CASE STUDY ON DEVELOPMENT AND APPLICATION OF INFORMATION MANAGEMENT SYSTEMS IN HIGHWAY CONSTRUCTION ENTERPRISES

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Keywords: Information management system (IMS), Highway construction enterprise, Case study.

Abstract: Due to the specificities in industry status, company characteristics and trends in development, the transportation industry needs information management systems more than any other industries and benefits most from such systems as well. However, in certain parts of China, management level and technological expertise fall behind the state of art. Therefore multiple problems rise in this field, including obstinately high cost, delayed information transfer, backward construction methods and wasting construction management. In order to propose effective solutions to the above problems, a case study is committed on the information management system construction of a highway construction enterprise in north-western China. This paper presents the case study from five aspects, including cost control, project management, human resources, financial management as well as office automation. Through longitudinal study of the Enterprise's requirements derived from business management, rapid development and specificities of the field, key technologies as well as solutions has been proposed in the enterprise informatization process to utilize the core competitive power of the company, providing valuable references for similar enterprises.

1 INTRODUCTION

There are certain specificities in information construction solutions of highway construction enterprises due to industry status, company characteristics and trends in development, which are listed as follows:

- Most of the enterprises in highway construction industry are geographically distributed in large areas. Flexible transfers could be achieved among various project sites.
- Most of the enterprises are administered in form of groups. As branches and subsidiaries of these enterprises commit diverse business, they have numerous requirements when accessing the Information Management System.
- The distribution of the enterprises will be further decentralized as the enterprises participate in international competitions and undertake international contracts. They may need to cross multiple markets and switch in various engineering fields in the short term.
- The construction and production are frequently committed at the sites far from the group headquarters, thus logistics are complex and complicated.

Due to these specificities, the transportation industry needs information management systems (IMS) more than any other industries and benefits most from such systems.

However, in certain parts of China, management level and technological expertise fall behind the state of art. Therefore multiple problems rise in this field, including obstinately high cost, delayed information transfer, backward construction methods and wasting construction management. In order to propose effective solutions to the above problems, a case study is committed on the information management system construction of a highway construction enterprise in north-western China.

Enterprise A, as a large-sized road and bridge construction group in China, has 1,900 employees and administers 11 subsidiaries. In 2010, it had 48 projects under construction. However, as the scale of operational management expands and competition in market aggravates, the challenges to the original Information Management System gradually emerge, which include:

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- the existing methods of financial management, project management, cost control and office automation no longer meet the requirements of rapid company expansions;
- traditional work patterns cannot fulfill the needs of quick and intense information acquisition;
- the extensive management methods cannot satisfy the requirements of refined management.

Consequently, Enterprise A is urged to build a uniform information management platform to support refined management, business integration and efficient information transfer as well.

2 DESIGN AND APPLICATION OF INFORMATION MANAGEMENT SYSTEM IN ENTERPRISE A

In this section, the design and application of the information management system in Enterprise A will be presented. First of all, system architecture design of IMS will be introduced. Subsystems of the IMS, including cost control, project management, human resources, financial management as well as office automation will be presented afterwards.

2.1 System Architecture of Information Management System in Enterprise A

In the latter part, the system architecture of Information Management System in Enterprise A will be introduced, including application structure, business architecture, modular architecture and software architecture.

2.1.1 Application Structure of Information Management System in Enterprise A

Information Management System in highway construction enterprises is composed of five fundamental systems, including system infrastructure (networking platform and system), data platform (fundamental database), data acquisition platform(data interface), business application (enterprise integrated application) and information publishing (public service).

System infrastructure (networking platform and system) is the foundation of Information Management System Construction. It contains network devices, communication links and database servers as essential network supporting equipments.

Data platform (fundamental database) contains data storage facilities, both software and hardware. For instance, database system and operating system are included.

Business application (enterprise integrated application) is comprised of business integrated, namely, financial management, overall budget control, progress control, quality control, personnel administration, rewarding and punishing administration, telemonitoring, cost control, contract management, material and device management, limit order management, personal administration, salary management, evaluation and assessment administration and remote attendance management.

