Integration of Geographical Information System and Government Project Administration Information System Based on Network Platform

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ABSTRACT: In this paper, the integration of geographical information system and government project administration information system based on network platform (GIS-GPA/NT) is presented for capturing, storing, checking, integrating, manipulating, analyzing and displaying the construction projects data related to positions on the Earth's surface and government administration. The system is developed for the municipal government body, which is responsible for the administration of construction projects. The scope of information processing and the type of information used in this system are discussed following the end-user identification. Then, the system structure and main functions are described in detail. Finally, the guideline and methodology of system development are presented.

[Keyword:] Project Management, Information System, and GIS

1. Background

China has been constructing a large number of infrastructures, factories, commercial buildings and housing for the development. Many of these projects are invested by the governments at the state, province or city level, or government owned companies or organizations. Therefore, the administration of government-invested projects has become very important for the municipal government. However, the government project administration is still very feeble in China. In 1997, World Bank signed a credit agreement with the Chinese Ministry of Finance for developing an information system for the administration of government construction projects in China. Tianjin, one of four municipalities directly affiliated with the Chinese central government, was assigned as an experimental city. In this paper, a proposal is presented for developing such an administration information system by integrating geographical information system and government project administration information system based on network platform (GIS-GPA/NT). This proposal was primarily approved to World Bank and is under the development for the Municipal Construction Committee of Tianjin, which is the highest responsible government body for the administration of all construction projects in Tianjin. Many municipal government bodies, such

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as design firms, construction companies, suppliers, and research institutes, belong to it or are under the guidance of it. In every city in China, there is such a municipal construction committee. This is a very important organization for capital construction and construction industry.

In this research, a geographic information system (GIS) is developed to link the huge administration information of various construction projects that may be in decision phase, design phase, construction phase or maintenance phase. Furthermore, the communication network makes it possible for users to access the system from various computer platforms located in different organizations and places. The significance of the system development lies in the improvement of information processing and effectiveness of construction project administration.

The main features of this system are as follows: (1) This system is an integrated system of GIS and project administration information system. It would be useful in the municipal government administration of construction projects in several purposes. For example, the user can obtain the project information (data of cost, progress, quality and contracts of project, etc.) according to the project location and integrate with other management systems. (2) This system is based on network. It is an open system not only for government bodies but also for organizations and people who are interested in the information from the system. (3) Most project management information systems (PMIS) provide the information in project implementation phase, and most facility management information systems (FMIS) are used in project operation phase. GIS-GPA/NT is able to exchange information from project decision phase and implementation phase to maintenance phase.

2. End-user identification

The basic end-users of GIS-GPA/NT are mainly the president, the presidential office and the responsible departments for construction project in the Tianjin Municipal Construction Committee. These departments consist of the department of investment planing, the department of approval of new construction project, the department of administration for design work, the department of administration for construction, the department of cost engineering, and the department of statistics.

Other end-users include the subsidiary divisions of the above departments, the offices of the committee, and some government bodies which involve the administration of construction industry or are interested in construction projects such as design firms, construction companies, suppliers or research institutes. The users perform information processing by the local area network (LAN) or wide area network (WAN) as shown in Fig. 1.

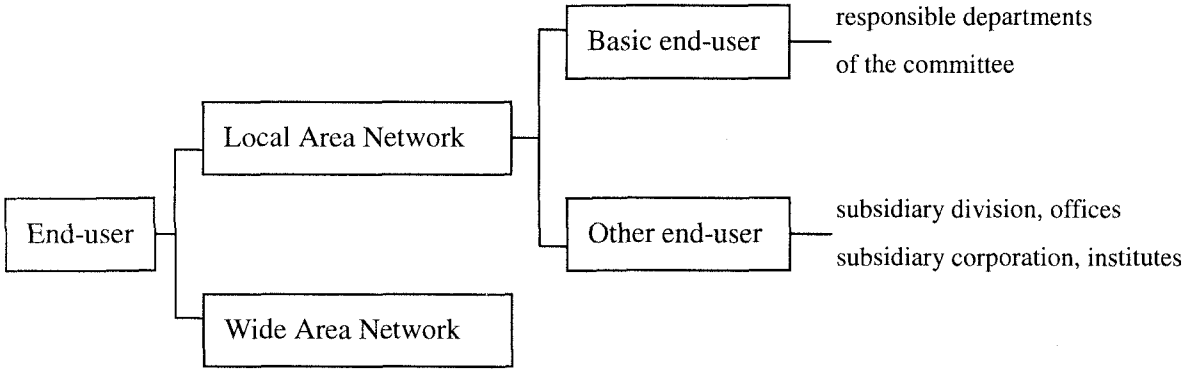

Fig. 1: End-user identification

The system should be developed to provide the following three types of services: the basic service of auxiliary administration to its basic end-users, the information services to other end-users, and the varied access priorities to its basic end-users and other end-user so as to assure the data security.

