Application of 3D Modeling in Managing Planning Control and Improving Public Participation

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ABSTRACT

The increasingly complex system that integrated into the modern city have always being the headache for the planner to understand and plan for their territory. With the development of advanced technology, the three-dimensional visualization technology has been developed and being improved day-to-day to help the urban planning fields especially in the decision making. Therefore, this research is an attempt to identify the application of 3D modelling in managing the planning control as well as improving the efficiency of public participation. This 3D modelling has been developed using CityEngine, The objectives have been formulated identifying the application of 3D modeling in planning control in term of development density and plot ratio and To analyze the criteria can be used in modeling the development scenarios. The method for this application is using the CGA rules which were applied to the GIS data that imported for ArcGIS software. The finding illustrates how the GIS layer generated into three-dimensional buildings, which have some features that can be used to control the urban planning. In addition, the 3D model has been exported to be visualizing using Web Scene interface that enable the user to view the scenarios in side-by-side viewport. Thus, it is recommended that this system would be implemented in the local authorities to improve the urban planning system.

Keywords — Geographical Information System (GIS), 3D Modelling, Planning Control, Plot Ratio

1. INTRODUCTION

This research is conducted to examine the application of 3D modeling and mathematical function as a tool for development control in the planning process as comfortably in the public participation. It will discuss on what extent these technologies can goes beyond in urban planning in society to help the planner, decision makers and public towards a more transparent planning system.

It is commonly known that the urban areas are the key player for a competitive economy whereby in a place, which contain many professional people as well as a space for creating prosperity. Urban Development refers to increase the diverse types of potential, which include the social, economic, environment, cultural towns, as well as the urban fields (Didulescu, 2010). This urban development wills involves some mechanism to ensure it can be successful which are the good public policy making as well as the integration of multidisciplinary field of knowledge (Klosterman & Brail, 2001).

For the last forty years, Geographic Information Systems (GIS) have been applied in many planning applications from a simple daily administrative system with strategic planning functions such as to evaluate the socioeconomic data in land use allocation tasks. It is a very useful device to help planners, decision makers as well as the community in order to efficiently reply to with the challenges faces, to plan for a successful future and improve the service delivery arrangement.

GIS will still act as the core of these systems in which it will be the main component and it must be updated frequently and well organized for spatial information planning. Most of the geoinformation community are two-dimensional or 2.5D based

in which it is no longer adequate as the world now is changing and the vast advanced technology available in the market thus increasing the demand for the community to upgrade the system by integrating it with the virtual reality, either 3D or 4D (Abdul Rahman et al., 2006).

2. PROBLEM STATEMENT

The current two-dimensional plan could not give a clear view for both parties especially the key stakeholder. Most of the data are still in two-dimensional view and it need to be transform using the 3D modelling especially for the registration of high-rise building (Hassan & Rahman, 2011). Even today most of the design works in urban planning and design are done in conventional media such as 2D mapping, sketches, photographs and such drawings, but these conventional media did not do much and enabling the developing ideas and improving proposals for either for the local authorities or other related parties (Koramaz & Gulersoy, 2009).

Surveyors, planners, developers and architects have used paper drawings and plans to document the land registration process. This system is inefficient and costly, without a clear and effective description or visualization of the third dimension. Multiple page 2D plans cannot be easily understood or visualized by people who are not familiar with the related fields. Apart from that, through an observation in the Kuala Lumpur area, there is some lacking in term of the guideline that emphasized on the aspect of skyline conservation as well as the building facade conservation. In addition to that, the involvement of the community in the decision making process is very important and in this situation, one of the main problem in gaining the involvement of them for public participation is because they could not understand or have a clear view on what will take place (Jamaluddin, 2012).

3. LITERATURE REVIEW

3.1. Geographical Information System (GIS) and 3D Modeling

Geographical Information System (GIS) refers to any location on the world's surface such as the location of the railways which make up the transportation network. Abdullah (2005) discussed that GIS is one of the effective tools in improving the management and decision making process for urban planning. 3D city model are growing rapidly as it involves many fields in the world. Chen (2011) in his article stated that, the application of 3D city model does not emphasize on urban planning only, but it also includes many other fields such as disaster management system, tourism purposes, navigation especially in visualizing and facilitating localization for indoor and outdoor navigation, as well as in the field of telecommunication.