Information publishing (public service) integrates modern media like websites and office automation systems. It provides convenient, efficient and effective communication channels for advertisement, enterprise notice as well as administrative examination and approval.

The application structure of IMS is presented in Figure 1.

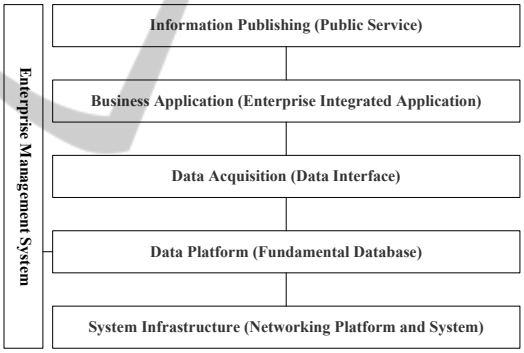

Figure 1: Application Structure of Information Management System in Enterprise A.

2.1.2 Business Architecture of Information Management System in Enterprise A

The business architecture is demonstrated in Figure 2.

2.1.3 Modular Architecture of Information Management System in Enterprise A

Figure 3 presents the modular architecture of the IMS.

2.1.4 Software Architecture of Information Management System in Enterprise A

Figure 4 presents the software architecture of the IMS.

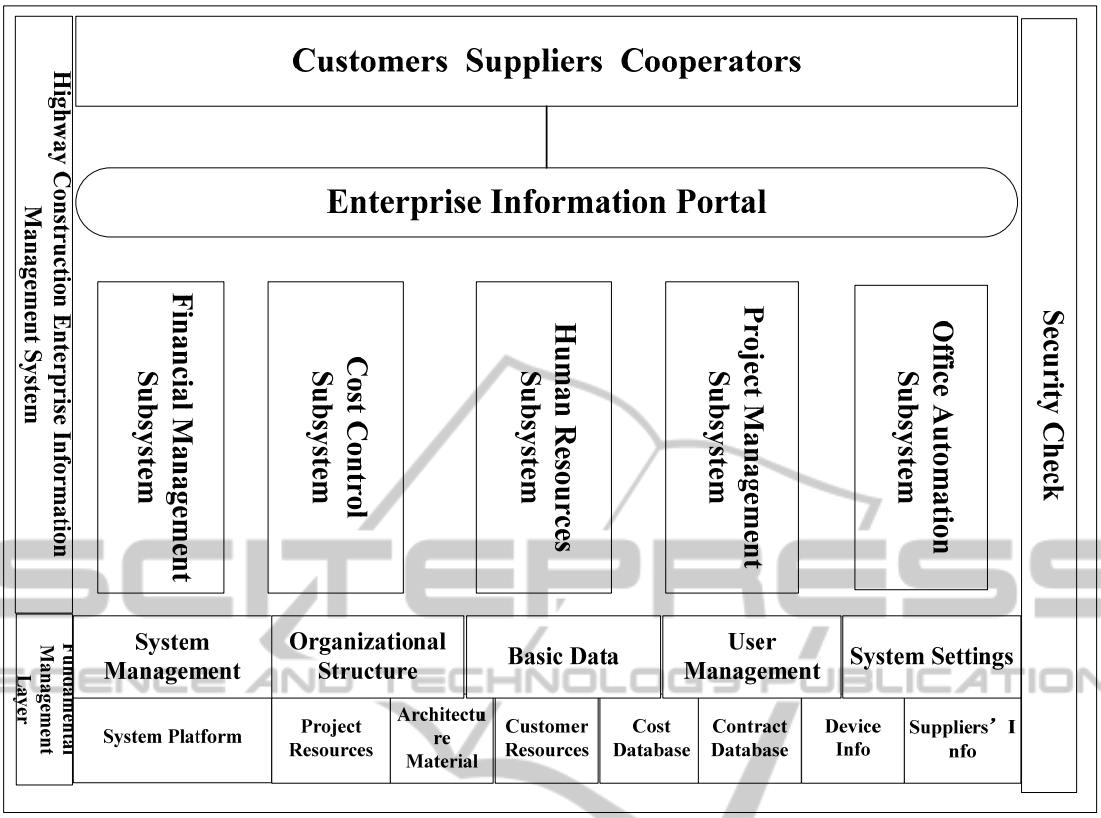

Figure 2: Business Architecture of Information Management System in Enterprise A.

