Model of the information management systems implementation in the sector of critical infrastructure of the state

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Abstract

Oil refining industry is the sector of critical infrastructure in many world states. The most important direction in the management of oil refining enterprises is the optimization of information automated enterprise management systems. The article analyzes the existing methods of management of oil refining enterprises, identifies their shortcomings, and indicates the directions for the development of the "ideal" model of the information system for the management of oil refining enterprises. Also, the main methods of market price formation, which affect the formation of the price of petroleum products, and the proposal of an improved model of the automated management system for the automation of business processes of formation of the cost of imported petroleum products will be considered.

Keywords

Oil refining enterprise, Optimization, Information automated enterprise management system

1. Introduction

In the conditions of globalization, the world prices of oil (part of the critical infrastructure – Fig. 1) and its derivatives have turned into one of the most important economic indicators [1], which directly affect the state of commodity and financial markets, as well as national budget systems. Exchange rates, stock quotations, and consumer and wholesale prices are formed under the influence of the expectations of business entities regarding the future dynamics of world oil prices. Forecasts of the world oil market are taken into account when developing state budgets and investment projects of the corporate sector. The prices of oil and its derivatives, in particular gasoline, significantly affect production costs.

The global oil market has a particularly noticeable impact on [2] the economy of the countries that export this resource. In such countries, revenues from the export of oil and other energy sources determine the dynamics of aggregate solvent demand and tax revenues to budgets of all levels and influence the formation of the national currency rate and the pace of the inflation process. Conjectural fluctuations of the world oil market largely determine the dynamics of macroeconomic processes. During periods of high world oil prices, favorable conditions exist for the development of the domestic economy.

A sharp drop in oil market quotations leads to crisis tendencies. Effective use of revenues from oil exports is an important prerequisite for accelerated development in the economy of innovative industries. The oil refining industry is an industry with increased requirements for the management of technological processes [3-5], production, and enterprises in general.

CMiGIN 2022: 2nd International Conference on Conflict Management in Global Information Networks, November 30, 2022, Kyiv, Ukraine
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At the moment, there is an urgent question about the need to develop a general strategy and a new concept of building management systems [6-8] at the level of individual enterprises and vertically integrated oil companies. Black gold is one of the most convertible non-monetary currencies on the planet [9]. Oil production and processing have been relevant for more than a century.

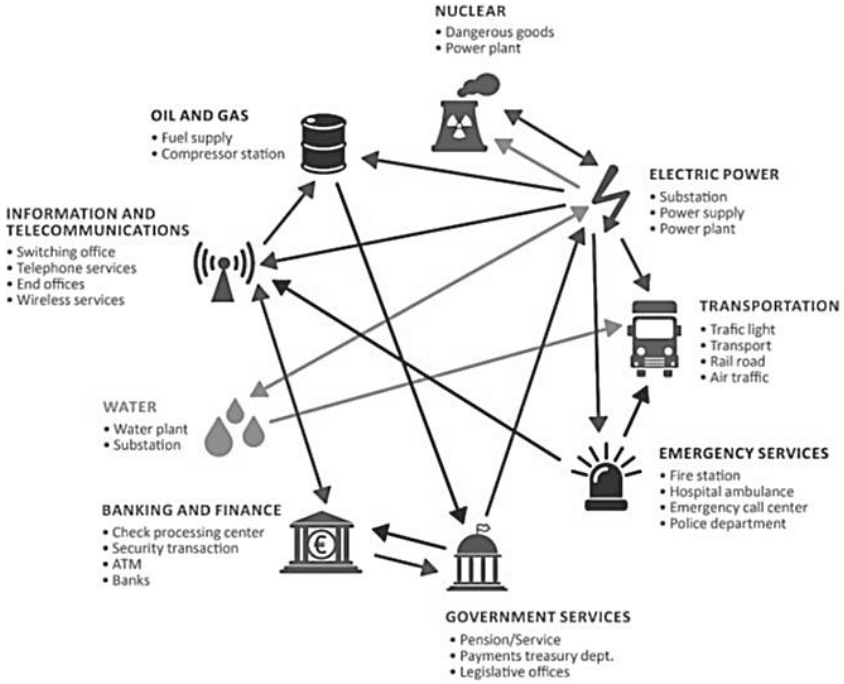

Figure 1: Sectors of critical infrastructure

However, in connection with the decrease in natural oil reserves, two questions arise and become relevant:

- mining with maximum use of the latest technologies;
- the most "modern" degree of purification and processing with the least losses.

