

Geographical Information System (GIS) as a Planning Support System (PSS) in Urban Planning: Theoretical Review and its Practice in Urban Renewal Process in Hong Kong

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Abstract

Planning Support system (PSS) is considered essential to urban planning specifically to make decisions or choices about alternative ways of using available resources, with the aim of achieving particular goals in future. Geographical Information System (GIS) has been used extensively in urban planning activities, whereas PSS are a class of geo-information systems composed of data/information, models and visualization tools that are primarily developed to support different phases of the planning process and its function. In this context, the GIS-based planning support systems is supposed to allow planners and citizens to quickly and efficiently create and test alternative development scenarios and determine their likely impacts on future land use patterns, associated population and employment trends, thus allowing public officials to make informed planning decisions (Ospina, 2004). Based on the archival research, this study aims to explore (i) the theoretical discourse underpinning the Geographical Information System (GIS), Planning Support System (PSS) and use of GIS as a PSS in the urban planning; (ii) the practical implication of GIS as a PSS with reference to the case of urban renewal process in Hong Kong; and (iii) key opportunities as well as limitations of use of GIS as a PSS in Urban Planning Process. This paper contributes to enrich theoretical discourse on use of Computer based technologies such as GIS as a fundamental tool in Planning Support Systems specifically to promote effective and efficient decision-making and urban planning process.

Keywords: *Geographic Information System, Planning Support System, Urban Planning, Urban Renewal, Hong Kong*

Introduction

Computer based technologies are gaining popularity to perform different planning activities. Planning Support system (PSS) is considered essential to urban planning specifically to make decisions or choices about alternative ways of using available resources, with the aim of achieving particular goals in future. Geographic information system (GIS) has been extensively used as a PSS in the context of urban planning and development. PSS are a class of geo-information systems composed of data/information, models and visualization tools that are primarily developed to support different phases of the planning process and its function. The GIS-based planning support systems allow planners and citizens to quickly and efficiently create and test alternative development scenarios and determine their likely impacts on future land use patterns, associated population and employment trends, thus allowing public officials to make informed planning decisions (Ospina, 2004). Indeed, GISs are an important components of a PSS because of their geoprocessing, graphic display, database and modeling capabilities but a PSS cannot consist of a GIS alone (Yeh, 1999a). Moreover, GIS is a tool being used to assist the process of decision-making but not to provide answers to all questions. In this regard, PSS must also include the full range of the planner's traditional tools for economic as well as demographic analysis and forecasting, environmental modeling, transportation planning, and land use modeling (Klosterman, 1995; Yeh, 1999a). It should also include technologies such as expert systems, decision support aids such as multi-criteria decision analysis, hypermedia systems, and group decision support systems. Nonetheless, GIS greatly facilitates different stages of the urban planning process, and has become a key tool in the PSS. This study first discusses on the theoretical discourse on GIS and PSS in urban planning, and then stresses on significance of use of GIS as PSS in urban renewal process in Hong Kong and finally draws opportunities and limitations.

Objectives

The main objectives of the study are

- To explore the theoretical discourse underpinning the Geographical Information System (GIS), Planning Support System (PSS) and use of GIS as a PSS in the urban planning.
- To explore the practical implication of GIS as a PSS with reference to the case of urban renewal process in Hong Kong.
- To explore key opportunities as well as limitations of use of GIS as a PSS in Urban Planning Process

Methodology

This study uses critical review of theories on Geographic Information System (GIS), Planning Support System (PSS), and use of GIS as a PSS in the context of urban planning and development process. Based on the archival research, the study explores the use of GIS as a PSS in urban renewal in Hong Kong.

Theoretical review

Planning Support System (PSS)

Planning is a continuous process, which involves decisions or choices about alternative ways of using available resources, with the aim of achieving particular goals at some time in future (Conyers & Hills, 1984; Sharifi & Rodriguez, 2003). Urban Planning is conceived as an activity with three main components: (socio-economic) analysis, (technical) design and (political) decision-making (Masser & Ottens, 1999). It involves many functions, scales, sectors, and stages (Yeh, 1999a). The functions of Urban Planning can be classified into general administration, development control, plan making, and strategic planning. General administration and development control are relatively routine planning activities, whereas plan making and non-routine strategic planning are undertaken much less frequently (Yeh, 1999a). The scale of the planning area covered can range from a whole city to a sub-region of a city, a district or a street block. The most frequently involved sectors of urban planning are land use, transport, housing, land development, and environment. At each scale of planning there are different stages such as the determination of planning objectives; The analysis of existing situations modeling and projection, development of planning options, selection of planning options, plan implementation, plan evaluation, monitoring and feedback (Yeh, 1999a).

To perform different planning activities effectively and efficiently, computer based technologies are gaining popularity. Planning support system (PSS) is essential to urban planning. PSS were first recognized in the late 1980s, as described by Harris and Batty (1993). They emerged through a convergence of efforts being undertaken in the areas of geographical information systems (GIS), large-scale urban modelling and decision support systems (Geertman & Stillwell, 2020). It is developed and advocated by many planners and scholars after 1990s although the underlying concept goes back to the 1960s. Over the last few years, certain individuals or groups, based at scientific research or planning institutions around the world, have been involved in the development, testing and implementation of a range of PSS. Klosterman (2001) suggests that the prevailing perspective of planning moved from the applied science approach in the 1960s through a focus on the political process in the 1970s to an emphasis on communication in the 1980s. The development of planning support system follows this evolutionary path. Urban planners, policy makers, and citizens now have the means to visualize alternative futures for their cities and regions.

PSSs are a subset of computer-based geo-information instruments, each of which incorporates a unique suite of components that planners can utilize to explore and manage their particular activities. The components may include data sets, computer algorithms and display facilities, as well as more abstract theoretical constructs, knowledge and modeling capabilities (Geertman & Stillwell, 2003). PSS can also be defined as spatial decision support systems consisting of three important components, namely: data, models and geo-visualization (Klosterman, 1999; Jiang, Huang, & Vasek, 2003) and are used to support the planning process by communicating information as well as by generating solutions.

Recent research and development of planning support systems (PSS) provide a range of interesting concepts and frameworks that can be adopted by system developers to design a multifunctional and planning-specific decision support system to meet the multifaceted needs of the planning process (Yeh & Qiao, 2004). It can be characterized as a spatial decision-making systems with particular application for planning, which involve a wide range of professionals with diverse backgrounds and the general public concerned (Jiang, Huang & Vasek, 2003). Harris and Batty (1993) also argued that the concept of PSS refers to an appropriate model for combining a range of computer-based methods and models into an integrated system that can support the planning function. More precisely, a PSS forms a framework in which three sets of components are combined: the specific planning task and problems at hand; the system models that inform the planning process through analysis, prediction and prescription; and the transaction of the basic data into information which in turn provides the driving force for modeling and design (cyclic process) (Geertman & Stillwell, 2009). Alternatively, Klosterman (1997) and Brail and Klosterman (2001) described PSS as information technologies that are used specifically by planners to perform their unique professional responsibilities. In their opinion, PSS have matured into a framework of integrated systems of information and software, which brings together the three components of traditional decision support systems-information, models and visualization-into the public realm.