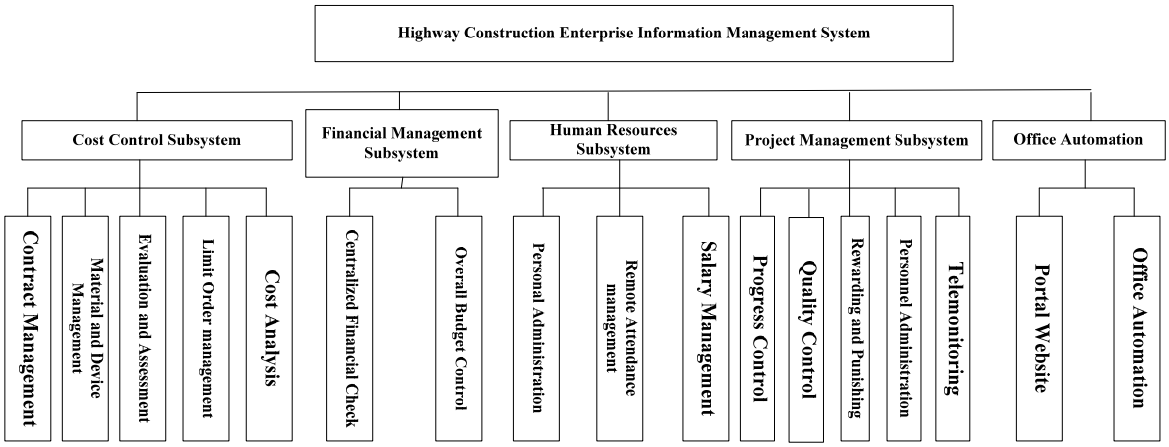

Figure 3: Modular Architecture of Information Management System in Enterprise A.

2.2 Development and Application of Cost Control Subsystem in Information Management System

Through in-depth study of cost control in Enterprise A, according to activity-based costing, a bicirculating cost control model is proposed in consideration of the enterprise's specificities.

On the level of project management, project control benchmark is built based on contract management, target cost and planned cost.

The cost will be broken down according to the dimension of time, resource categories and project components. During the project, cost control will be committed through the circulation of cost prediction-effect evaluation-benchmark adaption.

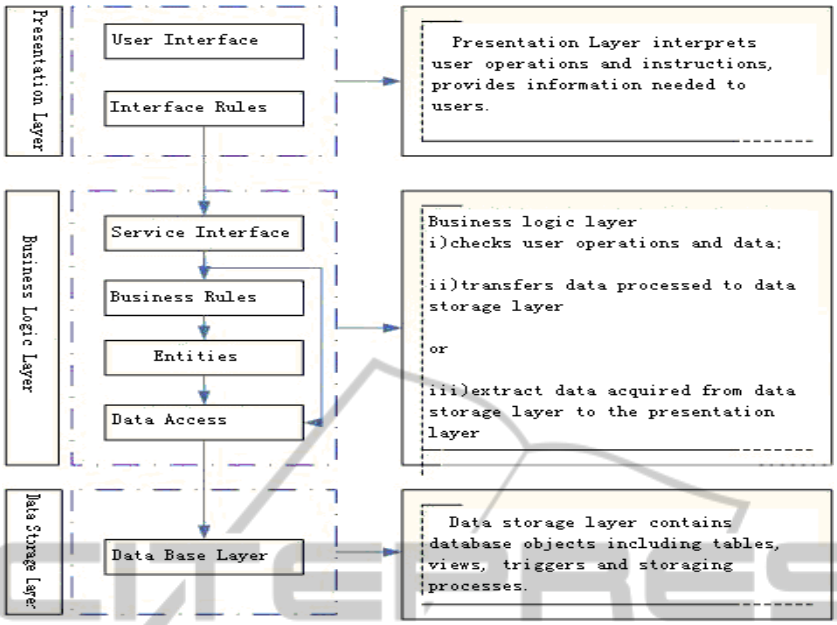

Figure 4: Software Architecture of Information Management System in Enterprise A.

