



# WORKFLOW SYSTEM DESIGN FOR NEW ENERGY PROJECT ORIENTATED COMPANY BASED ON PROJECT CLUSTER

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## ABSTRACT

To respond to the national call of the development of new energy, each state-owned electric corporation and even the private investors, take this opportunity to invest new energy projects and set up new energy project companies to manage the projects cluster. The main problem of management is how to reduce cost and promote efficiency and enhance the core competitiveness of enterprises. Some electric corporation have many new energy projects scattered in different distributes, and the project management process is more complicated than single project management, increasing the management difficulty. To solve this problem, it is significant and necessary to establish the project management system in line with Chinese new energy enterprises invested projects management features based on project cluster management theory. In practical applications, the project cluster management system is not a single information system, but the integration made up of several information systems. This article focuses on workflow system design based on the new energy project cluster management theory, and makes it come true with a collaborative office system.

**Keywords:** *Project Cluster Management; Collaborative Office; Workflow*

## 1. INTRODUCTION

At present, as responding to the national call of the development of new energy, Huadian New Energy Development Co., Ltd. Gansu Branch (which will be referred to as Company afterwards) invests more than ten new energy projects in Gansu, to develop and utilize the six clean energies gradually, which are wind power, solar power, distributed energy, hydropower and biomass energy. With projects widespread in Gansu, the Company's project management flows are complicated. Besides, the Company personnel coming and going between various projects and corporate headquarter, increases the difficulty for the normal implementation of the management process<sup>[1]</sup>. Therefore, the company's administrators plan to use the project cluster management mode to regulate these projects. The Company is equipped with some professional project management systems, such as PMIS, which cannot meet the demands of corporate executives on project cluster

management and decision-making though, and as a result, there still exists a lot of limitations in management. To resolve this problem, the Company cooperates with the North China Electric Power University, to develop a project management system jointly.

Project cluster management system, refers to the relating management information system combining with project cluster management theory developed with IT like Web technology, to improve the regulation level so as to satisfy the requirements of new energy electric project cluster management. Project cluster management system, proposed in this study, is a broad concept of a large system integrating new developed system with existing old ones together to realize the project cluster management function<sup>[2]</sup>. The system consists of three parts, respectively professional project management system, daily business management system and decision support system. Professional project management system contains PMIS, P3 and new energy project performance management system.

Daily business management system includes finance management system, human resource management system and cooperative office system. Some of these systems existed beforehand, while others need to be developed. Cooperative office system introduced in this paper is a new developed system belonging to daily business management system. Professional project management system and daily business management system are complementary and closely related to each other. They achieve sharing and transferring data by data integration, business integration and other IT tools, and constitute new energy project cluster management system together. Integrated project cluster management system not only meets the needs of new energy electric construction and operation projects clusters management, but also meets the new energy electric enterprises' management demands of the daily business and performance appraisal<sup>[3]</sup>. Thus, it realizes the project cluster management effectiveness, and improves the management level as well, as shown in Figure 1

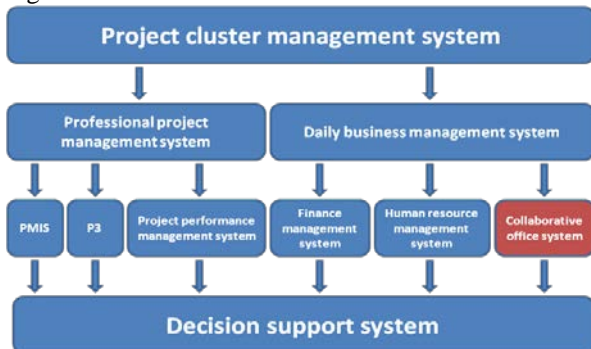


Figure 1 New Energy Electric Project Cluster Management System

The workflow system introduced in the research is achieved according to the cooperative office system of project cluster management system.

**2. TARGET ANALYSIS OF WORKFLOW SYSTEM**

As mentioned above, project cluster management system involves various application systems, including professional project management system and daily business management system. The Company needs to take advantage of IT tools to improve project cluster management efficiency. For example, PMIS is a professional system to realize the progress, cost, quality, contract and other

management goals of single project in project cluster; project performance management system taking project as evaluation object and integrating with human resource system, assesses both project management and operational levels; finance system integrates with PMIS for sharing project cost data.

