GIS IN URBAN PLANNING AND MANAGEMENT: MALAYSIAN EXPERIENCE

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Abstrak

Since the seventies, Malaysia is experiencing a rapid urbanization rate and becoming one of most developed countries in the Asia region. Urbanization contributes many advantages in terms of economics, but if uncontrolled, would produce negative consequences to the physical, social and natural environment. With the advancement of Geo-information Technology (GIT), which considerably influenced the dynamic nature of urban and regional planning, incorporation of GIT becomes imperative for better and improved decision-making in urban planning and management. It offers a solution to the urban problems and decision-making, which is more reliant to the real-time spatial modeling. Based on the Town and Country Planning Act 1976 (Act 172) latest amended in 2001, the development plans provide the development framework and guidelines which need to be continually updated according to the present situation of development. The integration of Geographical Information System (GIS) has provided a tool which can contribute to much clearer understanding of real planning problems as well as prescriptive planning scenarios to enhance the quality of urban planning and management. This paper will enlighten the need for GIS at strategic planning and management level. Example of the use of GIS for strategic planning at the higher level relates to the National Physical Plan, Regional Plan and State Structure Plan whereas at local planning level, the integration of GIS is at District Local Plan and Area Action Plan. This paper will also highlight on how GIS is applied for urban management purposes with focus on development control. GIS notably provide a strong platform to decision maker in its role as the main component in Planning Support System (PSS) and Decision Support System (DSS). Some discussion on database design, the analysis techniques, the framework of planning and management incorporating GIS will end the paper.

Keywords: Development Plans, Geographical Information System,
Planning Support Systems and Decision Support Systems.

1.0 INTRODUCTION

Development growth in most developing countries has become a global issue, as rapid urbanization process can no longer be controlled. Due to uncontrolled and unmanageable development, the physical, environmental and socio-economic aspects apparently suffered the largest impact. Apparently, the planning system has an important role in managing and controlling the development trends. At present, the advancement of geo-information technology (GIT) has considerably affects the dynamic nature of urban and regional planning in Malaysia and consequently improved decision-making, planning and management concerning urban areas. The Town and Country Planning Act, 1976 (Act 172) with its latest amendment in year 2001, manifested the concern of adopting the Geographical Information System (GIS) in the development planning process, especially in the preparation of development plans. The divulgence

of incorporating GIS in the implementation of development plans meets the main objectives of forecasting and determining future development strategies and policies by integrating the physical, environmental and socio-economic aspect of planning especially regarding the spatial context. This paper attempts to explain the use of geospatial information system in the development plans implementation and monitoring urban development based on Malaysian experience.

2.0 ISSUES OF URBAN PLANNING IN MALAYSIA

Malaysian government is currently adopting a continuous, cyclical planning system approach, which is based on the identification of needs and goals, the formulation and evaluation of alternative courses of actions and monitoring adopted programmes. The idea of urban and regional planning in Malaysia originated from Britain where it was first introduced. Chadwick (1971) stated that planning is a process of human forethought and action based upon that forethought and it is aiming at the best use of land and greatest possible 'improvement in the human environment'.

Planning human living environment is obviously easier said than done. The physical, socio-economic and environmental aspects are particularly of major concerns and should be taken into consideration in the planning process. In Malaysia, the instantaneous emergence of cities with residential, industrial and commercial centres proves that development is growing very fast. The course to becoming a developed country has faced the country with many difficulties and challenges. Apparently, urban problems in Malaysia are virtually insurmountable with respect to the vicious spiral urban squalor, squatter's growth, congestion and poverty, which in turn are fuelled by rural migration and resource exhaustion. Thus, planning and managing the urban areas has become the utmost task in dealing with issues and problems due to the tremendous development growth.

Apart from that, the loss of urban green, water and air pollution, erosion, floods, haze, and unpleasant odour occurred due to improper physical planning. Therefore, effective urban planning and management practice is imperative in order to delineate the limit of urbanization in certain areas.

