

APPLICATION OF INFORMATION AND COMMUNICATION TECHNOLOGY IN URBAN PLANNING AND MONITORING

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Abstract

Due to the complexity and uncertainty in the planning process in addition to the dynamic nature of urban planning and management, it is particularly important to have a well conceived information system, which can serve as the eyes and ears to development planning and monitoring processes. On the other hand, an effective urban planning and monitoring system will need to have the capabilities to accommodate strategic planning, facility management as well as problem solving. This paper will discuss various initiatives undertaken by several local urban governments through the application of information and communication technology (ICT) for improving the quality of urban planning and monitoring. Several related aspects such as the automation of the database, organisation of the system to facilitate ad-hoc query, analysis and development control as well as the use of planning support systems to enhance spatial modelling for the purpose of development planning and control will be the main focus. Development of web-based GIS to encourage public participation and establish system integration for data sharing between planning authorities will also be discussed.

Introduction

The framework for urban development and management can be viewed as a complex system as changes in one area, for instance intensification of use or changes in management practice, will often lead to change and pressure elsewhere. Acknowledgement of this situation is of vital importance to planners for it means that attempts to resolve a particular policy problem must consider the potential relationship between itself and other policy problems. Thus, policy-makers concerned with planning are faced with a range of problems which are inter-related in a most complex manner. The complexity, according to Simon (1982) is derived from the inter-relationships among the various elements in our organisations and the physical systems with which they interact.

The adoption of innovative technology such as that associated with Information and Communication Technology (ICT) can support planning and decision-making by offering relatively quick response on analytical questions and monitoring issues through the ability to retrieve information rapidly and efficiently, to model different development scenarios and to evaluate alternative solutions generated by various modeling procedures. With the continued development of ICT, there is a major opportunity for the urban authorities to use it to manage the allocation of scarce resources in a rapidly changing environment.

This paper will discuss various initiatives undertaken by several local urban governments through the application of ICT, especially those associated with Geographical Information Systems (GIS), for improving the quality of urban planning and monitoring. Several related aspects such as the automation of the database, organisation of the system to facilitate ad-hoc query, analysis and development control as well as the use of planning support systems to enhance spatial modelling for the purpose of development planning and control will be the main focus. Development of web-based GIS to encourage public participation and establish system integration for data sharing between planning authorities will also be discussed.

Evolving Concern Of ICT In Urban Planning And Monitoring

Much of development planning has to do with the use of the land and how the different types of land use relate to one another. The monitoring of land use change, on the other hand, forms an integral part of the urban planning process whereby policies and strategic plans are reviewed and updated. This task typically involves the identification of emerging land use patterns which are normally linked with other planning statistics such as employment, housing and population before the full significance of land use change are apparent. This requires planning programme to be adapted during their implementation as and when incoming information requires such change. Given the dynamic nature of planning and management, it is particularly important to have a well conceived information system, which can serve as the eyes and ears to a regional development planning and monitoring process. Hence, the planning development process requires a good support system to ensure a more rational and effective decision wherever planning management and development control are concerned.

The introduction of computers into planning in 1950s and 1960s was part of a more fundamental transition from the profession's traditional concern with the design of the physical city to a new focus on the quantitative techniques and theories of the social sciences. As suggested in Table 1, computers were assumed to play an important role in this task by collecting and storing the required data, proving systems models that could describe the present and project the future, and helping unambiguously to identify the best plan from the range of available alternatives (Harris and Batty, 1993; Brail, 2001).

