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## **Principles of an integrated information system for the management of the company's resources (means of production) in the mining sector**

### **Key words**

Coal mining sector, means of production, integrated information system, management

### **Abstract**

The coal mining sector uses vast resources and the efficient management of these resources is a major determinant of coal production efficiency. The paper outlines the underlying principles of an integrated information system supporting the decision-making in the field of management of the company's means of production. The conditions are defined that the system ought to satisfy, with the main focus on the supporting of mining operations planning as the distribution and location of the means of production

### **Introduction**

This study outlines the underlying principles of an integrated information system designed to support the process of resources (means of production) management in mining companies. An assumption is made that the newly-designed information system should implement all functions and tasks that to date are manually handled or which utilise separate computer applications.

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Dispersed data available in coal mines or in large companies or corporations grouping several mines (such as Kompania Węglowa, Katowicki Holding Węglowy, Jastrzębska Spółka Węglowa) repeated many times generate increased costs involved in data collection, processing and making it available. They can be destroyed by mistake, might get lost or repeatedly downloaded though in a different format. When the data are downloaded by several people, there is no strict personal responsibility for the type and quality of circulating data.

The underlying principles when creating an information system include the safe accessibility to data from any workplace within the mining company and unambiguity of the available data (i.e. elimination of redundant data). These principles underlie the ERP-class systems and the system of resources management should belong to this class, too. The system ought to utilise one database containing all required data and should comprise several access applications implementing various functions on the level of an individual mine or mining companies. These applications ought to support the planning functions as well as record keeping and control activities in connection with the created plans and schedules.

The analysis of tasks and functions performed by the company's departments responsible for handling the means of production in the mines identifies the key groups of tasks realised on various levels of management, covering:

- record keeping,
- planning,
- control.

Underlying principles of an integrated information system are defined taking into account this categorisation.

## **1. Record-keeping**

As regards the means of production, record-keeping means an inventory of past records. Information about available equipment are recorded by mining companies chiefly in an electronic format available in many book-keeping programs. Information registered in the Machine Card or Technical and Operation Documentation are in the written form. As a wide range of programs are now available, the following solution has to be adopted:

- a) there should be just one database for the entire mining company, no matter which book-keeping programs are used,
- b) all data on the company's equipment, its location and operation, including the technical data, book-keeping data, changes of locations, failure (shutdowns) should be recorded in the database,
- c) in specific situations: purchases of the new equipment, modernisation, liquidation, which have to be recorded, the data after downloading to the database would be only copied to the book-keeping programs in particular mines.

This approach ensures the cohesion of the database of the entire mining company, whilst the existing book-keeping programs are retained.

## 2. Planning

Planning of the future resources (means of production) refers to future projections covering:

- locations,
- keeping the equipment in the good working order (repairs),
- replacement of equipment.

In the coal mining sector the location of the equipment (assets) is of major importance because of changing locations of the working faces and complexity of transport paths to the new working locations. In information systems for management in companies where the locations of equipment and machines does not change, this problem does not exist. In the coal mining sector, on the other hand, this issue is of key importance to improve the efficiency of the available equipment. Hence the importance of planning of the locations of machines and equipment in the mining sector.

### 2.1. Planning of the working front

The starting point for planning how to best utilise the available equipment is the schedule of mining operations (location of the mining equipment). Such schedule, often drawn using the Excel worksheet does not fully meet the requirements of ERP-class systems.

Mine workings to be developed should be localised on digital maps of the deposit, these maps should include the data contained in the uniform database of the given mining company, available through network applications Development Schemes in individual mines. The existing and projected workings, indicated on these maps, should be registered together with their full description (dimensions, geological and mining conditions, currently used equipment, and in the case of workings to be developed also the mining or road heading technology, schedules). These should be available in the form of the company's database records. Before digital maps of the deposit can be implemented, it is recommended that the existing and projected workings should be registered in the existing database, with their full description, though no references shall be made to the spatial orientation.

The existing headings should be identified by the name and the neighbouring crossings. The description of projected headings should also refer to other conditions (for example the headings that have to be completed earlier) and to the list the target equipment. Accordingly, mine headings should be represented in the form of a network model, both for existing and projected workings. As regards the projected workings, the scheduling should be worked out, basing on the projected heading length, assumed driving rates).

The network of existing headings should allow the identification of machine transport paths between the working faces, and from the face to the shaft regions.

Developing workings shall be identified by the name and the neighbouring headings. The description of the developing headings should contain the data on the advance rates after the face operations are commenced, the projected face range and the existing or pre-planned equipment. In the case of projected workings, the information should be provided which

other face shall be mined first. In the case of projected headings, the schedules of mining operations shall be worked out, on the basis of the headings network structure, the working range and the assumed advance rates.