3.0 THE ROLE OF GEOGRAPHICAL INFORMATION SYSTEMS

The evolution of computer and information technology over the last few decades has had a significant impact on the planning profession. Computation were accepted as part of rational planning, quoting from Ayeni (1997), and Briassoulis (1999) further explained that the approach emphasizes (1) the need for as much scientific and technical imformation as possible to analyse comprehensive planning problems; (2) the use of scientific analysis and mathematical models to design optimal solutions; and (3) the primacy of technical and technological solutions to these problems. These strongly support the requirement of computer-aided techniques in the planning process. Aforementioned, in the planning procedures the needs of other planning statistic such as population, employment and housing is crucial in determining the emergence of land use patterns as they linked together, before the full significance of land use is noticeable.

Fundamentally, a GIS is able to support all the stages of spatial data processing including manual or semi-automated digitizing, checking and editing of digitized data, edge-matching of digital map files and output of information to graphics devices or hard copy plotter. Followings are the major functions of an information system:

i) The descriptive function – information should help to describe a situation;
ii) The cognitive function – information system should also contribute to improve understanding of urban and regional problems by providing the key factors and variables that can be analysed using urban and regional modelling and other statistical technique;

iii) The normative function – the information system can also contribute to improved action by reducing the cost of actions with known consequences or by reducing uncertainty about the consequences of actions already taken or about to be taken.

With emerging urban problems, planning authorities shall increase their ability and effectiveness in managing these problems. The urban system can no longer be treated in terms of simple land use and traffic concepts. The planner's conception of the urban system must extend to include a host of social, political and economic variables. The mixture of problems which must all be resolved together, creates a situation in which many alternatives must be tried, combined, improved and tested by analysis, by experiment, and by public discussion. Therefore, the application of GIS was persistently introduced in planning and management of urban areas. Later, it is known that the development of GIS provides a tool, which can contribute into much clearer understanding of real planning problems as well as prescriptive planning scenarios to enhance the quality of urban planning and management (Yaakup, 1991).

3.1 GIS and Spatial Planning

In planning analyses, information is derived from printed maps, field surveys, aerial photographs and satellite images. GIS systems enable data from wide variety of sources and data formats to be integrated together in a common scheme of geographical referencing, thus providing up-to-date information (Grimshaw, 1988; Coulson and Bromley, 1990). GIS has long been accepted as the most appropriate solution to address spatially referenced data. The essence of GIS in the plan making process, quoting Calkins (1972), suggested that 'better planning will be achieved through better information, and better information will necessarily flow from an information system'.

However, 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. Clearly, planning requires (i) information that is effectively "a spatial" at a particular level of analysis; (ii) information over time; and (iii) measures of spatial interaction. None of this can be easily incorporated into standard GIS packages (Harris and Batty, 1993).

3.2 Planning Support System and Decision Support System

GIS is a part of the Planning Support Systems (PSS), which alone can support decision-making and urban problem solving to a considerable extent. However, planners will have to adapt existing GIS tools to meet their needs. Traditional programming languages can be used to develop spatial analysis and modelling tools entirely independent of commercial packages. A combination of sophisticated GIS macro commands and traditional programming language can also be used to develop analytical models closely linked to full-featured GIS toolkits (Klosterman, 2001).

The PSS which is a combination of GIS data, urban model and presentation technique using computer for planning support has been increasing in use for more enhanced end products. The inevitable evolvement of Information Technology towards PSS means that the exploitation of GIS is more significant. GIS will serve first as a display and communicative device, producing maps and charts that describe past and present conditions and model outputs that suggest alternative futures, which support decision making. On top of that, the Decision Support System (DSS) is also known as a system in which decision makers could rely on in making decisions.

4.0 GIS APPLICATION IN DEVELOPMENT PLANS SYSTEM

GIS technology has long been applied in planning activities, which essentially include plans formulation as well as development control (Johar *et al.*, 2003). Federal Town and Country Planning Department had published the manual for preparation of development plans at various levels, with provision that all plans need to utilise GIS technology in their formulation.

4.1 Development Plans System

In ensuring the goal of effective planning in development plans, the Town and Country Planning Act 1976 (Act 172) (latest amended in 2001) required the formulation of plans at various spatial and administrative levels. The plans include:

- The National Physical Plan (RFN), which outlines the strategic policies for the purpose of determining the general direction and trend of the nation physical development.
- The Regional Plan, which establishes policies to guide and coordinate development for a region especially in the provision of infrastructure and facilities within the region.
- The State Structure Plan (RSN), which sets out the policies and proposals for the development and use of the land in a state.
- The District Local Plan (RTD), which translates the state policies at local level.