Table 1: Evolving Views of Planning and Information Technology

1960s	System Optimisation	'Planning as applied sciences' Information technology viewed as providing the information needed for a value-and politically neutral process of "rational" planning
1970s	Politics	"Planning as politics" Information technology seen as inherently political, reinforcing existing structure of influence, hiding political choices, and transforming the policy-making process
1980s	Discourse	"Planning as communication" Information technology and the content of planners technical analyses are seen as often less important than the ways in which planners transmit this information to others
1990s	Intelligence	"Planning as reasoning together" Information technology seen as providing the information infrastructure that facilitates social interaction, interpersonal communication, and debate that attempts to achieve collective goals and deal with common concerns

Source: R.K. Brail and R.E Klosterman (eds), 2001. *Planning Support Systems: Integrating Geographic Information System, Models and Visualization Tools*. United States of America: ESRI Press

The evolving concept of ICT has been accompanied by equally fundamental but largely independent changes in the prevailing views of proper ICT in public and private sector organisations (Yaakup and Sulaiman, 2003). The development of information technology can be viewed broadly as an evolving concern with data during 1960's, in which the prevailing technology was batch processing of custom design, single-purpose, and transaction based information systems on mainframe computers. In the 1970's, the emphasis changed to conversion of data into meaningful form known as information. In relation, data processing for operational needs shifted to Management Information Systems (MIS) and integrated with the development of Urban Information System (UIS), Geographical Information Systems (GIS) and Land Information System (LIS). Next in the 1980's, the change of approach from information to knowledge reflected to decision makers on desire for analytical modelling capabilities. Toward intelligence-base information technology in 1990's, Planning Support System (PSS) should be designed to facilitate collective design, social interaction, interpersonal communication and a community debate (Brail, 2001).

Good urban governance undoubtedly needs an effective role played by local governments. The practice of good urban governance calls for local authorities to direct their actions toward efficiency, effectiveness, accountability and fairness (Yaakup, 2003). This clearly requires that local authorities improve or change their approach to city management. Apparently, the advancement of ICT has made it possible to contribute to better local governance.

GIS For Urban Planning And Monitoring

Spatially referenced data is a fundamental part of an information-based approach to urban planning. As much of planning issues are location dependent, Geographic Information Systems is seen as an appropriate tool for supporting urban planning and monitoring. The application of GIS in urban planning and development control is expected to enhance the rationality in the process of deriving at good planning decisions.

The success factors of GIS implementation in urban planning and monitoring rely on the overall strategy involving database development, spatial analyses and presentation of data for the purpose of planning and development. Among the strategies include defining the requirement for GIS implementation, design and development of the database, development of analyses models as well as development of hardware, software and human resources (Yaakup, 1991).

Defining Requirements for GIS Implementation

GIS for sustainable urban planning and monitoring will need to start with the automation of the database. As it is costly to collect, store and sift through large quantities of unnecessary data, the most cost effective approach is to collect only the data required for the specific task, in this case for urban analysis and planning. Data collected either from existing records, aerial photography or field survey will need to be integrated using GIS methods. The urban GIS will need to be organized to facilitate ad-hoc query and analysis. Next, the ability to perform spatial modelling is also of importance, so that alternative scenarios can be generated. Then, there is the need for the application of valid criteria to evaluate the effectiveness of possible planning strategies before the final solution is determined (Yaakup and Sulaiman, 2003). In brief, an effective system in supporting urban planning and monitoring will need to have the capabilities to accommodate strategic planning, facility management as well as problem solving.

Development of GIS Database

A well-integrated and comprehensive database design, which meets the user requirements, is one of the important elements that determine the ultimate success of a GIS (Chamber, 1989). Basically, several important aspects to be considered in a GIS database design can be determined as follows:

- the applications to be developed
- the data needs of each applications
- availability and formats of existing data
- size/volume of the database
- hardware platform and its configuration
- users background
- organisational structure of the users and facilities

The information related to the above items can be gathered through a series of brainstorming sessions to clarify what the system will be used for and what products it is expected to produce. It is important to note that the development of the system is to be carried out with a continuous support and involvement of the organisation's staff especially those who will later use the system to ensure the requirements are most fulfilled.

Data Analysis and Spatial Modelling in GIS

GIS deals with spatial objects, their properties, and their relationships to each other. Planners analyse the past and the present, and then project to the future. GIS, on the other hand, is not in itself future-directed. However, it does a very good job of enabling us to store, process and visualize current and past information. Models are used to assist planners in looking to the future. They permit scenario building and provide an important aid to future-directed decision-making (Brail and Wiggins, 1999).

