Kuwait J. Sci. Eng. **30**(1) 2003

A web-based information support system for the pre-design phase of public projects

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ABSTRACT

Many public projects consume considerable time and suffer major delays during the pre-design phase due to lengthy approval processes and then face consequential changes due to insufficient scope definition. Such delays are costly to the government, and draw many complaints from the public who are to benefit from these projects. New database management technologies and the Internet and have provided opportunities to overcome the limitations of planning during the pre-design phase and improve the accessibility and functionality of needed data and information. This paper discusses the development of an interactive Web-based Project Pre-Design Phase Information (P3I) System. The Objective of this P3I system is to help planners and decision-makers in improving the management of the pre-design phase of the construction of public projects. It does this by providing a web site and a server to provide needed data through the Internet and the internal computer network of the authoritative agencies. In addition to delivering pre-design documents and plans via the Web and providing interactive feedback, the system enables some practical work to be distributed via the Internet; results of the work are monitored and analyzed. This paper presents the capabilities of the P3I system and discusses the implementation stages of a Web-based P3I system. It is concluded that it is time-effective to establish a Web-based P3I system for planning purposes and that it can benefit both the planners and the government end-user sector of the project.

Keywords: Construction communication, data-exchange, information technology, Internet, Intranet, pre-design phase, project management.

INTRODUCTION

Many public projects suffer major delays during the pre-design phase and face consequent design changes due to insufficient scope definition and ineffective control. These two obstacles are attributed to a seemingly endless list of variables, but are mainly due to slow decision processes, an inefficient flow of information, and lack of needed information. This inefficiency, specifically in the quality and timeliness of the information flow, is a fundamental problem in the construction

* A preliminary version of this paper was presented at PODC'99 as a brief announcement.

industry. In order for the scope of a project to be well defined, data from different organizations should be collected and stored in a readily available database.

Pre-design is a multi-party phase, and key players (end-users, agencies, executors, planners, architects and engineers alike) are always looking for ways of communicating information between related parties more quickly and efficiently. This multi-party nature creates a challenging environment for successful project implementation where success relies heavily on the timely transfer of information. Therefore, there is a need to find more efficient methods. To effectively and successfully manage the pre-design phase of project, an information system is needed to facilitate the collection of quality data in a timely manner and to provide quality database information for future planning of new projects. The Internet can be utilized as a vehicle for communicating data and information (Marchand 2000). Using the Web as a tool for the provision of information is an exciting prospect that promises to make construction project planning in the pre-design phase easier and more convenient, and it encourages interactive conception planning. Planners can schedule their time and can automatically monitor and evaluate the activities undergone in this phase. By merging techniques from knowledge and hypermedia systems, Web-based concept planning of a project can address problems such as lack of control and initiative, and difficulties in understanding the pre-design planning process. Other advantages of the Web include multi-platform access, non-reliance on specified meetings in a physical space, hypertext facilities with structure guidance, ability to offer planners a choice of resources, and feed-back using 'fill-out' forms.

A prototype communication system has been designed which enables planners to receive and communicate project-specific data and information in many formats from their personal computers or from their firms' network. The prototype is entitled the Web-based Project Pre-Design Phase Information (P3I) System. This prototype will demonstrate how data is acquired and transferred to the user using an Intranet, and then processed and delivered to project planners via the Internet. Today, business needs great internal communication, and an Intranet is one such form of communication. Large corporations such as ATT, VISA, etc. are using Intranet technologies in a highly effective manner. One of an Intranet's most obvious virtues is its ability to eliminate or reduce the need for paper documents such as internal phone books, procedure manuals, training materials, and requisition forms. These can be converted to electronic form on the Web and constantly updated for a nominal fee. Thus, this research and the P3I prototype will help enhance methods for storing and communicating project data and information, thus improving the quality and timeliness of construction project management.

The objective of this paper is to offer a design and an implementation strategy of a Web-based Project Pre-design Phase Information System for construction project participants where data and information are centrally stored and processed by a database management system. Remote data entry into the database is performed on-line using appropriately designed Web forms developed for controlling the pre-design phase. Reports can then be automatically generated and presented on-line using Web technologies. Data entry and report generation is controlled by providing security access codes to authorized individuals within the agency executing the project, the user organization, and the statutory authorities.

MANAGEMENT OF THE PRE-DESIGN PHASE IN THE PUBLIC SECTOR

The government of Kuwait is a key player in the Kuwaiti construction industry. It is heavily involved in the planning, design and implementation of large public projects including residential, infrastructure, transportation, public utilities, and institutional buildings. There are many governmental agencies in Kuwait, such as the Ministry of Public Works (MPW), The Ministry of Electricity and Water (MEW), and The Ministry of Housing (MH). These ministries have the mission of supervising the execution of design and construction projects within budgetary limits, envisioned time frames, and pre-specified quality standards, with the goal of achieving the user-client's expectations and requirements. Accomplishment of such objectives requires discipline, experience, innovation, and extensive cooperation among project parties.

The process

Pre-design is the first stage of any public project. Its execution involves several key players, including the user-client organization, the executor agency, such as MPW or MEW, and other statutory authorities. Statutory authorities include the Ministry of Planning (MOP), Kuwait Municipality (KM), the Legal Advice and Legislation Department (LALD), and the Audit Bureau (AB). Each authority has a role in approving a public project during the pre-design phase.

Figure 1 illustrates the sequence of events throughout the pre-design process. The pre-design phase commences when a government agency such as MPW receives an authorization letter from MOP or a user-client (usually a government agency that requires a facility to be built for their operations). The letter formally requests MPW to manage and oversee the design and construction of the project. At this early stage, the project is typically in conceptual form. The user-client's space requirements, cost estimate, and site selection are tentative.

