

Application of information technology to improve the management of mineral resources in Quang Ninh province - Vietnam

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Abstract. The current mining operation of mineral resources in Quang Ninh province-Vietnam is increasingly complicated. Correspondingly, the management of the mine sites becomes more difficult. Records and documents of minerals and mine sites are archived in different forms. Database systems are stored dispersedly and insufficiently; in many cases lack accuracy, topicality and have not been linked to each other systematically. These lead to many difficulties in accessing and extracting information for the implementation of management as well as for investors and people with related interest. In this paper an advanced software has been developed for the management of mineral resources and has been applied for Quang Ninh province. The software has improved the supervision and administration of the mining operation in the province.

1. Introduction

The development of Information Technology (IT) has profoundly changed the economy, culture and society of many countries including Vietnam. IT has been applied in various fields, promoting the economic development, transferring the economic structure and altering the social structure. It contributes to creating more professions, deeply changing the modern industries, improving the competition of traditional industries through assistant systems such as telecommunications, electronic commerce and multimedia services. Many developing countries in the past successfully improved and utilized IT and achieved great developments such as India, China and Korea. It is noted that the application of IT in the world are mostly limited to education, secure and military sectors. Applications in the management of mineral resources are modest and highly manual. The management files and documents are largely stored in hard copies, map files in AutoCAD, MapInfo, MicroStation, and soft files such as PDF, Word and Excel documents. Database systems are archived dispersedly and insufficiently; in many cases lack accuracy, topicality and have not been linked to each other systematically. These cause many difficulties in accessing and extracting information for execution of management and for investors and people with related interest.

In Vietnam, the operations of mineral resources in large scale and under strict administration from the government are mainly located in Quang Ninh province which owns abundant and diversified mineral resources. How to manage, protect, extract and

utilize these resources more properly, economically and efficiency is an urgent demand for the sustainable development of socioeconomic issues in this province.

Statistics from Quang Ninh Environment and Natural Resources Department indicate that in total there are 243 mines extracting 33 minerals of 6 different categories in this province. The raw productions per year are more than 1.4 million cube meters of limestone building materials, 474.000 cube meters of clay products, 79.000 tons of sand-soil building materials, 6.5 million tons of limestone cement, 1.3 million tons of clay cement, 76.000 cube meters of mineral water, 40 million tons of coal and 2000 tons of other minerals [1]. The mining and processing operations are being expanded that contribute to creating thousands of jobs for residents and promoting the socioeconomic development of Quang Ninh. However, the booming development of mineral operation has considerably impacted living environment such as air and water pollutions. Many mine sites do not strictly conform with the approved design that consequently causes waste of resources. The illegal mining operations sometimes remain uncontrolled that may trigger security problems. Some operators do not apply the management appropriately, obey rules and they lack administrative ability.

When the forth industrial revolution commences, it will be the revolution of connecting things, internet of services, etc. It greatly impacts the domestic economy, official government and especially mining companies with many unskilled labors [2]. IT can be a highly feasible solution for these above problems in Quang Ninh and for the management of mineral operation in general. The application of IT is expected to improve ability of governmental administration; reduce tasks processing time; better support for archive, search and processing applications in the mineral sectors. This paper presents the development of an advanced software for these requirements.

2. Fundamentals and database

2.1 Fundamentals for development of database and software

The development of database and management software has been implemented in compliance with the designated procedure attached in Circular 26/2014/TT-BTNMT promulgated by Vietnam Ministry of Natural Resources and Environment (MONRE).

Checking, editing and presenting specialized maps of Quang Ninh minerals has been implemented in compliance with the designated procedure attached in Circular 37/2011/TT-BTNMT promulgated by MONRE.

Geographic Information System (GIS) is an advanced technology that is being applied widely in developing database of natural resources and environment. Once completed, the system easily shares and connects to other systems of natural resources and environment. The applied modules in the software are as follows:

- GIS (ArcGIS Desktop) for editing and presenting specialized maps; building and updating database,
- WebGIS (GIS system distributed through network) for online distributing and broadcasting geographic information through internet.

Program applications are developed on web-based technology with client-server protocol. The management, storage, sharing and security are performed quickly and efficiently. The working environment is multiform, and the interface is friendly in both Vietnamese and English. The programming language is common (Java, VBA, SQL) which eases the maintenance, exploitation and development of the software.

2.2 Development of mineral resources database for Quang Ninh

The following information is included:

- General data of mineral resources in Quang Ninh,
- Data of areal distribution of mineral resources in Quang Ninh,
- Data of operating mines,
- Data of administrative offices and person or companies working in the industry,
- Other data (e.g., annual reports from companies and governmental offices).

The development of mineral database for Quang Ninh is implemented in compliance with Circular 26/2014/TT-BTNMT. The procedures are as follows [3]:

- Check and analyze the data collected,
- Design a database model,
- Create data of category and super data,
- Create data of database,
- Edit database,
- Test final project.

Objectives of management are shown in Table 1.

Table 1. Objectives of management in mineral operation.

