Planning and Design of a Management System for Architecture Company Project based on Petri Nets

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Abstract — This paper focuses on the research of project information management for the urban planning engineering company of the author, starting from the analysis of demand, this paper puts forward the system's functional and nonfunctional design target, summarizes the overall system design and module design ideas, then completes the design and implementation of project management system, and introduces the content and requirements of urban planning project management, as well as the guiding ideology, the popular modes (C/S and B/S) and their characteristics. Some related technologies are used in the process of system development. The intelligent urban planning project management system uses object-oriented software development method and chooses the Unified Modeling Language (UML) as modeling tool.

Keywords - Construction enterprises; Project information management; Network platform; Information system; Urban planning.

I. INTRODUCTION

With China's accession to WTO and the economic becoming open gradually, the urban planning industry is also facing enormous pressure that large international contractors are entering the domestic market. Facing enterprises and the urban planning unit's loose management, the domestic urban planning they are unable to compete with international large enterprises, [1] so we must introduce the standardized and scientific management system, and establish fast and efficient information system improve and accelerate the development itself.

Urban planning projects are open complex systems, management of which will exert great impacts on the national economy and on the benefits of the investor and the project participants. However, the management tools of different phases are isolated during traditional management of urban planning project. [2] A lot of potential disadvantages are caused, such as end user's requirements not be satisfied from the inception; difficult to manage the interfaces among different phases; the knowledge and experience owned by different participants not serve for the realization of the urban planning project objectives, in order to solve these problems, the guiding ideology of the management is gradually changed from division of labor to the integrated management. The paper tries making research into the integrated management of urban planning project to overcome the malpractice of traditional management of urban planning project. The simple Petri net is shown in Figure 1. [3]

II. SYSTEM DESIGN

The whole process of the development is introduced in detail according to the standard process of software engineering, from requirements analysis, design, coding and test. System modeling permeates the entire development process. [4] The UML use case diagram, activity diagram, class diagram, etc are also given in the thesis. The system adopts B/S structure, and supports all major browsers. It uses the network platform technology to achieve the core business of the system and the other process operation interface, and gives a specific implementation measures and technical characteristics. [5-7] Through the debugging and revising period, now the system is running well. It effectively improve the Department's efficiency and accuracy, It shows that the information society pays more attention on the software management system's application, for the importance of the urban planning units of the development and survival in the future, the technology and management's establishment is important for the domestic company to catch up with the foreign counterparts.

In addition, the application of data mining technology in the supplier evaluation is studied. The suppliers are classified legitimately, objectively, and comprehensively by using the weighted fuzzy clustering analysis method, and the effectiveness of the proposed method is verified. The results of testing and commissioning have shown that the system is reliable, stable and easy to operate. It can reduce the
manpower cost, improve the management level, and reach
the intended target. [8] With the promotion of enterprise
information, the traditional construction enterprises have
gradually realized the importance and necessity of the
enterprise information management in the new situation.

II. METHODOLOGY AND KEY TECHNOLOGY

Based on the integrated management theory and the
project management theory, new ideas for the integrated
management of the urban planning project are proposed
and its conceptual model is established according to the
characteristics of urban planning project in this paper. The
model contains two layers of meanings. [9] On the one hand,
as viewed from the various phases of urban planning project
the corresponding beam of the integrated management is
selected and mapped in each phase to carry out the integrated
management according to the characteristics of each phase.
In project decision phase, the life cycle integrated
management of urban planning project is carried on by using
the Life Cycle Cost Analysis and the Life Cycle Quality
Analysis. In project design and planning phase, the Quality
Function Deployment (QFD) method is improved and used
in the integrated management of the project stakeholders' 
requirements. [10] In building phase, the Genetic Algorithm
(GA) method is used to realize the tradeoff of the quality,
schedule and cost of urban planning project. In ending phase,
the theory and methods of Knowledge Management are used
to integrate the technology resource accumulated during the
whole process of urban planning project. On the other hand,
from perspective of the entire process of urban planning
project, the bi-level decision-making mechanism composed
of the owner and the participants in different phase is
proposed and used in the whole process integrated
management of the urban planning project. The research
provides a clear concept frame for the project staff to carry
on the integrated management of urban planning project.