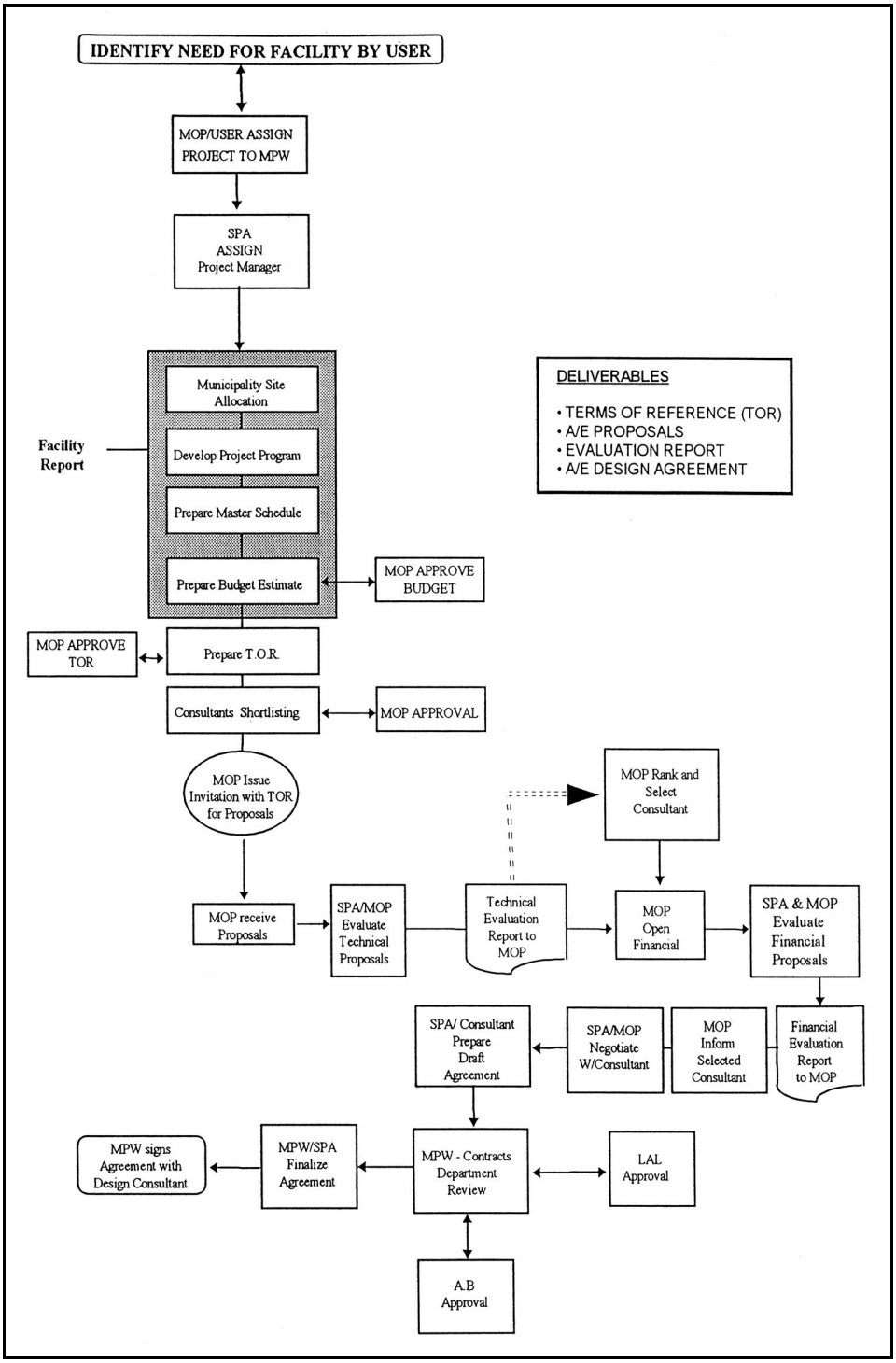

Fig.1. Pre-Design Process Flow Chart

Upon receipt of the authorization letter, MPW assigns a project engineer to the project, who familiarizes himself or herself with the nature of the envisaged project, through site visits and preliminary research. He or she establishes a conjunctive relationship with the user-client to understand and define project goals and requirements, analyze the tentative space requirements in relation to proposed project locations, verify appropriateness of the site, prepare a preliminary cost estimate, assess the feasibility of the proposed project, and develop recommendations in accordance with the findings and conclusions.

The project engineer initiates necessary communications and contacts with statutory authorities to define regulatory requirements. He or she ensures the availability of approvals by MOP (for funding) and KM (for site allocation). Consequently, the project engineer develops what is known as a "Facility Report." The report comprises preliminary information including the project program, a cost estimate, and work schedule. The purpose of the facility report is to provide a synopsis of the project requirements and expectations to the user-client and the MOP.

Upon approval of the facility report by the user-client and the MOP, the project engineer prepares the project's Terms-of-Reference (TOR). This document serves the purpose of soliciting both technical and financial proposals from design consultants. A TOR document generally consists of the project requirements, scope of work, issues and assumptions, guidelines, legal terms and conditions, and other pertinent information. Hence, it provides design consultants with a basic understanding of the project's objectives. MPW submits the TOR document to MOP and the user-client for review and approval. Subsequent to the approval of the TOR document, MOP issues the invitations to the short-listed design consultants to submit proposals. Meanwhile, MPW and MOP agree on criteria to evaluate submitted design proposals in terms of technical and financial evaluations, and then they solicit design proposals from international and/or local design consultants.

Upon receipt of proposals, MPW and MOP perform independent reviews and evaluations, which usually takes four to six weeks. MPW's review and evaluation of technical proposals is performed by a group of competent professionals. Afterwards, MPW prepares and submits a summary evaluation report that indicates the ranking of design consultants based on their technical proposals, along with MPW recommendations. On the other hand, MOP opens the financial proposals, and along with MPW evaluates them. Upon completion of the evaluation process, MOP and MPW together select a design consultant. MPW requests the selected Design Consultant to prepare a draft agreement. The draft agreement is then submitted to MPW's Technical and Legal Affairs Department for review and approval. At that point, the Technical and Legal

Affairs Department solicits approvals of MOP, LALD, and AB. Once approvals are obtained, the design consultant prepares the final bound volume of the agreement.

The process described above is complex, lengthy, inefficient, and costly. More importantly, it is too easy for errors, lost or misplaced information, or even fraud to occur. The P3I system is intended to significantly improve this process.

Forms of communication

Effective communication results in a clear transmittal, and a mutual understanding and interpretation of information. On the other hand, ineffective communication can often result in wrong transmittals, incorrect interpretation, or misunderstanding of the formal and informal information. Communications during pre-design phases are either verbal, such as at meetings, or written, such as letters and memos. Communications take place on a daily basis between MPW and Statutory Authorities/Ministries, potential consultants, and internal departments. For MPW, incorrect transmittal of information, whether written or verbal, can result in serious time delays during the pre-design phase. In order to prevent this, it is important for MPW staff to maintain effective communications through the use and implementation of a communication protocol.