There is also a third option – the combined use of "living" oil with artificially synthesized additives. In light of all these factors, both the improvement of management processes and the almost complete automation of mining and processing methods, their improvement and adaptation to modern economic conditions are relevant.

2. Analysis and problem statement

Analysis of modern information management systems [10-12] showed actuality and value for different sectors of critical infrastructure.

The purpose of this article is to create a more optimal modeled automated management system [13-16] for automating business processes of forming the cost of petroleum products. Since at the moment oil prices play a very important role in the formation of the cost of all products and many services on the market, due to fluctuations in the price of oil, a significant fluctuation in the price of other goods is possible.

3. The general mechanism of oil pricing

Let's consider the general pricing mechanism. The price of oil on the domestic market is formed by the reverse calculation of the world price of Brent oil: the cost of export duty (approximately 60-65% of the price) and transport costs are subtracted. There are small price deviations related to the domestic situation, but they do not play a serious role.

Thus, refineries buy oil at a price of about 35% of the world price. An increase in world prices is almost always reflected in an increase in motor fuel prices. However, due to time lags (between changes in world prices and export duties, between decisions on the redirection of oil flows, changes in the efficiency of business processes in oil refining, etc.), the domestic market's decrease in world prices is almost not reflected.

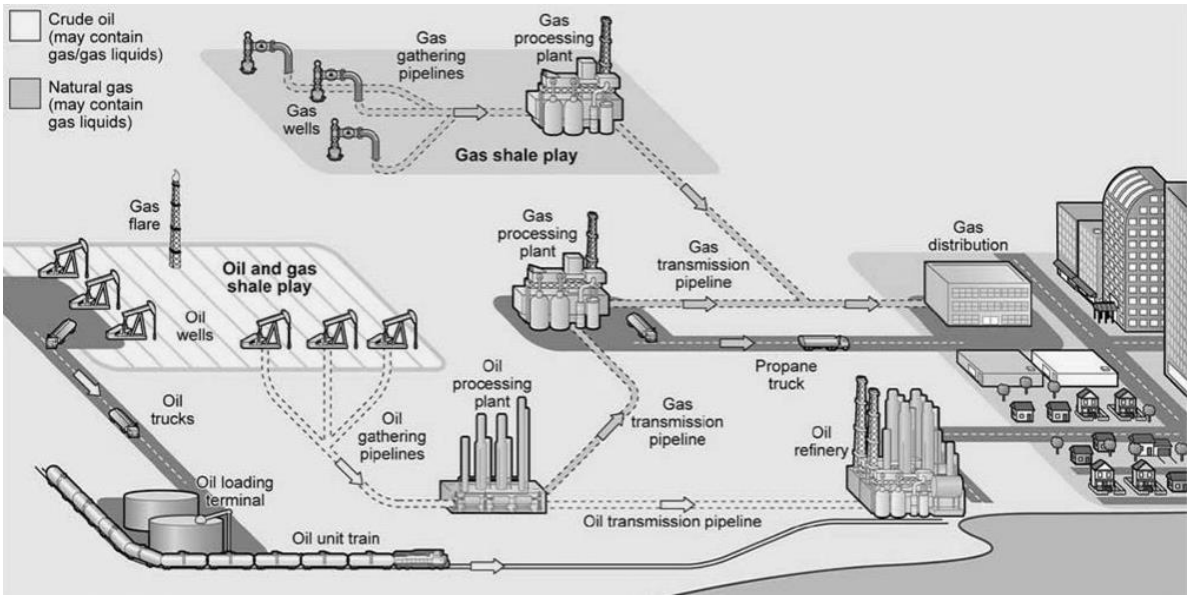

Figure 2: The oil and gas sector scheme [15]

Further, the price of future oil products includes transport costs and the cost of processing, taxes on oil products – excise duties and VAT, and various categories of "margins". In Ukraine, the profit (margin) throughout the chain is very high – about 20-30% of the final price. To a greater extent, it is concentrated in retailing, but the profitability of oil refining in Ukraine is higher than in developed countries.

