

Design and Implement of Enterprise Knowledge Management System

— In case of Zhejiang Electric Power Test and Research Institute

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Abstract—knowledge has become an important business asset with the development of the knowledge-based economy and the need of the flexibly respond to the changing market needs. Take Electric Power Test Research Institute of Zhejiang Province for example. Their knowledge can't be easily managed because of the complexity and the large quantity. It is difficult for the engineers to find the knowledge needed. Therefore, the establishment of a knowledge management system has become a necessity. In this paper, the Knowledge Management System of Zhejiang Electric Power Test Research Institute of Collaborative is introduced, especially the Knowledge Management System Design and Implementation .

Index Terms—Electric Power Research, collaboration, knowledge management, enterprise information technology

I. INTRODUCTION

With the deepening of the reform of electricity industry and the competition of electricity service market. The existing market share of Zhejiang Electric Power Test Research Institute is being challenged, how to respond to the fast-changing market appropriately and standardize the operations of enterprises at the same time become a pressing problem. Due to the reality, there are numerous departments, management departments and kinds of professional departments, there are different employees of different levels. How to manage them efficiently become an important issue for the leaders. And at the same time, large quantity of knowledge is accumulated during the developing process of the enterprise, their logical relations is very complex. So when the engineers are making designs, the search result they get are often not what they want, the engineers will pay more time to filter these results to get the information they want, it will influence the efficient use of these knowledge. Thus, the establishment of an enterprise knowledge management system is urgent.

The main issues currently facing reduced to the following points: 1. Business experience and knowledge of employees cannot accumulate. 2. Information is too scattered to share 3. Items cannot be efficiently managed and monitored. 4. Departments and business processes is becoming more and more complex. 5. The leader of the institution cannot real-time understanding the company's affairs.

In this paper, Theory research and practice is combined, take enterprise knowledge management system of Zhejiang electric power test research institute for an example, noting that only through the construction of enterprise knowledge management in order to effectively promote innovation and development of enterprises. Synergistic combination of gear linkage matrix model and design model, on how knowledge from the enterprise to obtain all the information platform for decomposition analysis, not only deepened the understanding of the theory of the previous, but also put forward including the importance of collaborative knowledge-building awareness, knowledge with the existing combination of management information systems, knowledge and business process integration, knowledge management and competence in five areas such as knowledge-sharing problems, and made a number of ideas to solve problems and cases.

II. SYSTEM DESIGN

A. *Ontology theory and ontology modeling*

Knowledge of how the information is represented, how it is organized, especially due to the rapid development of the Internet, in the face of the ocean of information, how to organize, manage and maintain information from a mass has become the field of enterprise knowledge management an important and urgent issues to be addressed. Ontology (Ontology) through the concept of the strict definition and concept of the relationship between the concept to determine the precise meaning of the concept that recognized the common, to share knowledge, in this series support the concept of knowledge search, knowledge accumulation, knowledge sharing will greatly enhance the efficiency, so that the true sense of the knowledge reuse and knowledge sharing possible.

Generally speaking, the concept of an ontology model include five kinds of elements such as category, relation, function, axiom and instance, thinking of the application of knowledge management system features, as well as drawing on relevant information, given that the form of a collection of ontology: ontology = (N , F, C, A, R1, R2). Of which, N is the name of ontology; F is N of the paternal ontology; C is composed of a collection of the

concept of ontology; A collection of attributes is the ontology; R1 is the intimate link between the concept, by the C of elements in the relationship between composition; R2 is the correlation between ontology. Knowledge management system in the ontology of knowledge in all there is a certain degree of inter-linked, on the basis of the above system is given in the form of ontology, the paper design of the ontology used to express the association rules between knowledge.

1) *Ontology-based Knowledge Base Model for Power Grid Operation*

Knowledge is a structured, easy-to-use and comprehensive knowledge of organized clusters of issues for the needs of a given area, using some knowledge representation in computer memory storage, organization, management and use of inter-connected knowledge of film collection. In this paper, power system operation by building a knowledge base of the storage and power system operation related knowledge, independent of the business application system (such as SCADA, EMS, etc.), in order to provide services such as knowledge inquiring, knowledge calling etc.