Order	Name of objective	Description
1	Administrative division	District, Province/City, Ministry
2	Unit running mineral operation	Organization, company and individual participated
3	Information of mineral	Information on governmental planning, authorization, state of mining, photos
4	Areal distribution of mineral	1. Zone in operation plus sparsely distributed area 2. Zone of prohibited mineral operations 3. Zone of provisionally prohibited mineral operation 4. Zone of nationally reserved minerals
5	Mine site	Mines are being operated and not yet operated
6	Specialized map of mineral	Specialized maps of minerals in Quang Ninh
7	Report of mineral operation	Sample reports of annual mining operation
8	Legal document	Legal documents of mineral and mining operation

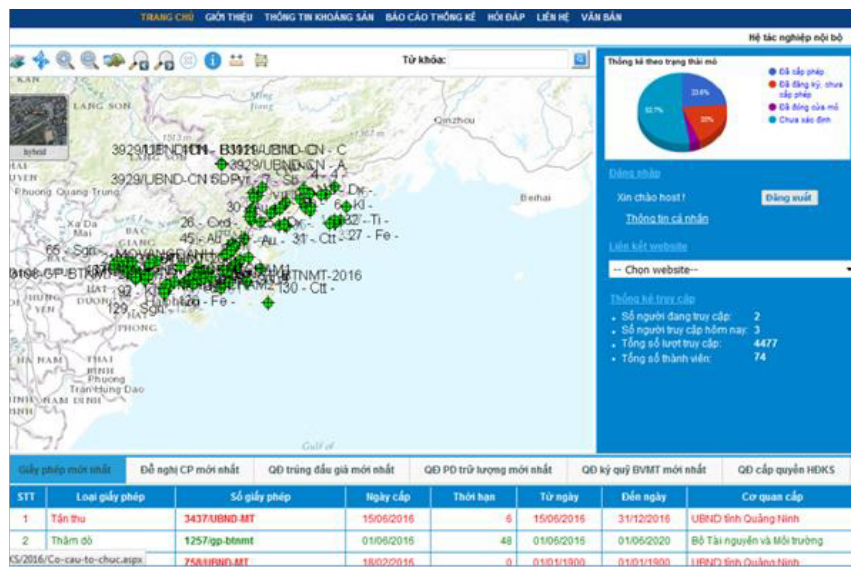


Fig. 1. Software interface: objectives of management.

3. Software for management of mineral operation

3.1 Computerization of management skills and process

The skills and processes are computerized as follows:

- Management of prohibited and provisionally prohibited mining operations; to determine zones not for auction of mining right authorized by the provincial people's committee; to consult and propose measures protecting unmined minerals; to schedule and run auction of mining right authorized by the provincial people's committee after approval,
- Management of scheduling exploration, extraction and utilization of mineral in the province; to timely detect and report new minerals to the provincial people's committee and to MONRE; to appraise file of recognized norms estimating mineral reserves; to appraise file of reserves approval; to audit and inventory the reserves which can be licensed by the provincial authority,
- Management of appraising files for the authorization, extension, withdrawal and return of exploration license; files for transference of exploration right and mining right; files for return of a part of exploration and mining areas; projects of mine closure; files for auction of mining right licensed by the province; to appraise pre-authorization of mining right,
- Management of appraisal of reports on mineral exploration for common building material, peat and sparsely distributed minerals authorized by the provincial people's committee,
- To audit and inventory the approved mineral reserves and periodically report to MONRE; to periodically report on mineral operation in the province or irregularly report by request from the provincial people's committee or MONRE.

3.2 Administrative functions of software

The administrative function of the software is a tool extracting and searching information for the enforcement of governmental mineral management in Quang Ninh. The software provides functions to manage mineral area; to manage planning, exploration and extraction of mineral; to manage files of mining licenses; to make a statistical report on exploration and to inventory mineral reserves; to notify current status of mining operation [1]. The detailed functions are given in Table 2.

Table 2. Administrative functions of software

Order	Case of application
1	Functions: management of mineral areas Management of information of (1) prohibited mineral operation; (2) provisionally prohibited mineral operation; (3) non-auction zones for mining right
2	Functions: management of schedule, exploration, extraction and utilization Management of file of (1) mineral schedule, exploration, extraction & utilization; (2) recognized norms estimating mineral reserves; (3) approved mineral reserves; (4) administrative division & administrative levels; (5) objectives in operation.
3	Functions: management of records/files on mineral operation Management of file of (1) mineral exploration license; (2) mineral extraction license; (3) transferring mineral exploration right; (4) transferring mineral mining right; (5) mine closure project; (6) auctioning mineral mining right
4	Functions: management of reports on mineral exploration Management of report on (1) mineral exploration for common building materials; (2) peat exploration; (3) sparsely distributed mineral exploration
5	Functions: statistic and inventory of mineral reserves (1) Management of report on statistic and inventory of approved mineral reserves; (2) Management of report on periodic statistic and inventory of mineral reserves; (3) Management of periodic report on mineral operation; (4) Notification/warning of mineral reserves as time goes by; (5) Warning of mining capacity of mine sites; (6) Warning of mineral exhaustion of mine sites
6	Functions: management of system catalogue Management of (1) legal documents on geology & mineral; (2) catalogue of source; (3) catalogue of mineral groups; (4) catalogue of mineral types; (5) catalogue of companies; (6) catalogue of administrative divisions

4. Conclusions

The application of the software provides a channel for exchanging information between administrative levels; improves the coordination between governmental offices; and facilitates the governmental administration. The software timely updates current mining operation with high reliability. This acts as a fundamental source for domestic and international investor to evaluate their potential investment in Quang Ninh. The environment of investment is accordingly improved. The program plays a role in propagating and improving the community awareness on mineral legal policies, rights and duties of the people's committee and residents.

The software facilitates management of natural resources; timely updates information for authorities; reduces time and manpower in manual searching and summarizing information in periodical management; accesses and decreases cost.

Organizations and individuals easily and quickly access the authorized information on geology and minerals. They are supported with favorable conditions to catch up with general and detailed planning projects of Quang Ninh. Thus, they can reduce the risk of

making inappropriate decisions due to untrue or insufficient information. Finally, time and effort will be largely saved due to the exchange and reuse of data.

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