Basing on those descriptions and work schedules contained in the database, the production plans are formulated, specifying the coal output and rock production in an individual mine and in the entire mining company.

This system ought to permit the development of schedule options for the development headings and mine workings, to enable the reliable comparison of the options. When the given option is approved by the mine director or the company management, the remaining options ought to be removed and the approved plan should be regarded as basic. As time passes, the work performance data shall be entered in the plan, thereby forming the second, updated version of the plan, to be compared with the basic one. Before working out a new plan of mining activities (for example after one year), the tasks still outstanding should become a starting point in the new plan.

## 2.2. Distribution of the means of production

The knowledge of available resources is required for effective management of equipment and facilities. Application of an information system should permit the required equipment sets to be generated in terms of current inventory and in the specified time intervals (with past and future references).

The key element is the plan for the effective administration of machines and equipment for the pre-planned period.

The plan of mining activities is the starting point and machines and equipment have to be chosen accordingly. The proposed information system should extensively support its users. Management and deployment of machines should be supported by the face equipment options, that is why a database is required that should provide those options, depending on face dimensions and technical conditions.

While choosing the equipment for an individual face, the distributor should consult the available plan options. The system ought to distinguish (for example by coloured marking) the equipment being at the company's disposal and available in the specified time periods (not used at other faces). As regards the powered supports section, on downloading the face data (cross-sections, length, face range, daily advance rates, operation time, geological and mining conditions, relevant indicators (e.g. AW) the system should indicate the set of powered supports to be deployed (with inventory numbers), which meet the relevant requirements for the whole time the operations are to be continued. After the face equipment is deployed, the information system should signal the need for overhauls and maintenance procedures after the face operations are over. Thus deployed equipment should be entered in the database containing a full schedule of equipment transfers (operation time, location-face number).

The access application supporting the administration of machines and equipment should provide for ongoing visualisation (on the time axis) of the face operations and the deployed

equipment (shown on graphs widely adopted by mines), on the other hand the system ought to enable the display and selection of available machine sets, even the particular machines and items.

It is assumed that in the first stage of system implementation the machine and equipment deployment schedules should be done manually whilst the transfers of machines between individual mines should be arranged between the mine employees responsible for the scheduling. The major advantage of this solution, apart from reduced workload, is that the required equipment can be chosen and ordered not only from an individual mine, but also from other mines within the company, as long as their machines are still available.

As soon as the system is implemented, it is suggested that manual control of the available equipment be gradually replaced by the proposed method whereby the machines and equipment be deployed to particular locations on the basis of mathematical models and criteria adopted on particular levels of the company. When no machines are available in an individual mine, the distribution of equipment should be effected on the level of a mining company. These proposals would have to be approved or modified by employees operating this application.

Application of the application in its centralised version whereby the available equipment is distributed on the level of the whole company basing on the accepted criteria and mathematical methods should be implemented as long as the results obtained in the previous stages are positive.

Neither manually controlled nor automatic distribution shall be able to always ensure that the available equipment should be wholly utilised. The necessary yet lacking equipment to be dispatched to particular faces should be entered in the relevant schedule and recorded in the database supporting the investment planning to indicate for which period of time the equipment should be needed in production.

The information system ought to provide the options of the equipment distribution schedule, and the currently chosen options have to be indicated. Once a given option is approved, it should be treated as basic and all other options shall be removed. The copy of the basic plan becomes the current plan, which has to be updated accordingly. Registered changes include the dates of equipment locations, transfers, as well as changes associated with updating of mining schedules. In the latter case the equipment distribution plan has to be modified to catch up with the changes in the plans of mining operations.

When new plans are being developed, the updated basic plan is the starting point for the future schedules.

Alongside the current forms of working out the equipment and machine distribution plans, the new schedules should be created in relation to the Development schemes in particular mines, specifying the extent of mining activities.

### 2.3. Planning of repairs

Any mining company ought to keep records of all repairs made by outside firms, for the purpose of management of repairs, repair cost analysis and to facilitate the selection of a future contractor.

Each piece of equipment (machine) registered as the company's or the mine's property should have a record containing its status, time history as well as the dates of future overhauls, the extent of repairs, costs etc. Thus recorded data shall be utilised to generate the schedule of repairs for an individual mine or for the entire mining company in the specified period of time, with costs specifications. The generated schedule of repairs shall be verified against the projected range of repairs, costs and dates, both on the level of an individual mine and the mining company. Once the repairs schedule is approved, it should be downloaded in the database and treated as basic. The copy of the basic plan becomes the current plan, which has to be updated and modified accordingly to indicate the real costs and contractors responsible for repairs.