A communication protocol can be described as a set of official formalities consisting of rules, guidelines, and procedures that govern forms of communication (letters, memos, and meetings) and their related actions. For example, prior to scheduling a meeting, there are a few guidelines that should ensure effective communications, and thereby reduce any potential liabilities that may arise. When MPW receives a letter from another ministry, the response from MPW shall be on a parallel level following protocol.

Variables affecting the pre-design phase

Many government projects consume considerable time and suffer costly major delays during the pre-design phase. Any project may be delayed because of a seemingly endless list of variables. These variables as reported by several officials and planners from MPW, MOP, LALD, and AB as they were interviewed as part of this research (Al-Tabtabai *et al* 2001) are:

- Slow decision-making process.
- Difficulty in the coordination of regulatory and governmental agencies.
- Lack of required planning expertise and skills by the governmental agency staff.

- Inflexibility by user-client administration toward pre-design procedures.
- Slow pre-qualification selection procedures of consultants by MOP.
- Poor attendance control over personnel or staff involved in the pre-design phase.
- Lack of training on planning tools and techniques and on studying user-client's requirements.
- Too little authority given to planners to approve pre-design changes.
- The government does not hire enough competent, specialized planners.
- Inconsistent coordination of pre-design documents and transmittals among the agencies.
- Inaccurate initial project scope estimates.
- Frequent pre-design change requests by the user-client.
- Poor application of planning and control procedures of the pre-design phases.
- Poor judgment and experience in estimating and planning procedures.
- No incentives for planner to finish ahead of or on schedule.
- No penalties for planners when finished behind schedule or to make planners more responsible towards completing the project on time.
- Poor meeting negotiation and team work.

These variables prove that there is a need to coordinate and report among MPW and the key players in planning a project. This need granted the research project with an ideal opportunity to test out new methods of participation by key-players in pre-design planning by utilizing the Internet, and running an exercise over the Web. The exercise provided the research project with a real example with which to develop, pilot and test simple pre-design participation that mirrored the functionality of the traditional way of pre-design planning.

THE INTERNET AND INTRANET AS A COMMUNICATION TOOL

While the planning process during the pre-design phase of a project in the government sector is still depending on stand-alone PCs and mobile phones, the communication medium is shifting towards more mobility with the advent of network computing and digital technology. Network computing and the wide area network systems such as e-mail, FTP, Internet and Intranet, etc. are not widely used among government agencies. The World Wide Web (WWW),

or the Internet, is a powerful tool for communicating a variety of data and information which, when used properly, has the potential of improving the quality and timeliness of information. This power results from the ease with which information can be obtained and shared on the Internet. The information to be shared resides on different computer hosts that are physically connected (networked) by the Internet. The Internet, if used effectively, can revolutionise the way planning and pre-design processes of government projects are managed.

Intranets use the infrastructure and standards of the Internet and the World Wide Web but are isolated from the public Internet through software and high-end routers known as "firewalls" (Koehler 1998). Intranet is internal and accessible only by employees or others with authorization. Who can access the information, application, data, knowledge, and processes through the same window (i.e., the browser). Security is maintained by the server, which recognizes the users by identification and password and gives access to customized screens and the level of information they desire or to which they are entitled (Barkowski 1999). Intranets pull all of the computers, software, and databases in the enterprise into a single system, effectively bridging the islands of information. However, an Intranet can do something far more important. The Intranet allows users to develop an Internet-based application, using graphical interfaces like the World Wide Web, while providing access to limited numbers of company employees through the use of intimate security mechanisms.

The successful implementation of Web-based applications depends on the state of technology and the functional requirements of such systems. The key technologies to the development are: (1) database and database management systems, (2) data acquisition and retrieval, (3) image processing and storage, (4) systems communications and network infrastructure, (5) system reliability and security, and (6) distribution of the databases (Nakano 2002).

The Internet and specifically the Intranet are gaining attention among researchers in the field of project management. There are numerous efforts in using Web-based technology, and many researchers have developed Internet based applications for various application domains in construction and project planning (Tan 1999, Barkowski 1999, and Wang *et al* 2000). A recent paper by Abudayyeh, O. (2001) provides a comprehensive literature review on the work done by researchers on utilizing the Internet as a mechanism for communicating project data and information.

Overview of necessary Web-based tools

Web development encompasses creation, modification, review and approval of files and documents. The development of a Web application involves issues relating to front-end protocols, back-end protocols, and network performance, as well as computer architecture and performance.

Front-end protocols

Front-end protocols connect the Web client and server in a simple request/response manner using hypertext. Hypertext is a non-linear text document with smart references within itself and to other documents. The advantages of hypertext include fast access to textual information, quick prototyping, and elegant user interface design and multimedia presentation. Hypertext documents may be delivered on static media such as floppy disks and CD-ROMs, and interactively on-line. Hypertext transfer protocol (HTTP) is a generally used standard for protocols in client-server communication and on the Web. HTTP is designed expressly for the rapid distribution of hypertext documents and it is the core protocol between servers and browsers. HyperText Markup Language (HTML) is the language used to prepare hypertext documents (Ladd & O'Donnel 1996 and Rosenfeld & Morville 1998).

Back-end protocols

Remote Procedure Call (RPC) and Remote Data Access (RDA) are some examples of back-end protocols invoked by the Web servers to provide services. The RPC protocol establishes a standard method for message passing communication between server and client systems. The RPC protocol is built on an external Data Representation (XDR) protocol which allows remote procedure calls to operate within a network of heterogeneous machines and operating systems. RDA enables a client to send Structured Query Language (SQL) statements to a remote system by means of the RDA protocol. The remote system (called an SQL server) returns the results of the SQL statements to the client.

IMPLEMETATION OF WEB-BASED P3I SYSTEM

The P3I system is a Web-based information system designed for the pre-design phase of public projects, where data and information are centrally stored and processed by a database management system. Remote data entry into the

database is performed on-line using appropriately designed Web forms developed for the Project Pre-Design Phase Information (P3I) System. Reports can then be automatically generated and presented on-line using Web technologies. Data entry and report generation is controlled by providing security access codes to authorized individuals (project managers, client representatives, planners, architects, area managers, etc.). The significance of this is that projects posted on the Web are accessible to planners and decision-makers from different locations. This distance communication could be utilized to revolutionize the way in which planning is performed. P3I can give planners and managers timely reports and details and online access to project and multi-project information from anywhere. It can provide decision support for project planning. The site can present budgets along with the progress of approvals.

The implementation of P3I was developed in three stages, namely: (a) development of the concepts, principles, and data needs relevant to the proposed project system (the conceptual model), (b) implementation of the Web-based project system, (c) testing and evaluation of the Web-based project system.

