., 2020). ERP has a dual nature: on the one hand, it is an information system, and on the other hand, it is a management standard (concept) that is implemented in this information system. ERP, as an information system, integrates the information used by multiple functional units of an organisation into a unified computer system. This means that instead of using isolated databases for each individual department (such as personnel, customers, orders, equipment, finance, warehouses, etc.) to manage information, the same database is used, which will allow the company's management and employees in different departments to have up-to-date information (Zaytsev et al., 2021).

The unified nature of an ERP system can lead to significant benefits, including reduced error rates, greater speed and efficiency, and better access to information. With better access to information, workers, and their managers can gain a better understanding of enterprise performance and make better decisions in terms of business development. The ERP system was chosen in this study according to the following main criteria: comprehensive functionality covering all existing business processes; ease of use; integration of various components of the system; performance; scalability; availability of means of integration with other applications; compatibility with other office applications; ease of management; availability of training technology for working with the system; sustainability of the system manufacturer; and availability of the system on the market, in the industry, and in the region.

Many researchers have indicated that modern software should not only meet the requirements of the company's business, it should also be an integral part of business processes and ensure their high-quality implementation (Zhu, 2021; Arbabi et al., 2020; Dubey et al., 2021; Korotkevich et al., 2019). Only in this case can the automation of management and the effective implementation of the software product with the competitive advantages it creates become possible. In the largest Russian companies, investment management at the level of individual projects is quite effectively automated (Zaborovskaya et al., 2019; Voliket al., 2021). However, there are still many unresolved issues of automating investment management at the company level, primarily control over the implementation of strategic investment plans, including operational and regulated reporting. The reason lies in the small number of products of the desired quality in the market. Thus, the largest national ERP systems, 1C and Galaktika ERP, do not yet have a special component for the development and maintenance of investment portfolios and programmes. Galaktika ERP, which positions itself as a full-scale management information system, considers the absence of excessive functionality to be its advantage over Western systems.

Despite all the advantages of ERP systems offered by the market, there is no universal software that can fully cover the needs for automating the management of all areas of a large company. For the purposes of the most complete and efficient automation of portfolio management functions that no longer fit within the old IM module, these functions were separated from the SAP ERP system into a separate specialised SAP RPM product (currently SAP PPM). Today, methods of investment management make it possible to form an optimal pool of projects (investment programme), taking into account funding restrictions, to determine the rules for ranking these projects and criteria for their effectiveness (such as net present value, payback period, internal rate of return, and energy efficiency), as well as the principles of their calculations. At the beginning of the introduction of special software, these methods should be developed and put into practice in the company. The problem of internal regulation of the investment planning process in power grid companies has not been resolved.

In accordance with current regulatory documents, the power grid company develops a five-year investment programme and submits it for approval by Rosseti PJSC and the Russian Ministry of Energy. The approved investment programme is subject to annual adjustments. The company develops a draft

of the adjusted programme, which also reflects its actual implementation for the current year, with subsequent approval by PJSC Rosseti and the Russian Ministry of Energy. To provide real assistance and support to its users, an automated investment management system is designed to perform a number of specific tasks: registration of the hierarchical structure of investment programme modules and flexible management. This is achieved by changing the structure itself, reassigning projects (titles) to the modules, bringing the planned values up in the hierarchy, and registering and grouping (creation of pools) of investment applications of applicant divisions for new projects and for changing current projects. Further, the responsible employees of the executive office are provided with the opportunity for a comprehensive analysis of incoming applications and bringing the decision on each of them to the applicants (in case of rejection, indicating the reasons or requirements for revision). There is also the opportunity for the divisions to obtain the necessary information on the progress of the implementation of each of the projects of the current investment programme, including data on the concluded contracts.

Since all the above procedures involve the processing of significant amounts of data, the system must have all the necessary tools to provide its convenience and reliability. These are mass-processing tools that are often missing in a standard solution. If it is required to enter and process large amounts of data within a short time, the convenience of the work actually means its feasibility. The problems stem from the fact that during the examination stage, the requirements of businesses and end users to the system were not clarified. As a result, the goals are not relevant to the tasks that need to be fulfilled.

Thus, the analysis of modern literature on the automation processes inspired the formulation of tasks that should be fulfilled by using the automated system for managing investment activity and capital construction (AS MIACC) based on the ERP system. These tasks include information support and automation of coordination and subsequent adjustment of the investment programme; automation of the operational, analytical, and external reporting on the investment programme; access to up-to-date information on the implementation of the projects of the investment programme to all interested employees of PJSC Rosseti Lenenergo; decision-making support; integration of several software systems into a single information environment; and completeness, relevance, and consistency of information.