III. PLANNING AND DESIGN MANAGEMENT SYSTEM FOR
ARCHITECTURE COMPANY PROJECT

Urban planning engineering project design include
planning and design and architectural design, engineering
urban planning important link very in the whole course, it is
the link of exerting a largest influence on project investment,
and to project function and use value too, the project mass
property influences the most important link. [11] Strengthen
the research of design management of the urban planning
project, to ensuring project quality; improving the project
investment benefit has very important meanings. Petri net
model is shown in Figure 2.

Figure 2. Petri net model

According to the characteristics of the urban planning
project, this paper sets up the improved house of quality
(HOQ) model that is suitable for the integrated management
of urban planning project stakeholders on the guidance of the
Quality Function Deployment (QFD) theory, and puts
forward the operational mode of integrated management for
stakeholders and its program. The improved QFD method
can improve the satisfactory degree of the urban planning
project stakeholders and guarantee the project going on
successfully by integrating the project stakeholders'
requirements and translating them into the process of the
urban planning project implementing. The relationship of C
and T is shown in Figure 3.

Figure 3. The relationship of C and T

The paper builds up the conceptual model of the whole
process integrated management of the urban planning project
according to its characteristics, based on which the bi-level
programming model of the whole process integrated
management of urban planning project is established
according to the optimization theory of the bi-level system,
and the corresponding solution procedure is proposed. The
process of solving the bi-level programming model can
coordinate the partial goals of the various phases and the
entire objective of the whole process of urban planning
project. To verify and demonstrate how the model works, the
model is used in the problem of project duration coordination decision-making between the project owner and the contractor in urban planning project. A numerical study showed that the model can help to actualize optimization of project duration coordination and Pareto improvement of revenue for two parties in the contract on condition that the project owner expects the contractor to actively compress project duration furthest by supporting revenue incentive measures instead of traditional direct instructions.

The achievements of this study enrich the project management theories and have important value for urban planning practice.

IV. SYSTEM DETAILED DESIGN AND IMPLEMENTATION

In recent years, it is a main trend of the development of the Project Management that applied the information manages technology to the Project Management. Using advanced technology of computer to integrate quality, time and cost of project, it let the project planning of urban planning make scrupulous, scientific, desirable and feasible. Furthermore, the method of project management not only is a research hot point of Project Management, but also is a poor point of Project Management at the present time. Average transaction response time is shown in Figure 4.

Since Dr. Petri proposed Petri Net at 1962, Petri Net is become one of hot research fields of scholars. The main research directions are the analysis of Petri Net, the extension of Petri Net and the application of Petri Net. Due to the strong capacity of Petri Net describe synchronous system and asynchronous system, Petri Net has got its rapid development. By now, Petri Net is applied in the office automation, the production of enterprise, and other fields. Take an example as shown in Figure 5 and Figure 6.

To achieve process integration in the global framework model of urban planning program, this paper presented a workflow model of the planning and design program by hierarchical timed colored Petri Net on the basis of analyzing the characteristics of workflow model and building a framework of workflow model of planning and design program in the implementation phase. On the basis of the workflow model, considering the resource constraints, this paper presented a resource model of the planning and design program by defining non-empty colored sets in hierarchical timed colored Petri net and expressing the classification and combination of resources with the token color.

The workflow model and the resource model of the planning and design program can not only explicitly illustrate the sequence, parallel, synchronization and other complex logic relationship between sub tasks of program in time and space Fields, but also reveal characteristics of the internal dynamic behavior of the program. The workflow model and the resource model can be used to master the whole process of implementation phases all-round accurately and achieve workflow integration, as well as optimize the resource allocation effectively, providing powerful guarantee to planning and design program in technological and methodological aspects ultimately. With the CPN Tools simulation platform for modeling and simulating an example of a planning and design program, the validity of the model is verified through the simulation analysis to the model structure, schedule and process optimization. The design singly of “Forest Hill” project is shown in Figure 7.
Once the workflow model and the resource model of planning and design program has been constructed, the process definition is finished. On the basis of process definition, for the integrated collaborative demand of the planning and design program in the computer network environment and functional requirements of planning and design program workflow management system for information integration, this paper developed a workflow management system of planning and design program based on the workflow reference model of WFMC and described the interface between each module, defined the functions and relations of modules and interfaces in detail. The effectiveness of the application system is analyzed subsequently.