While Hopkins (1999) believes that the search for an appropriate role for information technology in planning must begin not with the technology but with the planning problems. In his view, a PSS can and should be based on a common set of objects inherent in urban development processes (e.g. like actors, activities, flows, facilities) and on views (e.g. like sketches, models, scenarios) and associated tools that share these common objects so as to support a full range of planning tasks. In fact, PSS contributes to rationalizing planning and related decision making process by providing necessary support to systematically structure and formulate problems, develop alternative plans or policy scenarios, assess and evaluate their impacts(considering objectives of the relevant stakeholders), and to select of a proper policy or plan (Sharifi & Rodriguez, 2003). Moreover, underlying the development of a PSS is the assumption that planning is a dynamic process, and therefore requires the relevant support for continuous updating of data, generating and evaluating plans and policies based on the updated data and assumptions. The overall architecture of a planning support system can be expressed by the following diagram

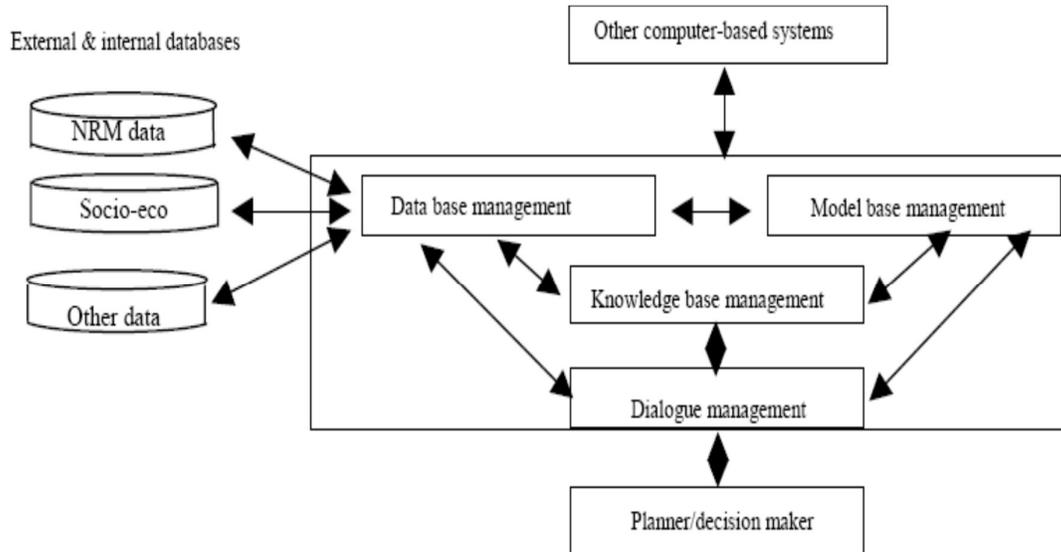


Figure 1: Architecture of PSS, adopted from (Turban, 1995)

The database management includes databases designed to accommodate and organize the basic spatial and thematic data, provide facilities for selection and manipulation of data as well as integrating data from various sources, while model base management includes quantitative and qualitative models that support resource analysis, assessment of potential and capacities of resources at different levels of management (Sharifi & Rodriguez, 2003). Therefore, the use of data base management, model base management and computer-based system integrated with a knowledge base management and dialogue management can help planners/decision makers to decide their plans or policies effectively and rationally. We can argue that PSS are a class of geo-information systems composed of data/information, models and visualization tools that are primarily developed to support different phases of the planning process and its functions.

Geographical Information System (GIS)

Geographical Information Systems (GIS) were developed in the late 1960s (Yeh, 1999a) and became popular so rapidly over the past decades that it is now accepted as an essential tool for the effective use of geographic information (Aronoff, 1991). The subsequent fall in the prices of hardware, computer storage, and peripherals accompanying improvements in the performance of hardware and software (particularly the speed of computer processors), and advances in the data structures and related algorithms of vector-based GIS, has made GIS more affordable, less time consuming and more workable (Yeh, 1999a). GIS are seen by many as special cases of information systems in general. Information is derived from the interpretation of data which are symbolic representation of features. ESRI defines Geographic Information System as an organized collection of computer software, hardware, geographic data and personnel designed to efficiently capture, store, update, manipulate, analyze and display all forms of geographically referenced information.

GIS can provide a technology and method to analyze spatial data, or information about and related to the Earth. Moreover, Maguire (1991) suggests that there are four basic approaches to defining and separating GIS from other types of information system: the process or function-oriented, application,

toolbox, and data base approaches. The process-oriented approach emphasizes the information handling capabilities of GIS. The application approach divides information systems on the basis of the problems they seek to address (e.g. welfare, banking and transport information system). The toolbox approach emphasizes the generic aspects of GIS and is represented by the widely used definition of Burrough (1986) i.e. a powerful set of tools for collecting, storing, retrieving, at will, transforming and displaying spatial data from the real world. The data base approach is probably the most widely used, because of the influence of database theory and practice on GIS (Maguire, 1991). GIS can be used for different types of works to provide geographical information such as: Cadastral information System, Image based information System, Land data system, Land information System, Geographically referenced information system, Natural resource management information, Market Analysis information System, Multipurpose Cadastre, Planning Information System, Property Information System, Spatial Information system, Spatial Decision Support system and Urban Information System (Maguire, 1991; Yeh, 1999b). Moreover, one of the most important uses of GIS is in the urban planning specifically as a Planning Support System. Hence, GIS is an assemblage of hardware and software that becomes useful only when it is properly placed in an organization and supported by expertise, structured data and organizational routines. When planning to introduce GIS, it is important to pay attention to all four links in the GIS chain as shown in figure below.

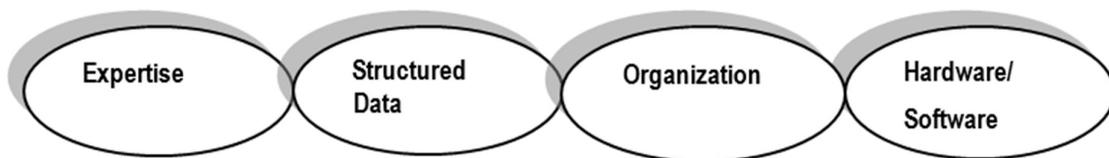


Figure 2: GIS Chain (Bernhardsen, 1999)

Use of GIS in Urban Planning: Essentials of PSS

Urban Planning is one of the main applications of GIS. The needs of planning have actually anticipated the development of GIS (Masser & Ottens, 1999). Virtually all the GIS systems that are currently in use in urban Planning have been developed since 1990 (Masser & Craglia, 1996). GIS is one of the most important computer-based technologies significantly used in urban and regional planning. It is a fundamental element of Planning Support system. As per Batty (1995) and Klosterman (1995), PSS comprise a whole suite of related information technologies (e.g. GIS, Spreadsheets, Models and Databases) that have different applications in different stages of planning. GIS are becoming important components of PSS by virtue of the geoprocessing, graphic display, and database and modelling capabilities they possess (Yeh, 1999a). GIS-based planning support systems allow planners and citizens to quickly and efficiently create and test alternative development scenarios and determine their likely impacts on future land use patterns, associated population and employment trends, thus allowing public officials to make informed planning decisions.