Cartographic modelling uses the GIS functions through mantic sequential for solving complicated spatial problems. Generally, cartographic modelling is a means by which data from various layers are manipulated and analyse to generate the existing scenario and the what-if effect of a particular action taken. This cartographic modelling method is used to picture the existing development scenario and all other related elements of an area (Ibrahim *et al.*, 2001).

Despite the proliferation of advanced equipment and software in GIS technology, there are still many constraints on the use of GIS in urban and regional planning, which limit their effective application. As pointed out by Scholten and Padding (1990), GIS systems are not advanced enough for mainstream urban policy making because of the rather limited possibilities for analysis built into them and are also rarely user-friendly. Hence, there is a need to integrate existing analytical techniques and GIS packages by adding modelling software directly into such GIS software or developing easy to use interfaces with already developed planning models (Openshaws, 1987; Worral, 1989; Harris, 1990; Brail, 1990). Examples of the use of GIS have shown much of the problems associated with GIS (Brail, 1990) could be reduced if not completely overcome. The introduction of new software and better analyses functions as integrated in other Decision Support Systems (DSS) and Expert Systems (ES) should also be explored.

Development of GIS Infrastructure and Human Resources

Requirement in terms of hardware, software as well as human resources depends on the requirement and goal of the system to be developed. Several technical factors need to be considered such as system ability and capability to process lots of data as well as execute GIS functions including data entry, management, analyses and display of data. The system development should benefit and fulfill the objectives of its implementation. This could be achieved either through large investments and adoption of a multi-node system network or a simple and stand-alone system with the use of software ranging from a simple system to sophisticated ones. What is of importance is that it needs to meet the technical ability of the staffs in the organisation as well as financial allocation for the system development.

Application Of ICT In Urban Planning And Monitoring In Malaysia

Currently, there are various initiatives undertaken by several local urban governments in Malaysia for improving the quality of urban planning and monitoring through the application ICT. The applications developed will be discussed based on different levels of planning management and functions.

GIS-Based Support Systems at Various Levels of Planning Management

As mentioned by Harris and Batty (2001), GIS were developed in as simple a form as possible so that they could be adapted to a wide variety of basic tasks from computer mapping to simple data classification, across a range of scales and for diverse system types. Several examples in GIS applications have shown GIS as an important tool in planning and management at various levels of planning management.

Regional Level

Example of GIS application at this level is the Application of GIS for Klang Valley Region (AGISwlk), which was meant as a planning support system for decision makers in planning and monitoring of the Klang Valley region. The database for AGISwlk was designed and first developed to support eight application modules namely built up area, green and recreational area, traffic and transportation, squatter and low cost housing, environment, utilities and community services, industrial and commercial development as well as population and socio-economics. This required as many as ten elements of data including base map, administrative boundary, physical characteristics, land development, population and socio-economic, environmental quality, traffic and urban transportation, green and recreational area, public facilities and utilities (Yaakup *et al.*, 1999). Subsequently, the application modules of AGISwlk were developed base on relevant sectors for development planning and monitoring of the region. Various analyses were carried out under each module through adoption of the spatial modelling techniques using various GIS spatial analysis functions. They were used to generate scenarios and predict “What-if” situation base on the various sets of predetermined criteria. The database previously developed based on macro data approach was subsequently updated to provide comprehensive lot-based data especially for supporting analyses in terms of providing solution to specific problems at micro level. The overall system is further enhanced through development of user interface to simplify data access and management as well as web based GIS for public participation and data sharing.

State Level

The State Level GIS is meant for strengthening the planning system at the state level. It should help the state government in coordinating and monitoring of development within the state jurisdiction. As in the case of Negeri Sembilan, the State GIS being developed takes into consideration the database requirements for development programmes formulation at the state as well as district level. The development of the so called state planning database has the objectives of strengthening the state administration through establishing data sharing between government agencies and departments involved.

