GOSPODARKA SUROWCAMI MINERALNYMI

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JAN JASIEWICZ*, ROMAN MAGDA**, EDYTA BRZYCHCZY*, STANISŁAW GŁODZIK*, TADEUSZ WOŹNY*

Resource management in the coal mining sector using integrated information systems

Key words

Coal mining, resources, integrated information system, management

Abstract

The coal mining sector employs huge means of production and their good management determines the efficiency of coal production. The study outlines the concept of an integrated information system to support decision making in the area of resources management, formulating the conditions that such a system ought to satisfy.

Introduction

Means of production in the coal mining sector are understood as those assets plant facilities which are necessary for coal production, starting from working faces right through to mechanical treatment plants or washeries. Main facilities in a mining company include all face equipment and machines, handling and transport facilities that carry mined coal to the shaft regions, hoisting facilities, transport facilities on the surface and coal treatment plants that handle coal to make it marketable. Those facilities form a sub-set of the company's fixed assets restricted to the main processes of coal mining in longwall panels, development and

* Ph.D. Eng., ** Prof., AGH University of Science and Technology, Kraków, Poland.

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preparatory works that ensure continuity of mining operations. Means of production do not include such fixed assets as ground, buildings and those machines and plants that are used for other purposes than coal production.

As regards mining companies, the available means of production determine the productivity levels and the actual production capacity. All changes in the size, type and structure of those facilities will affect the output figures and process dynamics. Mining operations determine their displacements in space and time. Every day working faces have to be moved as well as the mining equipment. Coal handling and transport paths are changed less frequently, they are lengthened or shortened and hence the amounts of resources are varied, too.

Since mining companies have to constantly adapt to variable conditions of the free market economy and have to restructure their production costs, they need reliable tools to manage the available resources in a centralized manner. The authors recommend the application of an integrated information system incorporating past records (quality and quantities of registered facilities), management of currently available resources (particularly in companies grouping several plants), efficiency assessment and the control of resource management.

1. Management of the means of production in a mining company

Management of means of production is a key aspect of company management and should involve all elements of the process:

— planning,
— organization,
— management,
— control,
— motivation.

Planning ought to take into account the future demand for the means of production, i.e. machines and facilities with specified parameters, stemming from current production plans to ensure the desired efficiency.

Organization should enable the company to meet those demands through defining the required formal and financial conditions.

Management involves the decision- making on each level, having relevance to formal and financial conditions clearly formulated in the process of organization.

Control should cover the supervision and monitoring of effectiveness of employed resources through the analyses of available data.

Motivation should provide incentives for the effective management of available fixed assets and resources.

A major aspect of the means of production is their strategic dimension and the associated key role in the functioning of the company. Decisions made on each level, having relevance to the management of these resources largely affect the company's market performance and

their impacts (negative or positive) might stretch over years. These aspects are of particular importance in mining companies as the costs of purchase, operation and maintenance of mining equipment and machines very high whilst the expected reliability levels determine the company's long-term capacity and financial performance.

Production levels and financial performance depend in a large degree on the overall management of the company's facilities and assets. Careful selection and employment of production facilities determine the production levels, labour – consumption, quality, work efficiency, production cycles and costs. Increased production levels and relative reduction of the production costs help the company to generate profits. Reduced costs of operational and preventive maintenance as well as repairs bring in additional profits. Proper structuring of available resources and the activities aimed to improve efficiency are time-consuming and costly jobs- so they must always be pre-planned in a rational and conservative manner. These factors largely determine the efficiency of resource management.