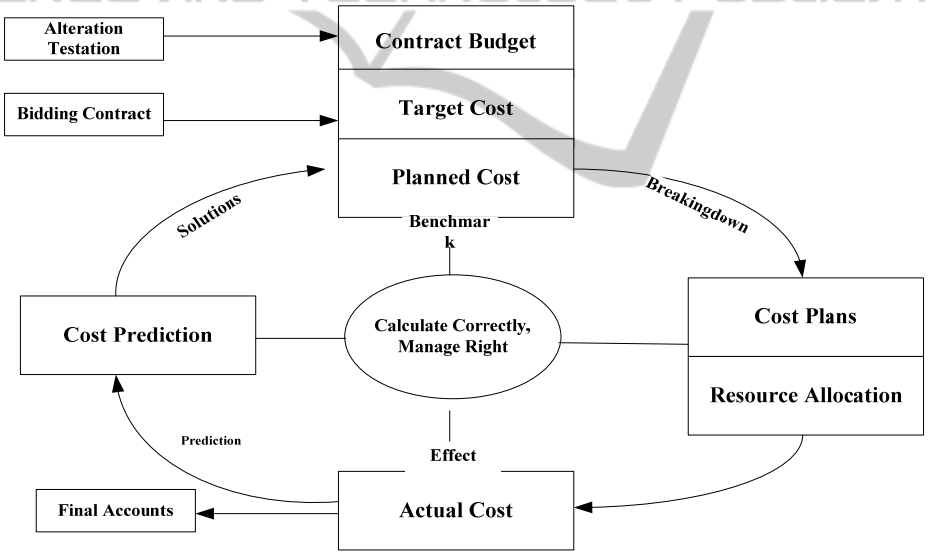

Figure 5: Cost Control Subsystem of Information Management System in Enterprise A.

The aim is to help the administrators calculate correctly, manage right and manage well.

On the level of enterprise experience, previous business data will be abstracted into management indexes, providing instructions for the biding and construction procedure.

These two steps will comprise a general circulation in the enterprise, continuously improving cost control.

The design of cost control subsystem is demonstrated in Figure 5.

2.3 Development and Application of Project Management Subsystem in Information Management System

As core of business management in highway construction enterprises, project management impacts upon the whole enterprise. Serious analysis of existing problems in project management and exploration of improving methods are the key issues.

2.3.1 Project Management Subsystem Modules

Project progress management contains plan report from each project department, engineering calculates report as well as engineering image report. The department of project management commits statistics and analysis to obtain overall management of project progress.

Project quality control is responsible for quality management during the construction process, including experiments and detection of material, end product and intermediate products; examination and experiments of mixture proportion and mixing control; testing and recording of quality control factors; collection, integration, analysis and feedback of quality information such as non-conforming products control records.

Personnel administration collects, selects, evaluates and manages labour information, raising project profits to ensure continuous development.

Rewarding and punishing administration timely collects relevant information from project departments, providing prompt feedback and urging quick responses to improve customer satisfaction.

Telemonitoring system leverages wireless video devices to monitor crucial project progress and quality at the scene. In order to make sure the construction of critical tunnels, huge bridges and precast plants can be constructed under complete control, 24 hours of project sites monitoring via wireless broadband devices and wireless communication network is implemented through real-time transfer of video images at key project sites. The Telemonitoring system is presented in Figure 6.

2.4 Development and Application of Human Resources Subsystem in Information Management System

The human resources subsystem will be introduced in this section, especially, system modules.

2.4.1 Human Resources Subsystem Modules

Human resources subsystem utilizes communication technologies to build standardized, normalized and networking platform for human resources management. In addition to meet basic needs of HR department, it contributes to cost reduction and efficiency improvement.

Human resources administration includes employee information management, attendance management, salary management and document management.

Employee information management collects and updates employee information in enterprise.

Salary management digitized salary information.