Stage 1. The conceptualization phase

In the conceptualization phase, existing data collection forms and project workflow reports are gathered and analyzed, in order to put together a list of data items that are used in managing the pre-design phase of construction projects. Current data processing methods and reporting formats for data and information acquisition, storage, processing, and reporting needs are evaluated to establish standard formats for data transfer. Although most projects have unique information requirements, a comprehensive site provides broad and intuitive categories for organizing information. Table 1 is a partial list of a comprehensive Intranet project pre-design planning site.

The basic premise behind the workflow paradigm is that the process of developing Web-standard formats consists of frequently repeated interaction patterns between people, projects, and the work-environment during the pre-design phase. The conceptualization stage starts with a selected MPW project engineer who is asked about the current mechanism by which he runs and manages a project. The P3I scope emerges from face-to-face discussions with the project engineer, after which the workflow is initiated. Then a Web development team enters, edits and monitors the reports submitted by the project engineer. The intent is clearly for each job to pass through enough checking to maintain quality.

Table 1. Pre-Design Web-based P3I System Site Content

Project Management Library	* Instruction on how to use the Web site * Project engineers manual * Policy and procedure documents * Templates and forms * Planning training exercise for newcomers
General Project Information	* Project description * Pre-design tasks progress * Phone and e-mails directories of key players * Project team rosters * Document control and approvals logs * Scope documents * Links to scheduling tools * Links to electronics document retrieval system
Technical Information	* Land survey and preliminary drawings logs * Preliminary estimates * Feasibility analysis and studies * Environmental impact studies * Links to diagrams and drawings
Management Information	* Meeting minutes * Approval logs * Master schedule * Task and resource checklists * Personnel evaluation * Pre-design change requests and notices * Integrated multi-project summaries
Financial Information	* Funding requests and accounts * Cash-flow baseline and projections * Multi-project financial statements
Statutory Authorities Information	* Links to statutory authorities' web-sites * Specifications databases * Procedures manuals * Approval and transmittal logs

Stage 2. The development phase

This phase was basically the selection and development of the infrastructure and application structure of the Web-based P3I system. This phase consists of five

main activities; (1) designing the data and information structure for the Web-based P3I system; (2) the selection of a database management system (DBMS); (3) linking the DBMS to the Web; (4) development of a user-interface; and (5) designing and implementing the security mechanism for P3I system users.

1. Designing the data and information structure for the Web-based P3I system

This activity consists mainly of designing tasks. These tasks are the design of the database management schema, the data entry forms, and the different reports that will be produced by the system. The P3I system includes the following tables: Project Category Table, Project Master Table, Fixed Data Table, Data Format Table, Yearly Record Table, Project Transmittal Log Table, and Yearly Data Table. The tables used are divided into four layers, as shown in Table 2.

Table 2. Database Tables in the Web-based P31 System

Layer	Name	Table Application
Layer one	Project Category Table	Lists all types of projects (housing, institutions, roads, utility, etc.)
Layer two	Project Master Table	Lists all the projects in the corresponding category. Each record in this table represents a unique project.
Layer three	Fixed Data; Yearly Record; Project Transmittals Log	* Fixed Data Table stores the basic information for each project. The data stored in the table remains the same for an extended period of time. * Yearly Record Table has one record for each year that has yearly specific data. * Transmittals Logs store all records and documents pertaining to a specific project among the key players.
Layer four	Annual Technical Data Table	Contains specific technical and engineering data sets (building codes, environmental, etc.) for each year.

The Project Category Table is used to list types of projects (housing, utility, building, infrastructure, road, etc.) along with its intended user. Each project has a record in this table. It determines if a corresponding table (the Project

Master Table) in the second layer exits for a particular type. The Project Master Table lists all the projects in the corresponding category. Each record in that table represents a unique project. The project data is presented along with the corresponding Project Data Table. The values for the project data include space requirements, site layout and geographical data. The Fixed Data Table stores the basic information for each project. The data stored in this table normally remains the same for an extended period of time. New values always replace old values, so information stored in this table is always up-to-date.

The Yearly Record Table has one record for each year that has year-specific data. Each record in this table has a corresponding table in the fourth layer. The Yearly Data Table contains specific data for each year. This table contains all engineering and technical data sets collected for a particular project, such as user requirements and specifications, special material specifications, special equipment and laboratory requests, and others.

2. The selection of a database management system (DBMS)

The second activity is to implement the database schema, reports and forms using a database management system. Since data sets have hierarchical features in this system, the relational data model stores lower-layer table names in the upper-layer tables. The data model of Web-based P3I is relational DBMS. Microsoft Access was used to design the database. Hierarchical database features were managed in this relational database to reduce the data redundancy and to speed up query processing. The information in the Web-based P3I system can be divided into two categories:

- *Text* - Project types, names, numbers, and facility information, etc. This type of data can be represented directly using intrinsic data types of access, such as text, number, and date/time.

- *Drawings and Diagram Objects* - The Microsoft Access program can manage drawing and diagram objects as OLE objects. An object (such as a Microsoft Excel spreadsheet, a Microsoft Word document, graphics, sounds, or other binary data) is either linked to or embedded (up to 1 GB) in a Microsoft Access table. The Web-based P3I operates the database at the back end. The method used to manage drawing and diagram objects in the Web-based P3I system was to store the complete path of the drawing and diagram files in text format.

3. Linking the DBMS to the Web (Web Server Site)

This task consists of linking the databases, forms, and reports to the Web using web-programming software. The result is a Web-based project system that has a centralized database and a number of electronic forms and reports that are accessible via the Internet. The Microsoft Windows NT 4.0 workstation was chosen as the platform for the Web server site. As for the Web design software, Microsoft FrontPage software was chosen. It is capable of meeting the desired specification of 800 pixel maximum screen width which ensures minimum screen width vertical scrolling of pop-up drawings and diagrams that are compatible with the most popular browsers, notably, the Netscape Navigator and the MS Internet Explorer.

A database connection must be created to use and access the information in the database. A database connection specifies the name, location, and types of database needed to be accessed, along with any other required parameters. MS FrontPage creates a database connection automatically when a system user imports data from a DBMS such as Microsoft Access. When managing and maintaining large databases, a network connection to a database server (e.g. Microsoft SQL server) can be created using a file or a string that defines the necessary information. Other features in MS FrontPage include:

- Filtering, sorting and formatting database results.
- Creating hyperlinks with parameters.
- Virtual paths, URLs are mapped to directories. The Web documents can be anywhere on the disks, and the administrator has complete control over the URLs used to access them.
- Virtual servers that support multiple home pages.
- User/group access control.