The above IT tools are not enough to realize the collaboration of project cluster greatly. Only with a standardized and integrated workflow system realized in cooperative office system, can the Company's project management works be connected to optimize the project cluster management<sup>[4]</sup>. The following lists the main current problems confronted in the Company project management and daily management:

Firstly, management flows are numerous and complicated. Departments shirk responsibilities and lack the communication; leaders make frequent changes in instructions, resulting in too many work duplications; mutual interference exists in flows and the coordination is poor among personnel works; matrix management pattern is easy to cause double instructions, which increases the work difficulties of the lower level<sup>[5]</sup>. To solve these problems, a reasonable workflow system should be established to identify the core workflows, to achieve closed-loop management of workflows through effective workflow transmission mechanism, and to control task time, unity and contradiction.

Secondly, management regions make restrictions. Project cluster management involves numerous projects distributed widely. If regulators participate in the flows of projects limited to their geographical location, management flows of other involved projects are bound to be delayed and interfered. Therefore, to achieve cross-regional management, a reasonable workflow system shall be established. Besides, information processing, transmission and storage security issues should also be taken into account, it is necessary to carry out the authentication of flow participants effectively to ensure that the information in the public network will not be intercepted, tampered, and deleted<sup>[6]</sup>. Through effective workflow control mechanism, automatic controlling and prompting can be performed for initiating, converting and ending works, as shown in Figure 2.

To solve the current problems of management in Company, a workflow system is designed to realize the following controlling targets.

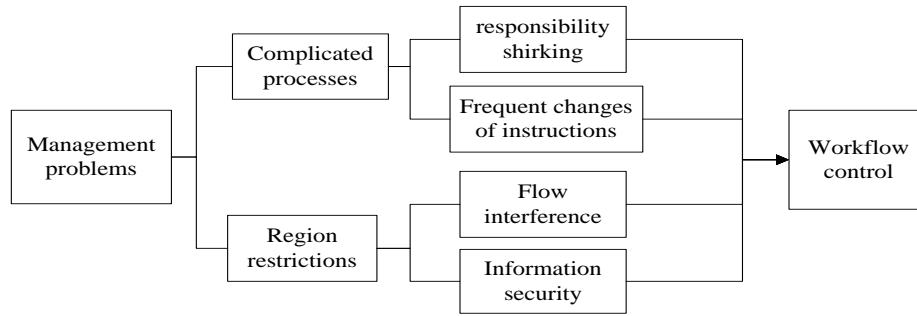


Figure 2 Problems And Solutions Of Project Cluster Management

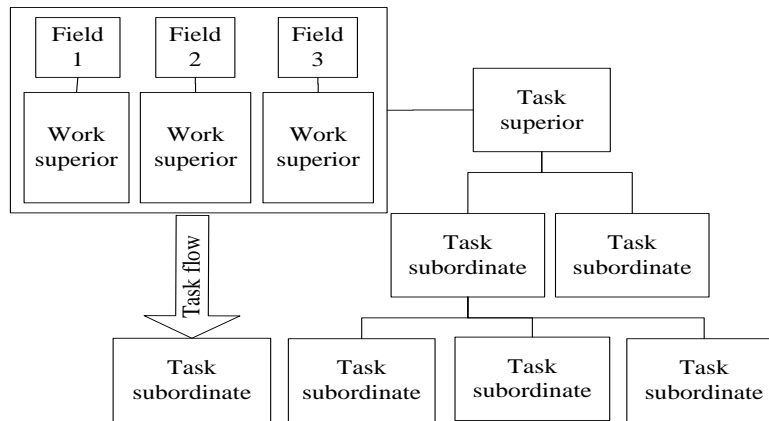


Figure 3 Core Workflow Tree Diagrams

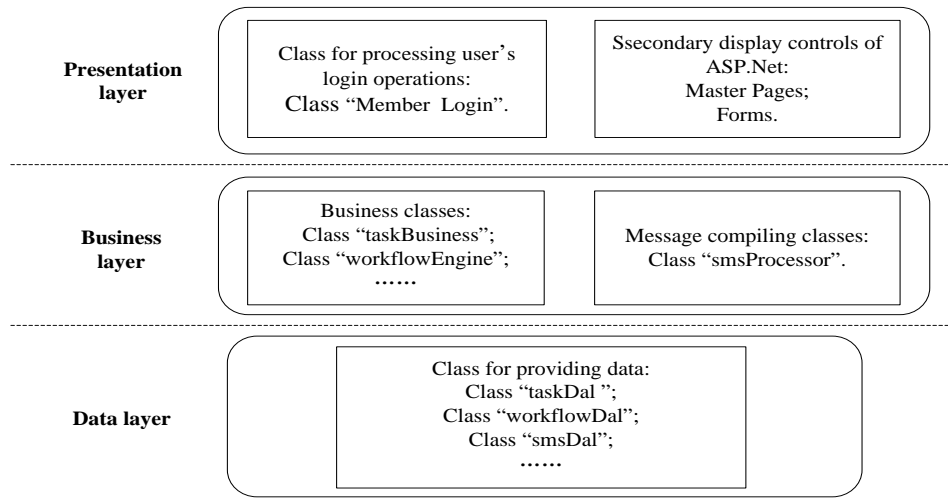


Figure 5 Overall System Architecture Diagrams

(1) Building effective task flow delivery system to reduce task loss and task conflict and to eliminate confusion in the task management.