Human is living in a real world that are so called three-dimensional earth, which consist of x, y, and z-coordinate (Abdul-Rahman, Zlatanova, & Coors, 2006). Dimensional model offers multiple opportunities to work: height adjustments, connection of elements that goes into it, creating a new product from the basics. Easy handling and completeness of the information provided can facilitates the design process. Finally, data can be integrated and exported into other programs, specialized in a certain field of activity, such as: design, urban planning, tourism, real estate property, police and security, etc. Depending on the technologies used for 3D modeling, the 3D replica can be constructed as a physical model or as a computer model.

CityEngine has established itself very well within the gaming industry since its very first commercial release in 2008. The software has been used extensively to create a highly detailed 3d model of fictional cities and urban landscapes (CityEngine, 2012). The main concept of the CityEngine is the "procedural" approach towards modelling efficiently. The computer is given a code based "procedure" which represents a series of commands - in this context, geometric modelling commands - which then will be executed.

The commands which are provided in the CityEngine's CGA shape grammar, such as "extrude", "split" or "texture" are widely known commands in most 3d applications and thus any user can adapt them easily and create complex architectural forms in a short period of time. The software has many advanced functionalities running under the surface while the user interface is relatively user friendly.

Planning control is an important tool or mechanism to control all types of activities in a particular place on earth, which comes under the jurisdiction of any related authorities. It is a complex process and tedious procedures (Che' Man et al., 2006). Planning control is basically an activity carried out by

the local authorities which involves the policies, as a guideline in which it needs to be taken into consideration in the decision-making process.

4. STUDY AREA

The study area is selected within the city center with a proposed redevelopment area. The study area should emphasize on the mixed use of development in which it might comprise of different use class order. The study area is located near a few major roads which are Jalan Imbi, Jalan Pudu and Jalan Traverse. With an approximately 210m^2, the study area is located near to Golden Triangle of Kuala Lumpur. The reason why this area has been chosen as the study area for this research is due to its location which is located at one of the main commercial areas in Kuala Lumpur or so called Golden Triangle Area. Another factor of the study is being chosen as it was gazette as one of the Urban Redevelopment sites as well as the Urban Regeneration site. This area has the potential to be developed as it is one of the areas which have a large concentration of the businesses to take place.

5. METHODOLOGY

Research methodology plays a vital role in shaping this research as it refers to how the researcher structures the research from the beginning until the end of the study. Stage 1 includes the preliminary research for this study in which it includes the goal, objectives, problem statement and so on. Stage 2 explains on the literature review about the 3D modelling, planning control, and public participation. Stage 3 and 4 involve the data collection and main processing in CityEngine. In addition, Stage 5 involves the stage of analysis and findings in which this stage illustrates how the data being analyzed and what are the findings from the analysis. Last but not least, the recommendations were made based on the analysis and findings.

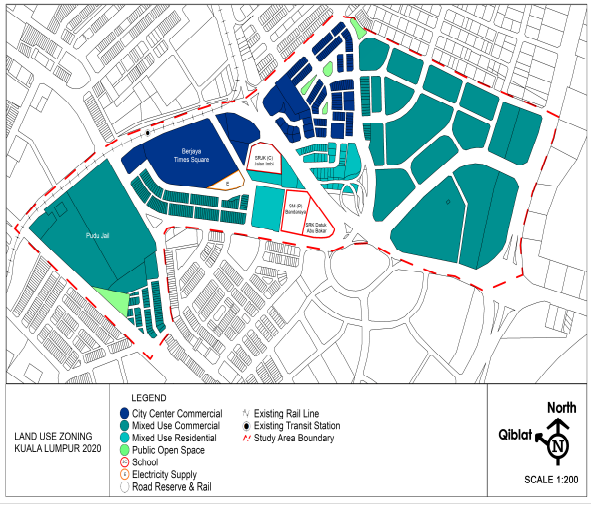

Fig-1: Study Area

.5.1 Main Processing in ESRI CityEngine

This stage will be the core stage for this research. The data that has been prepared using ArcGIS 10.1 will be used in processing and generating the model. CityEngine work on a various type of files in which for this research, the (.shp) data will be imported into the CityEngine Application as the polygon that later will be assigned with the rules which is one of the main features in the software.