Figure 1 shows the idealized strategic planning of development plans in Malaysia.

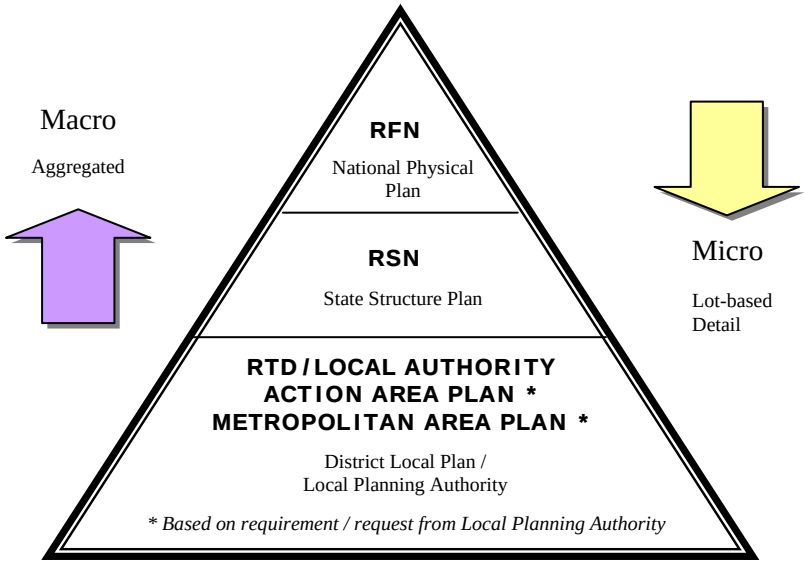

Figure 1: Hierarchical framework of development plan system (FDTCP, 2003)

4.2 The National Physical Plan

The National Physical Plan (RFN) outlines the strategic policies for the purpose of determining the general directions and trends of the nation's physical development. The RFN therefore requires a comprehensive information system in order to determine the trend and pattern of developments within a specific time frame as well as identify strategic land use and conservation policies.

At the national level, GIS is used mainly for data compilation, land suitability analysis and generate suitability maps (Yaakup, 2001). The RFN will enable the display of conurbation centres indicating urban growth, for example, throughout Peninsular Malaysia as shown in Figure 2. The map can then be analysed, such as to identify the relationship between population and job created in the region. Such analysis becomes important in projecting future requirement for housing,

commercial floor space, school, recreational facilities, etc. On the other hand, this can be used in making future economic decision (Yaakup, 2001).

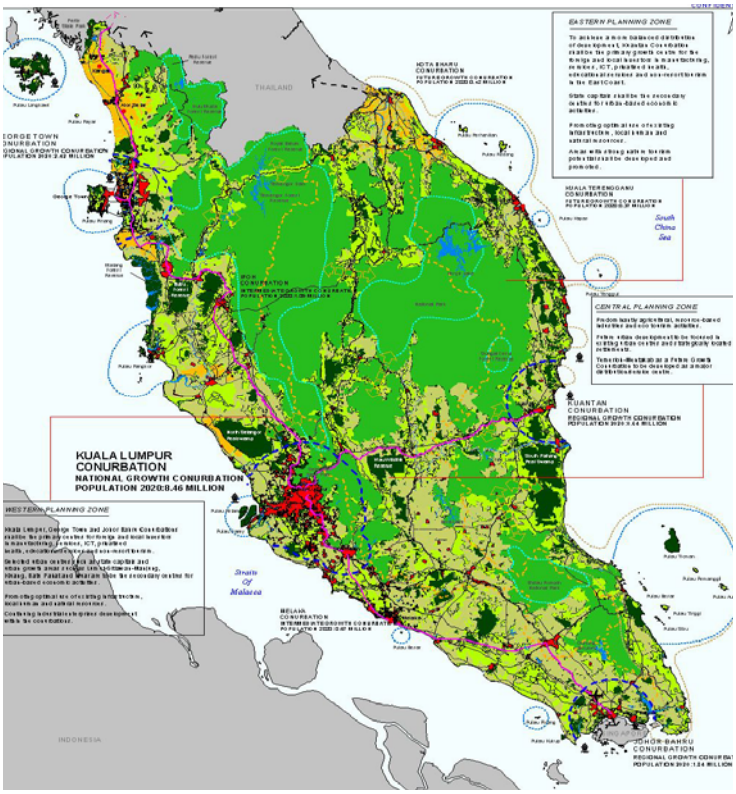

Figure 2: National Physical Plan: Alternative Development Plan Strategy (Technical Report of National Physical Plan, FDTCP, 2003)

Whereas, the use of GIS in the context of accessibility and transportation through applying analysis models pertaining to trip generation, travel pattern, gravity model and travel mode can be useful in transportation network planning either for inter-region or intra-region connectivity.