①It is needed to find out the core workflow in management. The core workflow is built on basis of reasonable work scope division. It requires personnel managing functions that do not cross with each other, in which way, even personnel has

more than one superiors in matrix management pattern, orders types never do cross. Thus, double instructions can be avoided. ②Based on core workflow, establishing single task delivery mechanism from instruction publisher to instruction receiver, make one subordinate faces only one superior instructions source without jumping level commands. ③Those who convey tasks should make task management, be responsible for

assigning, modifying, withdrawing and auditing tasks, while task receiver has duties of performing tasks and giving feedbacks. In this way, closed-loop management and task unity can be guaranteed. ④Automatic management must be realized for conveying, transferring and prompting tasks.

(2) Work transformation is performed automatically. Complex works of project cluster management process are made network encapsulation, while the corresponding operators only face up with a simple operating system.

The fundamental contradiction to be solved is between complex workflows of project cluster management process and effective project management. The specific objectives are: ①Authorized staff can initiate relating workflow; ②Personnel can handle the work and obtain the corresponding prompts when the workflow comes to him; ③Workflow initiator and others with requirements can view the workflow achievements and obtain the corresponding prompts when a workflow is completed; ④The workflow participants can get their required workflow related data mining information; ⑤The workflow initiator can manage the workflow; ⑥Relating staff can get appropriate response if any changes happened in the workflow.

### 3. WORKFLOW MODEL DESIGN

There are two kinds of task operators in workflow function model, one is task superior and the other is task subordinate. Relations between superior and subordinate are determined by abstracted workflow tree diagrams. Task superior is responsible for initiating task and defining the task nature and management mission. The so-called task initiation means to register a task in the system, and specify the object subordinate. Defining the task nature requires to stipulate time interval of task completion and describe the task contents<sup>[7]</sup>. Management mission refers to works of modifying, withdrawing and auditing task initiated. Task subordinates receive task, get informed of the task content and make the corresponding feedback to the task superiors at particular time. With the function model, workflow channel can be standardized to reduce the double commands interference in mainstream work; task changes can be restricted to one-time workflow; closed-loop management can be achieved to increase the efficiency of conveying and finishing task with the task feedback mechanism<sup>[8]</sup>. The process is shown in Figure 3.

The table “task” is used in the background database to store one-time task record, recording the related basic information of a task. The task completion status field “taskState” helps control the task flowing. Table “task\_relation” is to record the relating personnel of a task. In the table, “taskSuper” records the task superior, “taskSubor” records task subordinate, foreign key “tasked” is used to associate with the corresponding transaction. Each table is in line with the requirements of 3NF and they meet the function needs of maintenance and expansion.

From the perspective of object-oriented programming, the appropriate classes are used to build the system architecture in the program. In the task management, “taskBusiness” class is used to finish the business logic of functional requirements, including the task transferences, message operations and systems analysis. Class “TaskDal” plays the role of data provider for “task” module, and it is responsible for providing objects of business logic layer with basic data, such as inquiry for task content by “Id”. The database design is shown in Figure 4.

The target of workflow system is to integrate the complex project cluster management works’ network of the Company into a single system with information technology. This system encapsulates complex internal logics, and when facing the workers, it displays processed principled work arrangements. To achieve this workflow system, the first step is completing the optimization of the Company’s existing workflows. The optimization goal is to make use of computers to take over those complicated and repetitive tasks within existing flows, in this way to realize restructuring the workflows composition<sup>[9]</sup>. On basis of the optimized workflows, workflows’ natures shall be analyzed. Thus, participants, directions and information contents of workflows will be abstracted, after then, program modeling shall be performed.

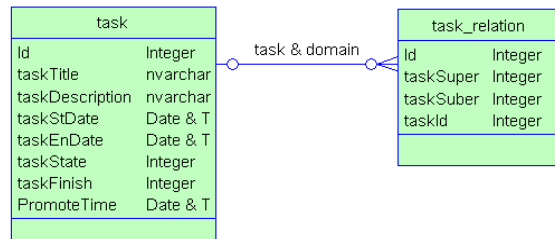


Figure 4 Database Design Of Task Flow Model



Based on the Company reality, the workflow model is designed as follows. The operators of a workflow contain initiator and participants. After initiator initiates a work, the system would transfer the workflow to the next corresponding participant according to the submitted workflow nature. Participants can complete processing the workflow at the information level. After each processed work, the system will automatically transfer the workflow. System automatically analyzes the current status of workflow, and sends reminders to the relevant personnel. After a work is completed, the system would automatically carry over the work to achieve the closed-loop management<sup>[10]</sup>.