3. Materials and Methods

The theoretical and methodological bases of the study are the works of Russian and foreign researchers, the works of researchers on the theory of project management and strategic management, and the works of specialists in the fields of automation and reengineering of business processes, information technology, and production management. The following methods were used during the study:

- abstract-logical method for studying the phenomenon and its processes through abstract logical reasoning of the process of automation of investment and project activities in the power grid company based on the implementation of an ERP system;

- economic and statistical methods of information analysis to build a functional architecture subsystem of project management and investment programme management;

- method of innovative business modelling of the process of managing investment and project activities in the electric grid company based on the implementation of an ERP system (which is a priority of this study);

- optimisation methods for creating types of reviews and versions of initiatives that are used for preparing documentation and reporting in the investment programme management subsystem at various stages of its formation, approval, and implementation.

The following materials were used: programmes, concepts, and financial and accounting statements of PJSC Rosseti Lenenergo. The project was developed according to the notations indicated in Table 1.

Table 1. Variables used for modelling

Source: compiled by the authors

№	SAP ERP PS	AS MIACC	Coding	Economic meaning
1.	***New construction and renovation projects***			
	Project Definition	Initiative	IXXXXXX	Title
	WBS element of level 1	Initiative	IXXXXXX	Title
	WBS element of level 2		IXXXXXX-AA	Start-up complex number
	WBS element of level 3		IXXXXXX-AA-ZZ	Construction project
	WBS element of level 4		IXXXXXX-AA-ZZ-YY	Consolidated cost estimate/Future Fixed Asset
2.	***OS procurement projects***			
	Project Definition	Initiative	IXXXXXX	Title
	WBS element of level 1	Initiative	IXXXXXX	Title
	WBS element of level 2		IXXXXXX-AA	Equipment group

From the point of view of methodology, the designed software should not only meet the requirements of the company, but it should also be an integral part of business processes and ensure their effective performance. Only in this case can the automation of management and the effective implementation of the software product with the competitive advantages it creates become possible. To date, in the largest Russian companies, the management of investment activities has been automated at the level of individual projects. However, there are still many unresolved issues of automating investment management at the company level, primarily control over the implementation of strategic investment plans—investment programmes, including operational and regulated reporting. These problems are likely to be caused by a small number of related products of the desired quality. Thus, the largest Russian ERP systems, 1C and Galaktika ERP, do not yet have a special component for the formation and maintenance of investment portfolios and programmes. Galaktika ERP, which positions itself as a full-scale management information system, considers the absence of excessive functionality to be its advantage over foreign systems.

Despite all the advantages of ERP systems offered by the market, there is no universal software that can fully cover the needs for automating the management of all areas of a large company. Therefore, for the most complete and efficient automation of portfolio management functions that no longer fit within the old IM module, these functions were separated from the SAP ERP system into a specialised SAP RPM product (currently SAP PPM). It turns out that applied tasks, such as portfolio and programme management, are more efficiently solved using special software (with the allocation of separate hardware capacity) designed to solve these tasks than the so-called universal software.

To date, one of the most advanced solutions in the field of investment and project management has been developed by the German company SAP AG, namely, PS (Project System) modules, which are a component of the ERP system, and a separate PPM (Portfolio and Project Management) application. The PS component is deeply integrated with other ERP system modules, such as FI, CO, MM, SD, and PM. SAP PPM also has built-in integration tools. Unfortunately, software manufacturers do not offer a ready-made solution for automating the management of the assets of electric grid companies and the management of investment activities in particular that would take into account all the features of projects in this industry (primarily grid connection projects).

Based on the experience of leading economists in automation methodology, work on the development and implementation of an ERP system will be carried out within the framework of successively implemented stages:

stage 1 – preparation and survey of the current business processes. At this stage, a survey of the enterprise's current business processes is carried out;

stage 2 – conceptual design. At this stage, decisions are made to determine the subsequent appearance of the system, and the research and coordination of the parameters of the created technical solutions with their possible implementation are carried out;

stage 3 – implementation of the solution. This stage involves development in accordance with the conceptual design solutions prepared. The functional architecture of AS MIACC includes four functional subsystems: data management, project management, investment programme management, integration subsystem, and reporting subsystem;

stage 4 – testing of the system. At this stage, the system and its final preparation for commercial launch are tested;

stage 5 – industrial operation of the system. At this stage, the system is fully operational;

stage 6 – replication of the solution. This stage involves the development and transfer of the solution or its parts to other enterprises.