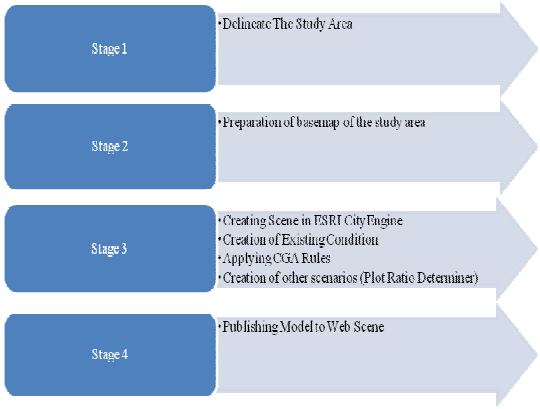

Fig-2: Main Processing in CityEngine

As what has been mentioned from the literature review, CityEngine application operate and run based on CGA rules. Thus, in this stage, two types of rules will be used, which are the Zoning Rules and Building Construction Rules and Floor Area Space rules. This stage is being conducted to achieved the first objective which is to identify the application of 3D modelling in managing the planning control in term of its density and plot ratio. The first rules is the Zoning rules. As can be seen in Figure 3, the inspector console is how the layer that have been imported from ArcGIS being connected with the attribute data that exist in each of the polygon layer. It also

allows the users to differentiate the multiple uses of usage in a multi-storey building.

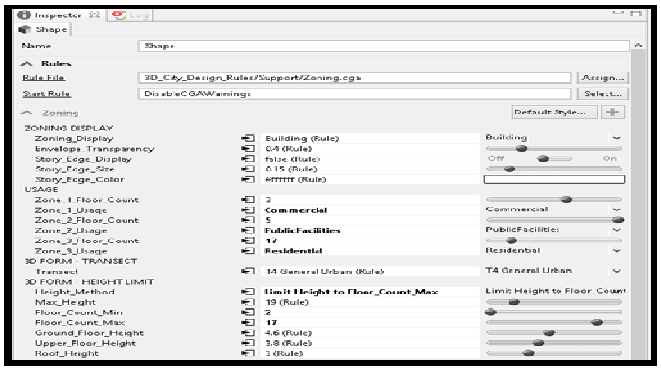

Fig-3: Zoning Rules Inspectors

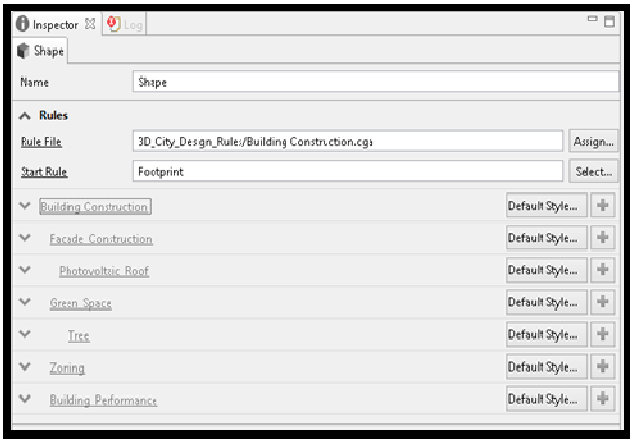

Fig-4: Building Construction Inspectors

Meanwhile, the next rules is building construction rules. This second rules is used to generate the 3D model of the building in the study area. This rules enables the user to user to generates the building footprint into the 3D model building based on the floor count attribute exist in the GIS data layer. In addition, this rules also allows used to demonstrate the building facade of the study area.

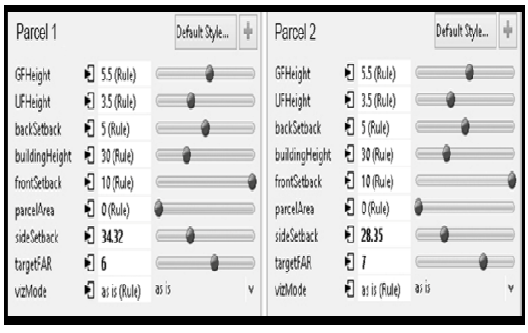

Fig-5: Floor Area Ratio Inspector (Scenario 1)