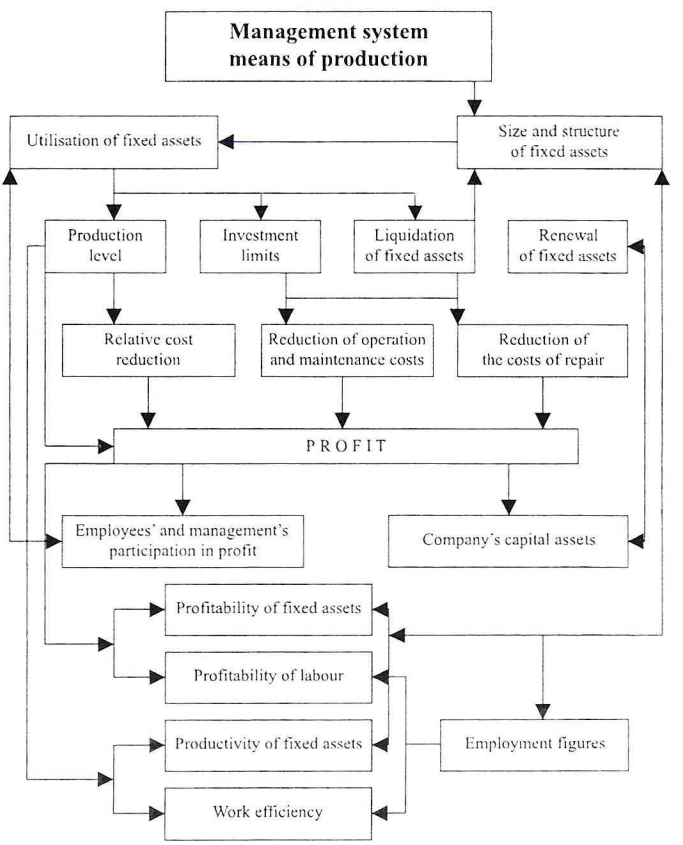

Fig. 1. Influence of fixed assets management on company's performance
(authors' own sources, based on Surowiec 2000)

Rys. 1. Mechanizm wpływu gospodarowania środkami trwałymi na wynik działalności przedsiębiorstwa
(opracowanie własne na podstawie Surowiec 2000)

The influence of management of the company's fixed assets, including the means of production on the company's performance is illustrated in Figure 1 whilst the key elements of fixed asset management (including means of production) are shown in Figure 2.

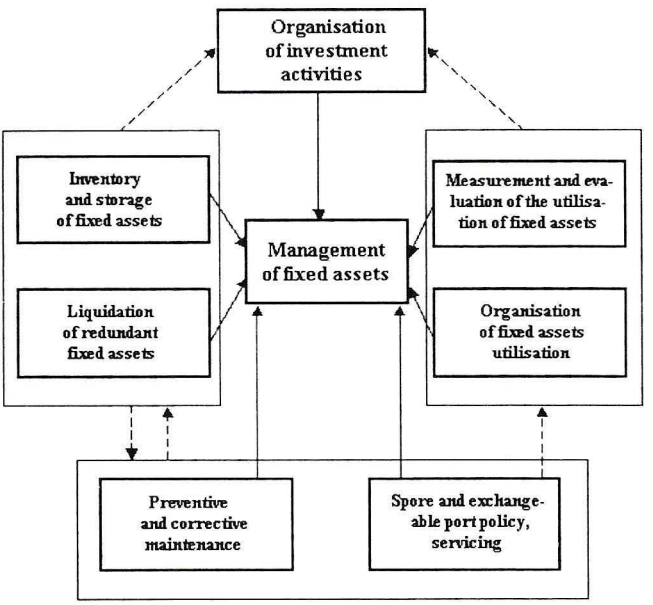

Fig. 2. Elements of the fixed asset management (authors' own sources, based on Borowiecki 1993)

Rys. 2. Elementy gospodarki środkami trwałymi (opracowanie własne na podstawie Borowiecki 1993)

These elements are categorized in 3 groups:

I – registration, storage and disposal of fixed assets,

II – keeping the fixed assets in the good working order through preventive maintenance, repairs, spare parts policy,

III – organizing the way the fixed assets are used in the company.

It appears that organization and management of company's fixed assets involves close integration of several functions. Their scope and extent in a given company largely depend on the level of saturation with those assets and the efficiency of those functions is controlled by the overall efficiency of all involved units.

2. Evaluating the management of the means of production

When properly used, the means of production fulfil the role associated with their utilitarian function and thus contribute to the manufacturing of products which meet the demand of various groups of consumers. This function implies that the means of production have to be used in a cost-effective manner.

The study of management of the means of production available to the company is the necessary tool in decision-making, both in current affairs and on strategic levels, to intensify the economic processes in the company. Such analysis should cover:

— overall evaluation of resources management,
— how the employment of the means of production should affect the company's financial performance and production levels,
— locating available reserves and how these can be utilized,
— establishing proper relationships between productive assets (and labour costs) and production levels,
— prognosticating the production levels in the light of the decisions made as to technical, financial and organizational conditions.

The assessment procedure should be directly associated with:

— planning, usage and servicing of the means of production,
— engineering and development,
— selection of machines and plant operation and maintenance options,
— repairs, preventive maintenance and scrapping procedures,
— creating reserves and working out storage procedures.