The approach taken in the GIS development took into account the requirements and functions of the State Town and Country Planning Department, local governments as well as the state technical departments. The considerations include planning, construction, maintenance as well as management of the database. This is to ensure that the data developed could be shared and used by all the identified stakeholders. In terms of coordinating development strategies at the state (macro) and local (micro) level, the need for consensus and data sharing between agencies involved is crucial. The overall system will include the development of the GIS database, the State Structure Plan Monitoring System, the District Local Plan Monitoring System as well as user-friendly interface for simplified data access. For the time being, the phase of GIS database development has been completed and will continue with data updating and maintenance apart from the development of the other components as mentioned.

Local Authority Level

The planning and monitoring support system for a local authority should be able to support decision making for a development proposal in its jurisdiction. As such, database development and system implementation need to consider requirement for data integration and sharing between departments involved. This may require the integration of several sub systems which have been developed relevant to the specific functions needed at certain planning approval stages or departmental tasks.

The Planning Information System as in the case of Batu Pahat, is implemented base on the workflow of planning application processing. The database was built using the database management system software (Microsoft SQL Server 2000) and could be accessed through the local area network. Apart from the development of a comprehensive GIS database, a customised system was prepared

specifically for the handling and monitoring of planning application for an area to include the sub systems for registration, technical checking, approval, updating as well as generating reports. The data query process and display of requested information is made easier and faster through a friendly user interface which was developed using the Visual Basic programming.

GIS for Development Plans Preparations

Development planning requires an effective planning approach to achieve the desired goals and objectives, evaluate alternative as well as control development programs that are in line with the current and future prospects. In Malaysia, the latest amendment to the act governing town and country planning requires the formulation plans at various spatial and administrative levels to ensure effective planning including (i) the National Physical Plan which outlines the strategic policies for the purpose of determining the general directions and trends of the nation physical development; (ii) the Regional Plan which establish policies to guide and coordinate development for a region especially in the provision of infrastructure and facilities of a region; (iii) the State Structure Plan which set out the policies and proposals for the development and use of the land in a state; and (iv) the District Local Plan which translate the state policies at local level (Yaakup *et al.*, 2003).

GIS technology has long been applied in planning activities which essentially include plans formulation. The Manual for preparing the various levels of plan has provided that all plans use GIS technology in plan formulation. Although the different spatial level and form of plans require different support in term of information system, GIS help enhance the rationality of the decision-making process by improving data accuracy and accessibility and as a consequences leads to 'better' decision. The same type of analyses may be carried out at every level of planning but the scope and scale of study as well as the criteria differs from broad in the case of the national level, to detail in the case of the local level in terms of deriving factors and weight.

At the National level, the plan essentially requires information of broad land use. Several study objectives were addressed for achieving the aims of providing comprehensive database and management system manual for spatial planning, providing indicative maps, providing policies and planning strategies for national spatial development as well as providing public institutional structure responsible for management, implementation and monitoring of the National Physical Plan. The study approach for the National Physical Plan provides for cyclic and continuous feedback on data compilation, analyses and strategies from the relevant agencies/departments. It uses GIS to determine land availability according to various criteria taking into account major factors such as existing urban areas, areas with physical constraints, agricultural areas to be preserved and so forth. Objective for carrying out the land availability analysis is to identify land which would be available for future urban development based on the two objectives of maximizing existing resources/investment and the preservation of the natural environment and national assets. The land availability analysis is carried out based on the sieve map technique. The National Physical Plan study will only focus on major and significant factors determining the level of suitability of areas for future urban development at a macro level. Thus, further detailed criteria would need to be looked into at other levels of planning such as the state and local level studies.

GIS is also identified as the main tool in the formulation of regional plans. Its functionalities is widely used to generate current and future development scenarios, which further facilitate among others, in determining future trend of infrastructure investments (Yaakup *et al.*, 2003a). The information at this level should help to describe the existing situation. It also contributes to improve understanding of regional problems by providing key factors and variable that can be analysed using regional and other spatial modeling techniques.