Attendance management uses finger print attendance management machines. The system applies bio-individual identification, networking and automatic statistics technologies. The attendance management system is demonstrated in Figure 7.

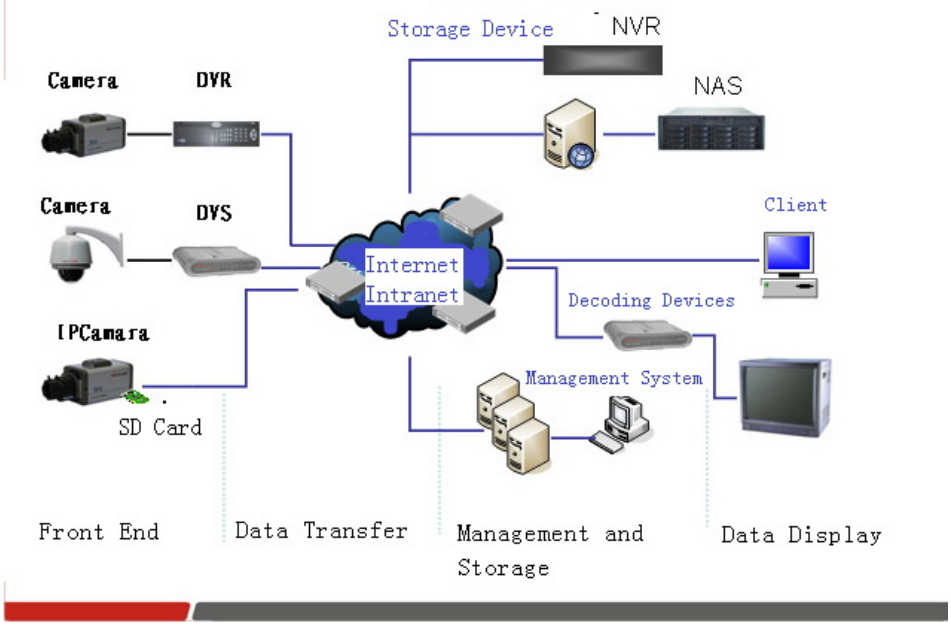

Figure 6: Telemonitoring of Information Management System in Enterprise A.

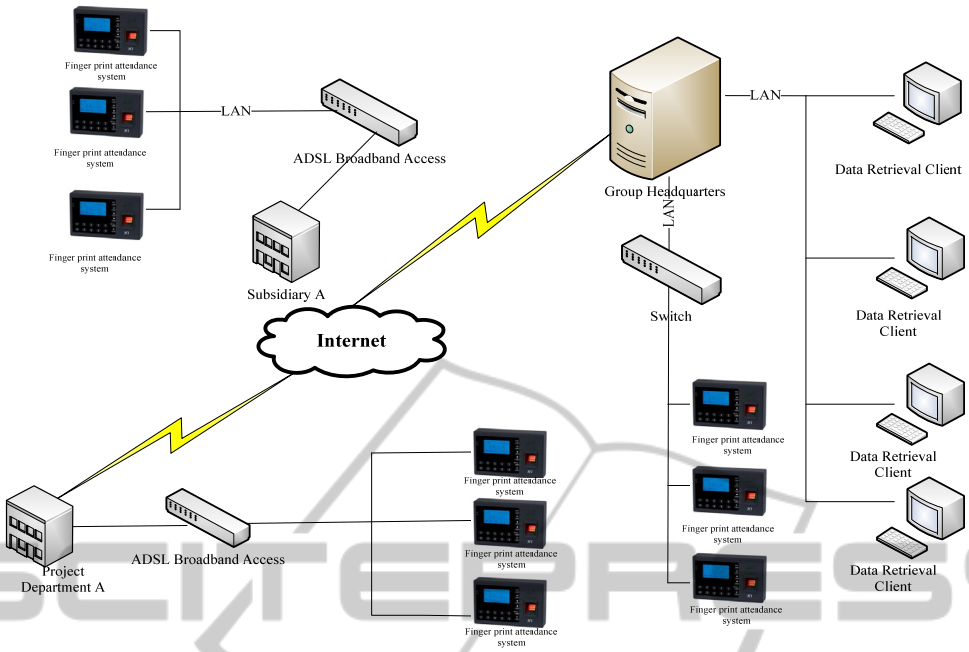

Figure 7: Use Case of Remote Attendance Management System.