The evaluation of management of the company's means of production requires that a system of management quality indicators be first developed. As means of production are numerous and belong to various categories, they cannot be reliably assessed using one common indicator, hence we have to apply a full range of indices.

The assessment of the quality of management of the company's means of production utilizes the following indices:

— dynamics, structure and technical conditions,
— technological advancement (mechanization, automated plants),
— effective use of machines and plants.

Both economic quantities to characterize fixed assets and indicators should be chosen such as to meet the criteria of the research project. They may apply to means of production of all types, or to selected groups or even single units, in terms of quality or/and quantity, in relation to past records and future projections, or in relation to other companies in the given sector.

Underlying the development of indicators are some methodological assumptions:

— management level in the organization structure (company, plant, department, division),
— type of the means of production to be assessed,
— logical and ordered set of indicators showing us how those means of production are functioning, what is their status, how they are managed and what might be financial effects due to utilization of available reserves,
— application of both synthesized and specific indices to assess the quality of management.

Evaluation of the quality of management of the company's means of production is a tool necessary for decision making in the long terms, these decisions being aimed to improve productivity, hence we can say these are strategic aspects. The evaluation function is also

required to ensure current management of available resources as it provides information about the cases of system malfunctioning.

3. Information systems supporting business management

In order to effectively manage the company, the management function has to be supported by relevant information systems.

Numerous computer programs are available on the market that support business management, and particularly the management of productive resources (labour, means of production). Information systems now in widespread use include:

— TPS – Transaction Processing Systems,
— OAS – Office Automation Systems,
— MIS – Management Information Systems,
— MRP II – Manufacturing Resource Planning,
— CIM – Computer Integrated Manufacturing and ERP- Enterprise Resource Planning,
— MSS – Management Support Systems,
— DSS – Decision Support Systems,
— EIS – Executive Information Systems,
— ESS – Executive Support Systems,
— ES – Expert Systems,
— CAD – Computer Aided Design, CADD – Computer Aided Design and Drafting, CAE – Computer Aided Engineering, CASE – Computer Aided System Engineering,
— CAP – Computer Aided Planning,
— CAQ – Computer Aided Quality Assurance,
— CAL (CAT) – Computer Assisted Learning (Training),
— CAM – Computer Assisted Manufacturing.

Interrelations between these systems within the management structure are highlighted in Figure 3.

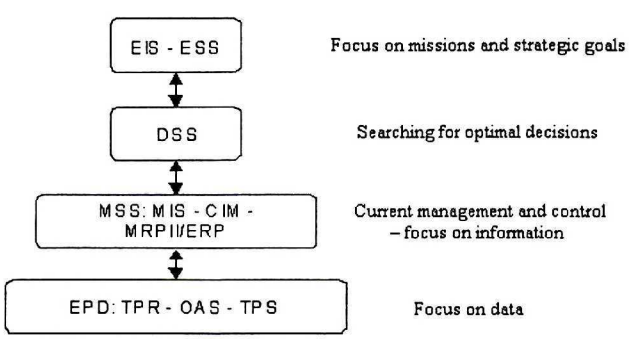

Fig. 3. Interrelations between the systems within a company (authors' own sources, based on Bielecki 2005)

Rys. 3. Relacje pomiędzy systemami w przedsiębiorstwie (opracowanie własne na podstawie Bielecki 2005)

An integrated management system, referred to as ERP (Enterprise Resource Planning) comprises several interacting applications (modules) that integrate the activities of a company or groups of collaborating companies on all levels and areas of management. ERP systems enable the optimal utilization of available resources and arranging all operations in an ordered manner.

These systems are supported by one data base for the entire system. The data are downloaded to the system only once and then can be displayed in all modules. Major benefits of ERP systems include their flexibility and adaptability to the specificity of a given company. ERP system extend to form MRP II.