Indeed, GISs are an important components of a PSS because of their geoprocessing, graphic display, database and modeling capabilities but a PSS cannot consist of a GIS alone (Yeh, 1999b). Moreover, GIS is a tool being used to assist the process of decision-making but not to provide answers to all questions. While PSS must also include the full range of the planner's traditional tools for economic as well as demographic analysis and forecasting, environmental modeling, transportation planning, and

land use modeling (Klosterman, 1995). It should also include technologies such as expert systems, decision support aids such as multi-criteria decision analysis, hypermedia systems, and group decision support systems (Yeh, 1999a,b). Hence, GIS is just one of the formalized computer-based information systems capable of integrating data from various sources to provide the information necessary for effective decision making in urban planning (Yeh, 1999a). It serves both as a database and as a tool box for urban planning (Figure 3).

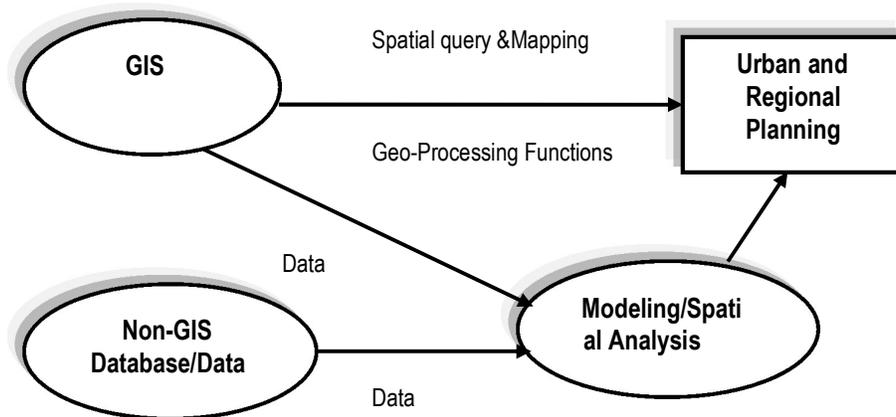


Figure 3: GIS and Urban Planning (Yeh, 1999a)

In a database oriented GIS, spatial and textual data can be stored and linked using the geo-relational model. Current GIS supports efficient data retrieval, query and mapping. Planners can also extract data from their database and input them to other modelling and spatial analysis programs. When Combined with data from other tabular databases or specially conducted surveys, GIS can be used to make effective planning decisions. As a toolbox, GIS allows Planners to perform spatial analysis using geo-processing functions such as map overlay, connectivity measurement, and buffering (Berry, 1987; Tomlin, 1990).

Database management, visualization, spatial analysis, and spatial modelling are the main uses of GIS in Urban Planning (Webster, 1994; Yeh, 1999a). Since, GIS is used for the storage of land use maps and plans, socio-economic data, environmental data and planning applications, Planners can extract useful information from the database through spatial query. Mapping, the most important visualization tools in GIS, can be used to explore the distribution of socio-economic and environmental data, and display the results of spatial analysis and modeling exercises. Spatial analysis and modeling are used for spatial statistical analysis, site selection, and identification of planning action areas, land suitability analysis, land use transport modelling and impact assessment. Interpolation, map overlay, buffering and connectivity measurement are the most frequently used GIS functions in spatial analysis and modelling. The use of the above functions varies according to different tasks and stages of urban planning (Yeh, 1999b). According to RTPI (1992), the many benefits using GIS in urban planning are: (a) improved mapping-better access to maps, improved map currency, more effective thematic mapping and reduce storage cost; (b) greater efficiency in retrieval of information; (c) faster and more extensive access to the types of geo-graphical information important to planning and the ability to explore a wider range of “ what if “ scenarios; (d) improved analysis; (e) better communication to the public and staff; (f)

improved quality of services, for example speedier access to information to planning application processing.

Different scales of planning require different data and technique. Raster data are more useful for city wide strategic planning as high resolution is not required. On the other hand, vector data are used for district and local action area planning because of the need for very high resolution analysis (Yeh, 1999a). According to Yeh (1999a), the data management, visualization and spatial analysis are used more in the routine work of urban planning while spatial modeling is used more in strategic planning. Moreover, general administration employs mainly data management and visualization. Finally, development control uses the visualization and spatial analysis functions of GIS most. Similarly, Plan making process also require the significant use of Visualization, spatial analysis and spatial modelling functions of GIS (Yeh, 1999a). Webster (1994) shows that there are significant differences in the degree of GIS use in the description, prediction and prescription planning process. Description is used more often in general administration, whereas prediction and prescription are used more often in plan making (Yeh, 1999a). Hence, the role of GIS varies in different stages of the urban planning process. It is more useful in modeling and development of planning options than in determination of planning objectives. As per Yeh (1999a), GIS can be extensively used in the different stages of urban planning process (Figure 4). However, GIS alone can't efficiently support the planning process, so its integration with other models or systems is needed. The use of GIS along with the other databases/models and remote sensing in the different stages of planning process can be clearly illustrated in the diagram (Figure 4).