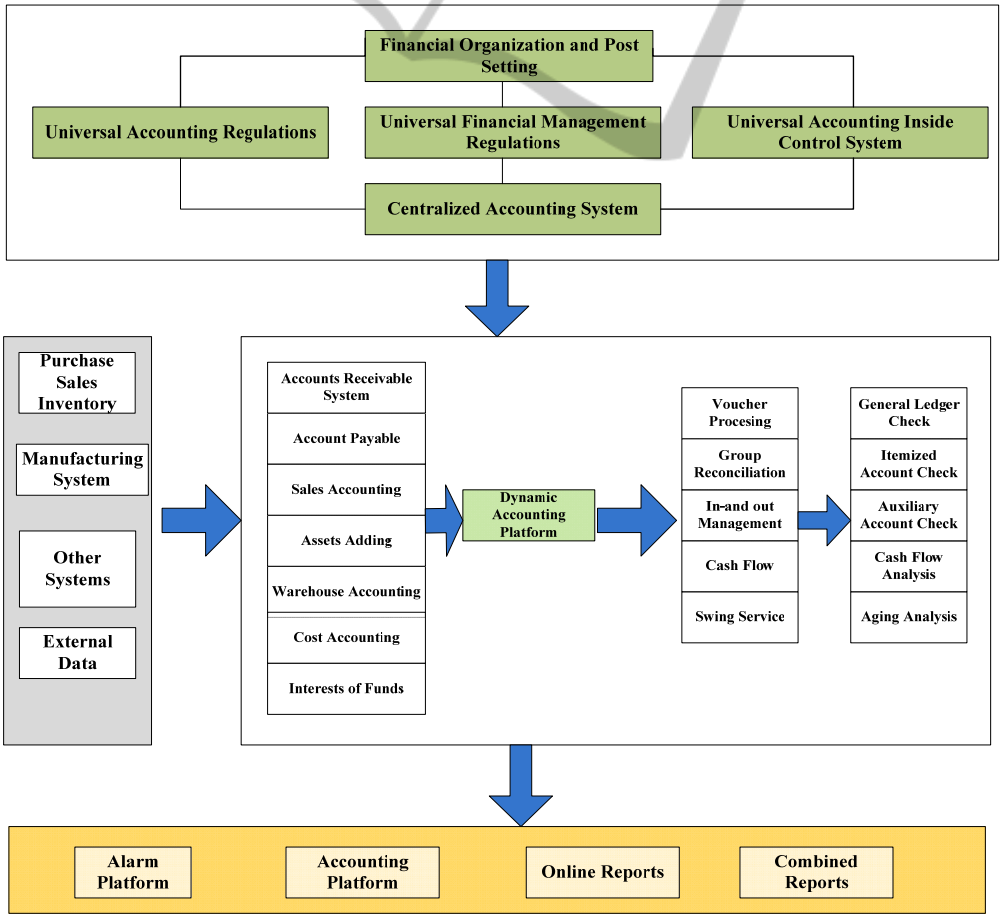

Figure 8: Business Architecture of Centralized Accounting System.

2.5 Development and Application of Financial Management Subsystem in Information Management System

Financial management system combines networking and information technologies with traditional accounting operations, builds centralized accounting platform according to accounting regulations. It normalizes basic data and integrates accounting system and business system, realizing overall budget control.

2.5.1 Application Architecture of Centralized Accounting System

Figure 8 charts the business architecture of centralized accounting system.

2.5.2 Application Architecture of Overall Budget Control System

Budget control commits overall budget estimation based on ERP system, thus budget data can be derived from business modes and historical data, addressing the difficulties of manual processing large volume of data in long-term based on complicated analyzing model. Meanwhile, according to the actual operational modes, budget model can be chosen among overall budget, accounting budget and specific budget. Nevertheless, choices of deploying distributed or centralized application can be made according to budget application modes.