In the past, the number of alternative planning scenarios was rather limited due to the difficulties in producing them, which include the time consuming procedures of creating scenarios as well as the evaluation that follows. Policy-makers, like most decision-makers, face the difficult task of evaluating

and examining the impact of various resource allocations. The evaluation process appeared to be quite static and limited. However, having prepared the evaluation model, the operation can be accomplished within a much shorter time frame by computer processing of the data and computer mapping of the results. Integrated Land Use Assessment (ILA) is a new concept recently introduced within AGISwlk, aimed at developing an integrated spatial analysis model with the ability to generate alternative development scenarios by integrating physical and socioeconomic information. The model developed is expected to dynamically support the preparation of the Klang Valley Regional Master Plan (PELAWI). The utility of the model is in assessing the sustainability implications of different development options. The concept of integrated approach in ILA is focused on the aspect of integration of the applications previously developed in AGISwlk, which are more towards sector-based. The introduction of ILA as an integrated land use planning approach that applies the GIS analysis capabilities while supported by the use of planning support system (What if?) is seen as a good alternative for achieving better and more rational decisions. ILA is also expected to cater BKWPPLK'S main tasks which include regional planning, facility management as well as problem solving.

The inspection and reevaluation process involve enormous collection of data to be analysed for the purpose of policies, strategies and key diagram formulation, which support in determining the direction of the state development. The state level GIS should provide a comprehensive database of spatial information which include land use, utilities, environmental quality, agricultural land, etc. The role of GIS is made explicit in the design and development of a system for spatial as well as attribute data entry, storing, updating, analysis and presentation. The choice of GIS as a planning support tool is mainly to assist in the preparation of the key diagram that is highly reliable and rational. GIS capabilities in handling spatial analysis will be used to identify potential area for future development taking into account socio-economic, environmental as well as physical factors (Yaakup and Sulaiman, 2003).

The system developed for the purpose of Pahang State Structure Plan formulation covers three main aspects where GIS is concerned. These are the database development, spatial analyses and development of an executive information system (EIS). The database developed was based on the guidelines outlined by the Department of Town and Country Planning (JPBD) to support sector-based studies and analyses relevant to the State Structure Plan formulation. The main concern of the State Structure Plan would be the preparation of the key diagram which involves a combination of analyses such as determination of area having potential for future development and area for conservation. In generating the development scenarios for the State of Pahang, the Multi Criteria Decision Making (MCDM) method is adopted. The *What if?* software was used for the generation of spatial scenarios while *Definite* was used to determine the appropriateness of weights and ratings as well as evaluate of the resulting scenarios.

The district local plans are legal document that become the basis of development guidelines and control at the local government level. These plans contain such details as land use zoning, development density, buildings' height, plot ratio, etc. which require detailed information of each plot of land to be formulated. The tasks of preparing and analyzing this information can be speeded up and made easy with the help of GIS. A zoning plan, for example, covers a large area that contains various land uses. It will be a great advantage to be able to evaluate each alternative of a zoning plan using GIS (Yaakup and Healey, 1994). GIS allows for selection of suitable locations of social amenities, different size of housing, as well as evaluating potential impact on the environment. Lot based GIS is needed for the District Local Plan preparation. At this level, spatial analysis will involve determination of land suitability through multi-criteria evaluation (Yaakup and Sulaiman, 2003). As in the case of Batu Pahat and several other local authorities, EIS were also developed to assist display and query of information through a user-friendly interface.

Development Control System

Development control is a tool being used by the local government to control development in satisfying all parties by maintaining comfort, convenience and efficiency and preserving their built and natural environment. Development control is considered the most important activity for a local authority. The control of development which involves the process of analysing the appropriateness of planning applications, requires various data from the relevant agencies. It is seen as a problem for the local authority, especially in collecting planning data which undoubtedly need for the use of new techniques. Thus, an information system is necessary to not only keep and display data pertaining to planning application (Table 2) for the purpose of administrative functions but should also be designed to facilitate planning and development control at strategic level (Yaakup *et al.*, 2002).