4.3 Regional Plan

Introduction of GIS for regional analysis has improved the decision-making process through improved data accuracy and accessibility and as a consequence leads to 'better' decision. The information at this level helps to describe the existing situation. 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 region. GIS is identified as the main tool in the formulation of the regional plan. A well integrated and comprehensive GIS database have been designed and developed regionally to support ten main application modules namely built up area, green and recreational area, traffic and urban transportation, squatter and low cost housing, environment, utilities and community services, industrial and commercial development, population and socio-economic, geohazard and tourism.

The introduction of Integrated Land Use Assessment (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. The developed model is expected to dynamically support the preparation of the Klang Valley Regional Master Plan. Figure 3 shows the model developed for ILA based on the planning process

and PSS framework as well as policy and strategy consideration which act as guidelines and direction for alternative scenario generation. Example of alternative development scenarios generated using GIS functions such as overlay, classification and measurement is illustrated in Figure 4.

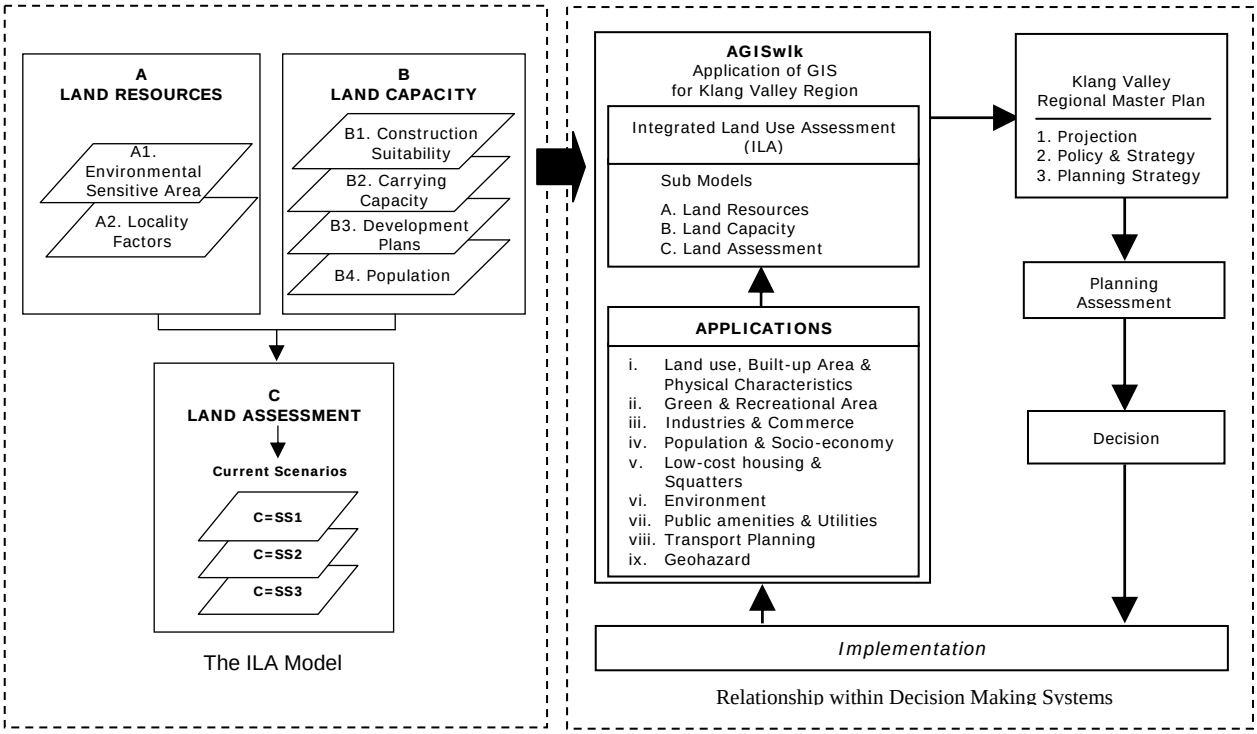

Figure 3: Model developed and implemented for Integrated Land Use Assessment of Klang Valley