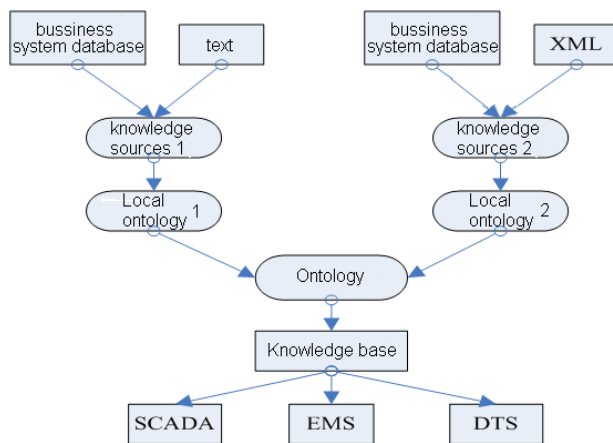


Figure 1. Power Network Operation Knowledge

Knowledge base means the business knowledge of the database system; related data and information of power system such as record text and graphic files (such as SVG). Knowledge of business systems by the source can be extracted from the local ontology. Local ontology is the concept of a business system with a description of the terms does not apply to other business systems. Therefore, the ontology needs to be integrated into the overall situation of the local ontology to form a common business system for each of the conceptual model. Ontology is the overall power system operation terms and concepts of the unified description of all business systems knowledge in the field of understanding goes for justice. Goes for the justice of both the goal of information integration is also the basis of information sharing. Ontological link between the overall combined to form a grid to run the knowledge base can store not only the structure of such a static grid of knowledge, to highlight the characteristics of power system operation can be stored in the dynamic knowledge. Ontology knowledge can eliminate the data redundancy and support unified

query of the knowledge to implement the share of information.

The knowledge base of power grid is described by the overall ontology of power sector. Overall ontology is divided into physical ontology and incident ontology. Physical ontology, also known as a static ontology, the power of knowledge to describe the concept of a static model, the concept of property, or bound by the conditions of justice, as well as the relationship between concepts. In the power domain ontology model, the objective refers to the physical ontology, the physical existence of the power system entities, such as components, equipment and a variety of devices to connect topology, also known as equipment, secondary equipment, as well as a variety of metering equipment. IEC61970 series of standards have been well defined within the scope of the vast majority of the data model with some data access interface.

a) *The definition of classes*

In the sense of conceptual modeling, IEC61970 standard definition of the CIM model is equivalent to the area of power application of the definition of the physical ontology. CIM components from package, including the relevant model is man-made sub-components approach, each packet is a collection of a group of categories, each class including a class of such property and related classes. CIM model is equivalent to the package is located in the physical ontology in the class diagram of the super-root class, is equivalent to upper ontology. CIM301 include 9 packages. Several generic classes is defined in these packages, class name is defined by attributes, and it is instantiated according to the needs of specific examples.

The physical ontology type of the objective world in accordance with the concept of the definition reflects the objective existence of classes of substances or objects, while the relationship between class reveals how their mutual structure. In the CIM model, the relationship between classes may be inheritance, association, aggregation etc.

1, the succession is a more common type (parent type) and a more specific class (subclass) of a relationship between. Subclass level inherits attributes and relationships from its parent.

2, correlation between the classes is a conceptual link. Each of the two roles is related. Role of each association in a direction that the role of target and source class is related classes. The objective of the role of a given class name, you can drive with or without words. Multiplicity of each role there / base, used to indicate how many objects can participate in a given relationship.

3, aggregation is associated with a special case. Classes and types of aggregation indicate that the relationship between the part of an overall relationship. Part of the overall class by class or contains some type of pose, and some is part of the overall class. CIM in the generating units described in class a brief description of the relationship between various types as shown below.