Database query: A password is needed to access the data entry and retrieval section of the website. Once in the website, the system user can submit data which is then stored in the database tables. Queries are then used to develop reports. These reports are displayed on demand. Two methods are provided for database query. The first uses an HTML form to collect all the criteria to construct a query. This method is called the *ordinary search*. Back-end database connectivity within Microsoft FrontPage will be launched to process the query and return the search result. This method is convenient to users who know exactly what they want to find. The second method is designed to lead users through a sequence of queries step by step. In each step, a list of selections will

be generated by Microsoft FrontPage based on some criterion. Since selection options are given, the user can construct the next query by just selecting from a drop-down list of options. This approach is especially designed for users who are not quite familiar with the information in advance. Also, this method could be used to do statistical searches, for example, to find all the project numbers in Kuwait City.

4. Development of a user-interface

The development of the user-interface was done by using HTML. The design of the system revolves around a Java map applet that allows the user to perform simple spatial query and attribute input operations. Using this Java map applet, users can view a layout of a project, perform zoom and pan operations to assist in visualization and navigation, perform simple spatial queries and then append attributes to specific features identified from the layout.

Front-end design using HTML form: The task of front-end design for the Web-based P3I system was to set up the HTML-form documents that are used as the interfaces for collecting user query information. It is a static form containing pull-down lists, text windows, and a search button. A good hypertext design must reflect these features while preserving the easy navigation ability. As mentioned earlier, the overall structure for the Web-based P3I system is a hierarchical model. Thus, two frames were used in the main page (i.e. the main user screen of P31). When the user clicks on the project, the system shows the location of the data. The items in this list can be selected, and P3I will query to the selected project and data record. The key information-retrieval functions provided by the system are listed in one frame, while the other frame is used to collect user query information for a specific function and invoke the search events.

Back-end services: The database connectivity within MS FrontPage is the main back-end protocol used by the Web-based P3I system to access the database. This connectivity has the following features:

- It shields application programmers from the details of the underlying database and communications software needed to access the target data.
- It defines an abstraction called a data source, which is a name that should have meaning to the end user.
- It maps this name to the appropriate implementation, network software, server name or address, and context within the DBMS.
- It allows multiple applications to access multiple data sources.

The majority of requests that the Web-based P3I system tends to serve will be

within the Intranet because the users interested in the information provided by this system will be mainly a group of engineers and Ministry management officers.

5. System Security for P3I System's Users

There is always a security risk associated with running a Web-based program on a server, since a rogue program can easily corrupt the data files being managed by the server if security procedures and security software are inadequate. Microsoft FrontPage provides administrative tools that let a system user set permissions and limit access to webs that he or she creates and edits on a Web server. FrontPage security is based on the security mechanism used by the Web server and its operating system. The project engineer of any public project can specify who can access webs in FrontPage by adding the users (and user groups) to the web's user list and specifying the type of access the user has. Users can have one of the following types of permission:

- Browse - the user can browse the files in the web.
- Author - the user can browse and change the files in a web.
- Administer - the user can browse and change the files in the web, and can also administer the web by adding and removing users. On systems running Internet Information Services (IIS), Microsoft FrontPage grants administrator access by default to all members of the Windows NT Administrators group.

These permissions are set on the root web (the top-level web on the Web server), and all subwebs below it automatically inherit these permissions. That means that a user with author permission can access all webs, and site visitors can browse all webs. If the project engineer wants to control the access to a subweb differently, he or she can set unique permissions for the subweb. This feature lets the project engineer control and divide web content among different sets of administrators, authors, and site visitors. On the other hand, the P3I system only provides information retrieval rather than database updating for non-credential information. No authentication or encryption was employed in this system for information that is not supposed to be confidential. The Web server will monitor and log access history, server error information, and server administration information.

Stage 3. The evaluation phase

The third research activity consists of the following tasks:

- Testing and evaluating the prototype P3I system,

- Modifying and refining the system based on the evaluation results, and
- Documenting the results and findings in a report and technical papers.

After the installation and initial testing of the P3I system, together with the completion of the communication hardware and software, a pilot service was established to test the reliability of the system and to establish the requirements of potential system users recruited from MOP and MPW who have a close connection with pre-design planning processes and procedures. These participants were offered access to the temporary website until a comprehensive and official launch was completed in order to identify faults or failures. The participants were registered and issued a username and password so that they could log onto the system. The test verified the reliability of the P3I system.

Web-based P3I system in practice

The P3I system is among the first on-line systems available to planners in a real planning participation process in Kuwait. The Project Engineer starts dealing with a public project by drawing a layout of a proposed project with its facilities after meeting with the intended users. This process involves a Computer Aided Design software tool (such as AutoCAD) and usually takes 10 working days. After that, the layout is scanned to the P3I Web site. Key players involved in the pre-design process can view a profile of a project, perform operations to assist visualization and navigation, ask questions such as "what is the space requirement of the specific facility of a project", and then make suggestions about specific features in the planned project. The structure of documents for the Web-based P3I system is shown in Figure 2.

When the system user first enters the site, after the initial welcome window, he or she is prompted to fill in a profile that describes his or her name, job function, roles, etc. This was seen as an essential part of the system design as it could be used to build up a database of users to help validate responses and finalize a user's space and technical requirements correctly. All user input is stored in the Web access logs and is then used by the Project Engineer for future analysis and feedback in the planning process. Figure 3 shows an example of a user input of a particular public project request. In this manner a project database is created representing a range of views, comments and decisions about pre-design planning issues of a specific project.