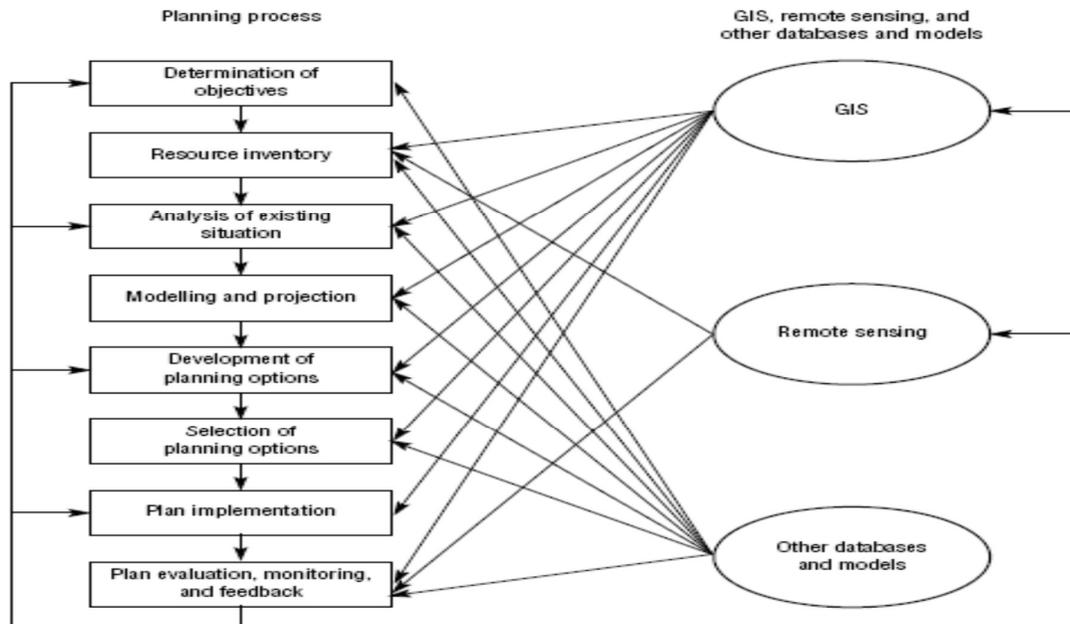


Figure 4: Integration of GIS, Remote Sensing, and other databases and models in the planning process (Yeh, 1999a)

Any type of computer based systems used to support the planning are the planning support system and GIS is one of the fundamental part of PSS. Typically, GIS provide generic solutions whereas PSS are specific and focused on the tasks of the application. This implies the handling of spatial and non-spatial data as well as spatial data; historical data sets as well as projections; qualitative information as well as quantitative; implicit and semi-or even ill-structured knowledge as well as explicit and well-structured

knowledge; and the modeling, design, and analysis of dynamic spatial data and information as well as the management and presentation of static spatial data or information (Greetman & Stillwell, 2003). It can be argued that PSS needs to incorporate a wide body of knowledge and use a broad range of data sources and, GIS needs to be complemented by theories and models from a broader perspective. Many models based on GIS have been developed as a PSS in the planning arena. From the technical and functional viewpoints, it has been commonly accepted that a PSS should be built on the basis of GIS technology (Harris, 1989; Klosterman, 1995). Based on this ideology, Putman and Chan (2001) has emphasized a model called urban model/GIS-based PSS, which is illustrated in Figure 5. According to them, to fulfill the function of planning support, a urban model/GIS-based PSS should be composed of at least three modules, or module groups such as (a) model knowledge module (b) model operation and (c) the information transformation/communication module. The data /information exchange engine in the system is provided by the external database management system (DBMS).The framework follows the flow of information in the planning process, which can be defined as information collection, information organization, and information communication.

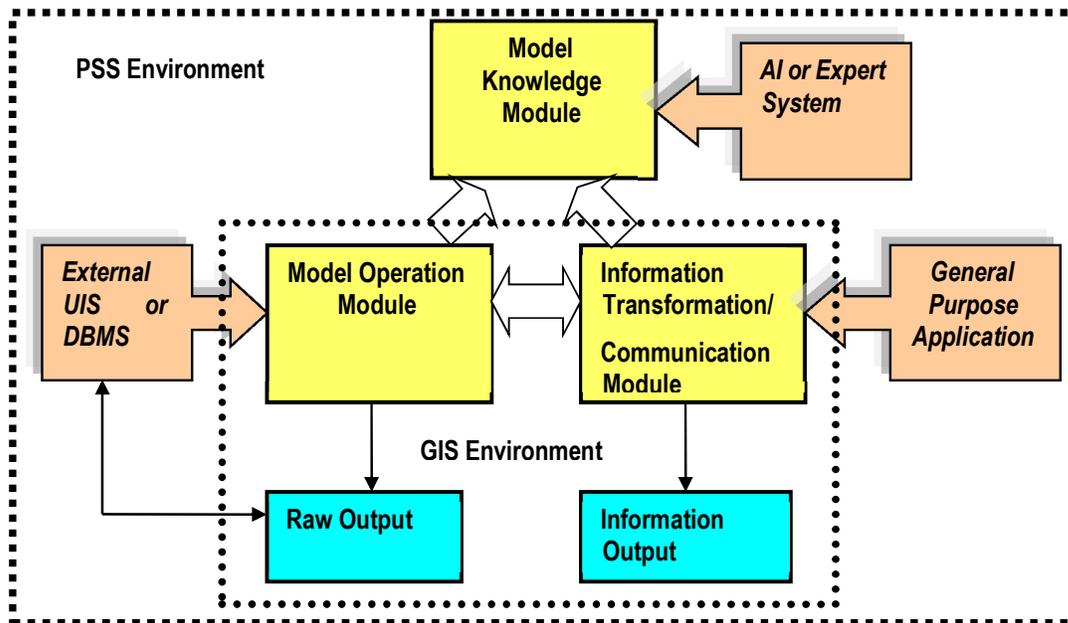


Figure 5: Overview of an Urban Model/GIS based PSS (Putman & Chan, 2001)

The model operation module and the information transformation/communication modules are the two major components of the information production function of the system. The model operation module performs both the functions of prediction and prescription, depending on the contents of the models included. Once the required information is generated from the analysis processes, planners have to communicate and exchange the information with other entities, which include experts, the public, and/or other PSS. With a further connection to a database management system, DBMS, the overall system would be able to cover a major portion of the several procedures of information production. In this model, GIS only serves as a one powerful component of PSS rather a whole PSS system. This can be further illustrated by the following relationship diagram. From the above explanations, it is clear that GIS has to work with other databases, techniques and models in urban planning process. GIS alone cannot serve all the needs of planning because the current generation of “general purpose” systems

cannot easily accommodate the particular informational, computational, and display needs of planning (Klosterman, 2001). Thus, each different planning situation will have its own planning procedures, underpinning theory, data, information, knowledge, tools, methods, presentation requirements, et cetera and will therefore require a customized PSS. On many occasions, a proprietary GIS will form part of a PSS, given the useful set of functional capabilities that it provides (Geertman & Stillwell, 2009).

