CBM-based integrated management information system design for mine construction enterprises

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Abstract

To solve existing problems in the management for mine construction enterprises, this research introduced the concept of CBM (Comprehensive Budget Management) on the basis of data and information demand analysis using enterprise management decision. Next, under the circumstance of project management, the market mechanism was introduced in mine construction enterprises, materializing the CBM-based integrated management information system design for mine construction enterprises. The system architecture encompassed six modules, namely, production progress management, project material management, mechanical and electrical equipment management, human resource management, integrated cost management and performance management. The system covered the integrated management information system for each process of the mine construction management. With the B/S structure, technological development approaches of this system consisted of UML modelling technique, dynamic configured technology, database design and implementation. The actual application of integrated management system in sample mine enterprises showed optimized enterprise management process and improved data processing proficiency, greatly enhancing the financial performance and competitiveness of mine enterprises.

Keywords: Comprehensive Budget Management (CBM); mine construction enterprises; integrated management information system; design and application

1 Introduction

CBM (Comprehensive Budget Management) enables enterprises to optimize the resource allocation, analyse, coordinate and control the budget implementation. Specifically, CBM facilitates the analysis, prediction and decision-making about sales and profits, production, costs, expenses and funds focusing on strategic targets of enterprises. The aim of CBM is to systematically and efficiently coordinate and implement business activities of enterprises [1, 2]. Chandler (1977) considered that CBM plays a crucial role in the maturing and development of modern business enterprises in the West [3]. CBM is widely recognized as a management system that greatly drives maturing and development of modern business enterprises, and a main method of internal management and control for enterprises. As stated by David Otley, CBM is one of the few management methods that can integrate all key problems in an organization into one system. Since the invention and application of CBM in enterprises like GE, Dupont and GM in America in 1920s, it has soon become a standard operation procedure of large business enterprises [4]. From the initial functions in planning and coordinating, CBM is now an integrated management tool that combines enterprise management strategies, enterprise control, motivation and evaluation [5, 6, 7]. Currently, CBM has become the core of management strategy of enterprises [8, 9].

With the gradual completing of China's market economy system, a fair market competition mechanism has been progressively established. Nowadays, mine construction enterprises are experiencing intensifying fair market competition mechanism [10]. The conventional business system based on administrative planning constrains the rapid development of mine construction enterprises to a large extent, and the restructuring of the business management structure of mine construction enterprises becomes inevitable [11]. The implementation of CBM based on project management becomes an irresistible trend of internal management for mine construction enterprises. Accelerating the restructuring of the management system for mine construction enterprises could facilitate the realization of competitive advantages in market and overall economic efficiency covering aspects like market scales, costs, prices and quality [12, 13]. From a general perspective, theoretical and application research on CBM among Chinese enterprises present the emphasis on planning and financial management. The systematical study integrated with business is limited [14]. The implementation and budgeting management demonstrates outcomes like insufficient science, seriousness and authority. The assessment outcomes could not be identified as relevant to the employees' benefits and compensation, and it is incomplete to establish feasible and effective incentive

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and restraint mechanism. Moreover, the budget management fails to motivate the initiatives of person in charge effectively, and various problems occur in the process of budget implementation like loosening budget constraints, formality in implementation and difficulty to realize expected management outcomes. The supportive role of the management information system on decisions of enterprise managers need to be further enhanced. Thus, based on the features of mine construction enterprises, the current extensive production mode can be reconsidered and changed because of its conflicts with the requirements of scientific management development for modern enterprises. Thus, it is of great significance to conduct scientific and systematic research on the production process, to integrate management information and to reduce production costs to the greatest extent based on information technology and the latest information management platform.

To this end, on the basis of analysis and summary of current CBM studies, this research introduced CBM in the mine construction enterprises, and integrated researchers' suggestions and experiences about improving internal management to combine CBM with distinct features of mine construction enterprises in China. A set of informatisation platform with project as the structural unit was also designed for mine construction enterprises. This research could provide effective guidance for mine construction enterprises to comprehensively and systematically implement CBM.

2 Features of the system

2.1 ANALYSIS AND RESTRUCTURING OF INFORMATIZATION-DRIVEN PROCESS

The principle of the optimization design for mine construction enterprises was to realize the restructuring of enterprise businesses under the collaboration of market chains and to materialize the optimal human-project combination and product/service performance. In this way, each process could directly serve for the project object. Besides, each basic decision unit was assigned with corresponding subsidiary autonomy, and the outcome of each process could be measured by currencies. This could further evaluate the quality, costs and benefits, and optimize the internal resource allocation via the structural integration, business process integration and resource integration. The optimization design facilitated the reduction of construction costs and the improvement of beneficial efficiency in enterprises.