4. Results

Based on a detailed study of the investment management processes in PJSC Rosseti Lenenergo, the decision was made to develop a new integrated solution that takes into account the requirements of the company. The solution provided for a certain extension of the standard functionality of the SAP PPM system with the help of further developments and the use of the functionality of SAP ERP modules already implemented in the company. These systems must be integrated with each other and with BusinessObjects BI, as well as with the technological connection management system (on the 1C platform). As a rule, the subdivisions that manage the investment and project activities of power grid companies belong to either investment management block or capital construction management block. The former are involved in the formation and control of the investment programme, while the latter are involved in the implementation of the projects included in the investment programme. The purpose of building AS MIACC was to create convenient working tools for executive office divisions and branches so that each block would perform its own functionality adapted to its specific tasks. Thus, SAP ERP was intended for capital construction departments (in terms of financial and logistics modules), which includes operational reports on projects with analytical data about costs, payments, receipts, supplies of materials and services, and control over the execution of contracts. The functionality of SAP PPM (formation and maintenance of the investment programme) and SAP BusinessObjects BI (formatted reports on the investment programme) corresponded with the tasks of investment management departments.

A shift was initially made from the WEB to the SAP GUI interface due to the slowness of the Java technology used in it. In the SAP GUI interface, users are offered a single-screen operation mode—a single entry point—to perform all operations. To do this, a report is created using ALV Grid (Enjoy Controls) technology with the ability to enter data and edit most of the displayed fields. The report displays the data of system objects (reviews, initiatives, and versions of initiatives) in accordance with the criteria specified by the user. The report screen contains panels and buttons with drop-down menus. Thus, everything the user needs for work is always at hand on one screen. Using the same technology, an additional report was created to work with the reviews.

Based on the applications approved by the executive office of PJSC Rosseti Lenenergo, a draft of a new long-term investment programme for a five-year period and a draft of the adjusted investment programme of the company are formed. Each project is approved once a year by the parent organisa-

tion (PJSC Rosseti) and approved by the Russian Ministry of Energy. Prior to this, documents of the investment programme of the established form are prepared. In the process of implementation during the year, changes are accumulated in the working version of the programme, which are then reflected in the adjusted investment programme for the next year. The project is closed in the system by setting the appropriate status on the project cards, which prohibits performing any operations except for viewing and using them in reports. The status is initially set for the project card in the Project Management Subsystem (PS SAP ERP module) (hereinafter referred to as the IP management subsystem) and transferred to the card of the same project in the Investment Programme Management Subsystem (SAP PPM) (hereinafter referred to as the IPR management subsystem). The signing of final acts of acceptance of work is a necessary prerequisite. The absence of an unaccomplished construction—that is, the complete commissioning of all the reconstructed and modernised facilities—is a necessary condition for closing the project.

The functionality of SAP BusinessObjects BI was used in our version of AS MIACC to prepare the planning and reporting documents for the investment programme. The SAP NetWeaver BW platform was used as the data store. All the necessary project master data and planning data are loaded daily into the SAP BW data warehouse from SAP PPM, and the actual data on the development of capital investments (costs), financing (payments), and the cost of fixed assets put into operation are loaded from SAP ERP. SAP BusinessObjects BI tools allow us to generate the necessary regulatory reporting forms and carry out a user-flexible analysis of all data of the investment programme and its actual execution. The two main subsystems are described below.

1. IP Management Subsystem

The IP management subsystem (SAP ERP system, PS module) is designed to control the life cycle of investment projects, and includes automatic creation of an investment project from the SAP PPM system, detailing of the investment project structure, cost collection, periodic, and final calculations, and closing of the investment project. The functional scope of the data management subsystem includes the following main business processes: detailing the structure of projects, reflection of costs on WBS elements (structural plans of the project), project closure, and reporting.

When the list of initiatives is approved and included in the IPR in the SAP PPM system, investment projects with the original structure are automatically created in the SAP ERP system (PS module). When automatically creating investment projects, the master data fields of the project definition and the parent WBS element are filled in by copying from the PPM initiative. When a project is closed, a final settlement rule (one or more) is entered, specifying recipients in the final settlement of the WBS element. An asset can be entered (partially or completely) to account 01, transferred between company codes, or written off (disposal). At each stage of the life cycle of an investment project, analytical reporting is available that allows us to evaluate the actual costs, structure, statuses, and basic data of the investment project. The functional architecture of AS MIACC includes four functional subsystems: IP data management, IPR management, integration subsystem, and reporting subsystem. The place of the IP data management subsystem in the functional architecture of AS MIACC and its connections with other subsystems are shown in Figure 1.