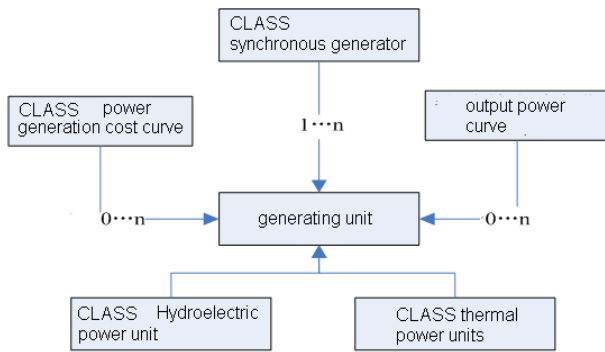


Figure 2. Generator set model

Types of generating units and the synchronous generator is a simple relationship between the association, a synchronous generator is 0 or a generating unit, a generating unit may contain 1-n of synchronous generator. Hydroelectric generating set classes and categories of thermal power units of the generating units from the upper class to inherit its attributes and relationships. Type of power generation cost curve and the generator set is the relationship between aggregations, a generating set contains a 0 ~ n curve of power generation costs.

b) Collaborative Ontology-based workflow model

Knowledge management must closely integrated with enterprises core business to enable the integration of people, process and knowledge. Consider from the current level of technology, the technology of work flow integrate people and process; the knowledge management system integrate people and knowledge. In order to integrate the three, the work flow model of collaborative linkage is used to resolve the problem of the integration of process and knowledge.

Workflow management system is composed by workflow machine, modeling tools, workflow model library and workflow instance library. The workflow machine is the core of the workflow management system. Users use the modeling tools to establish workflow model, workflow model is saved into the library, then the workflow machine can read the model and instantiate it and save it into the instance library for the workflow machine to execute.

We define the expandable workflow machine as a three-tire model: the core layer, the initial expansion layer and application expansion layer, as shown below.

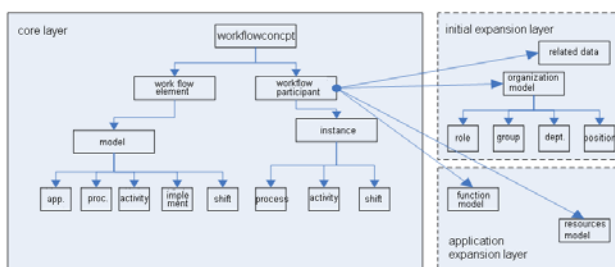


Figure 3. Workflow Meta-model of the ontology level

(1) The core layer: workflow process model and workflow involved in the workflow object model constitutes the core layer.

(2) The initial expansion layer: organizational models and related data model (or information model) is necessary for the process reference model, but specific applications may be provided by the system, as the initial layer expansion.

(3) The application expansion layer: applications such as function model, resource model (product model), and the value chain model should turn to the needs of enterprises.

Ontological hierarchy of ontology model is described as framework; framework knowledge description is a graphical way of knowledge representation. It can be directly used to represent the knowledge of an object or transaction by shared words and graphics in a top-down way.

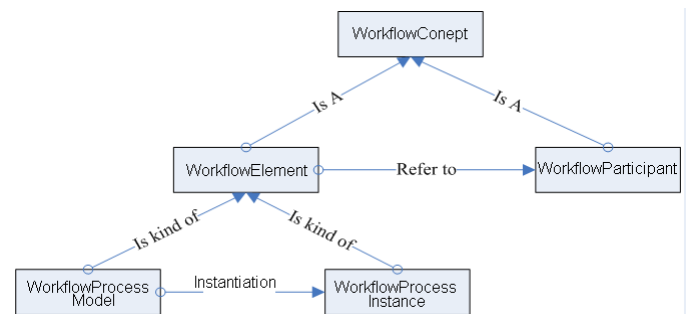


Figure 4. Workflow ontology model of the core layer

Root for the concept of workflow (WorkflowConcept), this is the most basic class, which includes a sub-class of general-purpose properties. Workflow Process elements (WorkflowElement) and workflow involved in the object (WorkflowParticipant) is a subclass of Workflow Concept. Involved in the process of definition of the concept of Workflow Element (workflowprocess elements) of the subclass, Workflow Process (process), Activity (activities), Connector (Connector), Rule (rule), Transition (transfer) and other types of inherited Workflow Element. Routing rules (Rule) contained in the transfer of part of the conditions and terms. Core elements from the workflow process (WorkflowElement) and workflow involved in the object (WorkflowParticipant) component.