2.2 SCIENTIFIC SYSTEM DESIGN AND COMPREHENSIVE FUNCTION INTEGRATION

This integrated management information system combined powerful remote applications and realized synchronous transmission for cross-regional management resource data in each project department, which would be analysed collectively in the central data bank. The advanced frame-based software technology ensured the flexibility, reliability and extendibility in the research and development. Distributed data processing of SQL Server and Internet/Intranet also promoted the centralized enterprise resource management. The all-informatisation management performed excellently in resource sharing, smooth information flow and intelligentised internal logistics, and materialized remote management and mobile support.

2.3 FLEXIBLE MODULE DESIGN AND CUSTOMIZED SERVICES

All functions of this system were designed on the basis of modules so that users could flexibly configure each module to their needs. The efficient data processing ability and complete data backup mechanism effectively reduced the network flow during data transmission, which shortened the system response time and guaranteed the effectiveness and accuracy of data. Users could easily operate the system after training.

2.4 ADVANCED TECHNICAL DEVELOPMENT SYSTEM AND GUARANTEED SYSTEM QUALITY

In the research and development of this system, strict process control was introduced for all internal units, and object-oriented UML modelling technique was applied in the design. In addition to the introduction of user-oriented design and UML-based depiction of all design models, RUP (Rational Unified Process) was introduced in the internal management for mine construction enterprises, which could guarantee the development quality and maintainability of the software system.

3 System structure design

This management information system improved the internal marketization for mine construction enterprises, their budget management, compensation management and implementation details of evaluation, and promoted CBM for mine construction enterprises. A range of modules were provided by the system, including production progress management, project material management, mechanical and electrical equipment management, human resource management budget management, and integrated management statements etc., which is shown in Figure 1.

Internet was used as a support for the system to ensure the information exchange within enterprises. The system network architecture and hierarchical structure is shown in Figure 2.