There are three groups of factors that determine the almost continuous increase in prices for gasoline and other petroleum products in Ukraine.

The first includes the linking of pricing and taxation of petroleum products to world oil prices (at the same time, the mechanism of lowering domestic prices following the decline in world prices does not work), as well as periodic increases in taxes on petroleum products. This leads to an increase in domestic fuel prices when global oil prices rise.

The second group of factors includes the monopolization of regional oil product markets by large vertically integrated oil companies [17]. This applies to the segments of refineries and oil depots. They form the basic level of prices in the regions, which the gas station segment, where the competition is higher, only broadcasts to the consumer market.

The third group of reasons includes the unfortunate geographical location of large refineries (high transportation costs), which does not correspond to the territorial distribution of demand, as well as the low technological level of Ukrainian refineries and the structure of the production of petroleum products, which does not correspond to the demand from the economy.

An important factor in the growth of domestic consumer prices can be considered the assumption that the production costs of oil refining will be attributed to a greater extent to the aviation kerosene, gasoline and part of the DP needed in the domestic market, than to the less necessary products exported as part of petroleum products, which are sent for export at prices oil The following image illustrates the main sources of oil and petroleum products in Ukraine (Fig. 3).

The named groups of factors simultaneously affect the amount of oil production and import, which determines the need for a systematic approach to the development of measures to limit the growth of oil product prices, because the exclusion of one factor may not lead to a decrease in final prices, but to a redistribution of price components among their recipients. For example, without limiting

monopolization in regional markets, tax reductions may lead to an increase in the share of profits of oil companies in the final price to a greater extent, and to a lesser extent to a decrease in the price level.

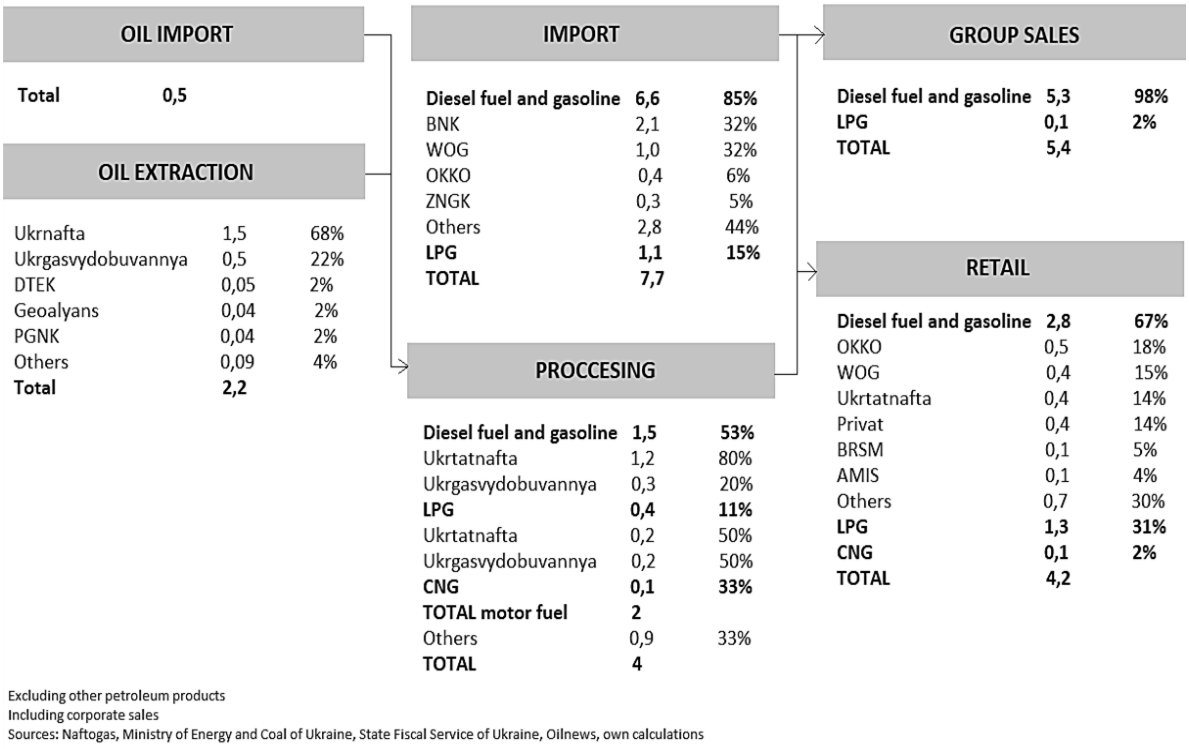

Figure 3: The main sources of oil and petroleum products in Ukraine

As a result of the study, it was established that the specified factors affect the construction of a single nomenclature of cost items of the studied enterprises, which makes it possible to develop codes of cost items for calculating the cost of production, namely:

- natural factors have an impact on the production and commercial activity of oil and gas production enterprises due to their territorial location and the size of the fields being developed;
- technical factors at all stages of the production process require an appropriate level of parameters of production equipment and aggregates, in particular, the progressiveness of the technologies used significantly affects the completeness of oil and gas production, as well as the reduction of losses at all stages of production;
- organizational factors are an essential condition for sustainable development of the enterprise [18].

Having studied the organizational and technological features of the production of oil and gas production enterprises, it was established that to improve accounting and internal control in the management system, it is necessary to display information in terms of responsibility centers and cost centers.

The table below (Fig. 4) will provide a more detailed description of the above-mentioned factors affecting possible costs for calculating the cost of production.

The main problem at most oil and gas production enterprises is the low efficiency of management processes and their weak influence on the components of economic activity, which does not ensure proper accounting and data control.

As a result of working out the specifics of oil and gas production enterprises, the following characterization of factors that influence the cost structure and cost structure of their products is proposed through the formation of their classification according to the following characteristics: natural, technical-technological, organizational-economic, which will make it possible to increase the informativeness of accounting data and the effectiveness of control procedures.

<table>
<tr><th colspan="2">Natural</th><th colspan="2">Technical and technological</th><th colspan="2">Organizational and economic</th></tr>
<tr><th>Ground</th><th>Underground</th><th>Technical</th><th>Technological</th><th>Organizational</th><th>Economic</th></tr>
<tr><td rowspan="5">Meteorological conditions</td><td>Places of communications</td><td>level of equipment modernization</td><td>level of technology</td><td rowspan="2">the level of organization of production management, labor, management</td><td rowspan="2">system of economic stimulation</td></tr>
<tr><td>Fluidity and fluidity of rocks</td><td>level of mechanization</td><td>level of use of new equipment</td></tr>
<tr><td>The depth of soil freezing</td><td>the effectiveness of using new equipment</td><td>amount of technological expenses</td><td>mode of operation of the enterprise</td><td rowspan="2">socio-psychological relations in the team</td></tr>
<tr><td rowspan="2">Depth of laying gas pipelines and construction of wells</td><td>level of automation</td><td>scope of works</td><td>rationing level</td></tr>
<tr><td>the level of suitability of fixed assets</td><td>mode of technological processes</td><td>level of forecasting</td><td>general education level of personnel</td></tr>
</table>

Figure 4: Classification of factors affecting the structure of costs and the composition of the cost of production at oil and gas production enterprises

4. Peculiarities of production cost formation at oil and gas production enterprises

In terms of market relations, the cost of production is one of the most important indicators of all economic entities of the state, as it is important in the processes of:

- determination of national income on a country scale;
- estimates of the completion of the plan for this indicator and its volatility;
- determination of prices for manufactured goods;
- identification of reserves of product cost reduction balances;
- establishing the profitability of production and certain types of goods;
- calculation of economic rationality and quality of innovation implementation.

Cost management of the company's products is a planned process that involves the creation of costs for production processes and the cost of certain types of goods, as well as monitoring the implementation of cost reduction, identifying reserves for its reduction. In general, the main components of the product cost management system are forecasting and planning, cost normalization, accounting and calculations, analysis and control, which are closely interconnected.

The main goals of the process of accounting for production costs and calculating the cost of products and goods at oil and gas enterprises are:

- accounting of the volume, quality and assortment of manufactured products (work performed, services provided) and control over the implementation of the plan according to these indicators;
- identifying the results of the activities of structural and other divisions to reduce the cost of production;
- identification of reserves for reducing the cost of production;
- calculation of the cost of production and control over the implementation of the cost plan;
- accounting of actual production costs;
- control over the use of raw materials for production, material and other resources, as well as compliance with established cost estimates for production maintenance and management.