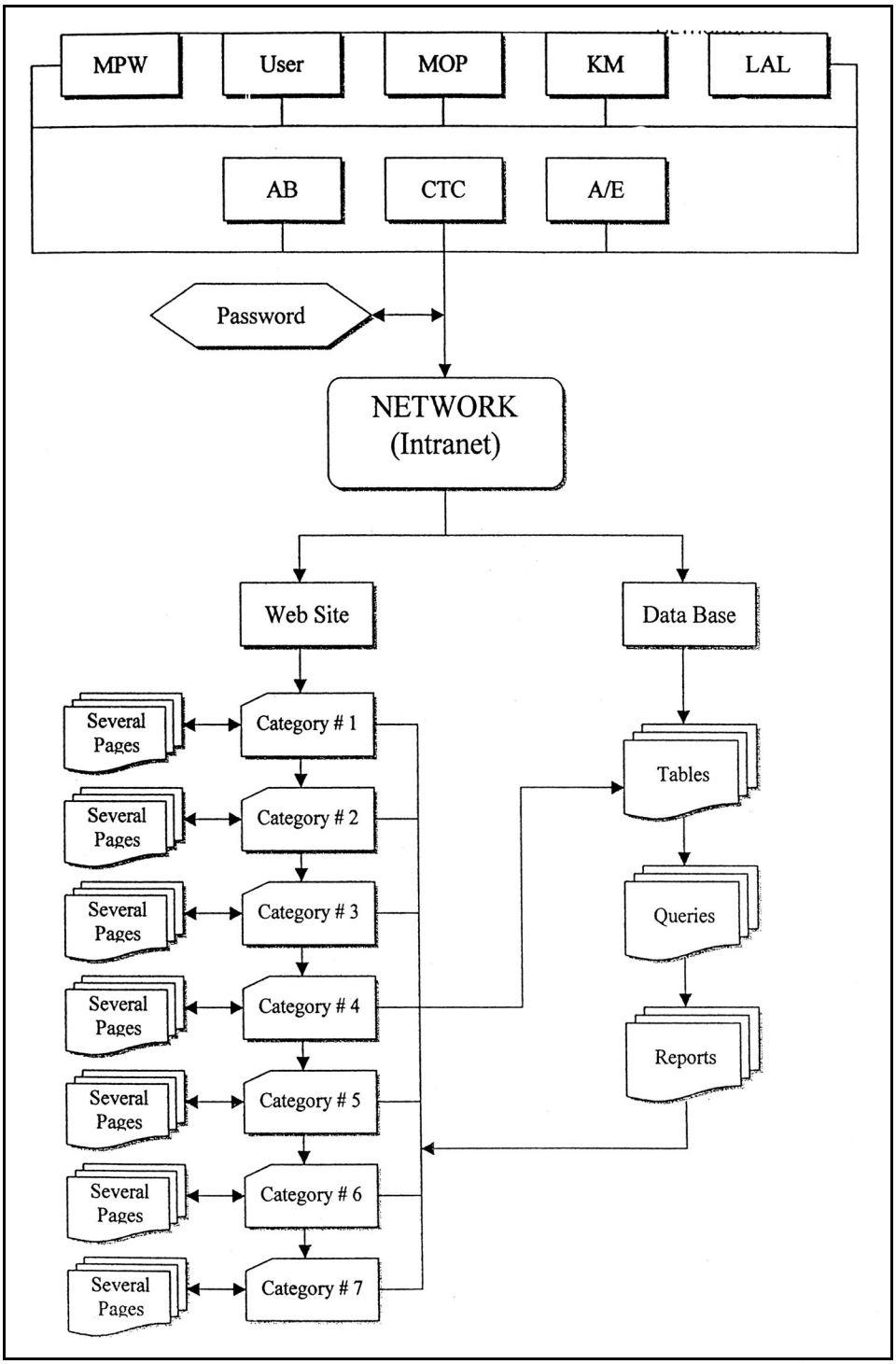

Fig.2. P3I System Framework

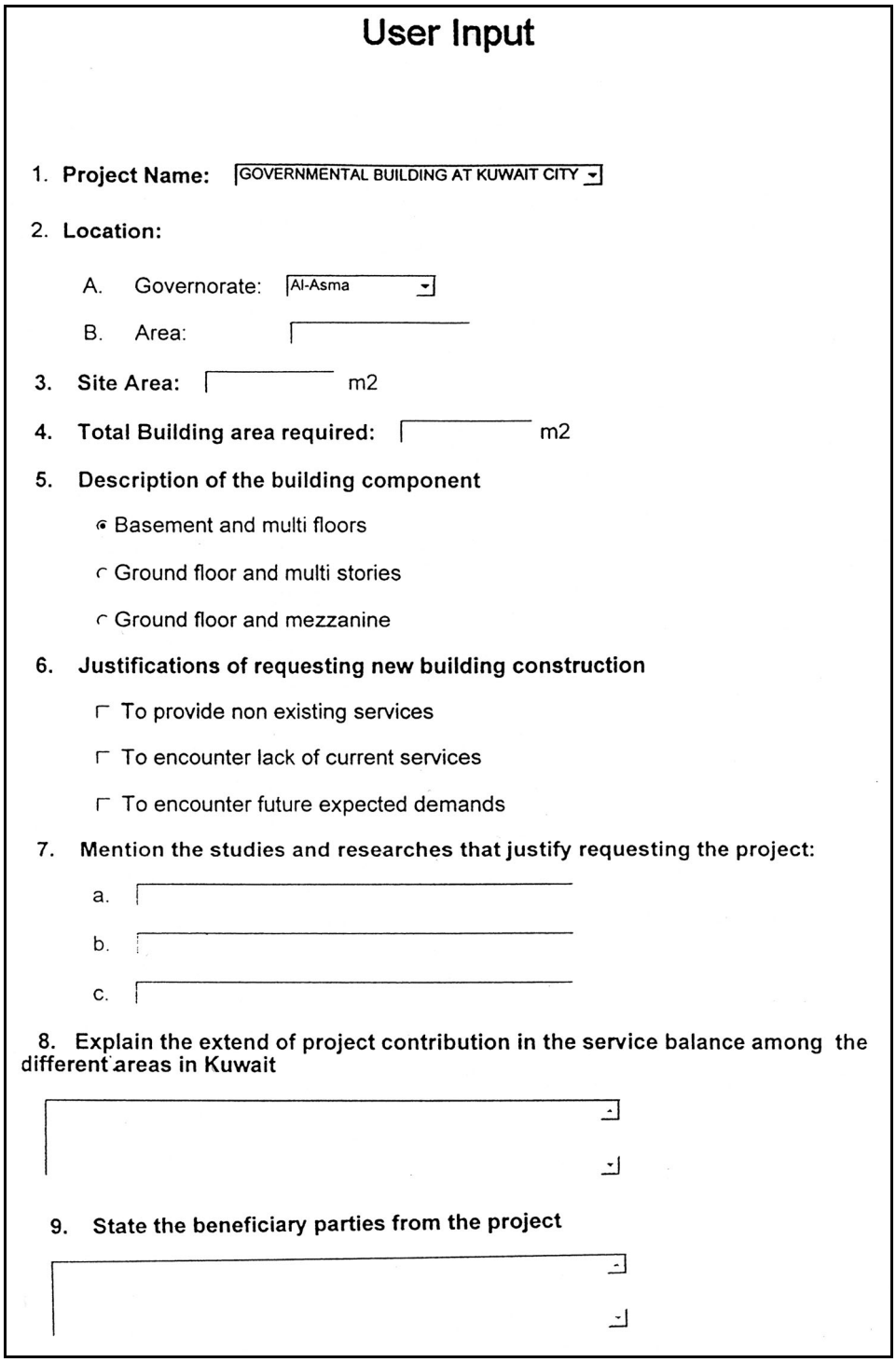

Fig.3. P3I System User Input Interface

Once the profile is completed and submitted, the layout of the project and the associated attribute data sets are downloaded. A window is displayed on the screen which contains "Instructions and Help" information, and which can be read while the project information loads. Once the project layout is displayed, the user can select any feature on the layout which causes a Window to display a form to the user to fill in with comments and suggestions regarding the selected feature. For example, if a facility feature is selected, and it is a multi-story building, then each floor has a form provided that allows the input of text relating to that floor. This officially and effectively registers the space and technical requirements to the system and to the project engineer. When the user has finished, he or she exits the system and is provided with a series of questions asking about the use of the P3I system, and requesting comments for future improvement of the P3I system.

One advantage to this Web-based method over the traditional pre-design planning exercise is the ability to instantaneously update the projects' database and profile users online. The online system has a long residence time allowing users and planners to use the system anytime, anywhere. The planners from different organizations do not need to attend a meeting at a particular time or place to approve a particular request. Rather, they can perform that process on-line. An example of this is an on-line government personnel approval form as seen in Figure 4. The system allows faster collection of results from log files, and the Web site can be used to disseminate results/feedback.

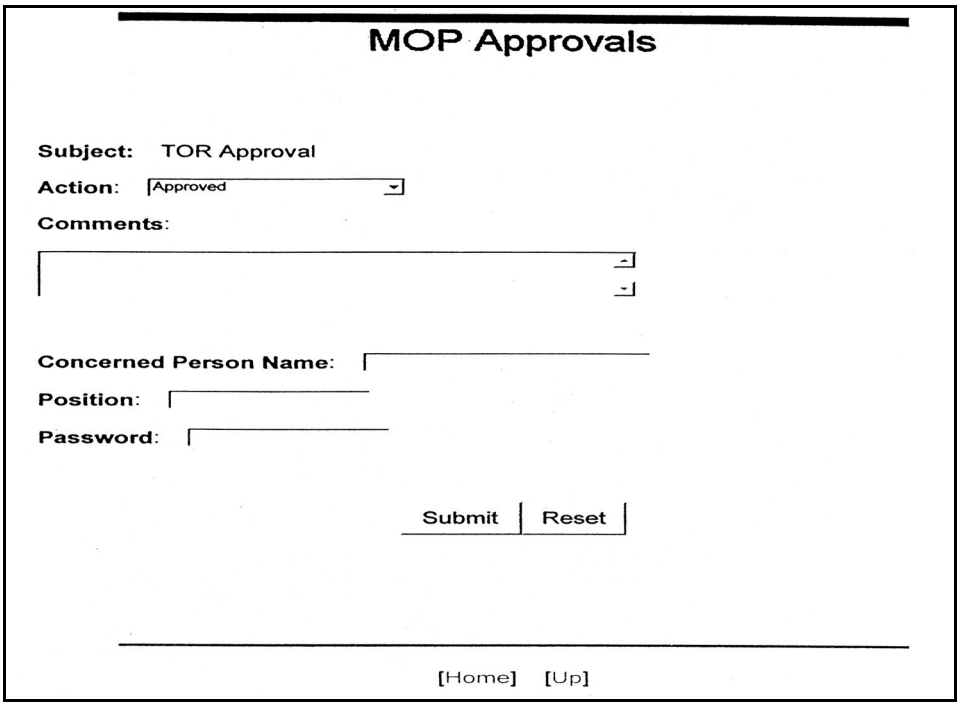

Fig.4. Document Approval Interface

Managing P3I prototype

The simplest approach to manage the content of website assets and files is suitable for a small website such as the P3I prototype, which consisted of less than 100 files. In this simple approach, there is one copy of the website, the live production copy. To make changes, a staff member can edit the assets directly. Since small websites are typically explanatory efforts, uptime isn't essential. The number of hits on the web is small, and the fact that files may be temporarily missing or incorrect on the production website doesn't affect many visitors. Live editing is adequate where the primary goal is to establish a concept. The major disadvantage of this arrangement is there is little control of the site. Typically the only version control consists of occasionally making an entire copy of the website.

