VIRTUAL AMPANG JAYA

An interactive visualization environment for modeling urban growth and spatio-temporal transformation

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Abstract. Virtual Ampang Jaya is an interactive visualization environment for modeling urban growth and spatio-temporal transformation to expose and evaluate the different layers of Ampang Jaya, consisting of social, economic, built and natural environments. The research will investigate the techniques of data acquisition, data reconstruction from physical to digital, urban analysis and visualization in constructing a digital model which may include low geometric content such as 2D digital maps and digital orthographics to high geometric content such as full volumetric parametric modeling. The process will integrate the state of the art GIS system to explore GIS powerful analytical and querying capabilities with interactive visualization environment as well as test the model as a predictive tool. The model will set as an experimental test pad in providing a new platform to support decision making about the spatial growth of Ampang Jaya by the various stakeholders in the planning processes. Such an environment will improve the subsequent digital models and research in the area of urban design and planning where visual communication is central.

1. Introduction

The key aspect of Virtual Ampang Jaya is to understand the complex spatial information about urban planning and design. This research embarks on investigating the techniques of data acquisition, data reconstruction from physical to digital, urban analysis and visualization in constructing a digital model of Ampang Jaya. There are different digital virtualities involving the cities based on diverse sets of philosophies (Hudson-Smith et al., 2005), combining various technologies (Batty, Hudson-Smith, 2001; Ospina,

Flaxman, 2006) where each is unique to its context involving environmental, social and cultural criteria. Malaysia's ability to respond to rapid urban growth hinges on adopting world best practice in the field of interactive virtual environments.

Framed in an interactive visual environment, the Virtual Ampang Jaya will function as a digital tool for modeling urban growth and spatio-temporal transformation of the city. As an analytical tool, the model will demonstrate and evaluate the socio-economic, built and natural layers of Ampang Jaya. By analyzing the established patterns, the digital tool enables another level of contribution, serving as a predictive tool to forecast the future direction of Ampang Jaya. Various scenarios can also be generated to study the impact with different sets of parameters.

Although highly realistic models are successful in communicating with the public audience, the Virtual Ampang Jaya will focus on analytical and querying functions that current GIS technologies can offer. This study also explores the appropriate hardwares and integration of softwares that are deem suitable for the neighborhood as well as for broader scale. While GIS has taken its toll from 2D representation to 3D representation since its starting in the 1960's, the third dimension is acting merely as an attribute to 2D that enables 3D analysis with limited capabilities (Bruce, 2007). With the increased and advanced use of GIS technologies and claims of its effectiveness in providing analytical and quantitative methods for urban planning analysis (Yaakup et al, 2004; Yin, Hastings, 2007), there is a pressing challenge to seek ways to effectively and efficiently adopt the information for decision making, combining analytical methods and models to support spatial analysis, modeling and mining processes (Jiang, Li 2005).

2. Visualization for Urban Design and Planning

Visualization in design and planning enables the integration of complex spatial information such as the evolution and transformation of the urban precinct as well as the impact of planned developments. Visualization for design and planning started in the 18th century using comparative perspectives (Hudson-Smith et. al., 2005). Since then, planners have developed an interest in visual means in their dealings with a diverse group of people (Ospina, Flaxman, 2006). In the past 20 years, visualization using desktop, network and various immersive media powered by digital computation of various kinds (Hudson-Smith et. al., 2005) has emerged as a powerful decision support tool. Today, many cities around the world have been actively engaged in 3D computer visualization in addressing various issues in urban planning where visual communication is the pivot.

Digital visualization and communication are expected to improve the environmental planning systems by making planning information more accessible and easier to understand by various stakeholders, including the general public. Environmental planning is a highly complicated process that requires a wide range of considerations. The technical consideration includes urban function and form; the economic addresses cost and benefit; the aesthetics relates to both appearance and experience; and the social involves allocation and provision (Duhr et. al. 2005).

There are three bases of visualization in the planning process. Firstly, to assist in looking at consequences from multiple views secondly, to extend understanding of complex urban planning and design, and finally, to facilitate in the communication processes (Langendorf, 1992 as cited by Duhr, 2005). As the web is slowly becoming a common platform to disseminate information to the wider public, it provides the interface for regulatory authorities to disseminate information and services of an individual city.