Therefore, the research and substantiation of the formation of the production cost of oil and gas enterprises is still an actual task.

5. Optimization of technological and information processes

Extraction and processing of oil has been and will remain very important in the industry, related to many areas of use of the results of processing. Increasing the proportion of important processing components is important both for building foundations and for already widespread applications.

The willingness of science to help is accompanied by attempts to create something new within the framework of already used methodologies or to optimize technological and information processes (Fig. 5) as much as possible. An increase in the share of science-intensive technologies allows for faster implementation of science in practice. The existing methods of management of oil refining enterprises (ORE) and methods of automation of process management have rich experience in introducing new technologies both in the processes themselves and in service systems.

The most progressive in the management of technological processes is their control with the help of computer technology, which highlights important decisions and manages many situations with a high speed of both assessment and decision-making and their implementation. Feedback in continuous manufacturing processes keeps the delicate threads of important chemical processes within the precise limits of their optimal conditions.

The main goal of the work is to identify potential opportunities for increasing the economic efficiency of the functioning of technological equipment, individual industries and enterprises. The tool for achieving the goal is the creation and improvement of management systems and information systems that meet modern global requirements and common corporate interests.

The creation of such systems is a complex process, starting from the inspection of the oil complex and ending with the provision of service for the installed equipment and systems as a whole:

1. comprehensive inspection of production premises;
2. development of the concept of automation and informatization;
3. design of management systems and information systems;
4. organization and holding of tenders;
5. support;
6. organization of deliveries of software and technical complexes;
7. engineering, commissioning works;
8. training and education of operational personnel;
9. consultancy;
10. service;
11. telecommunication support;
12. provision of information exchange with corporate services.

Concepts should include the architecture of the entire system [2], possible software applications of each level and suppliers of software and hardware systems, solutions for building a network structure and work schedule with reference to the execution of design and construction works. In addition, the concepts should define the stages of work, the cost and the evaluation of the economic efficiency of each stage. However, the task of the concept is not to select specific products and suppliers, but only to list them. The development and approval of design solutions for all types of refinery system support are carried out at the stage of technical design, and the subsequent selection of specific companies and products - at the stage of detailed design of the system. This approach makes it possible to create systems based on modern software and technology complexes with optimal costs.

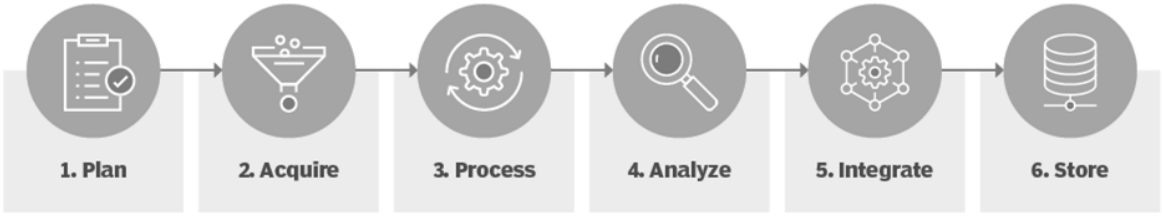

Figure 5: Traditional data lifecycle [19]

To solve these tasks, it is necessary to automate the business processes of the enterprise with the help of modern laboratory information systems capable of solving the following tasks:

- reduction of analysis time by connecting the equipment to the system;
- standardization and systematization of information;
- ensuring the completeness, efficiency and reliability of information;
- confidentiality and integrity of information;
- availability of information to users who are properly authorized to do so;
- reduction of labor costs for the organization of document flow according to indicators of product quality in laboratories;
- efficiency of obtaining information about the quality of manufactured products by the management personnel of enterprises;
- increasing the efficiency of the process of processing quality indicators by laboratory assistants;
- maximization of sample throughput and minimization of laboratory costs;
- control of the adequacy of instrumental and instrumental rates;
- reduction of data entry errors;
- improvement of analytical methods.

Laboratory information management systems should take into account all structural divisions of the enterprise that have significant responsibility in the quality management process (laboratory divisions, technological and production department, standardization and certification departments, management services of all production facilities of the enterprise) and ensure comprehensive automation of product quality. management at the enterprise.