The workflow management system of planning and design program is such a network management system which can realize automation, informatization and integration, and provide a platform for information integration, promote the organization integration, and guarantee the process integration in the implementation phases of planning and design program. With workflow modeling and workflow management system, the global framework model for integration management of planning and design program was realized.

Through the study of Petri Net, this paper applied Petri Net to the Project Management of construction. Firstly, presenting an Expenses Timed Petri Net to solve a defect of which the Timed Petri Net cannot describe the expenses of project. Finally, this paper integrating the parallel computation and the linear programming to present a new arithmetic, which is compute a critical path, and prove its validity and correctness. (Eq. (1))

\[ W^* = W_p \times W_{ps} \quad (0 < w_i^* < 1, \sum_{i=1}^{n} w_i^* = 1) \]  

Study main results of the research on Petri Net and the Project Management, and analyze the development of construction in recent year, and the prime features of project of planning and design. (Eq. (2))

\[ W^* = W_p \times W_{ps} \quad (0 < w_i^* < 1, \sum_{i=1}^{n} w_i^* = 1) \]  

Applying Timed Petri Net to plan modeling of project's duration, and analyze this model with methods of Timed Petri Net, and computing this model's critical path, and proving its correctness and feasibility. (Eq. (3))

\[ S = W^{*T} (RPX) \]  

Through the analysis of Timed Petri Net, consider how described the planning and design management system of project with Petri Net, and present an analysis method to optimization of planning and design management system of project. (Eq. (4))

\[ W_{EM} = W^{*T} RP \]  

Through analyzing and studying parallel algorithm and linear programming, present a relative linear programming based on parallel algorithm, which is used computing the critical path of Time Petri Net. (Eq. (5))

\[ S(x) = W_{EM}^* X = \sum_{i=1}^{n} W_{EM}^* x_i \]  

The modern management theory has merged the thought of the system engineering and idea changed, have characteristics such as clear goal leading, flexibility way, dynamic effective method and tool of resource distribution, science of organization, etc., become the design management effective method of the planning and design project. This thesis combines the modern management theory with project design management practice of engineering construction, study how to improve and upgrade the project design management level of engineering planning and design, full foot engineering planning and design project construction need, make architectural design trade of our country design market competition establish in an unassailable position in the whole world better. (Eq. (6))

\[ \text{max} \; S(x) = \text{max} \; \sum_{i=1}^{n} W_{EM}^* x_i \]  

\[ s.t. \; C(x) = \sum_{i=1}^{n} c_i x_i - C_B \leq 0 \]  

\[ T(x) = \sum_{i=1}^{n} t_i x_i - T_B \leq 0 \]  

\[ \text{......} \]
Through the design and implementation of the project management information system, I have a deeper understanding of the project cycle of project, but also more in-depth understanding of the architectural engineering project management concept. Write this article, I have a deeper understanding of the project. The system design and implementation of project management information planning and design Industry Company is to implement a certain reference.

V. CONCLUSIONS

Through the establishment of planning and design company project management system, the system has passed the test and trial operation, the system performance in good condition, realize the digitization, network planning and design sites, so as to realize the planning and design of information of enterprise management, project management system to achieve business project personnel, material, machinery and equipment, information management, contract, construction materials, package financial, process. The perfect combination of office, workflow, business model, project management, cost management, PDA, easy to set up a project management platform, support local and wide area networks, Internet, achieve any management. The tedious business of the company project management is simplified by the project management system on the one hand, through the examination and approval system of information, greatly improving the project management personnel's working efficiency; on the other hand, standardize the project management process, realizes digital and standard project management and implementation of the key data of engineering project concentration and sharing, and offers support for leadership decision-making. And the project management system has a large database support, provide a statistical analysis of the data, the realization of enterprise management decision support. In the user role, the system will be first-line staff, staff of the management decision-making leadership of people and companies in the same system platform, to give the role of different user permissions, according to a preset system business processes, complete the whole business of project management, through effective regulation and orderly process of collaboration to help planning and design companies realize comprehensive management of each project, enhance the ability of corporate strategic management.

REFERENCES