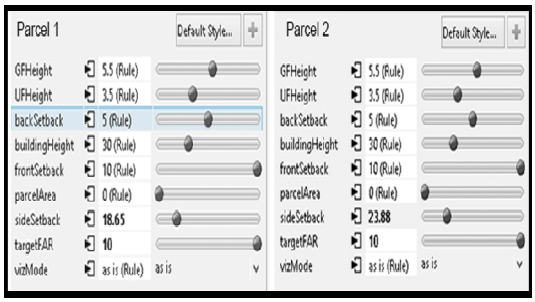

Fig-6: Floor Area Ratio Inspector (Scenario 2)

The third stages is conducted for the second of the research objective which is to analyse the criteria that can be used in modelling the scenarios. As the research objective, this Planning Support System will help the planner to deal with development plot ratio especially for the commercial basis land uses. As can be seen in above figure, it is the inspector whereby it can control the Gross Floor Area (GFA) based on the Floor Area Ratio (FAR) given. For this research, two scenarios were created based on different plot ratio and plinth area.

The last stage in CityEngine is conducted regarding on the third research objective which is to visualise the output using application features in improving the efficiency of public participation. After all the data being constructed and analyzed, the application has the features that allow user to publish the output of the three-dimensional virtual city.

6. ANALYSIS AND FINDING

6.1 Applying Land Use Zoning Rules

Fig-7: Thematic Land Use Map with Building Land Use

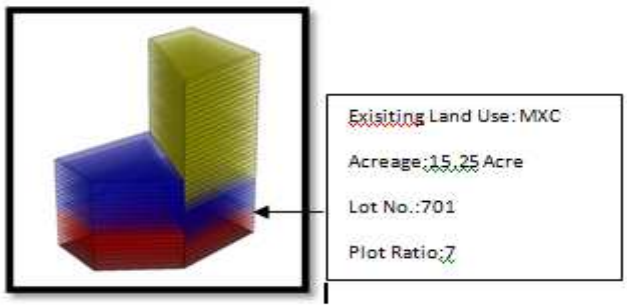

Fig-8: Different Use Class Order for Building Footprint

It can be seen that the CityEngine generates the land use attribute and visualized it in aerial view form. In relation to Figure 7 also illustrated the ability of this modeling in visualizing the 3D dimension of the selected area. The rough illustration of the physical form of the study area, including the building height information, was generated through the information attribute in the GIS data. In addition, the zoning rule allows differentiation for different type of use class order in a building. For example, for a parcel that has been constructed with a mixed use commercial, zoning rules would be able to show the vertical use of development as what can be seen in Figure 5.4. This figure indicated that the different use of development in each floor can be represented through different colors for different level of the building.

6.2 Applying Building Construction Rules

Figure 9 shows the building skyline of some part in Kuala Lumpur which include the study area in Bukit Bintang. These rules allow a great visualization of an existing view of the surrounding proposed development. It is most effective in controlling the building height and skyline of the proposed development and its surrounding area. This 3D modeling allows a more realistic monitoring of the urban skyline rather than observation of its use through two-dimensional building footprint plan. Figure 10 shows the capability of this Planning Support System to demonstrate the building facade at the area desired. Building façade is one of the important criteria that need to be considered in managing the urban design. Building façade rules allows a general visualization of the desired building facade regulation, and enables to monitor the building facade of a newly proposed development in ensuring its suitability with the proposed of the Design Guideline and at the same time preserves the identity of a particular area.