As the number of files grows, and the number of developers (i.e., personnel from the different agencies responsible for required data entries) increases, it is no longer practical to edit the production web server directly. In this case a separate web server or a *staging* server is entered, which runs a copy of the production web server, with the difference that changes that the developers intend to put into production are copied from the staging web server first, as shown in Figure 5. This solution works with sites up to 1,000 files, when the number of developers is less than five (Nakano 2002). The staging website solution will be adequate for P3I (after the prototype phase) where it consists of a handful of developers. The staging server introduces the important ability to test changes before they go on-line. Developers are able to detect errors before they reach the production site.

It is expected that each government agency has staff to produce their own Intranet website to facilitate communication and collaboration, both within their agency operation, and with external agencies. A set of requirements relates to administering the people who play different roles in P3I infrastructure. First, the Intranet content of P3I consists of independent managed websites owned by each government unit. Second, within each government agency, the files are further divided into different groups. For example, the programming group owns the application code that derives the Common Gateway Interface (CGI) subsystem, while the content group owns the text and image content. Third, the responsibility for the web presence falls on a business owner (e.g. MPW or MP), who determines the form and timing of changes to the website. Fourth, many different individuals play different roles in the overall administration of the P3I infrastructure and there needs to be a way to allow only particular people to perform certain operations. This contrasts with a small or medium-size web team that typically has more relaxed rules about permissions and access.