2.1. MOTIVATION

> Planners have long dreamed about tools that could match the scope of their vision.
>
> (Ospina, Flaxman, 2006)

3D models and interactive visualization have the potential to enhance the understanding of the complex spatial information about the city to different levels of people including laymen. This is among the key aspects for resolving the urban design and planning problems and producing better planning outcomes. Current research in computer visualization indicates that computer generated visualization is a result of inefficiencies in the conventional methods to deliver information (Duhr et. al., 2005) and suggest that conventional drawings cannot communicate effectively beyond the construction industry (Pietsch, 2000). Laymen often find that conventional planning materials are difficult to understand (Pietsch, 2000). 3D physical models and 2D and text based information used in urban design and planning such as maps, coded plans, sections and elevations need complex interpretations by the professionals. On the other hand, digital representations such as computer visualization models can relate better to the general public (Pietsch, 2002), and among the professionals as well. They have the potential to better translate and communicate planning materials more clearly and effectively than conventional methods (Duhr et. al., 2005; Pietsch, 2002; Meng et. al., 2000).

In the daily "reflection" and "creation" that include different professionals with different tasks and responsibilities, difficulties often arise as described by Stonor (2006) as "educated apart, they sit around the same table but do not always know how to talk to each other" and " one group designing the destinations and the other the connections between them". Stonor (2006) also suggests that the main success to focusing on common interest is having tools that can overcome the professional divides. The digital approach enables the integration of highly complex spatial information such as the evolution and transformation of the urban precinct as well as the impact of planned developments as "3 dimensional models speak in a common visual language that people can easily understand" (Yin, Hastings, 2007, p.62).

In its rapid urban development, Malaysia is striving for an efficient planning system to deal with current and future prospects. There is a strong need for Malaysia to develop an effective planning approach to achieve the desired goals and objectives, evaluate alternatives as well as control development programs (Yaakup et al, 2004). While urban growth modeling has the potential to enhance the process, Fragkias and Seto (2007) suggested that the current urban growth modeling should focus on the developing countries such as Malaysia where most urban growth will occur in the next two decades (United Nations, 2004), instead of primarily on industrialized countries.

2.2. URBAN GROWTH AND TRANSFORMATION

> Models are tools for organizing and describing the world.
> (Fragkias, Seto 2007, p. 859)

According to Sidiropoulos and Vasilakos (2006, p. 300), the city is a living organism that changes through time. Hillier (2006, p. 18) contradicted the view, citing that they were never organic, growing without human reflections and agency. He stated that cities have their own logic and the need for us to make sense of how economic and social factors impact on it. He describes that city grew by people reflecting on how the city had grown so far and working out what had to be done to adapt it to new needs or larger scale. In addressing these different fundamental views concerning urban growth, computer visualization allows us to approach the city as a site for interaction and provides new ways of encountering the urban space (Brewer, Dourish, 2007). It also offers us with the tools to enhance Hillier's process of 'reflection' and 'creation' to produce better planning and design. In the attempt to use the tools effectively, there is an urgent need to develop

expertise in the application of digital media to address problems of the built environment (Meng, Ahmad, 2005; Hudson-Smith et. al. 2005).

In understanding the city's spatio-temporal transformation, interactive virtual models are set to operate as urban growth tool. As a tool, it can learn about interactions among different parts of a system. It can also generate and test hypotheses about patterns and mechanisms as well as make testable predictions (AlSayyad, 1999). Visualization with urban growth tools enables us to capture both present and future conditions and plans with ability to present clarity, accuracy and respond immediately as well as offer innovative ways for information distribution (Hudson-Smith et al., 2005). The proposed urban growth model will carry out systematic studies and experiments in the context of Ampang Jaya to prove the reliability and validity of the computer visualization that current researchers entail (Buccolo et al, 2001; Mahmoud A.H 2001).