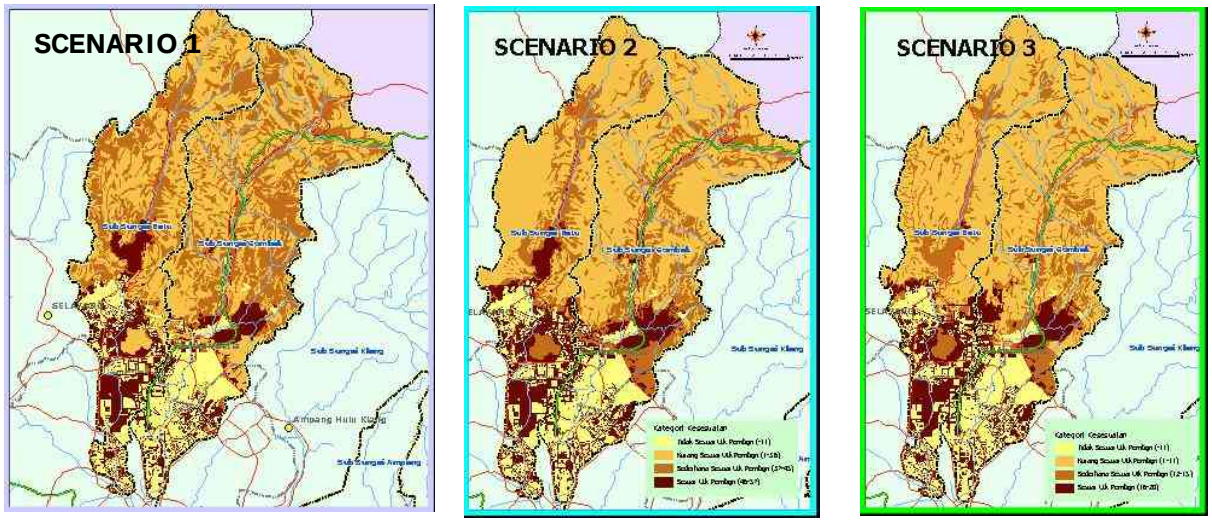

Figure 4: Integrated Land Use Assessment Development Options

4.4 State Structure Plan

According to the State Structure Plan (RSN) Manual, the preparation of RSN is crucial to initiate inspection on the state development when required or if changes in the sectoral policies occur, which will consequently affect the pattern of the state development.

The system developed for the Pahang State Structure Plan, for example, 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 to support sectoral studies and analyses relevant to the state structure plan formulation. Figure 5 shows the Multi-Criteria Decision Making (MCDM) method adopted to generate the various development scenarios.