Budget control includes budget planning, budget collection and approval, budget execution and monitoring, budget adaption as well as budget executive analysis. Each responsible department and enterprise' budget formation strictly conforms to the regulation of authority and data uniqueness. Thus completeness of enterprise budget planning is ensured and multi-layer budget control is established. Meanwhile, the statistics of budget facilitates timely strategic adjustment in group, providing references for rolling budget or next-term budget. The application architecture of overall budget control system is presented in Figure 9.

2.6 Development and Application of Office Automation Subsystem in Information Management System

The design of office automation subsystem will be introduced in this section.

2.6.1 Design of Office Automation Subsystem

The office automation system aims to build competent, stable and reliable information resource sharing channel to assist collaborations in enterprise. The design contains:

- construction of internal collaboration platform;
- building information publishing platform;
- automation of working procedure;
- knowledge management;

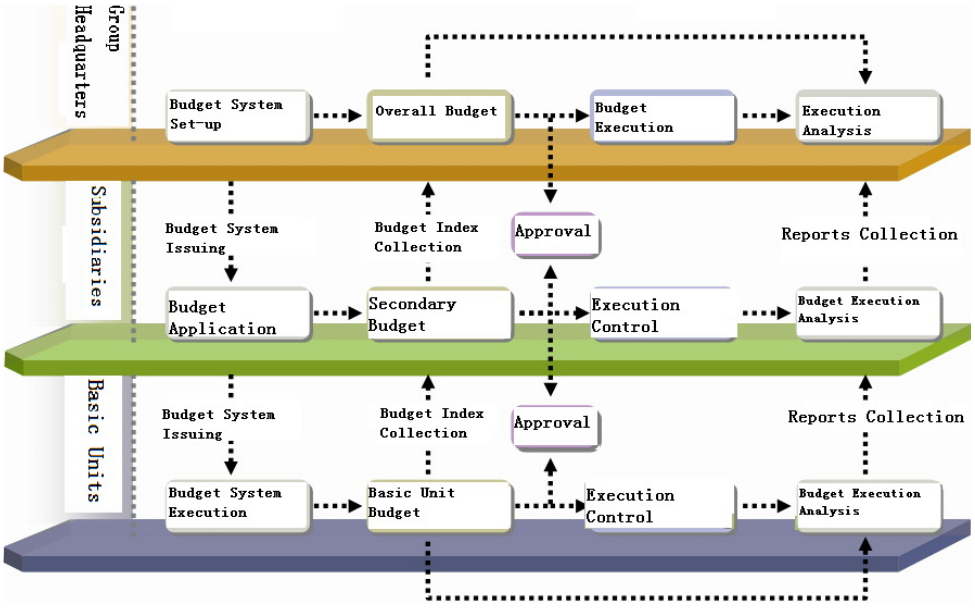

Figure 9: Application Architecture of Overall Budget Control System

- automatic transaction management, e.g., conference management;
- information integration
- distributed working.

3 KEY TECHNOLOGIES

Major considerations of choosing key technologies applied in information management system construction include well fitting existing management modes and cost-effectiveness. The project departments of Enterprise A are geographically distributed in China, requiring distributed applications. Meanwhile, Browser/Server architecture turns out to be a ripe technologies meeting the requirements to realize advanced management design with high efficiency. Major architectures applied are J2EE and .NET, each with its own advantages. In consideration of cost and efficiency, .NET is the choice option.

3.1 Application System Deployment Pattern

Enterprise A has two project management modes: direct management by group and self-administration by subsidiaries or branches. The operational modes and organization structures are similar within the group, thus the information management system applies completely centralized deployment pattern.

The characteristics of the centralized pattern are highly integration of business and data, as well as strict requirements on network access performance, security and reliability of server. Figure 10 presents the deployment of the applications in the information management system.

3.2 System Interface

The information management system is developed using WEB-based architecture and Microsoft SQL Server. .NET is used as application development tool. During the development, Object-Oriented principles are strictly followed. Component based methodology is used with focus on technical infrastructure. With the application of Web Service technologies, further development and third part application integration can be achieved. The design of system interfaces is demonstrated in Figure 11.