6. Identifying the shortcomings of existing automation methods and the main planning factors for the management of ORE processes

The current unstable economic situation, uncertainty of development prospects, instability in the directions of economic development of oil refineries give rise to problems and situations that require new effective solutions in the field of management and technical methods, as well as information technologies.

The main external factors that affect the management planning process are demand fluctuations, which have a huge impact on operational planning and capacity utilization. Volatility in supply chains, influenced by factors such as: price, quality and availability, which determine such a concept as profitability in the final cycle. No less problematic is the influence of state regulations regulating the supply and productivity of products.

Refineries are aware of the complexity of the challenges facing the industry. Hence the increasing use of hardware and software systems to support management decisions. Quite a few such complexes have been developed for specific areas of the enterprise.

They relate to such areas as: information technology process modeling technologies, modeling and design tools, modeling and optimization methods, drawing up schedules, efficiency control, energy management, forecasting changes in price indicators for the coming years.

Another significant drawback concerns the automation of the processes of processing product residues, in other words, the processing of production waste. As in all oil refining industries, oil refining has waste – oil sludge [20].

From an economic point of view, these are oil wastes that are generated during the extraction, transportation and processing of oil and are not found in a more economically profitable technology of use. These products are extremely dangerous for people and the environment. The nature of oil sludge is very diverse; its composition varies within certain limits for each industry.

The resulting waste is stored in specialized storage facilities, which are often worn out and overcrowded. They are also in dangerous proximity to reservoirs and quarries.

The reluctance to spend money on the disposal of these wastes in accordance with the norms, as well as the imperfection, laboriousness, often, unprofitability of this type of work lead to the fact that in this area the process is almost completely unmanaged and practically uncontrollable.

The introduction of management of the process of disposal and processing of waste, its inclusion in a technologically harmonious series of management, as well as the inclusion of a report on these processes in the field of information management is one of the key solutions to the shortcomings in this area.

An ideal, abstract model of the control of the IAMM of the oil refining industry provides for ideal situations in the processes involved in these systems [21].

It is this approach that contributes to radical and effective changes in existing or newly built systems.

7. Development of an ideal, abstract model of the ORE management information system

Oil refineries often need the help of specialists who can tell where to start a transitional modernization project. They should strive to maximize the economic benefits of modernizing automation systems.

Over the past 20 years, there has been a huge leap in technological and informational development. What was new yesterday causes a smile today. Legacy oil refining systems face both technical and informational challenges. Outdated technologies significantly slow down the process of reorganization and reduce the level of labor productivity.

Most systems of oil refining complexes use old machinery from the 80s and 90s of the 20th century. With each subsequent technological leap, this gap becomes more and more tangible. Therefore, currently, most refineries are forced to share the market with competitors, using the latest integrated security tools [22-24], the latest solutions, and technologies in the management of information systems, which gives obvious advantages in competitive battles [25].

According to analyst firm ARC Advisory Group, the total value of the world's end-of-life systems in use is about $65 billion, and the total value of systems in use is more than $53 billion. Additionally, ARC states that downtime costs averaged nearly 5% of total production in the manufacturing industry, or approximately $20 billion.

The situations of each individual enterprise are so individual and specific that a single scheme can exist only in a general, abstract form and is very different in details. Namely, these details should be calculated at the stage of designing the automation systems update.

The main requirements for creating an abstract model of the ORE management information system are:

- control of the measured parameters of all technological areas of mining at the enterprise in real time and transfer of information to the dispatch center;
- automatic regulation of all processing processes and accounting of all material and information flows;
- possibility of remote monitoring and making adjustments at all main levels of business processes of oil refining production.

An example of a generalized abstract model of IAMM in the form of the main levels of control of management processes will be given below (Fig. 6).

The upper level symbolizes the decision-making center, the place of storage, processing, and exchange of information at the level between the ERP system and the control room, which controls the flow of input and output data within the framework of all production processes.

The middle level represents well-control cabinets and telemechanics, other equipment installed in the explosion-proof zone. The oil well pump is controlled using a frequency converter, the oil pressure is monitored, the stationary sonar allows you to obtain an echogram in real-time, and the stationary dynamograph allows you to record the dynamic load of the well (dynamogram). With the help of an electricity meter, its consumption per well is controlled, a gas detector monitors gassing in the area of the wellhead, and a fire sensor signals the presence of air in the well. The well can work in autonomous mode under the control of the SCADA Pack controller, or in the dispatcher control mode, dispatcher data is transmitted via radio signal.