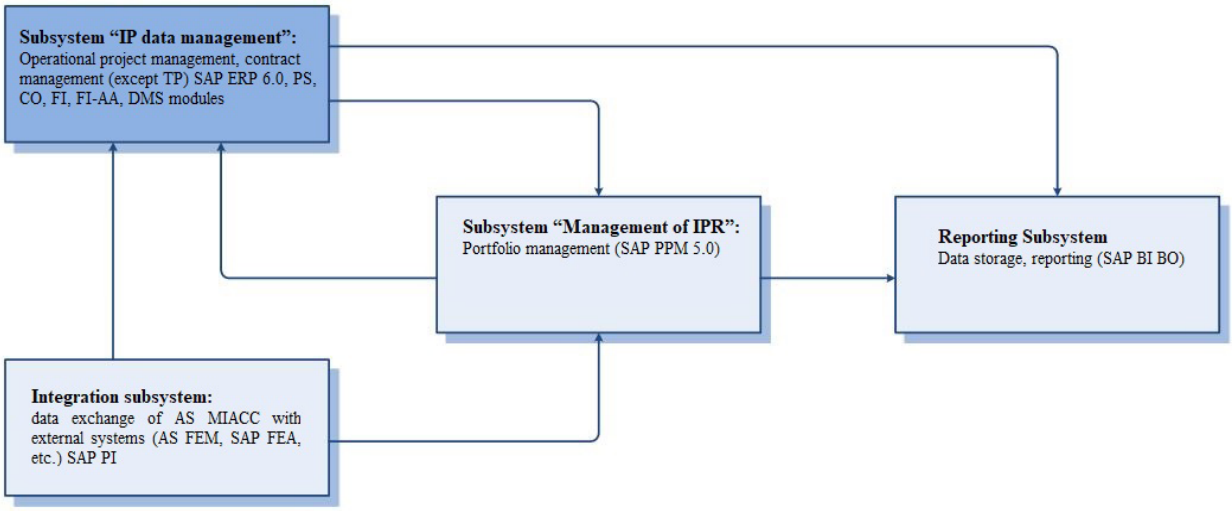

Figure 1. Functional architecture of the subsystems: IP management and IPR management

Compiled by the author

After creating a project and including it in the IPR in AS MIACC, an investment project is automatically created in the SAP ERP (PS module). When performing a purchase under the project for the purchase of fixed assets that do not require installation (Project Profile 2030), an additional WBS element is assigned at the lower level. A WBS element can correspond to an individual fixed asset or a group of purchased fixed assets. The WBS element will be created by employees of the capital construction department of the branches. Statistical key figures are used as a reference for internal allocations (for example, for cost allocation) as well as for key figure analysis. Planned and actual values of statistical key figures can be assigned to cost centres, internal orders, and WBS elements.

When performing the procurement of services for an investment project (R&D, construction, commissioning), both the top-level WBS element corresponding to the title (if it is impossible to allocate costs to deeper analytics) and the WBS element corresponding to more detailed analytics can be used as an account assignment object. The costs of depreciation of used fixed assets, wages, and settlements with persons accountable are collected at the production units (cost centres). Later, these costs are allocated to the WBS elements of projects in an economic way. Indirect costs can also be assigned to WBS elements for the maintenance of the structured plan of the project (SPP), in accordance with the general rule for the distribution of costs for the SPP. During the given period, the accountants of the branches and the executive office perform cost postings with the analytics of the capital construction departments.

Further, when closing the period at the branches, the accounting department starts automatic recalculation of costs from the capital construction units of the branches to the titles. As a result of this recalculation, the system automatically distributed the costs of the capital construction department (CCB) in proportion to the costs reflected in this period. Interest is distributed to WBS elements with a non-zero balance in the distribution period in proportion to current costs. Implementation is carried out with the help of a programme—a report. The final stage is the "Execution of documents for the project," after which the project is closed, while the initiative receives the status "Completed" in the system. When generating reports, reviews and alternative hierarchies of areas are used, which represent different options for classifying and grouping titles. Data exchange within AS MIACC is allowed between SAP ERP (PS) and SAP PPM systems. SAP PPM is external to SAP ERP (Figure 2).