3. Introduction to Ampang Jaya

Ampang Jaya which lies in the conurbation of Kuala Lumpur, the largest city of Malaysia is experiencing a huge urban expansion. Ampang Jaya in the past was a section of the smallest zone known as Ampang, under the district of Ulu Langat in the State of Selangor. Ampang was one of the earliest townships in Kuala Lumpur. Encompassing a total land area of 3,859 hectares, Ampang contained twelve villages. The current Ampang Jaya is a suburban municipality located in the districts of Hulu Langat and Gombak, following the split of Ampang into two zones when Kuala Lumpur was declared the Federal Territory in 1992. A section of Ampang is under the administration of The Ampang Jaya Municipal Council or known as Majlis Perbandaran Ampang Jaya or MPAJ. While the town centre for the other Ampang zone is in Kuala Lumpur, the town centre of Ampang Jaya is located within the area of Ampang Point which is relatively a new town development, an extension of the Jalan Ampang which is one of the busiest roads in Kuala Lumpur with extensive surrounding developments and connecting other parts of the city (Figure 1).

Encompassing a total area of 14,350 hectares (143.5 sq km), Ampang Jaya, from the Malaysian Statistics Department record in 2007 has a population of 574,300 and asset hold of 135,109 units. Its land use from the 2002-2005 demographic data of Selangor local councils is as follows:

Forrest:	50.7 % (72.8 sq km)
Housing:	36.4 % (52.2 sq km)
Public facilities:	5.2 % (7.5 sq km)
Agriculture:	3.1 % (4.4 sq km)
Recreation:	1 % (1.4 sq km)

Industrial: 0.9 % (1.3 sq km)
Commerce: 2.7 % (3.9 sq km)

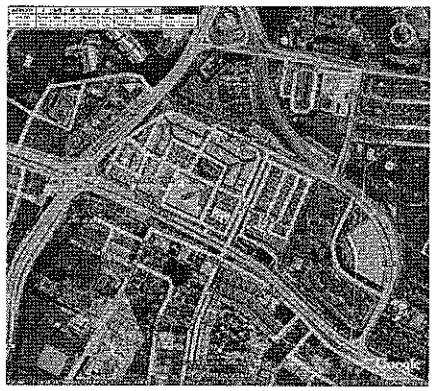


Figure 1. Aerial View of Ampang Jaya from Google Earth

3.1. ISSUES AND CHALLENGES

Ampang Jaya has flourished in great proportion over the last few years since its development as a commercial area in the last decade or so. The tremendous growth is particularly centred at its new township, known as Ampang Point which started development in the early 1990s. In the past few years, the surrounding area of Ampang Point has experienced a huge growth as a result of rapid development of hospitals, hotels and predominantly housing and commercial centres. These developments have stretched the surrounding road system to link with several elevated highways that further connect Ampang Jaya to Kuala Lumpur city and other parts of Selangor. These growth factors and accessibility have subsequently established Ampang Jaya as a highly favoured city in Kuala Lumpur and among residents and expatriates due to its proximity to the foreign embassies that are mainly located in Ampang. This has drawn scores of foreign investments to Ampang Jaya to accommodate their local needs, particularly eateries and gathering places while creating huge social and economic challenges (Figure 2a).

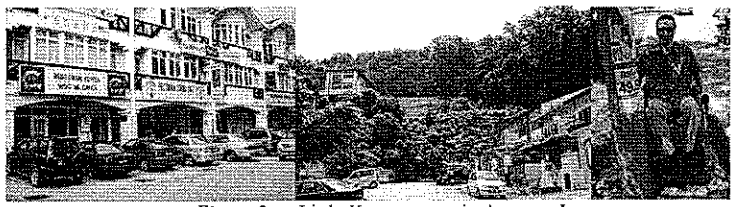


Figure 2 a. Little Korean town in Ampang Jaya
Figure 2 b. Housing and hillside development
Figure 2 c. Public access