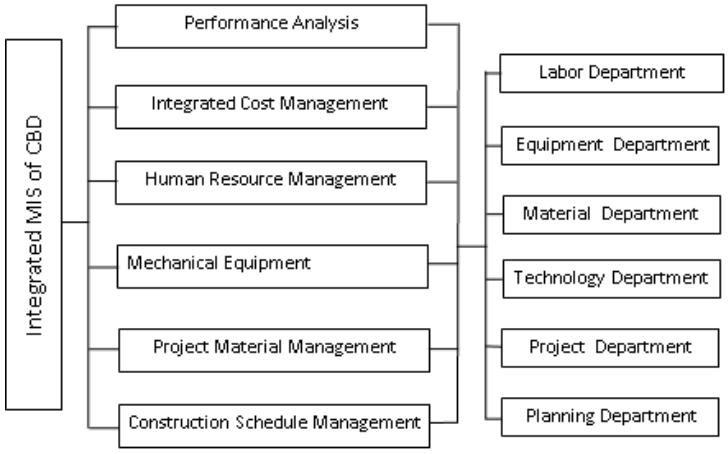

FIGURE 1 System structure diagram

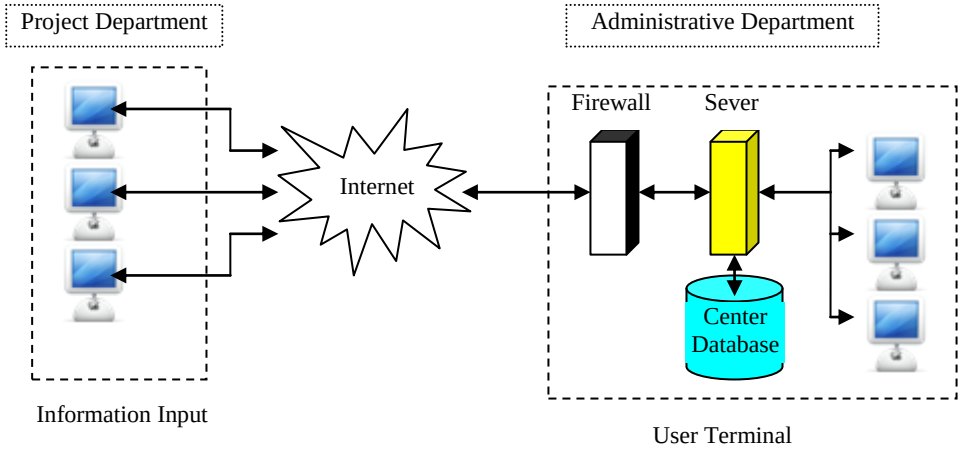

FIGURE 2 System network structure

4 Main modules and functions of the system

4.1 CONSTRUCTION SCHEDULE MANAGEMENT

The production progress management for the Project Department encompassed the following parts: daily construction report management, original records of construction units and scheduling information query. This module automatically produced daily reports, weekly reports and monthly reports of construction schedules. By the comparative analysis with the plans, this module dynamically controlled the implementation scheduling. Functions of this part were as follows.

4.2 PROJECT MATERIAL MANAGEMENT

Project material management covered material information, warehouse location, inventory / loss reports, material allocation / storage, cargo-dropping management and material information query. This module automatically formed dynamic statements of material statistics for the Project Department.

Functions of this module included stock material input, inventory and cargo-dropping, material inventory query, maternal balance query, monthly material statements and so on. The material plan management covered annual plans, monthly plans, supplementary plans, temporary plans and emergency plans. The material staff of each Project Department declared the above mentioned plans of material requirement and input the information in the system. The plans would be assessed by related departments. The system then collected all approved plans and formed the general plan of all material needs for construction enterprises.

The inventory input and cargo-dropping mainly registered the detailed stocking and cargo-dropping information. The data was to take inventory of materials. The material inventory and balance conditions referred to the statistics of all materials in the warehouse. The function gradually collected material statements of the Production Project Department and complete monthly material statements for the enterprises. The statements would be output according to the requirements to form the material costs in the expenditure part.

4.3 MECHANICAL AND ELECTRICAL EQUIPMENT MANAGEMENT

Based on the inventory analysis of mechanical and electrical devices, equipment coding was conducted to produce a variety of statements for integrated query of mechanical and electrical devices, basic information of devices, inventory and cargo-dropping management, device repair and acceptance, device allocation and management, usage monitoring, equipment scrapping management and device disbursement and settlement. The module functioned in effective and comprehensive management of all static and dynamic information in the full life circle of devices. Device status and distribution at different work sites were dynamically tracked, which presented accurate records, tracking and controlling of device-related processes, such as device purchasing, rental, examining, repairing, maintaining, and allocation of spare parts. Scientific and orderly management of devices could fully meet the production requirements, and provide proofs for direct expenses on mechanical devices in the cost management.

4.4 HUMAN RESOURCE MANAGEMENT

The module of human resource management is mainly provided freely to set enterprise's organizational structure. Under CBM managerial frame, information of functional departments and the project department such as basic information of employees, academic background, resumes, archives, contracts and other information were systematically integrated. This module also provided simple and direct logging in, query and modification. The employee attendance management recorded the attendance of each work shift of each construction teams and groups, providing a basis for labour costs in performance evaluation.

The module was founded on human resource planning and management, covering aspects like institutional framework, positions, human resource management, labour contract, recruitment, benefits, training and development, attendance and performance appraisal and remuneration. Meanwhile, this system could promote the automation and optimization of HR management process in an all-around way. Its primary functions included employee information management, compensation management, performance appraisal and management, labour management etc.

4.5 INTEGRATED COST MANAGEMENT

Integrated cost management module realized plan management of costs on material, labour, mechanical devices, and other items, and analysed the implementation of budget plans. The budget management sub-system realized budget management at all levels. With the logging and maintaining of cost items, a budget data platform within enterprises including specialized market items, specialized items, project budget of construction groups / teams. This module conducted data collection and analysis of device rental conditions. According to expenses of using construction machinery in projects, the overspending and surplus conditions of machinery costs could be gained. The module also developed and tracked the implementation of material requirement plans, thus dynamically realizing the rational purchase/inventory and distribution controls of materials. Moreover, this module achieved real-time tracking and assessing material consumption at each basic unit (project departments and construction groups), integrated analyses of costs on materials and devices, and accomplished overall and individual costs of at each basic unit and timely uploaded the data.

4.6 PERFORMANCE ANALYSIS

This module integrated information of the above modules, formed a complete business summary sheet for mine construction enterprises, and conducted business analysis. The business analysis was targeted at enterprise business states of each project department and summarized business states according to years and months. Functional departments summarized and analysed specialized costs, overspending and surplus conditions of comprehensive costs and the specific reasons according to the uploaded information of costs. Lastly, it would form performance analysis statements.