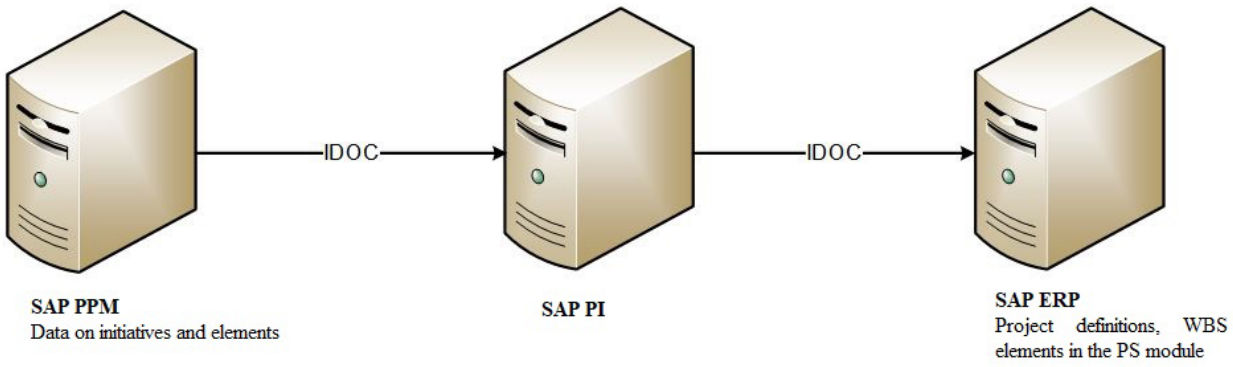

Figure 2. Interface for creating project definitions and root WBS elements

Compiled by the author

The reporting subsystem collects data directly from the ERP system using a trust connection. Integration with external systems is described in more detail in the DMS module on the integration subsystem. Cost planning takes place in the PPM system (IPR management subsystem) in the context of the main cost items on the initiative, whose code is the definition of the project and the top-level WBS element in the ERP (PS module). A detailed description of cost planning is given in the DMS module for the IPR management subsystem. Planned costs are not maintained in the IP data management subsystem. A comparative plan-fact analysis is performed in the reporting subsystem.

WBS elements are used to accrue costs for current activities, materials, and equipment, allocate costs of the capital construction department of branches and the executive office, and capitalise interest on loans and borrowings.

2. IPR Management Subsystem

The IPR management subsystem is designed to solve all the problems associated with obtaining summary data on IP within the IPR.

The functional scope of the IPR management subsystem includes the following main business processes:

- formation and approval of IPR;

- implementation of IPR;

- analysis and closing of IPR.

The formation and adjustment of the IPR should be carried out on the basis of the following principles:

- IPR is formed by including/excluding IP in/from it. The functionality of including/excluding a project from the IPR is implemented by changing the corresponding IP status. At the same time, completed IP should be automatically excluded from the current version of the IPR (despite the fact that the project is excluded from the current version of the IPR, information on the IP itself should be available for viewing through the appropriate reports);

- all numerical indicators of the IPR (financial, technical) are formed on the basis of IP data by direct summation of the corresponding indicators of individual projects included in the IPR;

- adjustment of IPR is a separate version of IPR, which includes corrected IP, and which is formed on the basis of data from the adjusted IPs.

Approval of the IPR will be carried out in the form of launching a standard approval flow, with

the possibility of choosing the approval route. Upon approval of the IPR, the reports “Memorandum for inclusion / adjustment of projects in the IPR” and/or “Order for the inclusion of projects in the IPR” will be automatically generated. At each approval step, it will be possible to attach various supplementary documents (external files: protocols, orders, technical documentation, etc.). Attached documents will be stored in the system and linked to the objects to which they refer.

The functional architecture of the IPR control subsystem consists of the following blocks (Figure 3): IPR formation block, IPR correction block, IPR coordination block, and IPR versioning block.