A planning application will be assessed in terms of current development scenario, land information, planning requirements and planning design. Ideally, consideration for planning and building approval involves a technique for the systematic compilation of expert quantitative analysis and qualitative assessment of project land use and property development viability, including its effect on the surrounding area, and the presentation of results which indicate the resulting scenarios (Yaakup *et al.*, 1997). It should also indicate the scope of modifying or mitigating these adverse effects. This allows the proposed development to be properly evaluated by the relevant decision making body before a planning permission is rendered. As such, planners require the most up-to-date planning data while considering development applications as the basis for decision making.

Table 2: Stages involved in planning and building approval and relevant functions of information system

Stages	Activities	Functions
Initial Discussion	Consultation to owner/developer regarding potential, planning requirement, policies involved in the area	Data Retrieval: <ul style="list-style-type: none"> existing development development status development plan planning policies
Processing of Planning Application	<ul style="list-style-type: none"> registration site visit gathering data from various departments identify planning issues preparing technical report analysing the application 	<ul style="list-style-type: none"> identify potential land for development translate policies formulated into spatial context identify development pressure area
Consideration by Urban Technical Committee	<ul style="list-style-type: none"> comment on technical requirement recommend the technical amendment to applicant 	<ul style="list-style-type: none"> data retrieval from various agencies able to facilitate technical evaluation
Consideration by Town Planning Committee	<ul style="list-style-type: none"> formulate and review planning policies considering planning application 	<ul style="list-style-type: none"> capable of analysing the development strategy provide information to evaluate the planning implication

The Computerised Development Control and Approval System implemented by the Planning and Development Control Department, City Hall of Kuala Lumpur, is one of the ICT applications undertaken to facilitate the procedures to control and monitor the city development (Yaakup *et. al.*, 2003b). The system being developed integrates seven sub systems, each executing specific functions while at the same time interacts with one another by sharing information sources.

i. Planning Authorisation Sub System

The Planning Authorization Sub System operates to process planning application, starting from the submission of an application until the Policy Approval or Development Order is issued. This sub system was designed to encompass six modules including the Advisory Module, Registration Module, Task distribution and LPP Module, Agenda Module, Decision Documents Module and Monitoring Module to allow users, among others, to observe the related policies and spatial information while evaluating the planning applications and requirements. Apart from saving time and space, it helps to minimise workloads and reduce the use of papers. Besides, the data-sharing concept will minimise

overlapping of data stored in the database as well as information processing and thus, increase the quality and productivity of work.

ii. Building Control Sub System

This sub system is meant as a support for the building approval process beginning from the submission of application for building plan approval issuing of Certificate for Occupation. The features are similar to the Planning Authorization Sub System, which include graphic and interactive interfaces and enable interaction between sub systems. This sub system will assist the Building Control Division in managing their activities through the five modules developed which are the Registration Module, Evaluation of Application Module, Agenda Module, Decision Acknowledgement Module and Monitoring Module.

iii. Enforcement Sub System

The Enforcement Sub System assists the Planning and Building Control Department in planning and carrying out enforcement actions. The processes supported include generating of reports on site investigation, issuing warning notices, implementing control activities and reports on certain decision made by the department. This sub system also provides simple means for the public in filing complaints and receiving feedbacks from the local authority apart from facilitating the management officials in acquiring investigation reports faster so as to act in a more effective and timely manner. Four modules were developed for this sub system, namely the Enforcement Module, Planner Module, Building and Sanitary Module as well as Monitoring Module.

iv. Geospatial and Planning Information Sub System

This sub system is developed to provide a complete spatial database along with the attribute data which recorded the Development Order Approval, Building Order Approval, and Building Occupation Order. Its implementation involves of the GIS database development, data collection, data conversion and updating of spatial and attribute data. This sub system also provides support in terms of spatial data for the other sub systems, while at the same time enable users from other divisions to retrieve spatial information through the interface programmes developed. The information required by users could be retrieved using the query functions through either 'parcel', 'road', 'section' or 'county' identifications. This sub system will definitely help in more rational making decisions.