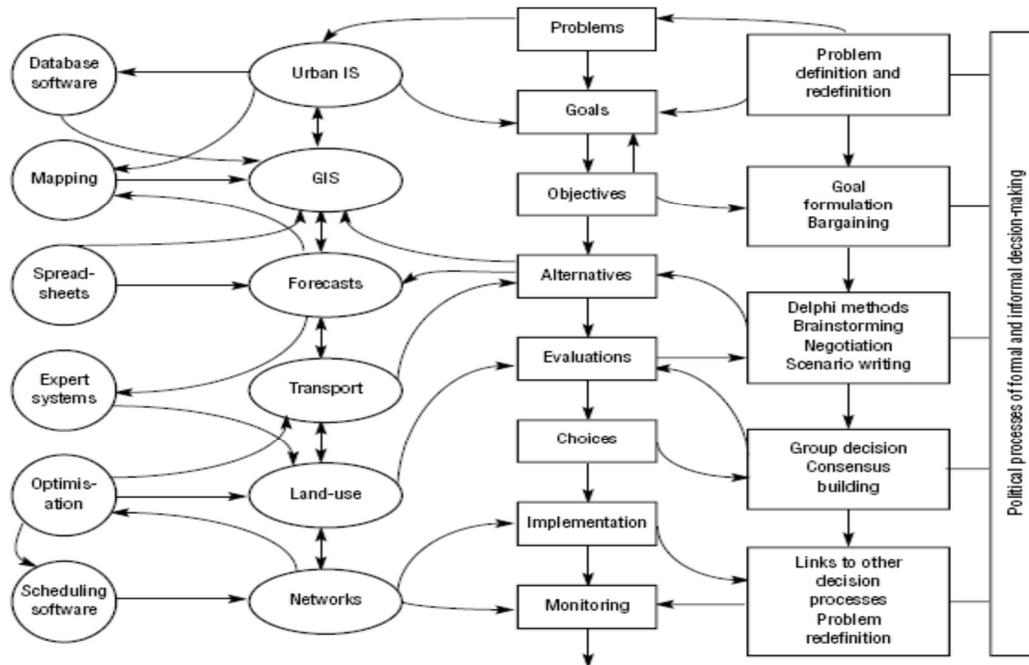


Figure 6: The Planning Process Supported by a formal computation desktop PSS (Batty , 1995)

Hence, all computer based systems having GIS as an important element and which have implications on planning process are PSS such as : Case based reasoning system, Cellular Automata, Entropy methods, Location allocation models, GIS 3-D visualization, web based information, other planning models etc. In summary PSS are not equivalent to GIS or any other decision support system, although elements of GIS are frequently found within PSS. Moreover, PSS are not a radically new form of technology that will replace existing planning tools but they take the form of information frameworks (Klosterman, 1997) that integrate the full range of information technologies useful for supporting the specific planning context for which they are designed.

Use of GIS as a PSS in Urban Renewal: A Case of Hong Kong

Urban Renewal in Hong Kong: An Overview

The urban renewal is a process of replacing the old dilapidated built structures by new buildings of modern standards in order to improve the quality of life of residents. It is a broad issue which includes economic, social, environmental, organizational, preservation and many others. Urban renewal is one of the fundamentals of urban planning and its prime aim is to improve the quality of life of residents and contribute for the sustainable development of the cities. Hong Kong is a densely populated city with about 7.413 million people and total land area is around 1100 Sq. Km. The developable area is

scarce due to its hilly topography. According to HK 2030, the population of Hong Kong will reach around 9 million in 2030, however the population growth rate is not as expected. Besides new town development and the harbor reclamation, planners have to find new ways to accommodate growing population. Like all other cities in the world, Hong Kong has also dilapidated urban areas facing various problems such as inadequate housing space, inadequate community facilities and environmental deterioration, etc. To solve the problem of urban decay and accommodate the increasing population, renewal of the dilapidated inner urban areas has become the most feasible solution, although works of Government and private sectors are often criticized by the public (Hui, Wong, & Wan, 2008).

Urban redevelopment in Hong Kong has been carried out by both private and public sectors. Government started to redevelop the old urban areas from the sixties. The efforts were related to redevelopment of Tsuen wan in sixties, Comprehensive redevelopment areas and Housing efforts in 70s, Redevelopment by Land Development Corporation in 80s and now the Urban renewal Authority is doing its job. To address the problem of urban decay and improve the living conditions of residents in dilapidated urban areas, the Urban Renewal Authority Ordinance (Chapter 563) was enacted in July 2000. The Ordinance provides a new institutional framework for carrying out urban renewal (HKSAR, 2001). The Urban Renewal Authority (URA) was established on 1 May 2001 with an aim to complete the 225 urban renewal projects in the nine designated areas. It is based on the principles of 4Rs i.e. Redevelopment, Rehabilitation, pReservation and Revitalization. Urban renewal or redevelopment in Hong Kong is mainly driven by three forces: need of improvement in environment, social need and enhancement in land value. In 2001, there were about 9,300 private buildings in the Metro Area, i.e. Hong Kong Island, Kowloon, Tsuen Wan and Kwai Tsing, which were 30 years old and above (HKSAR, 2001). The 20 year long term strategy of URA is aiming to: redeveloping the 2000 dilapidated buildings, rehousing 27000 tenants households, improving the environmental quality of 67 hectares of old urban area, providing 60,000 sq.km of open space, 90,000 sq.km of GFA for community facilities in old urban fabrics, and seven new schools (HKSAR, 2001).

Urban renewal is a complex phenomenon and a challenging task. Both private property developers/investors and Government agencies/institutions actively initiate urban redevelopment in Hong Kong. The objectives of urban renewal carried out by URA seem very comprehensive. They include: re-planning designated target areas, designing more effective and environmentally-friendly local transport and road networks, rationalizing land uses, redeveloping dilapidated buildings into new buildings of modern standard and environmentally-friendly design, promoting sustainable development in the urban area, promoting the rehabilitation of buildings in need of repair, preserving buildings, sites and structures of historical, cultural or architectural interest, local characteristics, preserving the social networks of the local community, providing purpose-built housing for groups with special needs, such as the elderly and the disabled, providing more open space and community / welfare facilities and enhancing townscape, landscape and urban design (HKSAR, 2001). The urban renewal is carried out by URA either by way of development project or by way of development scheme. The mode of operation is based on three ways: redevelopment by URA alone, joint venture with private developers or by selling the land to the private developers in a market price. There are various stages and procedures involved during the whole redevelopment projects. In general the essential stages commonly undergone by developers (either by Government or private sectors) involves the stages: (a) site identification (b) program formulation (c) acquisition of land and properties (d) submitting various statutory and non –

statutory applications (e) demolition and commencement of construction and (f) monitoring and feedback of the projects. During the redevelopment process, URA is facing the problems of site assembly, relocation and weak financial viability of projects. The multiple ownership, absentee landlord, costs related to relocating the residents and tenants (social cost, financial cost and shortage of rehousing resources) and reduction in development density/potential, fewer opportunities for plot ratio gain and increased difficulty and cost in acquisition are the major problems faced by redevelopment projects. Hence, the process of urban renewal is a multidisciplinary task. In Hong Kong, it has long been a popular issue in various disciplines including urban planning, real estate, social and political (HKSAR, 2001). Since various groups including the government, private property developers, residents, social workers and politicians are involved in the urban redevelopment process; the complexity of this problem is high. Compensation and rehousing arrangement for owners and tenants, evacuation of illegal occupiers, loss of business and employment and so forth are all the problems encountered in an urban redevelopment projects. Time and resources involved in the acquisition of properties, compensation and relocation of residents are huge and difficult to be expected (HKSAR, 2001). As per the Urban Renewal Strategy (HKSAR, 2001), URA should take care of all sectors of community and conduct the social impact assessment of the projects. It should also form the District advisory committee, Social service teams and facilitate the public participation. Hence, we can say that the urban renewal process in high-density city like Hong Kong is a complex and time consuming phenomenon and it needs a lot of informations, data and analysis for the planning and management of the projects.