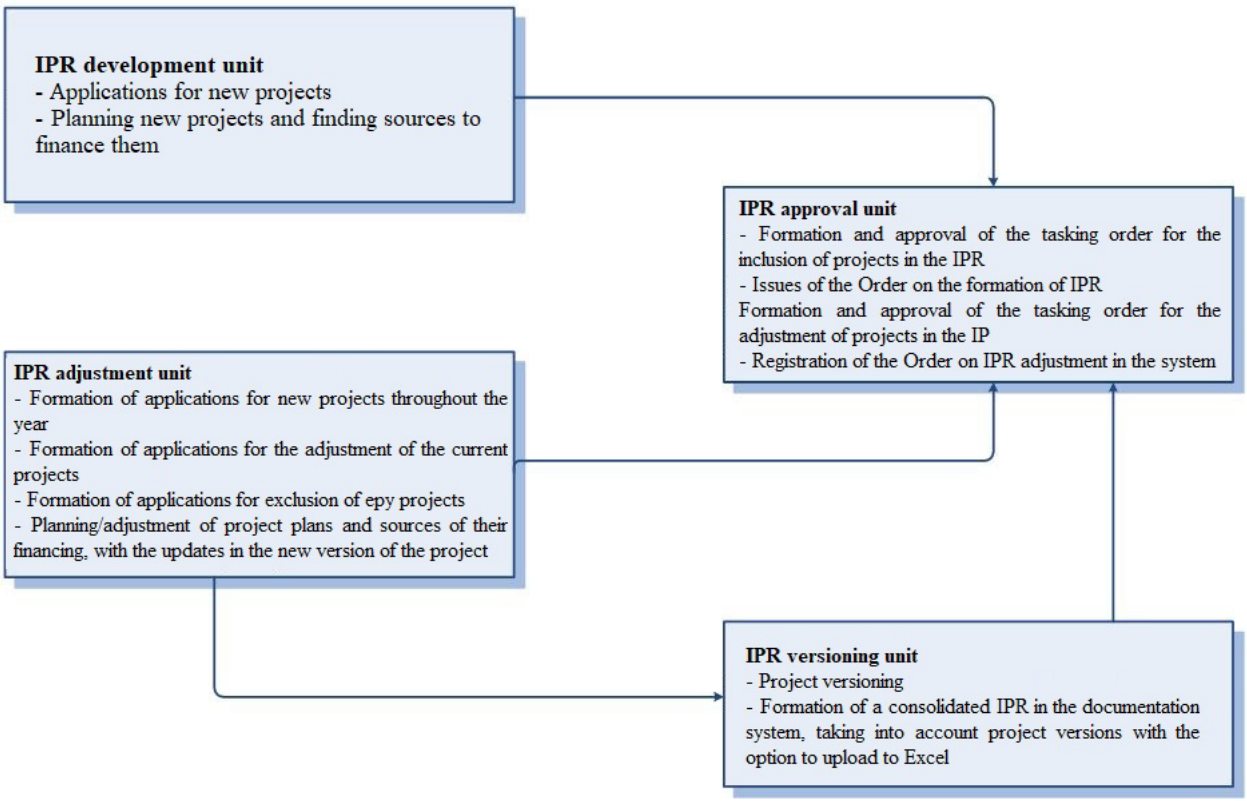

Figure 3. Functional architecture of the IPR control subsystem

Compiled by the author

Development of new reviews and initiatives/correction and deletion of initiatives/creation of new versions of initiatives is performed using a special interface procedure that allows you to enter and change object data in the most convenient way and with an acceptable processing speed. A new project in the system is created in the form of an initiative for future planning (development, financing of capital investments, commissioning, and decommissioning of fixed assets). IPR is corrected by making changes to the main data and/or data of planning initiatives with the obligatory creation of new versions of initiatives. Input is performed using the interface or by loading it from an external Excel file.

The system provides the following opportunities:

- fixing within the system the fact of inclusion in the IPR, exclusion from the IPR, suspension or change of the project at various stages of coordination, and approval of the IPR, which consists of the following:

- memo to correct the IPR;

- the result of the consideration of the Memo in the EO;

- order to adjust the IPR;

- instructions for the inclusion of RAB projects in the IPR (for the purposes of immediate imple-

mentation);

- approval of a long-term IPR by the executive office in PJSC Rosseti Lenenergo;

- approval of a long-term IPR by the board of directors of PJSC Rosseti;

- approval of the long-term IRP by the Ministry of Energy;

- approval of the IPR adjustment for the current year by the executive office in PJSC Rosseti Lenenergo;

- approval of the IPR adjustment for the current year by the board of directors of PJSC Rosseti;

- approval of adjustments to the IPR for the current year by the Ministry of Energy.

At each approval step, it should be possible to attach various supplementary documents (external files: protocols, orders, technical documentation, etc.). Attached documents must be stored in the system and have a connection with the objects to which they relate.

The analysis of the IPR and its projects is carried out by means of reporting in AS MIACC. The reporting was generated by means of SAP PPM and BI BO (Business Objects and Business Intelligence). For the purposes of reporting in BO, the actual data from SAP ERP and SAP PPM will be uploaded periodically to BW storage. The project is closed in the system by setting the appropriate status on the project card. A necessary condition for closing the project is the absence of construction in progress and the full commissioning of all created (reconstructed, modernised) facilities.

The data exchange of the control subsystem of the IPR AS MIACC is provided by the following systems: SAP ERP and an automated system for the collection and analysis of reports on the investment activities of PJSC Rosseti (based on the IBM Cognos platform). From the IPR management subsystem (SAP PPM) to the ACS of FEA (SAP ERP, PS module), the main data of initiatives and changes in them are transferred. Based on these data, SAP ERP (PS) creates project definitions and WBS elements at the three levels of the project structure hierarchy. Planned and actual data on managerial and regulated reporting on IPR in the established format are transmitted from the reporting subsystem of AS MIACC to AS to collect and analyse reports in terms of investment activities.