The whole episode of rapid urbanization has eventually grown Ampang Jaya out of proportion, way out sizing what it was earlier planned for. Ampang Jaya now becomes a dense place with massive traffic and parking problems that eventually lose its sense of place and they greatly affect the residents of Ampang Jaya. To prepare them in dealing with the issues and challenges following the rapid urbanization, the authorities are seeking for a more comprehensive and meaningful information concerning the city (Ampang Jaya Structure Plan, 1998). On the other side, the public quest for more transparency in the planning process by the authorities in carrying their public responsibilities. Apart from the public pressure and the urge to gain back their confidence, the local council known as MPAJ has realized the need to re order the development in Ampang Jaya. There have been calls for innovative design planning and control, targeting at residential development, re housing and controlling the mushrooming of informal kiosks, tackling traffic and parking problems. Other issues include public access (Figure 2c), rubbish dumping, hillside developments (Figure 2b), as well as aesthetics and city image. As a decision support tool and prediction tool, 3D modeling and visualization provide new mechanisms to address these critical issues affecting Ampang Jaya.

Along with the government's acknowledgement to act responsively towards a sustainable urbanism that demand for new alternatives, and as generally agreed (Ampang Jaya Structure Plan, 1998), the existing planning system can no longer deal with the issues and challenges that Ampang Jaya is now facing. A new system should provide a better platform to disseminate information about Ampang Jaya as well as improve the communication between the various stakeholders, including the decision makers and the public as it is the success factor to planning.

4. Virtual Ampang Jaya

Virtual Ampang Jaya is a proposed interactive visualization environment to address the needs for modeling urban growth (Brail et al, 2001; Batty et al,

2000, Fragkias, Seto, 2007) and spatio-temporal transformation. It focuses on acquiring and analysing spatial information through digital means to construct an interactive virtual environment of the city and subsequently to evaluate the virtual model for urban analysis. While demonstrating the usefulness of visualization in understanding the city, Virtual Ampang Jaya will translate complicated information about the city such as maps, plan and written information into responsive spatial information that is easily understood.

For better planning outcomes, the project addresses the current challenges and resolve the problems in urban design and planning by establishing a comprehensive understanding of Ampang Jaya. Virtual Ampang Jaya also responds to the pressing needs to develop expertise in the application of digital media in the built environment by offering a new way to look at the past, present and future of Ampang Jaya (Figure 3). Virtual Ampang Jaya anticipates contributing to the uptake of digital and multimedia methods in local government by facilitating current planning and consultation processes between decision makers and various stakeholders including the general public. While the technical process of developing the model may serve as guidelines to develop other city models, the social approach of using digital media in data management and to manage the city is pertinent to the effective use of 3D visualization and modeling in planning (Pietcsh, 2000).

Figure 3. From left to right; the development of Ampang Jaya

4.1. METHODS; DATA ACQUISITION, RECONSTRUCTION AND GIS

Data acquisition on a higher scale would attempt photogrammetric technologies or 3D laser scanning from point cloud such as airborne LIDAR (Light Detection and Ranging) to obtain GIS data and to determine height and building details. Economical but less accurate approach would rely on the current GIS datasets in MapInfo and satellite images in Quick Bird of up to 0.6 meter resolution that are readily available from the local authority. The past aerial photographs of Ampang Jaya dating from 1950 to the current date will be assessed from JUPEM (Malaysian Survey and Mapping Department). Old topographic maps, cadastral maps, street photographs and past buildings, road system and other past information of the city will be sought from the local authority's and libraries' archives. These aerial

photographs will be scanned and undergone photogrammetric processes to produce a georeferenced image or digital orthophoto. This orthophoto will mainly produce the contour and the DTM (digital terrain model) that will provide the base map with real topographic structure and height (Figure 4).