The system may offer the following modules:

— Business Planning – to create a general plan of company's activities.
— SOP – Sales and Operation Planning – to create the plan and schedule of manufacturing and sales in order to satisfy the requirements of the business plan. These plans provide the balanced values of sales, manufacturing levels and warehouse reserves in particular periods of time. These plans will be the basis for all operational plans in the company.
— DEM – Demand Management – to prognosticate and plan sales and confirmed customers' orders. The main aim is to determine the future demand levels and to update this value accordingly.
— MPS – Master Production Scheduling – to balance demand in terms of materials, production capacity and minimal reserves in relation to demand forecasts, approved orders, promotions.
— MRP – Material Requirement Planning – to schedule purchases, production and assembly operations with specified priorities for the supplies and production.
— Bill and Material Subsystem (supports management of materials) – to provide information about production orders, supply orders and priorities in this respect.
— INV – Inventory Transaction Subsystems – supports the evidencing of inventories, provides information about available reserves.
— SRS – Schedule Receipts Subsystems – to control the receipt of supplied elements and manufactured products, including those pre-planned using MRP and MPS.
— SFC – Shop Floor Control – to pass information about the production priorities between those responsible for planning and the factory floor personnel.
— CRP – Capacity Requirement Planning – to check whether the production and sales plans and schedules are feasible.
— Input/Output Control – supports the control of production capacities and can be used to control queues at each workplace, input and output levels on each workplace.
— PUR – Purchasing – this function supports the activities associated with purchases of products and services from suppliers to make purchase orders or supply schedules.
— DRP – Distribution Resource Planning – supports the scheduling of moves between various points of the distribution network and planning of inter-plant production.
— Tooling – supports the control of accessibility of special tools to ensure that the production plan should be executed.

— Financial Planning Interface – to enable the downloading of the financial data from the MRP II sub-system, data processing and data transmission to those responsible for financial planning.
— Simulation – allows us to evaluate how variations of MRP II components should affect the financial plans, material requirements, production capacity.
— Performance Measurement – providing ongoing control of the MRP II system efficiency. That is associated with formulation of goals to be achieved and checking whether these have been achieved.

Well known manufacturers of ERP systems are: SAP (my SAP Business Suite), ComArch (CDN XL), Heuthes (ISOF), Oracle (JB Edwards) and others (Baan IV, TETA_2000, Exact, BPCS, Movex, KAMELEON 2000, IFS, MFG/PRO).

Systems supporting DSS decisions are information systems providing information about a given field using analytical decision models, with the access to a database to support decision makers working in complex environments. Such systems include: PMS – Portfolio Management Systems, IRIS – Industrial Relations Information, IFPS – Interactive Financial Planning System, ISSPA – Interactive Support System for Policy Analysis, IMS – Interactive Marketing System, QSB – Quantitative Systems for Business – Decision Support Systems, CMMS – Computer Models for Management Science, VISA – Visual Interactive Sensitivity Analysis for Multiple Criteria Decisions Aid, DSSMS – Decision Support Systems for Management Science, QMwin – Quantitative Models for Windows.

ESS systems utilize the state-of-the-art. solutions in the field of IT to create the most comfortable conditions for decision-makers- members of top management. ESS – class systems help the managers to monitor things, at the same time focusing on company's operations and efficiency instead of optimization of individual decisions. Dedicated for that purpose are extended systems of questions and individual reporting as well as advanced communications tools. ESS class systems include: RediMaster, Easel, EIS-EpiC, HOLOS, FOCUS/EIS, EIS-TRACK, Express/EIS, GURU, EISTool/Kit, EIS Solution.

The interrelationships between these types of systems are shown in Figure 4.

Numerous computer systems are available that support business management at various levels of the organization and management of the company's fixled assets (and hence the means of production) becomes just one module of an integrated information platform.

The structure of the coal mining sector in Poland is heterogeneous. Mining companies, such as Kompania Węglowa, Katowicki Holding Węglowy, Jastrzębska Spółka Węglowa, Rybnicka Spółka Węglowa are organizations grouping several once-individual mines, or in some cases single mines form independent business entities. Experience earned in one of the mines might be easily transferred to others, because individual mines and mining companies are actually state-owned.

To facilitate and optimize the management of mobile means of production (continuous miners, shearers, belt and chain and flight conveyors and powered supports -s they vastly contribute to the operating costs), there is an urgent need to create an integrated information system for mining companies.