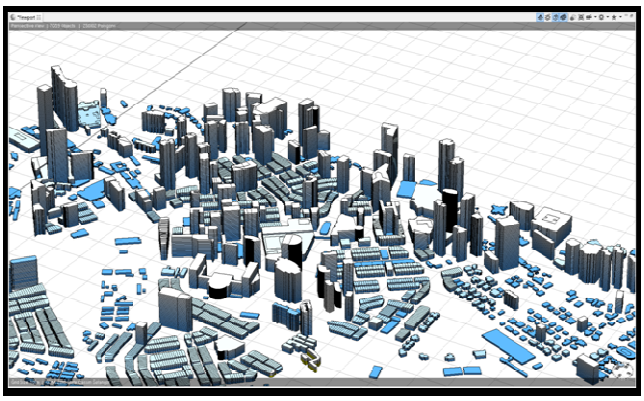

Fig-9: Generated Model from Building Footprint

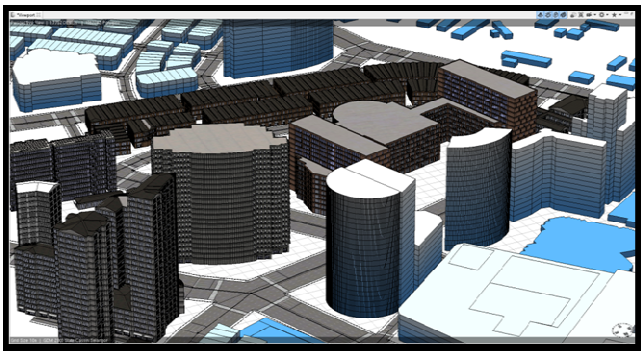

Fig-10: Generated Building Facade Using Building Construction Rules

6.3 Applying Plot Ratio Rules

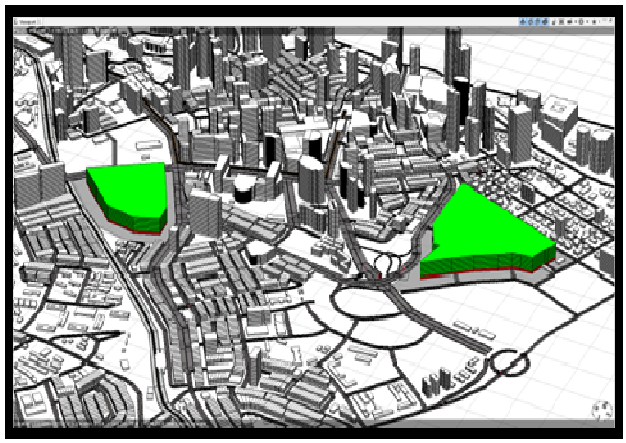

Fig-11: Visualisation for Scenario 1

It can be seen the two proposed development which represent scenario 1 for this research. Basically the buildings do not represent the real building design in the future, but it shows how the building footprint would be based on the Floor Area Ratio in which it will automatically construct as the picture above. It can be seen from Figure 5.9 that the built area for the proposed development is quite big compare to the rest area of the site. In addition, the building height for the two proposed site is not high as compared to other surrounding building due

to the plinth area that has been set up in the methodology stage.

Parcel	Parcel Size (M^2)	Plot Ratio	Gross Floor Area (M^2)	Number of Floor
A	88128	1:7	632447.27	12
B	136674.73	1:6	897673.46	11
Total	224802.73	-	1530121.73	-

Table 1: Statistic Gross Floor Area Band on Plot Ratio

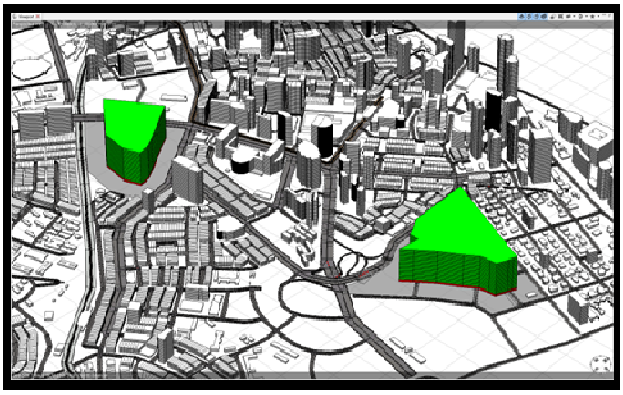

Fig-12: Visualisation for Scenario 2

It can be seen that the building structure for both sites is quite high compared to the building height from Scenario 2. One of the factors that contribute to this result is that the plot ratio used for both proposed site are 1:10 in which it allow more number of floors can be added, in relation to an additional number of Gross Floor Area (GFA).

Table 3 shows the statistic data on the relationship of the Plot Ratio with the Gross Floor Area and Number of Floor allowed for this proposed development. As far as it is concern, the mean allowable Plot Ratio for this study area is generally 1:5 to 1:7 in which this scenario being created to see what will happen if the maximum plot ratio being implemented in this study area. It can be seen from both proposed sites in which the allowable Gross Floor Area is almost ten times bigger from the actual parcel size.