3. The scope of information processing and type of information

(1) The scope of information processing

GIS-GPA/NT will process the information of multiple construction projects in the decision, implementation and maintenance phases based on the digital map.

The information in the decision phase includes the project proposal, feasibility study, and project approval, etc. (Wischnewski 1996).

The information in the implementation phase is from the design preparation phase, design phase, and construction phase. This information consists of the major design program, notification, documents of budget and cost estimate, procurement document, contract, document regarding time schedule, and construction quality and safety as shown in Fig. 2.

(2) The types of information

Two types of information are contained in the system GIS-GPA/NT, which are the construction project information and the geographical information.

The construction project information includes numeral values, character descriptions and hypertext data, etc. Numeral data include the information regarding the data of cost control, time control and quality control. The characteristic information consists of the approval documents of government such as the project proposal, feasibility study, contracts, report, and so on. Hypertext data include the drawings, photos, videos and moving images, and so on. These various types of construction project information are shown in Fig. 3.

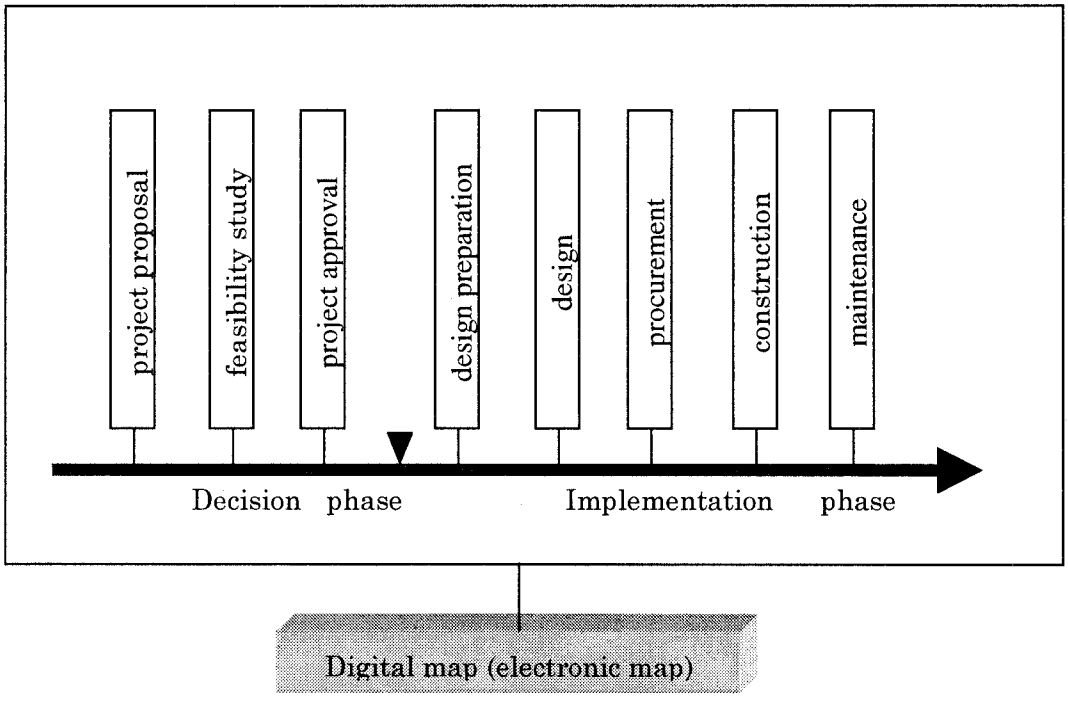

Fig. 2: The scope of information processing

The geographical information used in this research mainly consists of the base map, the urban planning documents, and other data about the city. The base map includes the basic scale topographic map (1:500 or 1:1000), the aerial photograph and the remote sensing imagery, and so on. The urban planning documents contain the urban strategic plan, the detail plan and the thematic plan, and so on. Other data about city consist of the administrative area, the demographic data, the urban infrastructures, the public facilities, and the protection of historical relic.

With the rapid development of information network such as Internet and World-Wide Web, these networks have been applied in the research, engineering practice and education (Bentley 1997). In this research, an open system is strongly suggested in order to technically exchange data and eventually share information with urban planning administration systems and other thematic information systems.

