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ERP Systems in Energy Industry - opportunities and challenges

Abstract. *The article describes the use of ERP systems to support the management of companies in the energy industry. It points out the functional areas of these systems, which, apart from standard modules, are necessary for effective decision-making. Current challenges for the development of systems are presented, including methods of artificial intelligence, machine learning, data analysis and prediction, as well as new technological solutions.*

Streszczenie. *W artykule opisano zastosowanie systemów ERP do wspomagania zarządzania przedsiębiorstw z branży energetycznej. Wskazano obszary funkcjonalne tych systemów, które oprócz standardowych modułów są niezbędne do efektywnego podejmowania decyzji. Przedstawiono aktualne wyzwania dla rozwoju systemów, uwzgledniające metody sztucznej inteligencji, uczenia maszynowego, analizy i predykcji danych, a także nowe rozwiązania technologiczne.* ***Systemy ERP w energetyce - możliwości i wyzwania***

Keywords: ERP systems, data analysis, energy industry.
Słowa kluczowe: Systemy klasy ERP, analiza danych, przemysł energetyczny

Introduction

ERP (Enterprise Resource Planning) is a category of business management software, typically a suite of integrated applications. ERP apps have been commonly used to manage many trades all over the world for many years, include the energy industry. In most countries, the energy industry is a strategic market sector often overseen by governmental bodies. Energy companies create intelligent enterprises based on intelligent cloud services that streamline and simplify operations [1]. Regardless of they and the enterprise type, power plant (coal, thermal, hydro, nuclear, solar) or electricity distributor, a reliable management approach is needed. In this sector, it is extremely important to implement the ERP system with specific, sectional functional and following the selected technological innovations. In this paper, we discuss the current requirements for ERP systems and emphasize the challenges in the development of IT systems in the energy industry in Poland.

Application of ERP systems

ERP systems integrate the organization's business processes into the main functional areas and enable communication between all departments and divisions of a company. They include core software components, often called modules, with a common database. According to Gartner's definition [2], ERP tools share a common process and data model, covering broad operational end-to-end processes.

The modular design of an ERP system incorporates distinct business modules which are independent of each other and could be deployed separately. Each module deals with different functions of a specific department of the organization. The individual ERP systems have their own structure, but we can distinguish the following areas as modules:

- *Finance* comprises tools for accounting and financial. It includes billing, payments and account reconciliation, which may be performed automatically. The module settings must be complied with the relevant regulations of the country. The module also prepares various reports in which we can check the profits and losses.
- *Supply Chain Management* includes all processes that transform raw materials into final products. It comprises many detailed elements in this area and procurement, storing, and delivery are the main.
- *Inventory Management* provides information about current stock and predicts future market demand. It may also include tools to manage storage space efficiently for optimum utilization.
- *Manufacturing* optimizes production capacity, production planning and product scheduling, helps in managing the inventory and quantities of manufactured products under the demand.
- *CRM* organizes all customer data, high-performing campaigns, and efficient service. Advanced functionalities of CRM provide you with data analytics and reports to gauge customer behavior, buying patterns, and satisfaction levels.
- *Human Resources Management* handles issues related to employees, such as hiring, training, development, payroll, safety, wellness, benefits, motivation, and administration.
- *Business Intelligence* includes tools for analyzing current and historical data to support more effective strategic, tactical, and operational insights and decision-making. Advanced functionalities provide data mining, data visualization, and data tools to help organizations make better data-driven decisions.
- *Service Management* supports the service company's processes. It focuses on service teams, their time and productivity management, task, and route planning.
- *Project Management* provides skills, tools and techniques required to manage and account for projects. It supplies daily monitoring of expenses and work performed according to goals or budgets for each project.

ERP modules automate and support a range of administrative and operational business processes. They must operate in real time with regular updates of tasks' status and fast execution of all requests.

According to the Panorama report for 2018 [3] enterprises that have implemented an ERP system with success have 80% higher information availability, 55% face better data reliability and 44% get improved productivity and lead time. But only 42% of respondents company in 2018 would deem their ERP Implementation a success.

Thus, it is very important to choose the right ERP software. The type of activity of the enterprise and its specific requirements has a huge impact on the choice of system.

Requirements of ERP in energy industry

In the energy industry, requirements and tasks of IT systems supporting and managing the operation of power plants are specified in the National Energy System and include requirements imposed by the European Union. Because of the strategic nature of these enterprises, the aspect of IT security and the vulnerability of the system to the potential possibility of a cyber-attack are extremely important. Other system requirements will be for power plant and energy operators.