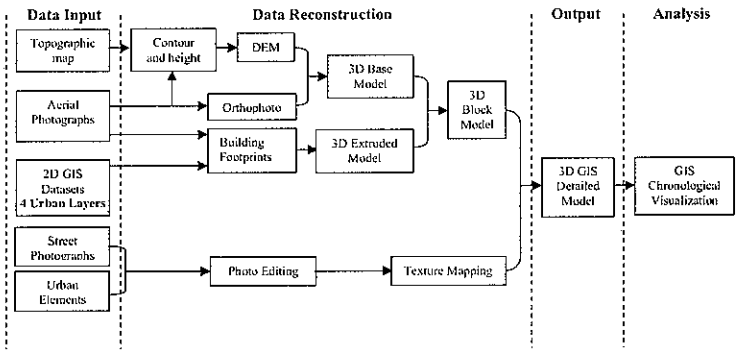


Figure 4. Process Framework for 3D GIS Modeling

4.2. MODELING

Traditional geometric constructions are generally based on CAD packages such as AutoCAD, 3D Max and can offer highly precise geometries. The development from physical form to digital data for Ampang Jaya using GIS database and softwares is contrary to the traditional methods of geometric constructions that are commonly employed in city modeling. 3D CAD models are often loaded with geometrical details, heavy, require good operating skills, and are time consuming, while they do not necessarily guarantee high level of reality. On the other hand, rapid modeling and methods such as texture mapping are inexpensive and add realism to the virtual models displaying details in color, texture and material. Rapid modeling includes texture mapping, building texture from oblique aerial and terrestrial images and panoramic image capturing.

In the last decade, GIS and Remote Sensing packages such as ArcGIS and ERDAS have been extended to generate 3D content. We propose to employ ArcGIS desktop softwares with Sketch-Up as the modeling software (Figure 5), (Salleh, 2008). Sketch-Up is the preferred modeling software for its short learning curve and user friendliness which are essential for modeling process. Currently, ArcGIS is compatible with Sketch-Up in complementing with details while maintaining spatial references. Orthophoto that was imported from ArcScene and ArcMap will be locked at the actual geographic location. Spatial referencing is a distinctive attribute in a modeling software and it can be carried out using Shapefile importer; a

plug-in for GIS in Sketch-Up. This proprietary plug-in enables detailed content to be built which is entirely compatible to the analytical functionalities and querying capabilities of state-of-the-art GIS. While the objects are georeferenced, it can also animate scenes, perform multiple spatial queries, view shed and shadow analysis, and various scenario based analysis (Shiode, 2001).

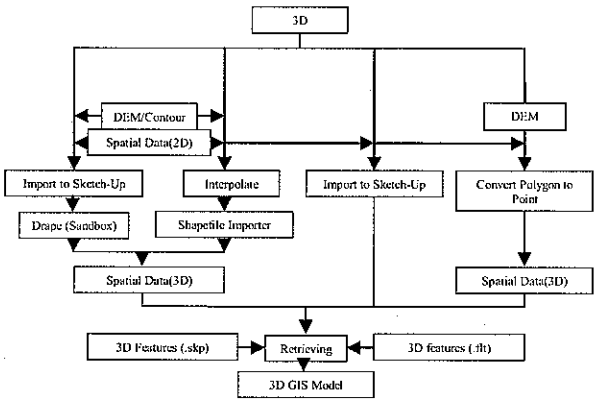


Figure 5. Example of the 3D integration using ArcGIS and Sketch-Up (Salleh, 2008)

Using Sketch-Up, digitized orthophoto of Ampang Jaya will be extruded into a 3D model while carrying the attribute data. A 3D model of Ampang Jaya from 1950 will be developed from the 2D GIS data layers consisting of social, economic, built and nature. Other objects including roads, landscaping elements and building entourage such as street furniture may be incorporated at the actual locations on site. Figure 6 illustrates the 3D automatic generation system employed for Virtual Kyoto (Takase, 2003, 2005).