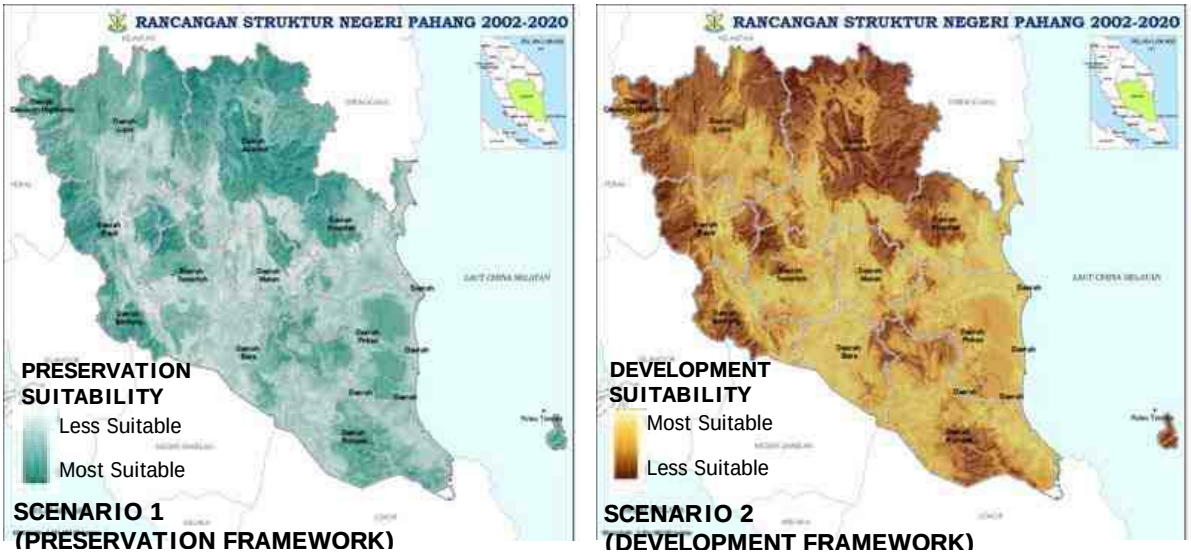

Figure 5: Development Alternatives for the State of Pahang (Interim Report, Pahang State Structure Plan, 2003)

The main concern of the RSN would be the preparation of the key diagram (Figure 6) that involves a combination of analyses such as determination of area having potential for future development and area for conservation.

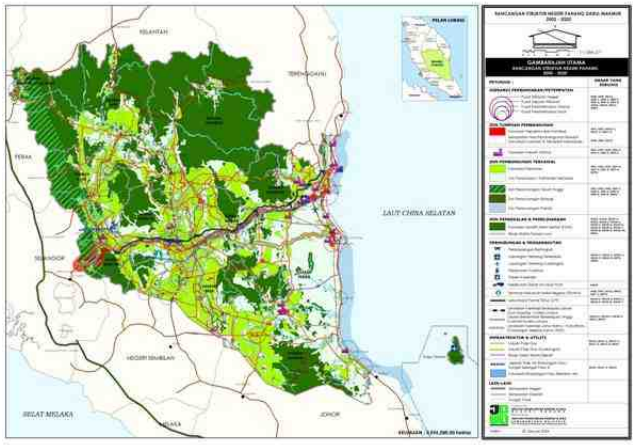

Figure 6: Key Diagram of Pahang State Structure Plan (Interim Report, Pahang State Structure Plan, 2003)

4.5 Local Plan

At the local government level, the district local plans are legal documents that become the basis of development guidelines and control. These plans contain such details as land use zoning, development density, and building height, plot ratio, etc., which require detailed information of each plot of land. A zoning plan, for example, covers a large area that contains various land uses (refer Figure 7). It will be a great advantage to be able to evaluate each alternative of a zoning plan using GIS (Yaakup and Healey, 1994). As in the case of Pekan district, the GIS database was developed for facilitating the preparation of the District Local Plan. The district covers an area of about 380,500 hectares, located in the east coast of the State of Pahang. A well-integrated lot-based GIS database and base map were designed to meet the local authority's requirement. At this level, spatial analyses involve determination of land suitability and allocation using the multi-criteria evaluation technique (refer Figure 8).

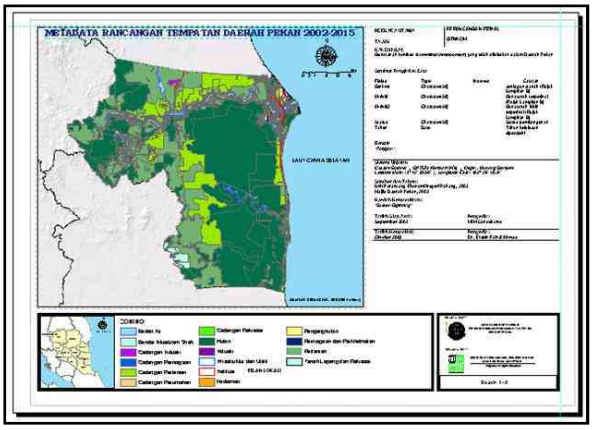

Figure 7: Zoning Plan for Pekan District Local Plan (Technical Report, Pekan District Local Plan, 2003)