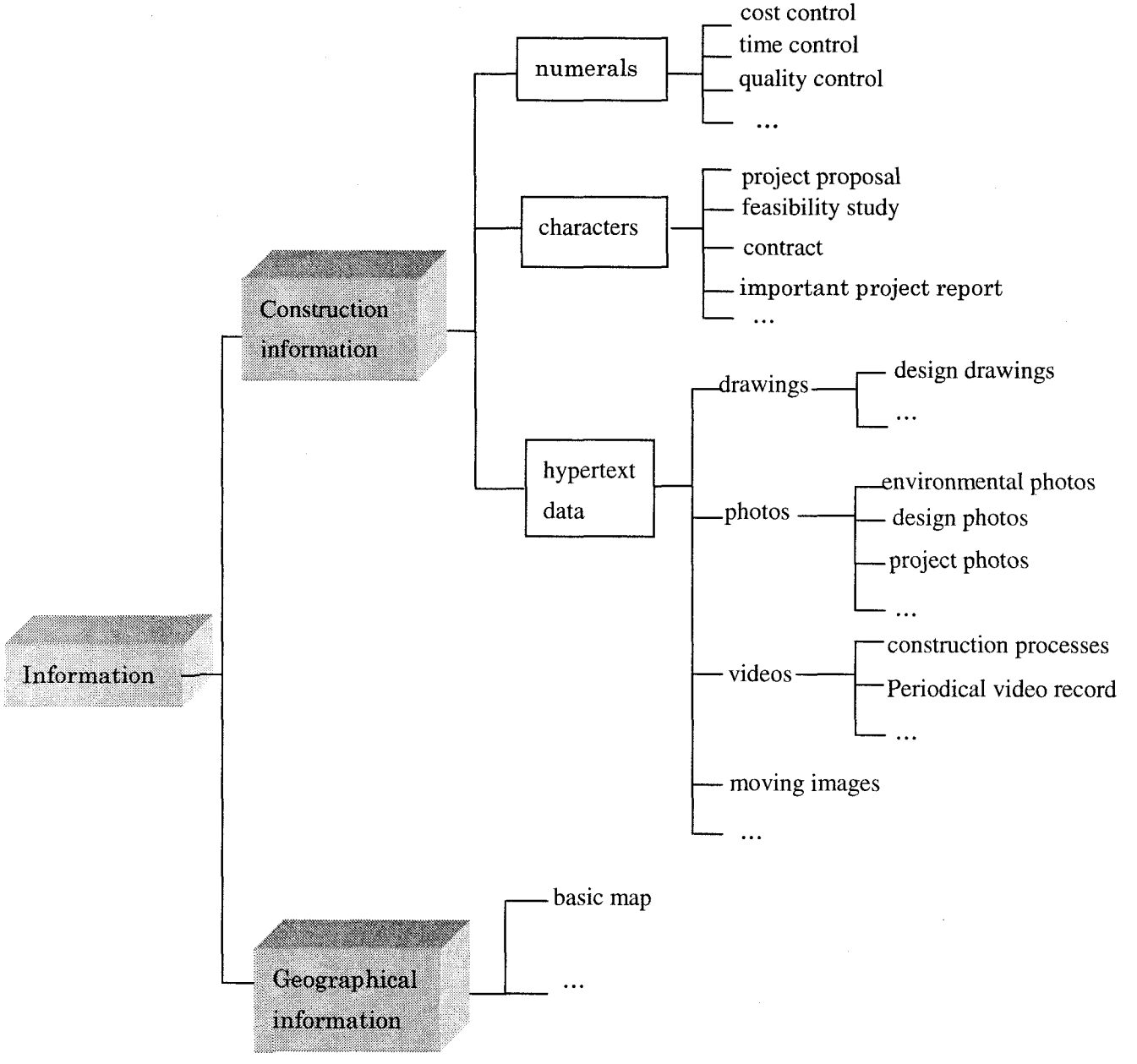

Fig. 3: The type of information

4. The structure and main functions of GIS-GPA/NT

(1) System structure

GIS-GPA/NT is different from the normal GIS. It is a computer system for capturing, storing, checking, integrating, manipulating, analyzing and displaying data related to positions on the Earth's surface and data related to government administration of construction project, based on network platform. GIS-GPA/NT consists of seven modules with different functions and two GIS databases. Fig. 4 shows the system structure and components. The two databases are used to enforce the functions in each module and updated by revising the available information with the development of construction projects.