Parcel	Parcel Size (M^2)	Plot Ratio	Gross Floor Area (M^2)	Number of Floor
A	88,128	1:10	911,105.92	26
B	136,674.73	1:10	1,378,709.66	25
Total	224,802.73	-	2,289,815.58	-

Table 2: Statistic Gross Floor Area Band on Plot Ratio

6.4 Web Scene Interface

After applying the related rules, that entire model of the study area can be viewed by using CityEngine Web Scene. This Web Scene can either be viewed offline (using local host) or being uploaded to ESRI CityEngine website. As can be seen from Figure 5.11 there are five main layers that have been use in developing the model for the study area by using CityEngine application. The 'eye' icon indicates that the visibility of the particular layer. In the layer 'Different Plot Ratio', the presence of another sub-layer that represents the different scenario which can be viewed side by side.

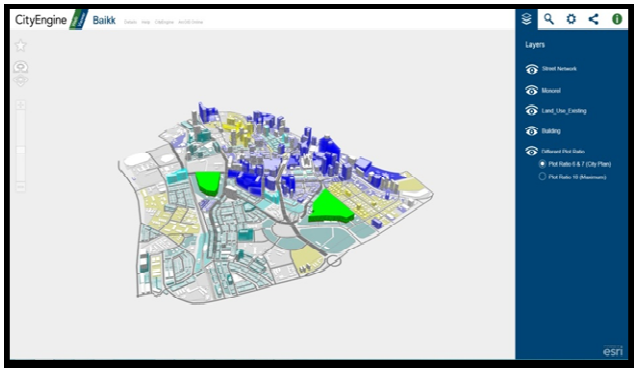

Fig-13: Webscene Interface

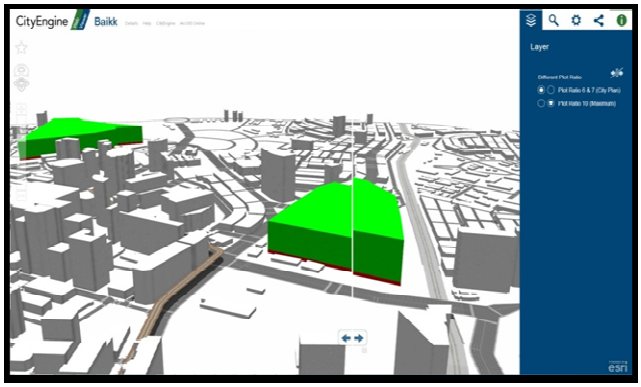

Fig-14: Two Different Scenarios Comparison

This layer can be chosen to display or to compare side by side with two other sub layers. In order to compare the two sub layer, the Split View button needs to hover and thus it will open the Comparison Mode Layer Pane. Figure above shows the different scenarios that have been created based on the plot ratio that has been set before. In this figure, different plot ratio scenario is viewed side by side, with plot ratio 6 at the left and plot ratio 1:12 on the right.

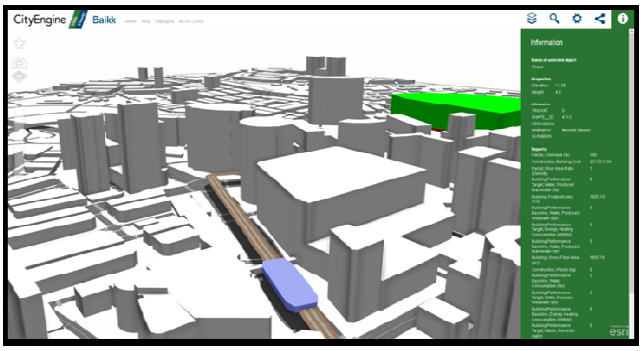

Fig-15: Model Information

Other feature of the CityEngine Web Scene is that it allows users to gain information of a particular polygon that exist in the model. The example is illustrated in Figure 13, as it shows the attribute of Monorail Station at Bukit Bintang once the mouse was clicked on it. The green panel indicates the attribute data of the selected polygon based on the attribute in the GIS data. In addition, the elevation of the polygon on the earth's surface is also visualized in this web scene.