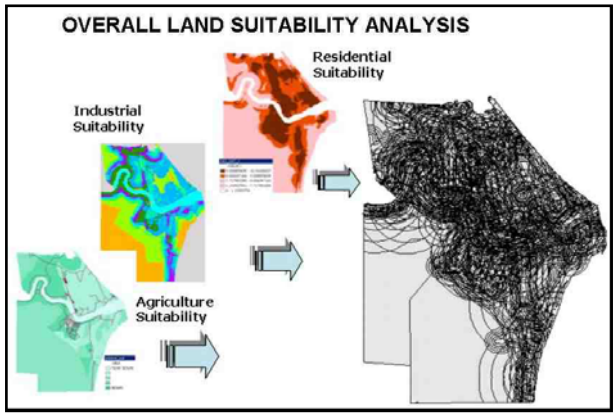

Figure 8: Land Suitability Analysis

4.6 Development Control Systems

Development control is a part of the urban management procedures. In the context of urban planning, the present system of development control in most local authorities in Malaysia is by the granting or refusal of planning permission for development. The local authority is empowered to grant or refuse any planning application in its area. The recent amendment to the planning statute requires that certain planning application be accompanied by a development proposal report which include a written statement and a plan to (i) describe the present condition of the land to which the application relates; and (ii) describe the proposed development, in particular on how it would be likely to have a significant effect on the built environment (Ali, 1990).

In most cases, a preparation of development proposal report involves a technique for the systematic compilation of expert quantitative analysis and qualitative assessment of the proposed project's land use and development viability, including its effect on the surrounding area, and the presentation of results in a way which enables the importance of the predicted results, and the scope for modifying or mitigating them, to be properly evaluated by the relevant decision making body before a decision on an application is rendered (Yaakup, Johar and Dahlan, 1997). Information required for a development proposal report would therefore include the following major aspects:

i. Status of land and restrictions;
ii. Land use analysis and intensity of development – this includes land use zoning, population density zoning, height limit, plot ratio, plinth area, predetermined public area;
iii. Analysis of issues and potential of sites – this includes site location, existing drainage system, topography and slope, existing road system, existing land use, natural features which must be preserved and development potential;
iv. Analysis of surrounding development – this includes infrastructure, type, intensity and facilities available in the surrounding area;
v. The policies of the Structure Plan and Local Plan if available.

Given the wide range of activities over the years, the local authorities have amassed a huge amount of information of which a substantial portion is geographical in nature such as layout of housing scheme, road and drainage system, composition and distribution of population, distribution of land use and so forth. An information system is therefore necessary to not only keep and display data pertaining to planning application for the purpose of administrative functions but should also to facilitate planning and development control. GIS for development control has been applied in the City Hall of Kuala Lumpur (CHKL) through the development of an integrated system that can be seen as an innovative approach to urban planning. In the case of Development Control System for CHKL, GIS application has been integrated with several other subsystems for urban management, particularly development control. Altogether, the seven subsystems developed are able to interact with and support one another by sharing information sources as shown in Figure 9.