The lower level is an important component of the abstract production model. It is necessary to implement analog and digital data input and output, which allows controlling and controlling

mechanisms and technological processes in industrial areas with the support of HART devices together with peripheral devices.

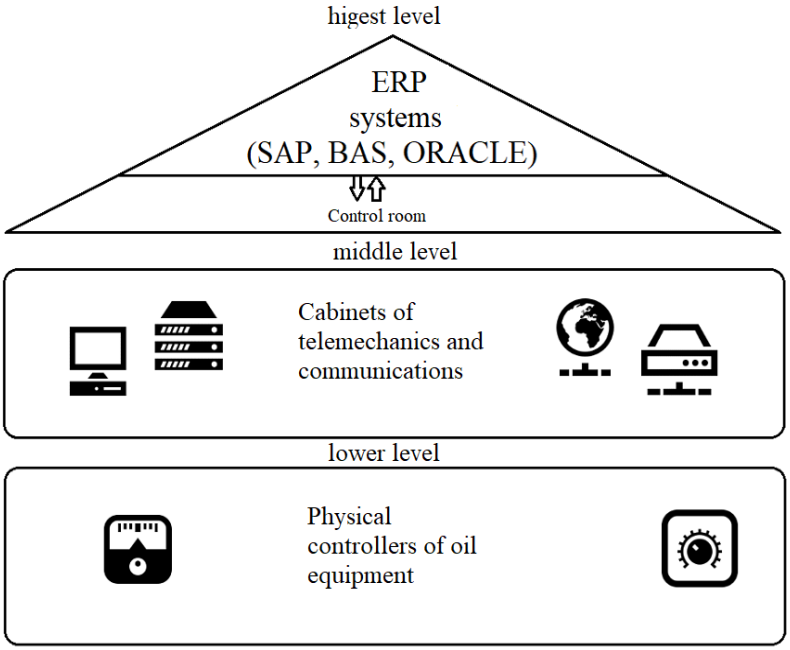

Figure 6: An example of a generalized abstract model of IAMM in the form of the main levels of control of management processes

The implementation of the following possibilities in the equipment of counters is also necessary:

- real-time module backup and replacement support;
- duplicated system bus and power circuit;
- the possibility of connecting several extension chassis;
- guaranteed delivery time of initiative messages of any module;
- changing the technological program without stopping the processes.

In this area of production, it is necessary to constantly improve the diagnostic process to monitor the quality of production, obtain the ability to analyze the process and its forecast.

The above-mentioned model, in addition to the listed main technological blocks, should have in its composition treatment facilities, a torch farm, a freshwater unit, a pump for production and rainwater, a block boiler room, etc. From each such object, the signals are sent either to a separate controller or to the controller in the operating room. In addition to the mode of collection and control of parameters according to the settings, remote and automatic control and regulation modes should play an important role in modern ACS of oil preparation. The operator's command from the computer carries remote control of the executive device.

Enterprises should strive for the maximum use of research and development of new technologies and create adaptations to the given living conditions and technical conditions of specific regions. This will minimize the risks arising both in the economic, technological, and information space.

8. Conclusions

The ideal model of the information system, common to all enterprises of the oil refining complex, should be a complex of rapid response to any non-standard situation and a flexible and adapted base for coordinated actions of all services in daily work.

From the point of view of modernization, the new technology of "electronic marshaling" eliminates the need to perform such dangerous and time-consuming work in simplified electronic accounts of the distribution of input and output data. Electronic sorting reduces the costs and risks associated with connecting legacy control systems to generate revenue.

Virtual input or output, as well as electronic routing, helps avoid tangled wires, allowing refineries to go from distribution cabinets directly to virtual input or output directly to the controller panel.

The main difference between the "ideal-abstract" system and the traditional one, while the essence of the activity, the main technological process, as well as the goals of the production and processing process remain unchanged, is a significant increase in productivity indicators at the same time. cost reduction. New intelligent refining technologies help increase the efficiency of control room operators, control engineers, and other service specialists.

In some cases, gradual, phased implementation of reconstructions is possible. Failure to take such measures means financial and technological problems, which entail an increase in the costs of operation and maintenance, as well as a decrease in the profitable part of the enterprise.

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