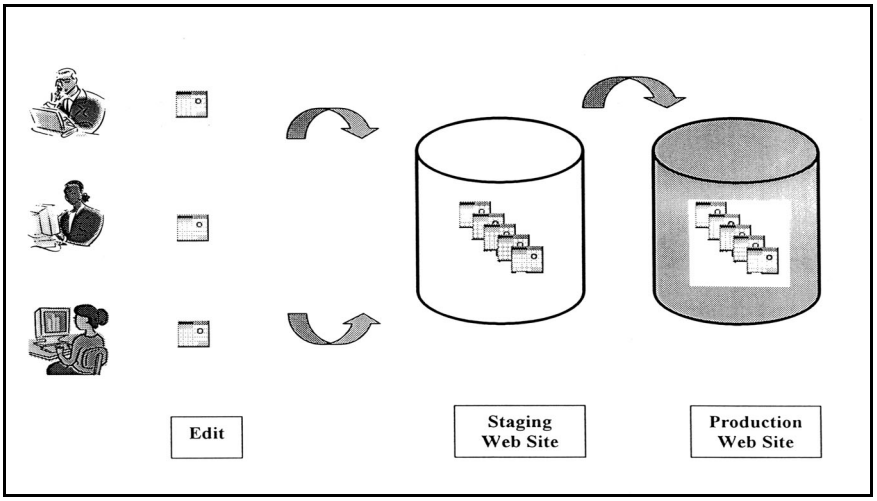

Fig.5. Copying a modified file to a staging web site allows a development team to test before deploying them to the production web site

1 - Each government agency is responsible for the following aspects of editing, managing and deploying a comprehensive P3I infrastructure:

   a - Specify the major subsections of the web files.

   b - Restrict who is authorized to deploy each section of the website, on a scheduled or on-demand basis.

   c - Specify the predetermined scheduled times that deployment occurs.

2 - The network infrastructure group is responsible for the following activities:

   a - For a given government agency, specify the production server that each section of the website is deployed to.

   b - Specify who is notified, and by what means, for success and failure of each deployment.

   c - Maintain the encryption keys used for the secure development of a comprehensive P3I website.

   d - Write and maintain the scripts that run before and after development of a P3I website.

Difficulties encountered

Using the Internet as a communication tool among planners and engineers of different agencies during pre-design is an innovation in the construction industry. The prototype P3I system so far built should be further developed and

improved in order to create a system that can be used in full functioning in the future. To improve this new concept and evaluate its impact on the pre-design process, answers to the following difficulties encountered during testing of the P3I system should be obtained and analyzed:

- Web servers were not designed for high speed transactions and high volume database requests.

- The actual ownership of all the different pieces of information and data can cause major problems in relation to who controls and owns the information. Any system that is map based could potentially be tied up in complex legal issues. The major problems encountered so far relate to the distribution of maps via the Internet by the Survey Administration (SA) at Kuwait Municipality. The SA is Kuwait's national mapping agency that holds the copyrights over most maps. Current SA thought relating to this matter is suggesting that a copyright fee should be paid to SA every time one of their maps is viewed or downloaded online. The copyright issue is probably the single most important factor which will prevent publicly funded organizations and projects from developing Web-based planning systems.

  - It is important that agencies' management develop careful procedures that dictate what will be published, how information will be transferred, and who publishes and controls that information.

  - Existence of an infrastructure is required for implementing this kind of technology application.

  - Availability of skilled, experienced, and motivated employees to operate the system is critical.

  - Computer illiteracy is common among government personnel even among planners and managers. This major source of inefficiency is a challenge for the success of Internet based applications.

  - Full conviction of the feasibility of using the Internet and a paperless approach in the pre-design phase by top management and administration authorities of the different governmental agencies should first exist.

  - There are many modifications that need to be applied on the systematical logic used for the current process of pre-design to suit the shifting to the electronic method.

CONCLUSIONS AND FURTHER RESEARCH

The sophistication of internal web networks continues to improve and will soon enable employees to fill out electronic forms for querying corporate databases, and to send and receive audio and video feeds. An Intranet is the next step in corporate applications for information distribution.

Four key conclusions can be drawn from the research thus far undertaken:

1 - The human-computer interface: there is a lack of basic computer skills among some government personnel and issues of interface design should be addressed. Systems need to be developed which can be set to different levels of skill dependent upon the user's knowledge.

2 - Spatial cognition: there is varied personnel understanding of pre-design technical information, which may influence peoples' use of P3I. Then again the question must be asked, do the planners really need to know how to use Web-based tools?

3 - Trust: The planners' trust of the system, the data contained in it and the purpose of the exercise need to be made extremely clear. There is the potential for misinformation and abuse of the system by persons who may have other motives. The Web is worldwide, and thus accessible by anyone which can lead to abuse. Results can be misleading if they are not checked to see who has been looking at the Web site and from where.

4 - Apathy: Maybe the glitzy hype of the Web will encourage more planners to participate.

Planners' involvement and efficiency and reliability of work can be maximized by Internet-based approaches, and the Web should be seen as a means of enhancing current practices, not replacing them. It has an extremely valid use particularly when information is acquired through lengthy time processes.

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Submitted : *2/12/2001*
Revised : *16/7/2002*
Accepted : *28/10/2002*

نظام دعم معلوماتي لمرحلة التخطيط (ما قبل التصميم) للمشاريع العامة باستخدام شبكة الإنترنت

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خلاصة

تستهلك العديد من المشاريع العامة والتي تنفذها الدولة وقتاً طويلاً في التخطيط وأثناء الإعداد للتصميم مما يسبب حدوث تأخير وذلك بسبب إجراءات الاعتمادات الطويلة من مختلف الجهات والوزارات مما يؤذي إلى زيادة الكلفة على ميزانية الدولة وإلى ازدياد الشكاوي من الشعب على تأخير إنجاز المشاريع والخدمات المقدمة لهم. وتقدم التكنولوجيا الحديثة باستخدام شبكة الإنترنت فرصة للتغلب على معوقات تخطيط المشاريع وتحسن من الحصول على المعلومات المطلوبة بشكل فعّال. وتناقش هذه الورقة العلمية تطوير نظام (P3I) دعم معلوماتي باستخدام شبكة الإنترنت يهدف إلى مساعدة المخططين وأصحاب القرار في إدارة مرحلة التخطيط (ما قبل التصميم) للمشاريع الإنشائية والعامة بسهولة وفعالية أكثر وذلك بواسطة تزويد الجهات الحكومية والتي تدخل في اعتماد المشاريع بالمعلومات والوثائق المطلوبة بواسطة شبكة داخلية (Interanet) معتمدة على شبكة الإنترنت ومتابعة المشروع والإجراءات والأنشطة المتعلقة بسير المشروع بواسطة الإنترنت وتبرز الورقة قدرات نظام (P3I) ومراحل تنفيذ هذا النظام. وتنتهي الورقة العلمية إلى شرح أهمية نظام P3I والمعتمد على شبكة الإنترنت وذلك في مساعدة المخططين والمستخدمين للمشاريع.