The initial expansion layer is composed by organization model and information model (workflow relevant data, WorkflowRelaData). Organization model and information model is to participate in the workflow object (WorkflowParticipant) sub-classes, the work flow through the expansion of participation of target groups. Application layer, including the expansion of the functional model and resource model are, of course, WorkflowParticipant sub-classes, which combines the application of business through succession workflow object class to participate in the work flow to achieve the expansion of ontology, namely the expansion of the work flow model. Workflow Participants (WorkflowParticipant) the definition of the object name,

object path, object attributes and object operations, such as object type attributes. The initial layer expansion as follows, in which the role of the concept of speaking from the work flow involved in the sub-class object, but in the realization, the workflow involved in any sub-class object is not a sub-class approach to the definition, but as the work flow involved in the examples to describe the object, that is the way to meta-data to describe.

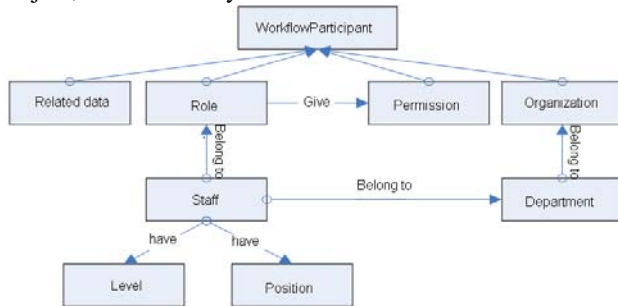


Figure 5. The initial expansion of layer

Workflow participant is used to define all the resources used in the workflow or participate in the workflow. Each instance in it is a class of the enterprise model such as role, application, devices, document etc. A workflow participant has 0 or more attributes, and the attribute include attribute name, data type, default value etc. Operation is defined as the methods of the participants, each method have name and return type, an operation can have 0 or more parameters, and each parameter have its data type and transmission direction.

B. Collaborative matrix and gear linkage model

Any enterprise has seven basic elements: the elements of people, elements of process, elements of knowledge, the elements of client resources, the elements of the projects, material elements and financial elements; the seven factors was not isolated, there must be strong correlation between them, at the same time these elements in the enterprise organization flow between various departments. As the leaders of an enterprise, their requirements of information is full ranged, for example, the leader want to know about an employee, the leader will concern about: how he finishes all his tasks in the enterprise? How he contributes and accumulates his knowledge in the enterprise? What is his client and supplier like? How is the condition of the project he is responsible for? When the leader concerning about an employee, he will care about not only the archives but all the information mentioned above.

The traditional solution of this problem is considering in an "one-dimensioned, single-threaded" way, in this way, we must establish an customer management system to manage the customers, establish a document management system to manage the documents, a employee management system to manage the employees etc. These management systems will solve some short-term problems, but the key problem is that in the enterprise, these elements should be strongly correlated with each other.

Enterprises have been looking for a method to manage all the elements of all the knowledge in the enterprise in a "three dimensional multi-threaded" platform. "Coordination matrix model" give a suitable solution for the enterprises on this key problem.

Coordination matrix model: an effective solution to enterprise information management needs mesh. Matrix model collaborative enterprises to effectively address the various elements of the various departments are coordinated network structure and operation of "three-dimensional multi-threaded" needs to provide the solution: in the system, if users find an information point, with the associated information for all points information has been found. For example: to find a company's internal sales staff, then with the sales-related: personal financial information (wages, benefits, costs and expenses), he managed client, he wrote the documentation, he subordinates the management, he to participate in the project, he used the company's assets, the organization of the work he has all the information like a network of personal data by employees of the information nodes to be extracted quickly.

Coordination matrix model is an effective solution to the "network enterprise information management" demand management platform for collaboration, this is the logic of the ideological dimensions of the system and another system is also a need for power transmission in the need for a model to support "synergy matrix" operations.