7. RECOMMENDATION AND FUTURE OUTLOOKS

This study has demonstrated the function that 3D modelling provided in its application in managing the planning control and improving the efficiency of the public participation. Planning control and public participation are widely used in urban planning discipline, in which it deal with the development that already exist or future development that are going to take place.

In general, the following points recommended in implementing the 3D modelling in managing the planning control and public participation:

i. The planning exercise need to continuously being controlled and the data should be captured in a manageable database. Computer-generated databases which consist of 3D modelling of the urban areas should be developed to support the planners in managing the planning control.

ii. The new technique to improve the public involvement should be introduced to ensure that the communities have the access to the planning. An application that user-friendly should be establish to encourage the community to get involved in the planning to ensure any circumstances can be reduced in the future once the policy or guideline being implemented.

Meanwhile, in term of the limitation and what improvement needs to be made base in using the Planning Support System are as below:

i. Development Of The Scenarios

The first constraint in conducting this research is to develop the scenarios for the study area in Bukit Bintang. Even though both two parcels has been gazette by Kuala Lumpur City Hall as one of the redevelopment area for Kuala Lumpur, but the detail of the proposed development for that particular areas were not sufficient in order to conduct this research. The use of plot ratio as the indicator to differentiate the scenarios were not enough as it just give a general scenario on what is going on in the future based on the relation of the plot ratio and gross floor area. Instead, the scenarios need is not accurate, as it was just using the assumption based on the Draft KL City Plan 2020-Volume 2.

ii. Writing CGA Rules

As the City Engine is the core-processing tool for this research, there are some difficulties in developing the model in that Planning Support System application. Basically, the application was run by using CGA Rules in which the users need to create the rules by their own in order to run the system. Even there are a lot of rules that already been created and can be use once it have been downloaded, but somehow there will be some lacking in using it and those who want to alter the rules, need to understand the method of writing the script rules for this application.

In practicing the application of 3D modeling in urban planning, the Planning Support System must be more urban planner -friendly in which most of the planners are not computer-engineering based as they are not familiar in writing the scripting for the rules. It is recommended that the Planning Support System should be able to allow the planner to create the rules by their own desire based on the criteria needed without having difficulties to prepare with some other material to develop the model.

iii. High end hardware and Software

Most of the Planning Support System needs very powerful and updated computer hardware in order to run that application. The computer hardware must have the capabilities to run the application especially when applying the CGA rules if it involves generating a large scale of model in the CityEngine.

8. CONCLUSION

Briefly, this study is being conducted to identify the use of 3D modelling in managing the planning control and in improving the efficiency of public participation. A Planning Support System was used in this research in developing and generating the three-dimensional model of the study area in Bukit Bintang in order to identify the effectiveness of this method in urban planning field. The proposed (Che'Man, Yaakup, & Johar, 2006) model gives a clear view in understanding some mechanism that can be used to visualize the study area in term of its land use distribution in multidimensional perspective, building skyline pattern as well as its facade, and the impact of using the plot ratio control for a development that will take place.

BIBLIOGRAPHY

[1] Abdullah, A., "Applications of Planning and Decision Support Systems", Kuala Lumpur: Bureau of Consultancy & Entrepreneurship.

[2] Abdul-Rahman, A., Zlatanova, S., & Coors, V., "Innovations in 3D Geo Information Systems", New York: Springer. Retrieved February 17, 2014, from http://books.google.com.my/books?id=BQ2NuFhI7SgC&pg=PA469&dq=gis+and+3d+modeling&hl=en&sa=X&ei=OnDGU5TAOYu48gXty4CQDA&ved=0CDMQ6AEwAQ#v=snippet&q=Developing%20Malaysian%203D%20Cadastre%20System-Preliminary%20Finding&f=false

[3] Che'Man, N., Yaakup, A., & Johar, F., "GIS in Development Control Process: The Case of Development Control System for City. Tokyo Academic, Industry & Cultural integration Tour", Shibaura Institute of Technology, Japan.

[4] Didulescu, C., "The 3D urban Model", A neww tool in Support,.

[5] Klosterman, R. E., & Brail, R. K., "Planning Support Systems: Integrating Geographic Information Systems", Models, and Visualization Tools. Redlands: ESRI.

[6] ESRI., "ESRI CityEngine", (ESRI Press) Retrieved November 2013, 21, from ESRI: http://www.esri.com/software/cityengine/features.