#### 2.4. Planning the investments in the means of production

Any mining company ought to register all information about the purchases of equipment or the conditions of its lease, for the purpose of analysis of investment activities and to facilitate the selection of future contractors.

Each piece of equipment (machine) registered as the company's or the mine's property should have a record indicating its liquidation date. Thus recorded data shall be utilised to generate the schedule of purchases to reconstruct the equipment. The need for purchase of new machines and means of production stems also from the equipment distribution scheme. These information should be recorded in the database of investment plans.

Apart from purchases of new equipment, the company must be able to procure the equipment in some other way, with exact specification how (rental, lease).

The moment the purchase is effected or the equipment is obtained elsewhere, the equipment is registered in the database of the means of production, with the details of the transaction. The database of realised investments is useful in planning future purchases as it provides valuable comparisons for negotiating the purchase conditions.

Like the plan of repairs, the plan of investments should be worked out on the level of individual mines and then on the level of the entire company. The system ought to permit the recording of several options, and one of them is selected and approved as the basic plan. As the investment process continues, the plan has to be updated accordingly by downloading the data about tasks already completed, removed or modified. The subsequent version of the plan should be continuation of the previous one, with the main focus on tasks still yet to be completed.

### 3. Control of the company's means of production

The effective management of the company's means of production requires efficient supervision and control. Efficient implementation of the control function requires reliable tools to assess the adequacy of the generated equipment management plans and to monitor the

implementation of these plans. Reliable tools ought to be provided by the designed information system for management of the company's means of production. An access to one complete database permits extensive analyses to be performed, covering:

- lists of available assets (means of production, categorised into those currently employed, those under repair and those still available;
- checking the adequacy of:
  - schedules of mining operations,
  - schedules of machines and equipment distribution,
  - repairs schedules,
  - investment plans;
- checking the effective implementation of:
  - schedules of mining operations,
  - schedules of machines and equipment distribution,
  - repairs schedules,
  - investment plans;
- operating costs of machines and equipment;
- time histories and locations of machines.

Effective execution of the control functions must be possible both on the level of individual mines and the mining company. Mine operation schedules and machine distribution plans ought to be available online to facilitate approval procedures. On the company level, the plans ought to be approved in a similar manner.

### **Conclusions**

Effective management of a mining company's fixed assets is a major determinant of company's market performance. As the capital outlays required for purchases or procurement of those fixed assets are considerable, their effective utilisation is of key importance that refers mostly to those means of production that have to be relocated. They have to be effectively utilised so as not to generate additional costs. Inefficient utilisation of these assets raises the costs of production of one ton of mined coal. It often happens in the mining practice that after mining out a part of a deposit with the specified geometric and physical and mechanical parameters, certain pieces of equipment become redundant for a while and hence could be effectively utilised in another mine. Optimisation of management of those means of production within a mining company should ensure such transfers of equipment between individual mines as to maximise the productivity and cost-effectiveness. Of particular importance is the fact that highly-efficient equipment for longwall mining, characterised by high-maintenance costs, should be utilised in an optimally efficient, cost-effective manner, the target objective being not the performance of individual mines but that of the mining company as a whole.

The management of the company's fixed assets in a mining company might be supported by computer techniques and the state-of-the-art IT technologies permit the creation of an

information system for optimisation of resources management. This study outlines the principles of an integrated information system to support the management of means of production in the mining sector, developed by the Department of Economics and Management in Industry AGH-UST, as a part of a research and development project.

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#### ZASADY BUDOWY ZINTEGROWANEGO SYSTEMU INFORMATYCZNEGO NA POTRZEBY ZARZĄDZANIA ŚRODKAMI PRODUKCJI W GÓRNICTWIE WĘGLA KAMIENNEGO

#### Słowa kluczowe

Górnictwo węgla kamiennego, środki produkcji, zintegrowany system informatyczny, zarządzanie

#### Streszczenie

Górnictwo węgla kamiennego angażuje znaczną ilość środków produkcji, którymi optymalne zarządzanie w sposób istotny wpływa na efektywność procesu wydobywczego. W pracy przedstawiono zasady budowy zintegrowanego systemu informatycznego wspierającego podejmowanie decyzji w zakresie zarządzania środkami produkcji. Sformułowano warunki, jakie winien spełniać proponowany system. Szczególną uwagę zwrócono na wspomaganie planowania robót górniczych jako miejsc pracy środków produkcji.