Gear linkage model: the effective delivery of the core engine power and coordination to support the operation of matrix. Gear linkage model is the key to the design: The system provides a core engine (similar to "gear school Hopewell Center") to support the various system application modules (each module similar to a gear): knowledge of document management modules, workflow application management modules, human resources application management modules, customer relationship management modules, project management module, financial management and asset management module of the collaborative operation of modules, as long as a one module (gear) rotation can be more agreeable to the Center through the gear drive other modules (gear) rotation. The operation of a module to bring the operation of the other six modules, greatly enhance the function of the module, while improving systems, and meet the requirements of collaborative management of enterprises.



Figure 6. Collaborative Knowledge Management gear linkage model

Collaborative knowledge management matrix model based on collaboration and interaction model of gear design. Matrix model based on collaborative information network map the characteristics of knowledge management and other strongly correlated with the seven modules. When we find in the system when a document with the documents related to all of the information has been extracted: with this document related to human resources, projects, assets, etc., makes this document all information related to the structure of , organized the show.

III. SYSTEM IMPLEMENTATION

Our system uses Windows 2003 Server Edition and J2EE architecture platform, and it is developed based on the structure of B / C / S three-tier model, the technology is advanced, the implementation is efficient and it is easy to maintain. Modular, process-oriented and systematic design ideas are applied in the development process. System development techniques and the main points include:

JBOSS application server architecture is used; full application of object-oriented design system design; depending on the application type, the use of middleware technologies, improve system reliability and stability; the use of relational database Oracle 10i, a wide range of integrated data management; grading and opening up the use of information, the method of licensing authority, the establishment of system security mechanisms.

A. The implementation of main function model

Establishment of directories for knowledge documents is an important step in the management of knowledge. In this process, we mainly consider three aspects: document directory, positioning systems and search powers.

1) Directory configurations implementation

Knowledge resources for the content of our institution are complex; systems are wide, through a unified system of classification of knowledge. We designed two kinds of classification of the document directory. One is the classification of the document directory, and the other is multi-dimensional directory; document directory categories are in accordance with the traditional "functional" approach to the management of file management, and multi-dimensional classification of the main directory of the various professional departments in accordance with customary access to classified documents.

Document directory is divided into the first tier classification: the rules of the system, producing technical reports, review (test) inspection report, inspection report, the assigned contract management, community activities, and the corporate culture. The second level is set according to our organizational structure. For example, the institution-level document is in an individual directory, and the documents of different major are placed in different directories too.