Fig. 1. The basic structure of ERP

The main requirements for the power plant IT systems are determined of the available electrical power, organization of fuel supplies and their consumption, monitoring the operation of equipment, supporting the work of the power plant engineer, power plant operation control at the state level and support for research activities, financial processes, human resources, and administration. All power plants operating in Poland are part of the National Power System. Besides standard ERP system modules such as finance, HR, distribution, manufacturing, service and the supply chain in the energy industry, these systems should also support the following specific functionalities:

- *Asset management*, because power plant construction, maintenance of the power grid, analysis of the existing grid requires careful tracking and management. Handle the records of thousands of spare parts and consumables, as well as planning repairs, supplying spare parts, ordering, and accounting for repair and maintenance works.
- *Geospatial planning* is important for the energy sector to connect resources with geospatial data, such as plant locations or regional energy distribution.
- Then, for energy corporations, power outages are one of the biggest problems. The key challenges in this industry are avoiding downtime, extending a life cycle, and reducing repair costs. *Failure management* functionality addresses them. Because when the installation is down, the company receives no money and must also spend money on troubleshooting.
- *Risk management* warning of potential threats, e.g., related to natural disasters, so you can prepare contingency plans.
- *Complicated project management* used to manage the full life cycle of projects. The solution fully integrated with other system components from areas such as finance, supply, warehouse, sales orders, production, design, human resources, documentation management, and asset and service management, enabling full project management related to infrastructure development.

The main requirements for the energy operators' IT systems are:

- schedule for consumption readings, to optimize the work of the collectors and to predict the amount of the customer's next bill early enough,
- To effectively manage customers, each of whom requires a separate billing, supply contract and different billing cycles. For example, issue a sales document every month invoices based on monthly consumption readings and billing according to actual consumption invoices based on a six-month calculation period. For the period between meter readings, it is necessary to generate budget billing plans. Thus, the following functionality is needed: consumption calculation, budget billing plans, calculation of electricity consumption for customers,
- The functionality of managing basic technical data, device installations and measurement results is required.
- Energy companies contact other companies, such as distributors or builders, as well as individual clients, such as end-users. *Customer services* should have multiple levels — from phone support to technical support — and associated costs and include services like issue fixes, incident resolution.

Table 1 shows list of specific requirements for power plant and energy operators' companies.

Table 1. List of specific requirements for energy industry companies.

POWER PLANT	ENERGY OPERATORS
• determination of the available electrical power, • organization of fuel supplies and their consumption, • monitoring the operation of equipment, • supporting the work of the power plant engineer, • power plant operation control at the state level • asset management • geospatial planning • risk management • complicated project management	• schedule for consumption readings, • consumption calculation, • budget billing plans • management of regional structures • management of the technical core data, device installations and measurement results, • calculation of electricity consumption for customers, • asset management • customer services • exchanging of data between companies operating

ERP systems in energy industry

According to the [4] in the worldwide energy industry, the most significant ERP software are SYSPRO, INFOR, SAP Business One, Sage X3 ERP, Microsoft Dynamics AX, S2K Enterprise, NetSuite ERP, IFS Applications 10, Cetec ERP, Priority Software ERP, E2 Manufacturing and Global Shop Solutions.

In Poland, in this sector, in huge companies, the most popular systems are SAP, IFS Applications and Microsoft Dynamics. The following chart (Fig.2.) presents a

comparison of ERP systems in Polish used in energy-producing companies and energy operators.

IFS Applications 10

IFS offers ERP, EAM (Enterprise Asset Management) and FSM (Field Service Management) software for the energy, utilities and mining sectors [6]. The system uses many years of experience and extensive knowledge about the specificity of energy companies and about the problems they face. Solution IFS "Electricity Transmission and Distribution" provides functionalities for managing complex transmission network assets, optimizing asset performance management, meeting all budget and cost goals of the organization in terms of technical infrastructure maintenance. It allows to optimize service delivery processes which affect improving customer satisfaction.

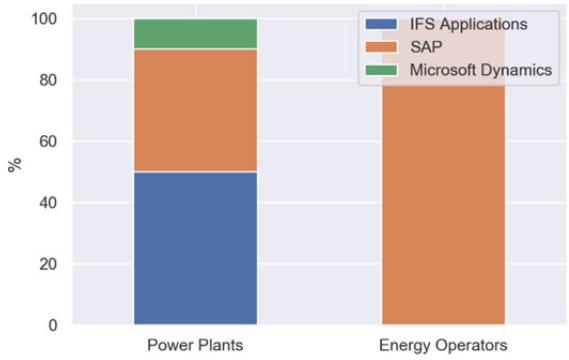

Fig.2. ERP systems in Polish energy industry.