These seven function modules are:

M1: Project planning and approval information management,

M2: Project management information management,

M3: Design information management,

M4: Procurement information management,

M5: Construction information management,

M6: Project maintenance period information management, and

M7: Project comprehensive information management.

The two databases of GIS-GPA/NT include the geographic database and the attribute database of management information. Both databases are interconnected via their common numeral and character fields such as the reference number and the name of each construction project. The geographic database processes several types of spatial data including any information about the location and shape of, and relationships among, the geographic features, the remotely sensed data as well as other map data.

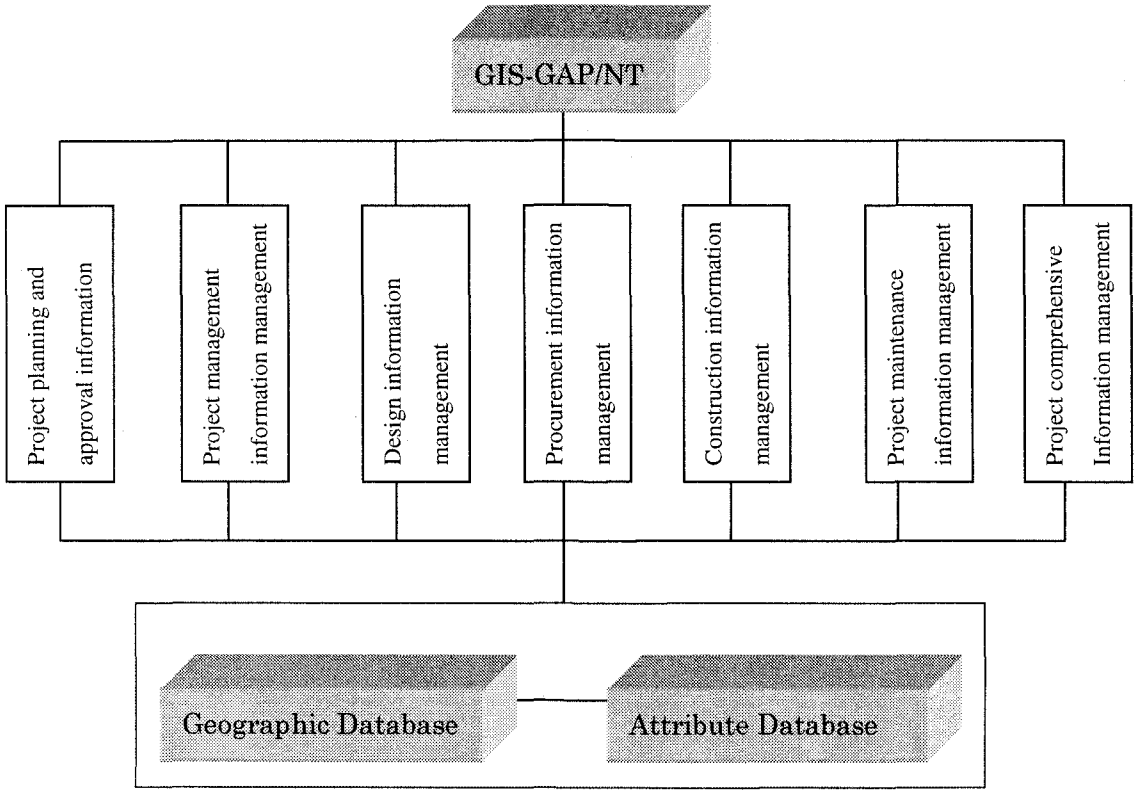

Fig. 4: The components of GIS-GPA/NT

(2) System functions

The functions of each module are defined as:

a) The functions of M1

① Project proposal information management,
② Project feasibility study information management, and
③ Project registration and approval information management.

b) The functions of M2

① Important project management implementation information management,
② Project management companies and project managers information management, and
③ Project management contract information management.

c) The functions of M3

① Design notification information management,
② Conceptual design approval information management,
③ Design development approval information management,
④ Preliminary cost estimate information management,
⑤ Design contract information management, and
⑥ Project definitive cost estimate information management.

d) The functions of M4

① Bidding approval information management,
② Procurement documents management,
③ Accepted bid documents management, and
④ Contract documents management.

e) The functions of M5

① Construction commencement approval information management,
② Construction quality information management,
③ Construction safety information management,
④ Expenditure information management,
⑤ Schedule information management,
⑥ Completion acceptance information management, and
⑦ Final account information management.