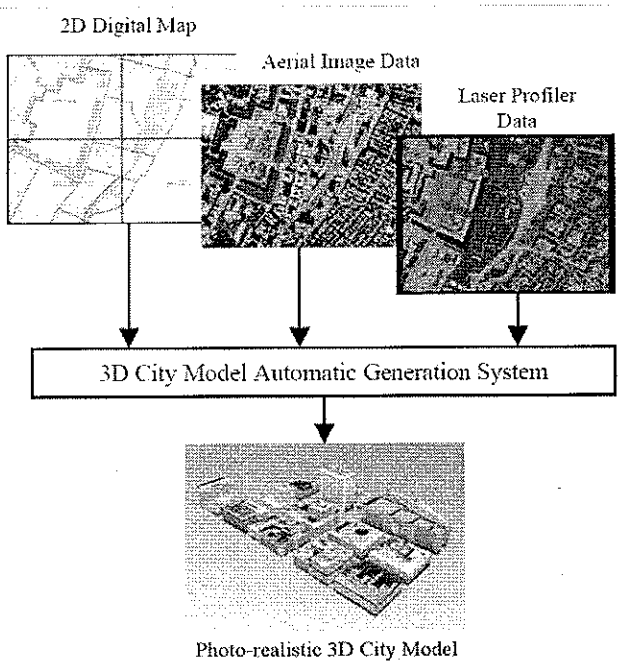


Figure 6. Example of the 3D city model generation system used for Virtual Time-Space of Kyoto (Takase, 2003, 2005)

4.3. VISUALIZATION

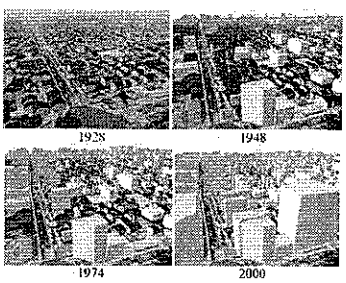
The visualization model (Kim and Bejleri, 2005) will incorporate a movie growth (figure 7) of Ampang Jaya, displaying qualitative and quantitative responsive spatial data information on time line. There are different softwares that can perform geospatial visualization including Urban Viewer that are compatible with the main 3D modeling platform for cities in Japan called MAP CUBE (Takase, 2005). While modeling softwares such as SketchUp have enhanced their functions to incorporate geospatial and interactive visualization, GIS softwares are becoming more actively engaged in virtual cities. The visualization can be recorded and played in Windows Media Player or Quick Time, or further extended into VRML player such as Canoma.

Visualization with GIS provides a new approach to urban design and planning; problems of site location, large settlement design and community planning, public participation and a myriad of possibilities. Visualization growth of Ampang Jaya attempts to animate data layers of social, economic,

built and nature through spatio-temporal; space and time animation and simulation in ArcMap, ArcScene and ArcGlobe to understand how they change with space and time.

Social	– indicate communal spaces and its serviceability to other parts of the city.
Economic	– animate large scale settlement growth, commercial and business centers to understand the pattern.
Built	– animate the building development to understand the population increase and boundary changes.
Nature	– animate the changes in the landscape and forrest encroachment due to building development.

These data layers will be animated in ArcScene (figure 7) and ArcGlobe incorporating real time where simulation scenes will be viewed by users from any angle and height while users are allowed to select or hide layers as they navigate through the scene (figure 8). 2D map tracking can be viewed simultaneously in ArcMap to keep users on track.



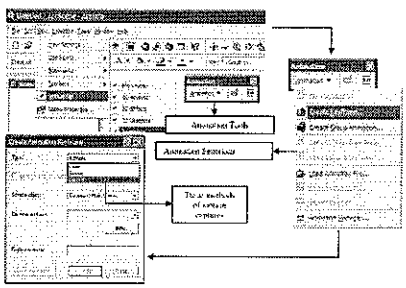


Figure 7. (Left) Example of urban growth of Virtual Kyoto (Takase, 2005)
Figure 8. (Right) Example of animation development in ArcScene (Salleh, 2008)

While GIS softwares are able to interactively visualize 3D models, the challenge lies in the technical limitations, unfamiliar and resistance towards the new tool by the stakeholders as users over the new media. Taking into consideration that the tangible media is important in rooting the digital visualization in a more realistic and familiar representations, a 3D physical model scanned and modeled from its digital representation will be showcased alongside. Issue of abstraction and realism would also be addressed at the site in written explanation. We forecast a minimum of one workshop to be carried out where the model will be stationed to deal with different levels of familiarity of users in handling with digital media.

4.4. ANALYSIS

Adopting the Community Taxonomy (Snyder 2003) as a guideline, the analysis will focus on four layers; social, economic, nature and the built environment to study the growth and spatio temporal transformation of Ampang Jaya over 50 years. While using ArcGlobe as interactive visualization viewer, we will also explore its querying and analyzing capabilities. We hope to establish a comprehensive understanding of the city by exposing the various layers of the city that maybe limited under the abstract 2D data.