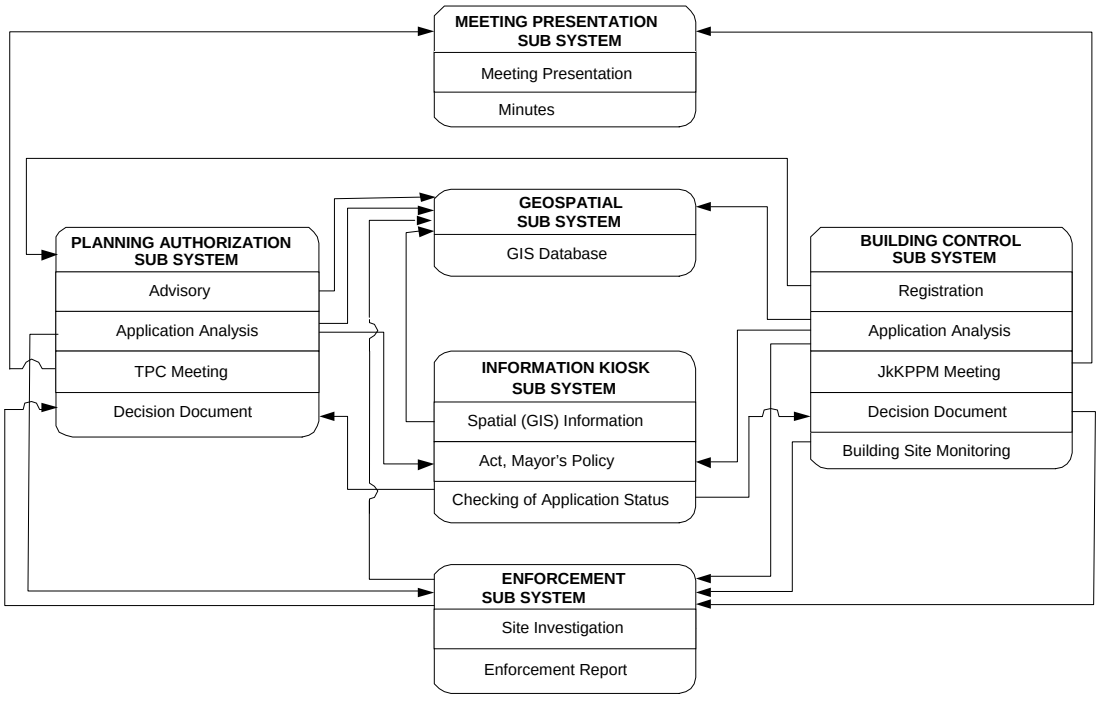

Figure 9: Subsystems interaction in CHKL's Development Control System

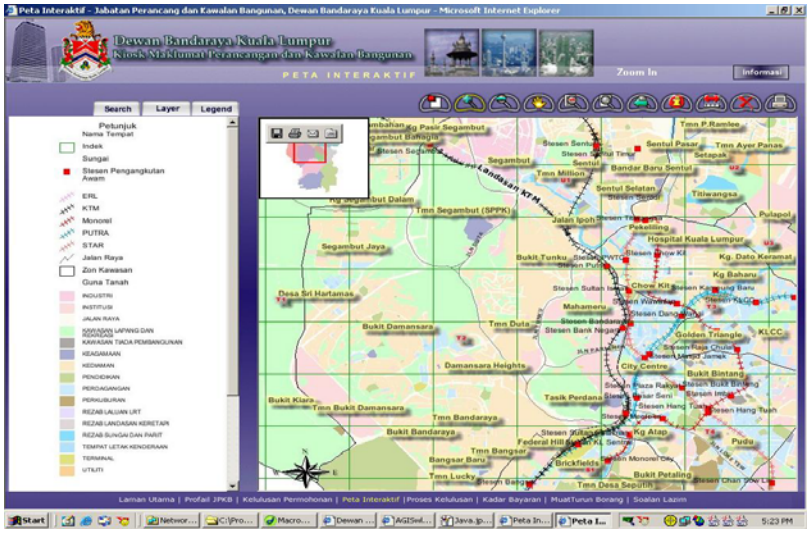

Figure 10: Interface for Interactive Maps Application through the Information Kiosk

Figure 10 shows the interactive maps application for CHKL whereby GIS was adopted and incorporated with the information system for planning for the purpose of development control.

5.0 DISCUSSION

All examples and discussions regarding the GIS applications in strategic planning and urban management involved a lot of planning and statistical information in which some of the information are confidential. This becomes a challenge especially in data sharing.

There are several matters that would be significant to be further discussed in adopting GIS for urban planning and management, such as:

i. different spatial level and form of plans require different support in term of information system.
ii. the various skills required for preparing development plans using GIS. They include the ability to build up and manage the database, which should incorporate socio-economic attributes of the local population. Managing services at local level would also call for contiguity and proximity analysis. Cartographic skills are of importance if plans are to be exhibited.
iii. analysis techniques and models to be used including potential surface analysis, carrying capacity, etc, which should be able to highlight the suitability of development activities and evaluate the carrying capacity of an area.

6.0 CONCLUSION

GIS has proven 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 planning problems. Various scenarios that 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. However, the ease with which a GIS can manipulate geographic information has also created a major difficulty as users unfamiliar with GIS techniques or nature of geographic information can just easily mistook invalid analysis as valid ones. On the other hand, issues pertaining data sharing involving confidential information, standard database design, appropriate analytical techniques and the planning

framework itself need to be resolved in adopting successful GIS for urban planning and management purposes.

In the management aspect, the systems such as that had been developed have provide planners with new tools to implement their work more efficiently, especially with support of the interactive and user-friendly interface provided to ease the use of the sophisticated system without the need of advanced technical skill. The systems developed have made it possible to understand the dynamics of urban growth, to constructively manipulate those dynamics, and most important, to set forth better and practical urban futures. All in all, the success or failure in the adoption of GIS for urban planning and management depends on a variety of human, organizational and technical factors.

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