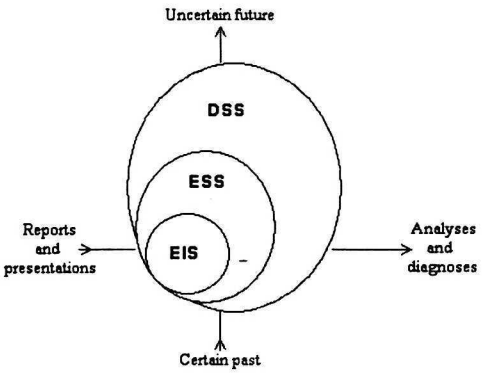

Fig. 4. Interrelationships between EIS-ESS-DSS class systems (authors' own sources, based on Bielecki 2005)

Rys. 4. Zależność pomiędzy systemami klasy EIS-ESS-DSS (opracowanie własne na podstawie Bielecki 2005)

Programs mentioned in previous sections have never been implemented in the coal mining sector yet (dedicated software was applied in KGHM Polska Miedź (Polish Copper Corporation) by SAP) and they are not tailored to the specificity of the coal mining sector. Attempts were made in COIG S.A. (MZZ system) to create an integrated information system to manage a multi-plant company whereby individual modules were developed to support fixed assets management (MZZ – Inwestycje, MZZ – Remonty (Repairs), MZZ – Awarie (Failures), Szyk/Maszyny 2.

The MZZ platform integrates several information programs (for example: FK, eRU), at the same time enabling the analysis of available data in a manner facilitating their effective utilization.

The program – module SZYK/Maszyny 2 is aimed to integrate data gathered from various fields of company's operations to facilitate the recording and status analysis of the available means of production through:

— downloading the data on new machines, taking into account their sub-assemblies and parts, ascribing machine parameters and features,
— changing the structure of introduced machines,
— grouping of machines,
— adding machine drawings with specification of major components,
— assigning the workplace for machines in accordance with the KSO file, checking the time history of a machine operation as well as other machines commissioned to work at the given place in a specified time,
— downloading the data and monitoring of machine life phases (production, repairs, removal), tracking of their time history,
— monitoring the failures of machines, groups of machines, sub-assemblies and parts – data from the system AWARIE,
— other failures (data from the system AWARIE).

Modules MZZ-Inwestycje and MZZ-Remonty utilize data from various information systems, and like other MZZ modules, enable the cost analysis (with categorization of costs) borne in connection with specific tasks and orders, as a part of investment activities and repairs.

Systems developed by COIG S.A. were aimed to facilitate book-keeping, hence their applications to the control of the means of production are rather limited.

An integrated information system for the management of means of production should enable:

a) sharing information on technical and organizational issues (advantages and disadvantages), potential adaptation of available equipment in similar geological conditions. This information should be available to all interested engineers, in all units of an organization;
b) control of management of the mining equipment within the given organizational structure (Corporation or Holding) to ensure its optimal utilization (equipment might be transferred from one mine to another). The system provides information about the accessibility and availability of the relevant equipment;
c) evaluation (and forecasting) of financial performance in the future associated with decision options relating to the location of the mining equipment, or necessary purchases (loans) of the required and not available equipment.

The system ought to incorporate the following elements:

— database about the available means of production (technical data, costs, organizational),
— location of workplaces where machines and facilities are placed,
— future production plans,
— module to enable effective use of available assets, extended to include optimization procedures and mathematical functions to evaluate the efficiency of fixed assets management.

Each element of the system ought to comprise several modules interacting within a platform, to give a full picture of the status of resource management at the same time supporting the management function on all levels within the company.

This software is particularly difficult to create because of specificity of internal conditions in a mining company:

— production process where the product (sometimes even without preliminary treatment) is extracted directly from the deposit,
— mechanization of production,
— deployment of costly machines and facilities, time-consuming jobs and tasks.

To create an effective systems to support resource management in a mining company, all these aspects have to be taken into account, as they might determine the functionality of such software.

Summary

Management of company's means of production requires that the basic data be available on available resources, their deployment and efficiency of their use. Effective management of resources should be supported by an integrated information system to assist in decision--making on the level of individual mines and mining companies, The study outlines the concept of an integrated information system to support decision making in the area of resources management, formulating the conditions that such a system ought to satisfy.

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JAN JASIEWICZ, ROMAN MAGDA, EDYTA BRZYCHCZY, STANISŁAW GŁODZIK, TADEUSZ WOŹNY

ZARZĄDZANIE ŚRODKAMI PRODUKCJI W GÓRNICTWIE WĘGLA KAMIENNEGO Z WYKORZYSTANIEM ZINTEGROWANEGO SYSTEMU INFORMATYCZNEGO

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 koncepcję zintegrowanego systemu informatycznego wspierającego podejmowanie decyzji w zakresie zarządzania środkami produkcji. Sformułowano warunki, jakie winien spełniać proponowany system.