The study will deliver an experimental test bed for improving urban design and planning in the social, economic and environment by studying the growth pattern of the city. It acts as a temporal visualization to display the current scenario as well as reflect the past involving historical, environmental and large scale settlement patterns. By understanding the past and the present situation, we can presumably predict the future (Figure 9). As predictive modeling tool, we may also visualize the future patterns of urban design, land use, neighborhood and regional visioning, transportation planning, landscaping and site planning. Responsive spatial information would enrich understanding of the issues and help to facilitate the planning process which would presumably result in better decisions being made. Complex city information that is tailored to a particular group of professionals is translated into responsive spatial information will be more easily understood by stakeholders who are not taught to read information such as coded plans and maps. While providing an improved platform to disseminate the information, the model is also projected to develop better understanding about their city among the public. Feedback from the various stakeholders will be collected for analysis and future research.

> Rationality is based not on pure logic and the abstract evaluation of evidence but rather on informed consensus formed by a community of individuals in a particular place and time.
>
> (Klosterman by K. Brail et. al. 2001).

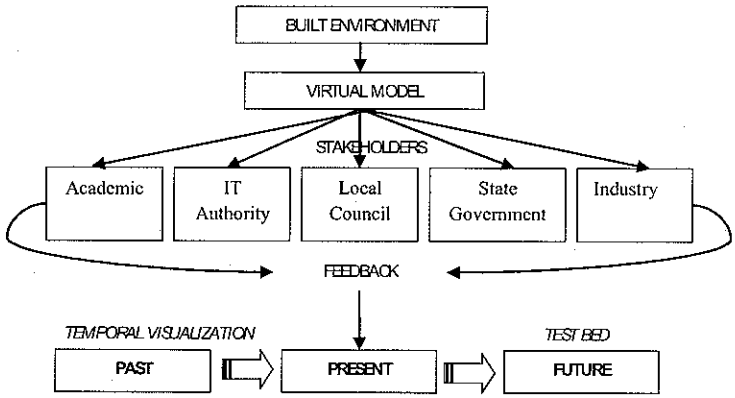


Figure 9. The Role of Virtual Ampang Jaya for Urban Analysis

5. Conclusion and Future Work

While it may provide as a guideline for the use of computing in planning for the authorities in Malaysia, the model can be further developed into a prototype that may incorporate GeoImmersive videos into GIS environments. Integrating spatial information with GIS database as a decision support tool and prediction tool, many doors are open to new findings and innovations about improving our cities that is demanded by many quarters; government and private and may be extended into other contexts. Batty (Batty, 2000) suggested 12 categories that can benefit from the new media; architecture, telecommunications, emergency services, facilities and utilities management, marketing and economic development, property analysis, tourism and entertainment, e- commerce, environment, education and learning and most engagingly, city portals as the entries to urban information hub. Building industries like asset and facilities information management may also profit from the application of GIS into the world softwares, for example AutoCAD Geospatial and Infor's Datastream. On the extreme end, future research into developing prototype models could move from 3D GIS and CAD into the virtual world and online design over the World Wide Web (Bruce, 2007).

Providing an insight on how to use the new media in the future, the visualization modeling may suggest a significant improvement in the planning system of Ampang Jaya and in Selangor as a whole. A new and unique innovation in the communication aspect of planning is also timely in conjunction with the new One Stop Center (OSC) system currently introduced that has since revolutionized the planning system in Selangor. The new system urgently needs a new tool and 3D interactive computer

visualization has the potential to enhance planning information to bridge the gap among the professionals by clearly depicting the issues that affect the environment. 3D modeling and visualization is also paralleled to the national call for Electronic government (e-govt) which is a flagship application of the Multimedia Super Corridor (MSC) project that aims to redesign the system of the government to bring about fundamental changes from the society level (Meng and Ahmad, 2000) as well as to meet with global IT and digital technologies expectations and future challenges.

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