AS MIACC uses several hierarchies of IPR articles: The main one corresponds to the basic classification of articles of the investment programme in PJSC Rosseti Lenenergo. Alternative hierarchies correspond to classifications of investment projects that are different from the basic ones. These are used in the formation of documents and reports on IPR. The creation of the main and alternative hierarchies of IPR items is implemented in AS MIACC through the creation of a portfolio of projects and a hierarchy of areas. The portfolio corresponds to the investment programme of the company as a whole. One portfolio is used for one IPR for which the basic parameters of the IPR are set. Areas are related to the structure of IPR articles, which form a hierarchy. Initiatives can be assigned to areas at the last level of the structural hierarchy (both main and alternative). The initiative corresponds to an application for the inclusion of a project in the IPR or a project included in the IPR. The status of the project in relation to the IPR is determined by the status of the initiative. The assignment of an initiative to an area belonging to the main and alternative hierarchies is done at the moment the initiative is created.

AS MIACC provides for the creation of reviews and versions of initiatives that are used for the preparation of documentation and reporting on IPR at various stages of its formation, approval, and execution. Each initiative is included in a new version when it is created, or any changes are made to it in terms of basic data or planned values. Each new review is created for the purposes of forming, coordinating, and approving the IPR/adjusting the IPR by higher authorities or making current adjustments to the scope and plans of ongoing projects. When any review is saved from the list, the system automatically creates a version of each initiative included in the review. The initiative version code is exactly the same as the review code under which this version was created. Review versions are created regardless of the

type of initiative and the status set for it at the time the review was created.

Table 2 presents the review statuses implemented in AS MIACC.

Table 2. Review statuses

Source: compiled by the authors

Number	Status name	Comments
1.	<Empty>	It is used for reviews that do not correspond to any IPR documents created by users to solve operational problems
2.	To be considered	It is used for reviews of AMW
3.	Approved	It is used for reviews of: AMW(R), FPC, RSP, IPR-EO, IPR-SD, IPR(K)-EO, IPR(K)-SD
4.	Approved	IPR-ME, IPR(K)-ME

Table 3 presents statuses of initiatives grouped into four groups are implemented in AS MIACC.

Table 3. Initiative statuses

Source: compiled by the authors

Number	Status group name (a field in the initiative card)	Status name	Method of implementation	Conditions of implementation	Where it is implemented
	Status of the application for IPR adjustment				
1.		Initiation	Automatically	At the time of the creation of the initiative. Initial status	
2.		Inclusion	Manually	When an initiative is included in the Memo review. The initiative was never included in the IRP by order	Branch
3.		Adjustment	Manually	When an initiative is included in the Memo review. An adjustment is required to the initiative previously included in the IPR by order	Branch
4.		Suspension	Manually	When an initiative is included in the Memo review. The actual execution of the initiative previously included in the IPR has begun (a work contract has been concluded), but its continuation is not required.	Branch

Number	Status group name (a field in the initiative card)	Status name	Method of implementation	Conditions of implementation	Where it is implemented
		Exclusion	Manually	When an initiative is included in the Memo review. The execution of the previously included initiative is no longer required, the work has not actually begun, the contract has been terminated, there are accepted “junk” costs	Branch
	Status of the decision of the EO on the application (Memo)				
		<empty>	Automatically	At the time of the creation of the initiative. Initial status	
		Approved	Manually	It is set for initiatives/ adjustments of initiatives approved for inclusion in the IPR adjustment order	EO
		Rejected	Manually	It is set for initiatives/adjustments of initiatives not included in the IPR adjustment order	EO
	OS input status				
		< empty>	Automatically	At the time of the creation of the initiative. Initial status	
		Partial input	Automatically	It is implemented in SAP ERP PS project and given to SAP PPM initiative	
		Full input	Automatically	It is implemented in SAP ERP PS project and given to SAP PPM initiative	
	IPR status				
		<Empty>	Automatically	At the time of the creation of the initiative. Initial status	
		Approved by EO	Automatically	When saving the corresponding review in AS MIACC	
		Approved by the Board	Automatically	When saving the corresponding review in AS MIACC	

Number	Status group name (a field in the initiative card)	Status name	Method of implementation	Conditions of implementation	Where it is implemented
		Approved by the Ministry	Automatically	When saving the corresponding review in AS MIACC	

During the approval process, users are given the opportunity to generate reports "Memo for inclusion/adjustment of projects in the IPR" and "Order on the formation/adjustment of the IPR". At each approval step, it is possible to attach various supplementary documents (external files: protocols, orders, technical documentation, etc.). The attached documents will be stored in the system and linked to the objects to which they refer.