Application of GIS in Urban Renewal

Urban renewal process needs effective and efficient analysis of different kinds of data and information. Planners who work on urban redevelopment have to handle massive data and information in their daily day to day works. GIS has become the fundamental tool to solve the problems of planning. Effective use of GIS may help to solve almost all the problems of urban renewal however GIS itself alone can't tell the answer of all questions. Financial viability is necessary in redevelopment projects. Both Private property developers and Government aim to maximize their investment returns from urban redevelopment projects with minimum risks. Private property developers look for redevelopment sites that involve shortest acquisition time and bring greatest enhancement in gross floor area and value from future development. However, the aim of the Government may not only focus on maximum returns; it has more people centered approach (HKSAR, 2001). To determine the maximum attainable gross floor area and best feasible land use, it is required to assess the three types of development controls i.e. planning, building and land lease simultaneously and the strictest one prevails. Regarding planning control, Private property developers or URA could increase the development potential by applying for rezoning of land and permission of a particular use to the Town Planning Board in accordance with s12 and s16 of the Town Planning ordinance respectively. In addition they can apply for bonus plot ratio in pursuant to provisions in the Building (Planning) Regulations. Lastly they are allowed to modify the lease conditions such as user and height restrictions by applying to the Land Department. URA has to deal with multi data for multipurpose tasks. Such data in Hong Kong can be gathered from wide range of government departments and organizations such as data regarding urban planning from planning department, land administration from land department, building construction from building department, taxation from rating and valuation department, land property ownership from land registry and

demographic from census and statistics department and so on. The contents of these data normally include base maps, demand data, supply data, transaction data and miscellaneous data. Base maps show the basic geographic features such as roads, buildings and is used for organizing and locating all relevant information. Demand data such as population census and household statistics show the locations and numbers of real state users. Supply data indicate the amount and location of particular type of land and property. Transaction data includes information on prices and rents. Lastly, miscellaneous data includes regulatory data such as zoning plans, and images which includes aerial photos and satellite images, etc. These data should be accurate and up-to-date. Without a complete up to date and accurate database, all the planning procedures implementing upon it would be allegorical to “garbage in and garbage out”. The manual collection and analysis of data is too much complex and time and resource consuming. In this context, GIS can be extensively used as a supporting tool for database management, mapping and spatial analysis, thereby makes the process of urban renewal very easy and faster and utilize minimal resources.

The relevant data can be stored and managed as a centralized database system and planners can retrieve the data and perform the spatial query functions. Further, the development concept plan can be visualized into 3D modelling by integrating with GIS, which is also important to understand the redevelopment which helps to convince the relevant government department and all affected public to the concept plan. Efficient Visualization is very much helpful when development concept plans have to be discussed in political decision making and public participation process (Masser & Ottens, 1999). Moreover, the integration of multimedia data types and the use of GIS in the internet and intranet environment can also support renewal process by providing informations and opportunities to the public for effective participation. Unlike the past in which citizens had to go physically to the town hall to examine plans, they can now see them in their offices and homes via the internet at any time. The WWW can help in the development of multimedia based collaborative planning system. The use of GIS for database management, informations, spatial analysis, modelling and visualization can significantly support the Urban Renewal process. With the help of following chart we can understand how the scattered data in Hong Kong can be represented in GIS.

Table 1: Data to be included in Property Database (Mao, 2003)

| Data and Information | Representation | Format of original data | Source of data |
|---|-----------------------|--------------------------------|---|
| Land auction and Tender | Attributes | Text and Numeric | Lands Department |
| Lease Modification and Land exchange | Attributes | Text and Numeric | Lands Department |
| s 16 and s17 planning applications in accordance with Town Planning ordinance | Attributes | Text and numeric | Planning Department/ Town Planning Board |
| Demolition consent of buildings | Attributes | Text and Numeric | Buildings Department |
| Ratable value | Attributes | Text and Numeric | Rating and Valuation Department |
| Transactions of land and property | Attributes | Text and Numeric | Land Registry |
| Airport (Height Obstruction) ordinance | Line | Image(Paper Map) | Civil aviation Department |
| Floor Plans of Private developments | Embedded Object | Image | Sales Brochures by property developers |

| | | | |
|---|------------|------------------|--|
| Future supply of properties to be completed | Attributes | Text and Numeric | Annual Report of Listed Property Companies |
|---|------------|------------------|--|

Besides the basic procedures, URA or the private property developers may need to follow the different procedures to meet their determined objectives. Following explanations help to explain the application of GIS in urban renewal through the perspective of both private property developer and government, however, their ultimate goal may not be the same.

GIS for Site Identification and Program Formulation

Suitable site identification and program formulation is the initial stage during the process of urban redevelopment. In general, basic information of short listed sites and its vicinity are required so as to study the feasibility or redevelopment potential of the projects. To analyze the feasibility or viability of the projects, urban renewal authority or private property developers may use GIS functions, analyze extensively and select the best viable project. Mostly, private property developers want to maximize their benefit and they need preliminary assessment for redevelopment potential. At this stage, massive data and information are needed for analysis. Property data and information in Hong Kong are fragmented and users are required to collect them from various scattered sources (Mao, 2003). Moreover, the multi-owned high rise buildings are scattered in different locations. For urban renewal, it may take a lot of time and resources in collecting, updating, managing and analysis of relevant data. These data are particularly crucial during the beginning stage, as they will also affect the time for site assembly and determination of the redevelopment viability. Since, GIS can help to store, manipulate, and analyze physical, social and economic data of a site (Yeh, 1999a), Planners can easily analyze the existing situation and redevelopment potential through spatial query, mapping and spatial analysis functions. Moreover, they can also extract data from their databases and input them to other modelling and spatial analysis programs (Yeh, 1999a). Map overlay analysis and buffering could be used in various steps of the site identification or in checking the redevelopment potential of the Site. Moreover, for this purpose, planners need to set up the standardized key criteria. These criteria are essential to use data and other information to assess whether a particular site is suitable for redevelopment. Different developers (whether URA or private sectors) may have different conception on the parameters or adopt different approaches during the stages of site identification. Planners need to use the standardized criteria and should be considered in the context of GIS application (Mao, 2003). Some of the key criteria are: land use, gross floor area, legal interests affected, age of the buildings, plot ratio etc.