v. Information Kiosk Sub System

This sub system is built for internal users as well as the public to gather information through the Planning and Building Control Department's web site. This kiosk provides detail information on Kuala Lumpur, the Planning and Building Control Department as well as development control and enforcement. The system enables users to obtain information related to the City Hall of Kuala Lumpur apart from various forms and support documents provided. The system also allows the City Hall to announce important issues and application results to the public as well as provides function for access of spatial data through the internet.

vi. Document Processing Sub System

The Meeting Presentation Sub System enables the smooth progress of a meeting by providing facilities for displaying related information on development applications being discussed including plans, GIS related data and other associated information such as documents, maps and so forth. Information such as location plans, site images, perspective diagrams and proposal plans can be illustrated with a clearer image and can be retrieved promptly compared to conventional procedures.

vii. Meeting Presentation Sub System

This sub system is designed to store and retrieve all documents in a more systematic manner. This may solve the problems of storing and locating of physical files. All documents will be converted into digital formats and stored in the system database. This will enable users to manage the documents more efficiently and simply as and when they are needed.

Interactive User Interface to Simplify Data Access and Applications

As indicated by Chu (1999), 'informatization process' brought mainly by the innovation of computer-communication technology, is provoking tremendous changes in the cities and regions by breaking traditional organisation of space and time and is believed to become the central issues of the planning field. Since the importance of information is increasing day by day in almost every aspect of human affairs, the method of creating, obtaining and distributing information becomes also important.

Meanwhile, more and more studies are undertaken to further incorporate the use of GIS-based innovative technologies for the purpose of planning and monitoring. These include the development of planning support systems while providing interactive as well as user-friendly graphical interfaces to enable the use of the systems without the need for advanced technical skills.

Executive Information/Support System

Executive Information System (EIS) or Executive Support System (ESS) is a GIS-based support system developed for planning authorities to assist the display and query of information through a user-friendly interface especially for users without or with limited GIS skills. GIS display capabilities are also utilised for the purpose of public participation which is legally required in preparing development plans. This is important to gain feedback from the public for the review of plans. EIS or ESS is designed for simplicity, ease of use, through a windows-based interface, and to tailor data requirements available to local authorities and is expected to assist in the decision making process.

The system developed provides access to a comprehensive database which include spatial data and analyses results, policy and guidelines for the purpose of planning and reviewing where development plans preparation is concerned. The implementation of EIS/ESS with user-friendly and interactive interface through customisation of standard GIS software will ease the process of files or data retrieval, manipulation and updating apart from reviewing of plans, policy and guidelines. Examples of such system are ones developed for the Department of Town and Country Planning for the preparation and review of the Pahang State Structure Plan and Batu Pahat District Local Plan.

Web-based GIS Applications

Web-based GIS is currently one of the GIS-based innovative technologies being employed intended at upgrading the quality of urban planning. State of the art Web-based GIS are built on integration of multi-related technologies that include Object-Oriented Language, GIS package and language, HTML, CGI, and the theories about Public Participation GIS (Chang, 1997). The implementation concept base on global data sharing permits users to acquire and implement activities of interest the same way as implementation of application through the local area network. The implementation of web-based GIS is seen as a good means to encourage public participation as well as able to act as a gateway to data integration and sharing between planning agencies involved, especially through distributed data access. A good case study for the use of high-end technology in the application of web-based GIS for urban planning and monitoring is provided by the AGISwlk project.

i. Web for Public Participation

Public participation in urban planning is needed as a means of improving information and to facilitate the adaptability of the system. In Malaysia, the preparation of the development plans called for participation as a value consensus mechanism, not only from the public at large but other agencies to allow data sharing and to ensure more informed decision.