IFS offers project and asset management and service management functions with core ERP functions for the power transmission and distribution industry. It provides the functionality for customers who specialize in electricity transmission, power distribution networks, field services and the operation of smart meters.

IFS supports breakthrough technologies appear in the energy market and customer requirements are changing. IFS software supports the electricity generation market that is constantly changing, and the cost of renewable energy is getting lower.

IFS provides ERP and EAM solutions for both on-premises and cloud-based applications.

SAP

SAP in energy data management has comprehensive solutions and provides all steps for profile-related data, from collection, validation, estimation, storage, and provisioning. It enables energy settlement or billing.

SAP supports requirements for various types of billing options, such as time of use, real time, or critical peak. It is possible to balance energy quantities, energy schedule management, and energy portfolio management in real time [7,8]. Two other modules, SAP Field Service Management and SAP Intelligent Asset Management, are very useful in energy companies' activity SAP Field Service Management can help improve the efficiency and productivity of field service operations by linking and streamlining data to service processes, improve decision making, optimize route planning, and reduce costs. SAP Intelligent Asset Management facilitates collaborative resource management and allows you to take full advantage of the Internet of Things (IoT).

An interesting solution supporting current trends is SAP E-Mobility - a new, cloud-based solution for the operation of a large-scale electric vehicle charging infrastructure network. It enables the creation, operation, and management of charging infrastructure networks to transition to sustainable and comfortable electric mobility for individuals.

Microsoft Dynamics

Microsoft Dynamics provides tools for the energy market to design, manage, and install all kinds of solutions like oil, gas, biomass, water, solar, wind, and geothermal. It supplies an energy consumption, energy trading, compliance management, production, and distribution management.

System Microsoft Dynamics includes resource and project management functionalities, capabilities to analyze customer insights, tools for trend predictions, and sales and marketing automation.

It uses Cloud computing and AI to manage the logistics to provide households and companies with energy.

The solutions of the software producer also apply to renewable energy. It supports using the Internet of Things to generate, use and distribute energy from wind, water, the sun, or other sustainable sources effectively.

Challenges of ERP in energy industry

Here have been significant changes in recent years in the energy trade. Modern, efficient technology for generating, transmitting, and storing electricity causes that IT tools should propose new functionalities to manage energy more efficiently. The most important challenges of ERP in the energy industry are as follows.

Distributed generation - new and technologically advanced solar farms or wind farms are emerging. Small hydropower plants are also becoming popular. They are a relatively cheap source of energy and can quickly change the generated power depending on the demand. ERP systems should also include management of energy production, which merges the classic and alternative way.

Treating data as an asset is one of the research trends. Recently, data discovery offered great opportunities for supporting decision making and optimization of management activities. Data in ERP systems and converge different data sources for deeper intelligence [9]. In the energy industry, both predictive applications for demand and supply forecasting as well as predictive maintenance solutions are needed, e.g., to predict the amount of mandatory purchase of energy from micro-installations, predictive maintenance to predict machine failures and situations requiring action by using huge amounts of historical data and power computing.

Automation and robotization of business processes in ERP should effectively support enterprise and can cause improvements in overall employee experience and a reduction both in cycle time and in quality issues, and rework associated with manual data entry.

ERP system can be also extended through *the Internet of Things* to track inventory levels, predictive maintenance, reported location and shipment tracking [8].

Using wearable tech may be very important in enterprise management thanks to combining data analysis and prediction. This will not only allow employee and energy plant monitoring, but can significantly affect improving employee safety and field service.

The equivalent of augmented reality should be one technology necessary in future ERP. Augmented reality (AR) means viewing the objects/things on a computer with a feel of the real world. It may effectively reduce the complexity of maintenance and service operations. An

example is a breakdown machine repair in a manufacturing unit when instead of calling and waiting for the specialist to arrive and repair it on-site, the repair can be done remotely using the actual physical real picture of the machine.

Conclusion

The article presents aspects of supporting the management of an energy enterprise by ERP systems. IFS Application and SAP have the most comprehensive solutions necessary in the energy industry and aims to be a leader in this area. However, the IFS system includes good asset management and machine service but does not have solutions related to current trends in automation and prediction. SAP proposes good customer management but hasn't a specialized solution for power plants.

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