Table 2: Standard Key Criteria for Site Identification (Mao, 2003)

| Criteria | Sub parameters | Reasons |
|-------------------------------------|--|---|
| 1. Land Use | OZP and Government Lease | To understand possible change of land use To understand the land premium implications |
| 2. Existing GFA Potential GFA | Building(Planning) Regulations OZP and Government Lease | The more the difference the more the potential gain To select the strictest for Comparison |
| 3. Interests/ or Owners affected | | The more interests/owners of properties involved, the more is time expected for site assembly |

| | | |
|---------------------|--|--|
| 4. Age of Buildings | | Older buildings are generally less well- maintained and obsolete |
|---------------------|--|--|

The above mentioned criteria can be put in to different layers to facilitate analysis. The base map along with textual and numerical data can be used significantly to analyze the different criteria. These data are represented in the form of point, line or polygon. The criteria should be defined to satisfy the project objectives by arranging data into layers and techniques such as overlaying and buffering can be adopted for analysis. Demographic and property data are represented by different thematic layers prior to analysis. Hence, the overlaying functions, buffering, manipulation and other GIS application can be used according to pre-determined objectives of the project. Indeed, a comprehensive data base is required for the analysis. URA and private developers can clearly understand the problems with the help of centralized data base system. By using GIS as an integrated platform of database management, analytical tool and its extended use, URA or private developers can minimize the time and resources for site identification, easily identify the viable option and make clear formulation of redevelopment programs. Hence, GIS can be extensively used as a planning support system in site identification or checking the redevelopment potential during urban renewal process.

GIS for Acquisition of Land and Properties

Land resumption in Hong Kong can either be initiated by the government or by the private property developers. After studying the feasibility, identifying a viable site for redevelopment and formulating the programs, URA or private property developers will commence to acquire the legal interests of subject land and properties. This will account for the greatest portion of time of the whole redevelopment process, subject to the number of legal interests involved. Though there are differences in the approach of acquiring the affected interests within the redevelopment limit, the principle is to acquire all the legal interests in order to clear the site for redevelopment. For private property developers they can apply under the land (Compulsory sale for redevelopment) ordinance after getting 90% or more undivided shares in lot for compulsory sale of the remaining undivided shares for redevelopment. On the other hand government or URA can apply for land resumption under the Land Resumption Ordinance. Based on these relevant ordinances, the criteria for land resumption is to identify all affected interests such as lots and buildings within the resumption limit and to ascertain there is no missing interest. The identification of affected interests is the most critical and important part of land resumption. After such identification, offer of compensation will be made to the owner of affected interests to compensate their loss due to resumption of their properties and rehousing of the affected tenants will be done properly. Thus under such circumstances, the aim of the affected interests identification is to locate and identify all legal interests within the proposed development area and offer compensation to those to be resumed (Chan, 2003; Chan, 2004).

According to the practice adopted by URA, the stages of affected interest’s identification in land resumption are: collection of information, analysis of information, calculation of compensation and offer of compensation. In order to ensure that there is no missing interest (lots and properties) to be resumed; all legal interests (including government land and government property, if any) should be identified within the designated proposed project area at the earliest stage of acquisition (Chan, 2004). For these purposes, a lot of data and information regarding the lots, government leases and conditions

with lot plan, deed of mutual covenant, land status plan/Lot Index plan, assignment plan, General building plan and other relevant documents are needed (Chan, 2004). Moreover, land resumption need multi data regarding land information, buildings, existing developments, planning information, development plans, utilities, community facilities, transportation, environment and the socio-economic. In this context, since GIS has capability to include all the components into one database system, all informations can be managed into one centralized database. With the required data available, the efficiency and effectiveness of the affected interests identification may be greatly improved by saving the time and human resources in collecting and studying the paper records from various statutory bodies (Chan, 2004). Hence, the centralized database system can provide the standardized degree of data accuracy and the frequency of data updating. It will undoubtedly save the time and manpower in maintaining the up to date information within one centralized data base system. This nature of GIS can help to calculate property values, compensation and other social, economic, cultural and environmental costs. Relational database management system of the GIS also facilitates the searching the aspatial based on selecting the concerned spatial features (Chan, 2004). The overlay analysis and many other functions such as data input, data storage, editing and manipulation, spatial data query, database management, integration with planning models, 3D Visualization with GIS, and many other operations may give much benefit to conduct above mentioned procedures of land resumption exercise in Hong Kong.

Since the traditional methods of land resumption are time and resource consuming, GIS can acts as an alternative measure to assist the current practices and expand the current system of land resumption in Hong Kong. Moreover, with the strong capability of GIS to integrate with other planning models, we can understand and analyze the property values, calculate compensation needed, identify affected residents and tenants, rehouse the tenants, and know other informations regarding land resumptions. These characteristics and functions of GIS support the land resumption process extensively and save time, money and many other resources. It also provides accurate and effective database through which planners can perform many functions by integrating with other technologies. Hence, use of GIS in land resumption exercise in Hong Kong supports the Planning Procedures of Urban renewal, thereby proves it an effective PSS for urban renewal.

GIS for Urban Renewal Concept Plan

GIS has been extensively used for two-dimensional visualization. The scope of GIS in urban planning has now further strengthened by its possibility to use in urban design or development concept plan with three dimensional visualization and integration with necessary data. For nearly a decade, GIS has widespread development for urban design (Batty et al., 1998). As Batty et al. (1998), stressed that some of the most significant developments took place at MIT where Shiffer (1992), Singh (1996) and Ferreria and Wiggins (1993) had developed urban design from a GIS perspective by building an array of tools for sketch planning, Visualization, and local urban analysis in various types of multimedia and visualization. Since the urban renewal process in Hong Kong aim to redevelop, rehabilitate, preserve and revitalize the old urban fabrics, the existing old dilapidated built form and environment would be replaced by new development of modern standard and environment friendly design. The 'before' and 'after' condition of the project site is required to analyze effectively. To address the complexity and function of the new development, considerable information needs to be processed and exchanged

between affected communities (residents and tenants), the general public, Professionals and the decision makers. In this process, communicating proposed ideas of urban renewal project to the political decision-makers or the wider public is a fundamental task for success. Hence, an essential component in Urban Renewal is to communicate with citizens about the physical, socio-economic conditions and be able to interactively visualize the proposed design alternatives. The affected community both residents and tenants are aware of the development concept i.e. the whole built environment and impacts of the development. In this context, GIS with its capability to simulate 3 dimensional visualization and integrate the 3D visualization with the information (data) such as socio-economic, transportation, community facilities, demographics etc, would largely help URA or Private Property developers to understand the volume of the development concept, measure the impacts of projects, inform and convince the general public. The two dimensional maps or CAD drawings are lacking for such supports. Data Visualization is very helpful to planning. It can help planners to explore data, and calibrate and visualize the results of planning models (Yeh, 1999a).