Web-based GIS for Klang Valley is initiated as an extension to the prior developed Application of Geographic Information System for Klang Valley Region (AGISwlk). While AGISwlk was meant as a planning support system for decision makers in planning and monitoring of the region, the Web-based

GIS is more towards inviting public participation apart from providing information in the form of maps and data for public access, and paving the path for data sharing with agencies having the same interest. The web-based GIS intended for public participation consists 10 applications as in AGISwlk including Population and Socioeconomy, Land Use, Tourism, Industry and Commerce, Environment, Traffic and Transportation, Utilities and Public Amenities, Green and Recreational Areas, Housing and Squatter Settlements and Geohazard. Through the web pages developed, users will be provided with a toolbox that functions in the implementation of the *Zoom In*, *Zoom Out*, *Pan*, *Hyper Link*, *Full Extension*, *Identify* and *Query* operations on the selected displayed maps. The operations offered a means for the users to display maps, submit query as well as display data sources and data structure base on selected maps (Yaakup *et al.*, 2001). This enables user to carry out the intended operations more interactively and easier without the need for any specific skills. Therefore, it is more time effective. Consequently, it assists public participation which is useful in making decision for urban planning and management. It will be a simple way for the public to access information through the Net. At the moment, web-based GIS can be seen as an effective means that allows transparency in planning processes.

ii. Web for Stakeholders' Data Sharing

For the purpose of coordinating development in Klang Valley which consists of five districts and involves eight local authorities, the use of GIS for planning and monitoring extends far beyond the need for a comprehensive stand-alone database as previously been developed in AGISwlk. Consequently, the GIS database needs to be integrated with the information owned and kept by the local authorities as well as agencies directly involved in planning and monitoring of development in the region. As such, the project AGISwlk initiated by BKWPPLK, which has full control of its data and focus information within Klang Valley, is currently web enabled to allow their identified stakeholders benefit the existing applications in the project as well as data sharing. The web application developed is believed to be an effective channel for the integration of the available data sets apart from encouraging data sharing between the various agencies involved in shaping the urban environment of the region.

Currently, data sharing has already been made effective between AGISwlk and several government agencies in Klang Valley, among others, the Minerals and Geoscience Department and the Federal Territory of Kuala Lumpur Department of Education. Continuing series of discussion with other related agencies has shown to be a successful effort.

The use of web-based GIS as a new medium for exchanging of data and gathering of information brings numerous benefits. It provides a simple means for the local authorities to provide or exchange spatial information on-line. Data integration through the distributed GIS database is expected to minimise redundancy in data preparation as well as overlapping of information, apart from reduce time consumption and cost for database development.

Concluding Remarks

The quest for sustainable development calls for the urban governments to be more efficient in their approach since they have to manage the current urban condition, while at the same time keeping in mind the needs of future urban population. Due to the complexity and uncertainty in the planning process in addition to the dynamic nature of urban planning and management, it is particularly important to have a well conceived information system, which can serve as the eyes and ears to development planning and monitoring processes. The introduction and advancement of ICT in the field of planning provides great opportunities for planning authorities to migrate from the conventional working procedures and manual filing-based system to a computerised system environment, while at the same time support strategic planning and rational decision making.

The widespread introduction of innovative technologies such as the use of GIS has provided an exciting potential for geographic information to be used more systematically and by a greater diversity of discipline than even before. GIS has proved to be invaluable tool for evaluating alternative solutions to urban planning problems. Planning database can be extensively interrogated to generate several alternative solutions to urban strategic planning problems. Various scenarios which take into account the socio-economic characteristic of urban dwellers, the constraints of physical development, availability of land and land suitability for different kind of development can be generated within GIS or through incorporation of modelling packages and other planning support systems. Meanwhile, web-based GIS is seen as an evolving approach that provides large opportunities to GIS users in improving their involvement in planning and management for a more efficient and well-organised urbanisation projects. This approach is able to support global GIS application in carrying out survey and making more rational decisions. The extra effort required by the initiator of the GIS application is to have internet server, backup server, software tool to make the application web enabled and disaster recovery programme.

However, it should be noted that the implementation of these technologies involves far more than hardware and software decisions. Effective implementation rests on a thorough and systematic evaluation encompassing planning, operational, organizational, institutional, personnel, financial and technical aspects. More research and attention need to be directed toward organizational and institutional issues, as well as developing the technology for planning and management purposes.

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