f) The Functions of M6

① Project maintenance document management, and
② Project construction contract completion information management.

g) The Functions of M7

① Comprehensive capital construction plan information management,
② Plan of capital construction and project registration comprehensive information classified inquiry and statistics,
③ Preliminary estimate of construction project information management,
④ Project registration comprehensive information classified inquiry and statistics,
⑤ Project management comprehensive information classified inquiry and statistics,
⑥ Design comprehensive information classified inquiry and statistics,
⑦ Procurement comprehensive information classified inquiry and statistics,
⑧ Construction comprehensive information classified inquiry and statistics,
⑨ Project completion comprehensive information classified inquiry and statistics,
⑩ Maintenance comprehensive information classified inquiry and statistics, and
⑪ Construction contract completion comprehensive information classified inquiry and statistics.

5. The guideline and methodology of system development

GIS was introduced into China since the early 1980s due to the experience of GIS development in Japan, North America and Western Europe (Zhao 1994). Actually, GIS is a more powerful tool for construction management in China than in these countries as the planning and investment of construction projects are mainly carried out by the local government. In China, GIS applications have contributed to a certain achievement in areas of construction project management, business administration, urban planning management, state territory information system, resource and environment information system, and territory management as well as disaster prediction and analysis (Yan 1993). However, some of those systems were not developed very well due to the lack of preliminary study and negligence of secondary development of standard software.

The development of GIS-GPA/NT must be application oriented and fully applicable to government project administration to provide valuable information to Tianjin Municipal Construction Committee and other relevant municipal government bodies.

With the consideration of data collecting, data maintenance and data updating in GIS system as well as GIS application in the local network workstation, ArcView and AutoCAD Map should be introduced in the system.

Network platform could be used in the following protocol: (1) SMTP, FTP, TELNET, WWW, (2) NetBEUI (NetBIOS extended User Interface), and (3) Windows NT.

(1) The guidelines of the system development

The guidelines of the system development could be stated as follows:

a) Demand of construction administration

The development and applications of this system should promote the municipal construction committee's reformation of construction project administration, and be helpful for establishing a rational and effective administrative model. The conventional administration methodology should be renewed to improve the methods and means of government administration of construction projects.

b) Application of information technologies

The system should be developed through applying the latest developed GIS platform, the advanced database management system, and the most popular programming language.

c) Application of network technology

The power of the information network is brought to construction project management enable the Intranet/Internet connection among users and the system.

d) Application of commercial software

It is preferred to adopt the commercial software for some specific functions of this system such as statistic analysis by revising the available software if necessary.

e) Cooperation of government staff

Modern society has evolved into an era of knowledge-based economic development, and the major element of knowledge infrastructure is the educated personnel. The knowledge and abilities of the government staff in management and computer have a close relationship with the development of system. Furthermore, there may exist some technical or political problems that will appear and need solutions along with the development and implementation of this system.

(2) Methodology of the system development

This system is relatively a large information system. According to the software development experience, it is recommended to implement the development by stages so as to utilize the latest technologies regarding software and hardware. Three stages are suggested as follows:

Stage 1: Initial application of designed functions of the system in decision and implementation phases of construction project in certain experimental area of the city,

Stage 2: Fulfillment of all designed functions through the experimental application and perfection of the whole system, and

Stage 3: Commercialization of this system for the purpose of the promotion of the computer-aided construction project administration in other large and middle-sized cities.

The development of such a system is time consuming, and needs long-term contributions of engineers from different disciplines. Therefore, the development procedure should be planned in advance. The following five steps are proposed for the development of this system:

Step 1: Identifying the end-user's basic requirements for information and operation,

Step 2: Building up a prototype that meets these requirements,

Step 3: Making end-users to use and evaluate the prototype, and analyzing and revising it according to the end-users' new requirements,

Step 4: Building up a new version of the prototype by refining and consummating it, and

Step 5: Repeating steps 3 and 4 to create a final version of the system that will meet user's requirements.

Along with the continuous advancing of hardware and software technologies and the acceleration of end-user's requirements, the system should be updated timely.

6. Conclusion

This paper aims to develop a new concept of the integrated information system linked with geographical data for the municipal government administration of construction projects based on network platform. This study can be concluded as:

(1) This system is developed to control multiple municipal construction projects from the viewpoint of government administration.

(2) This system processes all information in the construction project decision, implementation and maintenance phases.

(3) Users may access this system from different computer platforms via information networks.

(4) This system services for all organizations and people who are interested in the information about construction industry or projects.

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