The background database uses table “workflow” to register a new workflow, recording the nature and initiator of the workflow. Table “workpart” is in storage for recording participants of workflow, including their detailed characteristics and their relating workflow. Table “workflowentity” stores one-time initiated workflow, including the corresponding workflow types, initiator information and the current status. Table “workflowinfo” records one-time workers’ processing information for a certain workflow, the contents of which contain the corresponding workflow and workers, and the detailed condition of this work.

.Net programming is used to achieve workflow engine. Class “workflowEngine” aims at realizing business operations of workflows, encapsulates the concrete analysis and operations of workflow database, such as status analysis, next phase staff analysis. This class provides a variety of interfaces to other businesses, to enable them to get access to various kinds of workflow analysis results. Class “workflowDal” is created to meet data access needs required in the business layer.

#### 4. SYSTEM TECHNICAL ARCHITECTURE

The workflow system is realized relying on collaborative office system. System uses the Asp.Net 3.5 web programming tool to satisfy the program entity required by function model, and SQL Server 2005 is used in the database management system. System applies a three-tier architecture model, divided into presentation layer, business layer and data layer. Each layer carries out its duties respectively without cross with other layers, which increases the program reuse rate and reduces the code amount as well.

The presentation layer is responsible to show information for system users to and collect users’ information. The content includes the classes for

user authentication (class “member”), classes for obtaining the final data (class “Provider”), and caching mechanism and master pages offered by .Net. The business layer performs processing the core business, contents of which contain workflow business classes (class “workflowEngine”), task business classes (class “taskBusiness”) and message compiling classes (class “smsProcessor”). The data layer involves various classes providing data to the business layer. These classes are attached to each data module storage set, working responsible for selecting, deleting and inserting the module data, and for providing a variety of data interfaces to business layer<sup>[11]</sup>. The order from the top down of the three layers is: presentation layer, business layer and data layer. Each layer is working for supporting its upper layer. The design improves the maintainability of the program and increases the possibility of program expansion. The overall system architecture is shown in Figure 5.

Main technical schemes:

(1) SQL Server 2005 database management software is used as the system database. SQL Server 2005 is a comprehensive database platform, taking advantage of integrated business intelligence (BI) tools to provide enterprise level data management. SQL Server 2005 database engine supplies relational data and structured data with a more secure and reliable storage capabilities. It works as good database software either from perspective of amount and security of data storage, or from point view of data operation efficiency.

(2) ASP.NET technology is used to build server application based on B/S structure, core of which is a workflow management engine. ASP.NET compiles and runs the program based on common language, so its powerful nature and adaptability enable it to run on almost all the platforms of Web application software developers. ASP.NET also has mature security solutions, which is a mature technology in user’s interaction, program processing architecture, portability and security.

(3) Short messages receiving/sending and analyzing technologies based on the database interface. There is out-purchased equipment, GSM modem applied. GSM modem, as an industrial grade modem supporting GSM wireless communication, is generally able to realize functions like wireless GSM calling, sending messages and data exchanges, by inserting SIM cards of domestic mobile operators into France WAVECOM or Germany SIEMENS GSM module. With database interfaces supplied by GSM modem,





data can be sent and obtained, which could then be analyzed.

(4) The electronic signature and security technology. Electronic signature can display signature of the user on the electronic documents, and the legality of electronic signature is ensured with its security technology. Electronic signature used in collaborative office system is a plug-in based on Microsoft Office Word, which utilizes public key technology of the server to achieve the authentication of signature user. When a file is signed, this document will be automatically encrypted, and thus to prevent further illegal tampering. With the corresponding interface program, electronic signature can be embedded in the workflow process.

## 5. CONCLUSION

With the increasing size of the new energy market, the complexity of the new energy project management gets deepening, and project cluster management becomes the inevitable trend in new energy power project development. However, the current widely used traditional single-project management system shows obvious limitations in the project cluster management within new energy electric companies. Using information technology to develop or integrating existing systems of an enterprise to form a set of project cluster management system based on project cluster management theory, makes great significance for increasing the level of project management of the new energy enterprise. This paper designs workflow system for a new energy project company based on the project cluster management theory. By implementing the collaborative office system, and integrating the system with project management system, finance management system, human resource systems and other systems organically, the research achieves sharing data and information in the system. As a result, these individual systems can form a joint force to jointly support the company managers' decision-making in project cluster management process effectively.

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