Web Service leverages standardized Web Service Description Language as interfaces to clients on Internet/Intranet.

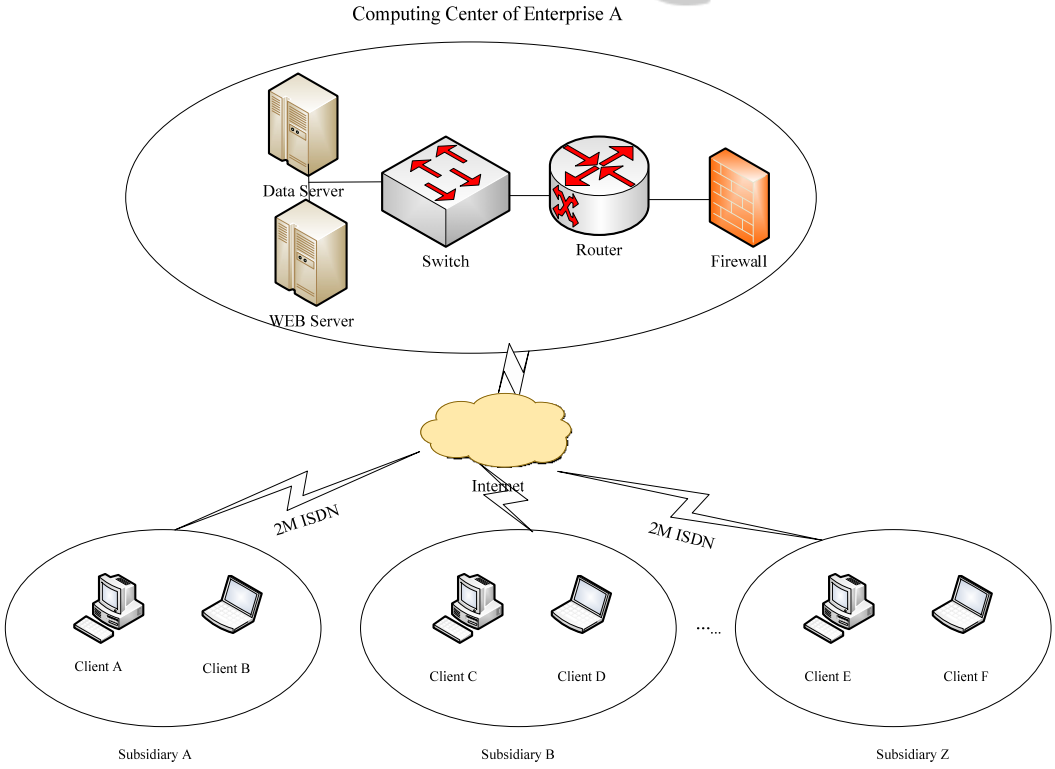

Figure 10: Application System Deployment.

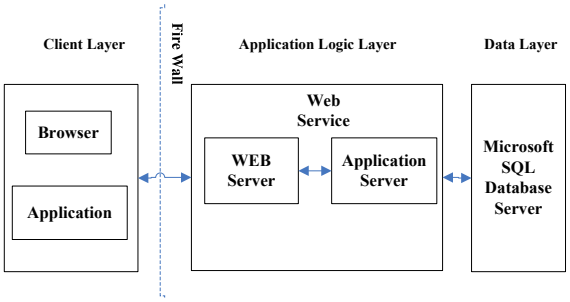

Figure 11: System Interfaces.

4 CONCLUSIONS

Construction of the Information Management System studied in this paper fills in the blank of research on information management system in Gansu province, P.R. China. It may effectively guide information construction of similar highway construction enterprises. Since the information management system has been put into use since 2009, the contract fulfilment rate reaches 100% and material amount has been taken under control, which implies that the "calculating correctly and managing right" goal is achieved. The case study suggests that the construction solutions of the information management system are sound and applicable. Moreover, the system architecture is reliable. The whole information management system has satisfied the actual demands of the enterprise, leaving sufficient spaces for future expansion.

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