A user interface is created in AS MIACC to work with reviews, initiatives, and IPR documents. It is a screen with initiative fields displayed on it that will be available in both viewing and editing modes. The interface is designed to perform the following functions:

- creation of new initiatives;

- adjustments to the master data of existing initiatives;

- input and correction of planned data of initiatives;

- removal of initiatives;

- creation of reviews with the inclusion of selected initiatives;

- creation of versions of the initiatives included in the review;

- formation of documents on IPR in accordance with the established format (Memo, Order, IPR);

- formation of flexible reports of any format;

- uploading reports with subsequent saving on the user's personal computer.

Further, the possibility of creating and modifying objects using batch input (uploading Excel files) is retained. Batch input programmes are redesigned, taking into account changes in the composition of the initiative fields, planning indicators, the emergence of new directories, etc. In the financial planning view, all analytics by funding sources and all indicators of economic efficiency are excluded.

5. Discussion

In the course of the study, it was scientifically substantiated that the strengths of the SAP PPM functionality (which determined its choice and success of implementation) included the following:

- ability to work with multiple portfolios of projects. Each of the portfolios can have one main hierarchy of areas (positions, articles), and several so-called classification hierarchies. Each project can be simultaneously assigned to several hierarchies of one portfolio, which opens up wide opportunities for analysis, generation of planning, and reporting documents with the necessary detail. In previous studies (Zaytsev et al., 2021; Korotkevich et al., 2019), only one portfolio of projects was considered. In our opinion, a systematic approach can reduce the risk of production disruptions;

- the ability to maintain versions of projects that are necessary for playing various scenarios for the implementation of the investment programme as a whole, as well as saving the history of changes An attempt to introduce such a workflow has already been made in the automation of project activities (Kozlov et al., 2019; Kudryavtseva et al., 2020). Our proposal is fundamentally different. Thus, according to our decision, each document generated in the system corresponds to a separate version of the investment

proposal or project. As a result, the existing or planned data of the project included in the memo and the order, and the adjusted investment programme may differ significantly, but all these documents are stored in the system and are available for analysis at any time;

- the functionality of reviews, which are essentially containers and allow us to create various sets of investment proposals or ongoing projects (including options for an investment programme) to solve specific business problems. The prerequisites for introducing reviews of investment proposals or ongoing projects (including options for an investment programme) to solve specific business problems have already been discussed in scientific works (Zaborovskaya et al., 2019; Volik et al., 2021). Reviews are an additional and more independent means of grouping projects than areas (which make up the hierarchy of investment programme items). In the proposed solution, we strictly regulated the process of creating and using reviews, providing for each selected business process a separate type of review, a rule for generating an identifier, and limiting the user's ability to work with reviews of each type. Each review is a document stipulated by the company's internal regulations for the formation and execution of the investment programme. This document can be downloaded, saved, and printed at any time as an Excel document of the established form. Examples of such reviews are the following: a tabular appendix to the memorandum of the branch for the adjustment of the investment programme, the decision of the executive office on the memorandum of the branch, and the order of the head on the adjustment. Applicants in the branches are able to track the life cycle of their investment proposals, results, and reviews at various levels of management and the progress of the projects in one system, without resorting to other sources of information.

6. Conclusion

The introduction of AS MIACC in PJSC Rosseti Lenenergo, based on the SAP ERP system, allowed us to:

- raise the level of automation of strategic investment planning and ensure high accuracy and consistency of investment program data while significantly saving time and money;

- improve the management of projects and the Investment Program as a whole, which have become transparent and clear. Due to the flexible analytical reporting of SAP BusinessObjects BI, investment programmes can now be viewed from different angles and get up-to-date data on their actual implementation;

- receive full analytical information about all completed, launched and proposed projects at any time;

- identify unwanted changes and quickly respond to them;

- get an easy way to control consolidated investment costs, subject to tight budget constraints across the entire investment program;

- obtain a tool for rapid preparation of documentation for the investment program for submission to higher organisations, taking into account changing requirements;

- ensure the preservation of the history of investment programs, their formation, adjustment, implementation, and easy access to archived data;

- retrieve information concerning personnel more efficiently, reduce the administrative burden associated with tracking the execution of tasks and forms.

Thus, a new integrated solution was developed to manage the investment activities of a power grid company that takes into account the requirements of the company. The solution provides for the expansion of the standard functionality of the SAP PPM system with the help of developments as well as the use of the functionality of SAP ERP modules already implemented in the company. It is necessary to set further areas of research into the automation of managing investment and project activities in a power

grid company based on the introduction of an ERP system. It is planned to rationalise and streamline data flows between the subsystems of AS MIACC and external systems based on the use of artificial intelligence, to bring the profiles of investments and objects into line capital construction in progress, and to expand practical testing in power grid companies in other regions.

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