(1) the Performance of Project Department

$$\mathrm{TR}_{pd} = \sum AUP * UBP . \tag{1}$$

In formula (1), TR_{pd} is total revenue, *AUP* is accepted unit projects and *UBP* is unit budget price of mine construction enterprise;

$$\mathrm{TC}_{pd} = (LC + MC + MUC) * ACODC * ACIC * ACLIE * ACT . \tag{2}$$

In formula (2), TC_{pd} is total costs of mine construction enterprise. *LC*, *MC* and *MUC* are the abbreviations of labour, material and mechanical usage costs. *ACODC*, *ACIC*, *ACLIE* and *ACT* are adjustment coefficients of other direct costs, indirect costs, labour insurance expenses and tax.

$$NP_{pd} = TR_{pd} - TC_{pd} \tag{3}$$

NP_{pd} is the net profits of each project department of mine construction enterprise.

(2) formula of Mine Construction Enterprise's Operational Performance

$$STR = \sum TR_{pd} + OI \quad (4)$$

Where *STR* is total revenue of mine construction enterprise and OI is other income.

$$STC = \sum TC_{pd} + OCAI \quad (5)$$

In formula (5), *STC* is total costs of mine construction enterprise and *OCTI* symbols other cost adjustment items.

$$NP = STR - STC \quad (6)$$

So, *NP* is net profits, which is key indicator of operational performance of mine construction enterprises.

Functions of this module include: (i)developing involved functions in function application requirements based on all technical, quality control, performance and other plan management indexes, designing cost plan sheets, plan management of cost items of individual item and unit project, forming settlement prices of projects and working procedures; (ii)when the unit price of materials and salaries was changed, the system could automatically recalculate the settlement price; (iii) it could also realize the comparative analysis with actual expense indexes, and analyse the quotas for overspending (surplus) of each item. With the produced variance report, enterprises could carry out corresponding management measures based on the data, thus greatly improving the precision and pertinence of CBM.

5 System implementation and application

5.1 TECHNICAL IMPLEMENTATION APPROACHES

According to the above systematic analysis and design concept, the system adopted the B/S structure, with Windows Server2008, Web server and IIS7.0 as its servers. SQL Server2008 was used as the back-end database. The operation system at the client end was Windows XP. For front-end development tools, VB.Net and C# were selected. With the networking protocol of TCP/IP, the system was designed to facilitate the connection with Internet. Key technologies included UML modelling technique, dynamic configured technology, and database design and implementation technology.

The system was an Internet-based system with Java Applet embedded. Applications were designed at the server end and the client's end only presented necessary system information, which guaranteed the security of procedure codes. The data confidentiality was protected by four levels of security control approaches from operation system, database and application to data operation. Besides, a secondary password technology operated by different roles and different managers was also applied, which enhanced the safety and reliability of data.

5.2 SYSTEM APPLICATION

CBM system has been used in 12 projects of mine construction enterprises such as No.4 Engineering Department of China Coal First Construction Company limited for over 2 years, and its performance was unanimously highly regarded by managers of these enterprises. The system greatly changed the extensive construction management mode of mine construction enterprises into a process starting from project analysis to budget decomposition, then to real-time dynamic input of integrated costs and feedback of business performance. This process not only better fit CBM-based construction mode but also improved the construction efficiency. The mine construction enterprises have witnessed great improvements in aspects like management performance, management mode, management system and methods, management mechanism, management foundation, business process, organization structure, rules and regulations, basic data, information integration and processing, employees' overall competence, decision-making quality, enterprise image and competition etc. At the mean time, the system boosted the innovation of project management.

6 Conclusions

In order to obtain competitive edges in the fierce market comp, mine construction enterprises need to maximize their values, save costs and keep precise profit and loss accounting. With the core of project costs, mine construction enterprises should develop their overall strategy, business strategy and business strategy and strategy, forming strategic budget management and establishing CBM. On the basis of project analysis, CBM adopts cost budgeting as the starting point, cost control as the principal axis of budget control, and costs as the principle indicator of performance evaluation. CBM could facilitate mine construction enterprises to build a new enterprise management system that fits actual conditions of enterprises, materializes orderly management, smooth operation and appropriate monitoring. Besides, it could clearly define responsibilities and rights and coordinates the internal production and business activities by the relationship of market transaction. With CBM, enterprises could minimize diverse forms of wastes and improve their competitiveness significantly.

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