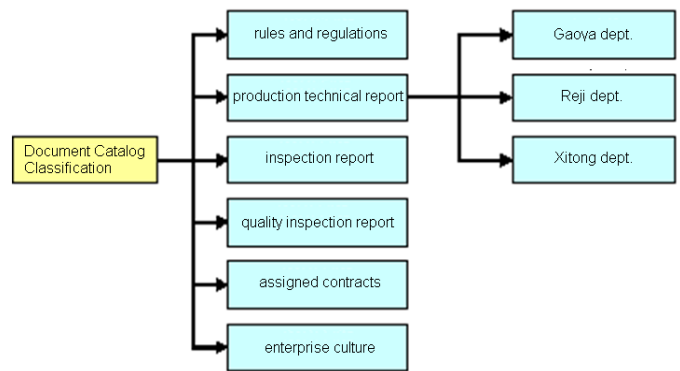


Figure 7. Document Catalog Classification Chart

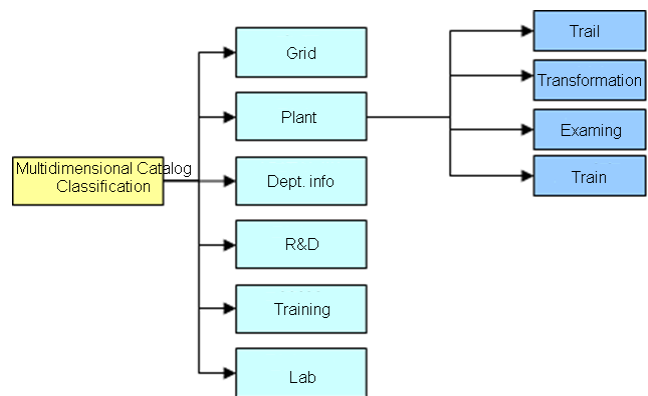


Figure 8. Multi-Catalog Classification

Such as "XXXX turbine power plant equipment in 2007 evaluation report", when create a new document in the system, which according to founder and the professional process, automatic document directory specified for the "production of technical reports" - "by the heat engine"; At the same time in order to facilitate post - Search, you can specify the document directory of multi-dimensional "power plant" - "services" - "test." This document can be assigned to this classification tree to the two. This classification and multi-dimensional classification of the directory to meet the needs of the professional categories, the actual classification can be used to achieve the requirements.

2) Custom configuration of permissions

When all the knowledge is placed together in a knowledge management system, the applications have to ensure the safety of these knowledge and the documents. we have horizontal and vertical permissions system combination to solve this problem. As a result of a knowledge base for each directory corresponds with the appropriate departments, to find the directory and the corporate sector Knowledge corresponding mapping relations, we can set up through the horizontal authority to control documents, such as financial-related article directory applications mainly in the financial sector, business sector, mainly in the business document applications. In this way, between avoids the possibility of cross-leaked.

Vertical file permissions set to consider two factors and user documentation. Enterprises can set up each document to the appropriate security level. Some common documents, such as corporate culture, rules and regulations, such as commonly used, its security level is relatively low, you can fully share in the enterprise. Like contracts, financial statements and other related confidential documents, only in a small range of content-sharing, the security level higher than it should be set up. Similarly, the system also can set up each user's security level, and the user's security level and the corresponding documents to the security level. In this way, the security system put the definition of vertical clear.

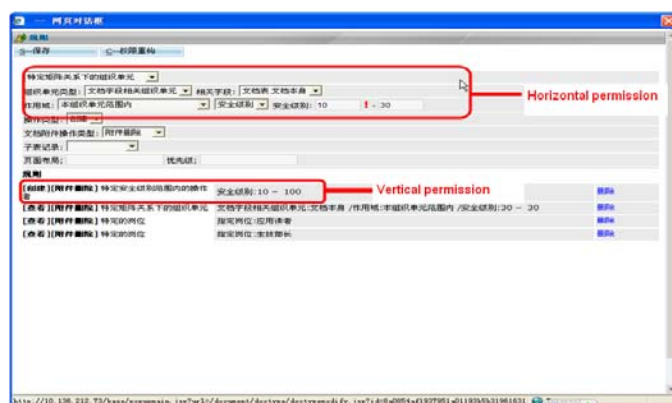


Figure 9. The definition of permission

Horizontal and vertical security system is combined together and constitutes a more rigorous, standardized, improved document permissions system. In this way, we can ensure that the information in the document at the same time be fully utilized to minimize the chance of being leaked.

3) Location Search implementation

Faced with massive documentation of knowledge, the user can quickly locate, retrieve the contents of the required documents. If there are only hundreds or thousands of documents, the employees can find what they want easily. However, in our institution, from the beginning of MIS use a date, the number of up to tens of thousands of documents. At this time, users need to retrieve the documents they need when they encounter difficulties, can not find what you want, or enter a Mesh search out after too much documentation, it is difficult to filter. To resolve this problem, we proceed from the following three aspects.

First, the increased ease of retrieval. This can be achieved through the establishment of a more complete realization of the naming rules.

Second, by setting the words, a summary of the core of the directory or some other information, allows users to keywords, summary and other relevant documents retrieved.

Third, use multi-dimensional classification method to search positioning document.

B. Take technical report for an example

Collaborative knowledge management platform modules linked together, primarily through the design of the data we load, data display and data linkage achieved. Data is mainly responsible for carrying the data collection, form the basic definition of data fields. Data display is mainly responsible for the completion of data display, display data in accordance with the system requirements. Data linkage is responsible for the definition of the form fields and the associated Knowledge Base for related categories.