The planning process usually begins with some formal analysis of the problems based on good information, followed by systematic analysis of the options that might be designed to solve or alleviate these problems, and ending with the choice of a best option which is then implemented. Moreover, it is now widely agreed that design and planning are too wide, too diverse, too participatory, and too political. In this context, the use of GIS can extensively support the urban renewal process by giving opportunities for maximum public participation. The affected community, in the urban renewal process, may experience difficulty in understanding the complex spatial relationships of physical form when portrayed by limited presentation capabilities of the 2D traditional media. Three dimensional GIS can simulate a number of before and after scenarios, thereby can play an important role in facilitating communication and information flow among the participants.

GIS is capable to deliver very fine data which has profound implications for urban redevelopment and urban design. It gives accurate information of renewal site such as buildings blocks, streets, open spaces, community facilities, heritages, greenery, landscapes etc. Merging of visualization techniques and information could benefit significantly. In order to approve the redevelopment scheme from Town Planning Board, a development concept plan should be submitted by URA either through s12 or s16 application (HKSAR, 2004). Three dimensional visualization of the redevelopment concept plan integrated with necessary information such as visual impact assessment, traffic impact assessment, environmental impact assessment, social impact assessment, economic impact and many other impact assessments as per urban design guidelines can be done by GIS. This could significantly help to compare and decide the best alternatives and also to convince the stakeholders. Certainly, there are many opportunities to use GIS with many other 3D models. Virtual reality and GIS with multimedia may also support to understand and analyze the future impact of redevelopment on the society and environment. Internet and intranets are also useful to communicate design. Hence, with the help of simulation tool, participants can easily analyze the social and physical conditions and impacts of the urban renewal project, thus support the decision making in planning process.

GIS and Planning Models for Facility Planning in Urban Renewal

Urban renewal involves a lot of planning steps and exercises. Facility planning or infrastructure development or social service planning are the fundamental parts of Urban renewal. The affected community is provided with new facilities such as health care center, elderly care, child care center, open spaces, transportation, pedestrians, greenery, and many other social services and facilities. In order to make the planning exercise more convenient, GIS with integration to other models can be effectively used to plan and design the community facilities. Location–allocation model may help in planning for the provision of open space and community facilities. Data visualization is useful for displaying the results of complicated Location–allocation models (Yeh, 1999a) and can also enhance the human-computer interaction in the decision making process (Yeh, 1999a). Similarly, integration of GIS with remote sensing, transportation models, spatial interaction models, environmental models, economic models and other planning models can be extensively used to plan, design, implement and understand the impacts of urban renewal projects. We can say that GIS is just like a pencil and planners can use GIS for whatever they want to sketch. The various functions of GIS such as data capture, store, manipulate, spatial analysis, visualization and its capability to integrate with many other models, information and data has significantly support the planning system. In short, GIS is a kind of planning support system and its database management, spatial query functions, centralized database, integration with 3D Visualization, information and planning modeling and techniques can support significantly the urban renewal process in Hong Kong.

Problems of Implementation of GIS-based PSS in Hong Kong

The use of GIS in urban planning does not depend solely on the development of new GIS software and hardware (Yeh, 1999a). There may arise many problems implementing the GIS-based PSS in Hong Kong. The quality and reliability of data, time taken in collecting and conversing the data into GIS could weakens the use of GIS in urban planning. The weakness on linkages of GIS database management, mapping and spatial analysis functions with the planning models may cause difficulty to implement. There is still lack of fully integrated planning models into GIS. Even the current available urban models were developed in the context of their own specific purposes and theoretical background, users may have difficulty to understand how they work, what are their limitations and what can they do. Putman and Chan (2001) suggests that defining what PSS may be is easy (relatively Speaking) while implementing one is hard (an understatement).The combination of complex data, complex software and complex planning problems require genuine specialist (Masser & Ottens, 1999). Moreover, the problems to implement GIS as a PSS are not only depend on the GIS itself but depends on others factors such as the status and character of the organization, data, state-of-the art of planning, and staff etc.

Organization

In today's democratic and political society, planning decisions are made by politicians rather by planners. There will be no meaning of PSS if it is not used by planners. In this regard, there seems difficulty to use GIS as a PSS in urban planning. Nonetheless studies on the applications of GIS repeatedly show that staff and organizational factors are more important than technology in successful

application of GIS (Yeh, 1999a). The implementation problems may arise due to lack of strong information management strategy, lack of commitment to and participation in the implementation of any form of information technology by individual at all levels of organization and lack of a high degree of organizational and environmental stability.

Data

There is no life in GIS without applications and there can be no application if there are no data (Yeh, 1999 a,b). The lack of available data remain one of the major hindrances in the use of GIS. Since, lack of up to date database causes many problems to speed up the planning decisions. Planning process involves analysis of diversity of data and they are often found in scattered form in Hong Kong. In the case of urban renewal, the properties such as buildings possess multi ownership and scattered locations. Conceptually the idea of centralized database system and simulation of buildings and individuals is quite impressive but, in practice, data are not easily found and gathered. Moreover, 3D GIS visualization is not easy in practice as explained in theory. The real time data input and processing may take longtime and weakens the public participation. The data collection, continuous updating and conversion take time and consume many other resources. These problems may cause difficulty in implementing GIS as a PSS in Hong Kong.

Staffing

With the rapid growth of GIS, there is a shortage of human resources even in the developed countries. The use of GIS is still limited in research and teachings in Universities. It is not widely used by all planning organizations and institutions because of the lack of knowledge, skilled man power and other resources. There are only few persons who know about the scope and opportunities provided by GIS in urban planning. The latest technologies are not easily transferred to all professional. Lack of experts on GIS could be the limitation of its use.

State of the art of Planning

Though GIS technology has been developed extensively and could be used extensively in urban and regional planning process, Hong Kong still do not have adequate capability to utilize all applications of GIS in urban planning. The integration of 3D Visualization and information, virtual reality and many other modeling and techniques are not used sufficiently in daily practice. Moreover, all planners are not well- known with the opportunities provided by GIS in urban planning. Due to various reasons mentioned above and expensive cost of new software's, the wider scope of GIS in Urban Planning has been limited to certain functions only.

Conclusion

GIS are increasingly used in the field of Urban and regional Planning in both the developed and developing countries. It has proved as an effective and essential planning support system for urban and regional planning. Recent advances in the integration of GIS with planning models, Visualization and internet will make GIS more useful to urban planning (Yeh, 1999a). Moreover, there may exist confrontation between two questions: How will GIS technologies change the urban planning? And how

will the need of urban planning shape the development of GIS? (Masser & Ottens, 1999). It is clear that use of GIS in urban planning has significantly supported the planning system, however, its extensive implementations are still limited in both the developed and developing countries due to various problems such as lack of availability of data, well equipped organizations and expert staffing etc. New researches and applications of GIS in urban planning are continuously progressing and people are now more aware of its use. Its proper use in planning could support the planners to analyse, manage and proceed the planning effectively. GIS is a fundamental part of PSS and its integration with other techniques and models has provided maximum benefit in urban planning, and thereby an essential and effective planning support system.

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