Zhejiang Xinhua technical report is the most important test of an internal source of knowledge. In the project implementation process, the documentation required to fill in the information submitted to the approval process, the process can be automatically archived after the end of knowledge classification system.

1) Data bearer

The system management platform, the form data can be flexible configuration. We have established the basic form of information, field management, and form the layout of the form. The definition of basic information form the main form type and database name; field management of the definition of form-related fields, including field names, expressions, field types, field attributes, field verification, display labels, display name, etc.; form the definition of relations between the combination of the main table, a table can abstract the main table and the corresponding combination of sub-table out; form the definition of the layout of the main page.

技术文档-主表			
填写人	周周	项目归属	
部门	信息所	单位	
填写日期	2008-10-28	原件	
项目编号		试验调试开始日期	
项目		试验调试结束日期	
文件名称		报告编写天数	
相关文档		报告审批天数	
检索号		备注	
文件密码			

技术文档-子表			
分发单位	份数	装订格式	
<input type="checkbox"/> 生产院长			
<input type="checkbox"/> 总工程师			
<input type="checkbox"/> 分管副总	1		
<input type="checkbox"/> 信息所归档	1		
<input type="checkbox"/> 信息所资料	2		
<input type="checkbox"/> 本部门留存	2		

Figure 10. page performance

Main table include: the document name, document attachments, access number, dense documents, test start time debugging, testing debugging the end of time, fill out the people, departments, fill in the date. Sub-table include: the distribution of units, shares, binding format, the distribution pattern. Configure the main table of information related fields:

2) Data linkage

In the type of knowledge management, we define a category named "technical report", including the classification, name, default title, default classification and definition of competence. The use of front loading in the configuration form of the "documentation" field, through the configuration process, "the document type field" and "technical report form" in the "Related

Documents" in the knowledge management field and type in the definition of " types of knowledge report "interrelated, so that the flow generated by the document, automatic archiving to the knowledge management category of technical reports.

3) Process Configuration

Technical Report approval process is: Project applications--- submitted to department heads-- in charge of Deputy Director for approval ---- Print room print information ---distributed ---archiving information ---- end .

4) Node Manager

"Nodes" can be understood as a process flow must go through several locations, that is, the request is from a node into another node, in each node by the relevant staff to deal with the request, which is "node operator".

5) Export management

Operator node is set up, close the window, click "Export Management", under the map shown to the Export Administration page, select the node for each export, export management workflow that is the definition of the outflow from a node, you should transfer the next target node and the conditions to be met. In addition to the end nodes do not need to set up exports, the other on each node must have at least one exit.

流程信息	节点管理	出口管理	表单布局	文档字段类型	关联授权	批量处理
*****请选择当前节点*****						
A-添加出口 D-删除出口 S-保存						
选中	节点名称	条件	出口名称	目标节点		
<input type="checkbox"/>	开始		部门负责人审核	部门负责人审核		
<input type="checkbox"/>	部门负责人审核		副总审批	副总审批		
<input type="checkbox"/>	副总审批		打印室打印	打印室打印		
<input type="checkbox"/>	打印室打印		信息所分发	信息所分发		
<input type="checkbox"/>	信息所分发		信息所归档	信息所归档		
<input type="checkbox"/>	信息所归档		结束	结束		

Figure 11. Export management

C. System Testing

1. into the production plan - click on the "new", after the approval process, the project entered the implementation.

2. In the project, you can see project-related customer information, business statistics, technical reports, the implementation of information and human resources are synergies associated automatically.

3. Found in the system when a process with the processes related to staff, clients, projects, documents and other information can be found in the process.

Test results: The system succeed to meet the collaborative matrix model, knowledge management is the core, and other project management, human resources and process management share their information such as collaborative interaction module, the relationship is shown in the table 1.

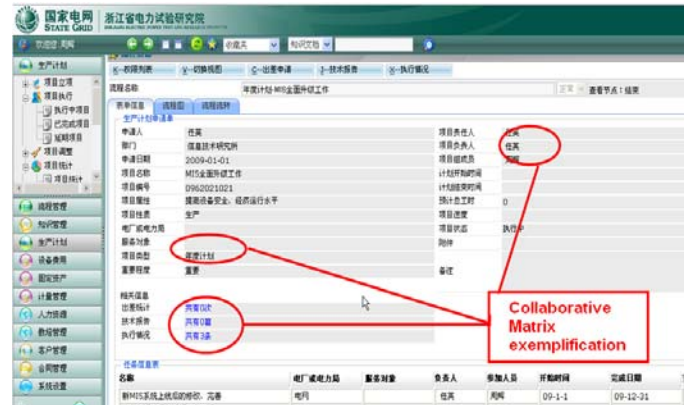


Figure 12. project related information

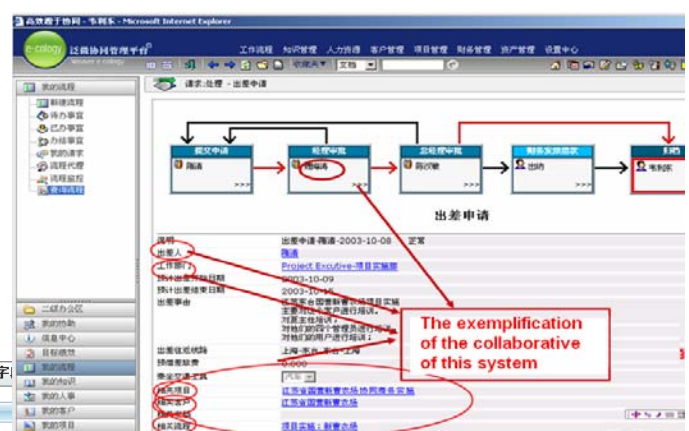


Figure 13. Business trip related information

TABLE I
COLLABORATIVE INTERACTION RELATIONSHIP

Collaborative Matrix	Knowledge Document	Project Management	Human Resources	Process Management
Knowledge Document	Document & document collaboration	Project & Document collaboration	Staff & Document collaboration	Process & Document collaboration
Project Management	Document & Project collaboration	Project & Project collaboration	Staff & Project collaboration	Process & Project collaboration
HR	Document & Staff collaboration	Project & Staff collaboration	Staff & staff collaboration	Process & staff collaboration
Process Management	Document & Process collaboration	Project & Process collaboration	Staff & Process collaboration	Process & Process collaboration

IV. CONCLUSION

The system bases on the ontology theory modeling, using the collaborative matrix and gear linkage design. Matrix model based on collaborative information network map the characteristics of knowledge management and other strongly correlated with the seven modules. When we find in the system of knowledge when a document with the documents related to all the information has been

extracted: with this document related to human resources, projects, assets, etc., makes this document all information related to the structure, and organized the show. The design provides a comprehensive knowledge management framework, standardization of the knowledge of the organization entirely. With traditional knowledge management system compared to the advantages of:

1. Flexible adjustment and the free expansion: users can build the framework of this system, add and expand the direction of different business management module. These plug-in adjustment operations, the expansion will not affect the basis of platform software architecture to maximize the knowledge management system from the implementation of the system out of control and overturned the risk of Reconstruction.

2. Organizations and permission management: support a complete model of corporate organization to support a modern matrix organization, Expandable Organization scalable interface. 3. Business Workflow: collaborative platform is the industry's most powerful and most complete work flow system, not only has the strong support of the workflow capabilities, but also provides the most complete system to support workflow tools, business processes can the design, implementation , monitor, analyze, and improve the provision of a comprehensive support.

Collaborative knowledge management system is a business to some extent the level of information-based, it should be a gradual process and should be put it the construction of enterprise information to the overall

planning of the overall consideration. The Collaborative Knowledge Management system of Zhejiang electric power test research institute is a main line item to knowledge management as the core around the personnel management; cost management and material management more latitude for three angles of observation, analysis and use of. The system is fully taken into account the problems faced by the enterprise in order to "knowledge management" as the core, from project management, knowledge management, equipment management, human management, process management, contract management, and so on several major modules, the realization of the institution departments and personnel effective cooperation between States, for all types of project management provide a strong protection.

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