ASSESSMENT OF A PHYSICAL PLANNING PROJECT THROUGH VIRTUAL REALITY

A case study

WAEL ABDELHAMEED
Department of Civil Engineering and Architecture, College of Engineering, University of Bahrain.
P.O. Box 32038, Isa Town, Bahrain.
wael.abdelhameed@gmail.com

Abstract. The study reports an application of VR models in the assessment of a part of physical planning project. The project outputs were different reports, GIS data and maps, and CAD drawings. The GIS data were used to create the VR models by importing Shpfiles of the GIS project outputs to VR software. The study presents VR models and the assessment of the physical planning project in terms of: 1) effect of the population increase, 2) effect of the required residential units, and 3) quality assurance for the current situation and future situation. The method used to build up the VR Models was through satellite images (by Google Earth Pro) and VR software (by UC Win/Road). Different models were built up to visualize and assess the alternative solutions and various influential factors. The study employed Virtual Reality in various urban and planning problems through models that are employed as tools of communication and design. The visualized environment and the associated models facilitated the evaluation of important areas, namely: impact of different factors and alternative solutions. The study concludes that the processes, such as decision making, visualization and representation, performed through VR manifest its importance to different design phases of urban and physical planning.

1. Introduction

The term 2.5D in city modeling is used for describing models where the Z value presents each pair of XY coordinates (Sinning-Meister and Gruen, 1996). The 3D models of physical planning are basically a computerized or digital model contains the graphic representation of buildings and other

objects in 2.5 or 3D. The most important characteristic of 3D models that are considered solid models are the possibility to navigate through the model by walking, flying and examination (Bourdakis, 1997). Walking means moving on the model surface, flying has three dimensional freedom of movement and examination is a view where the entire model is visible in the view port and the user is free to rotate the object in three dimensions. Using static modeling, users only move the object rather than engage into the environment. Using virtual reality manifests its importance in this specific point, where VR offers new technique for visualizing 3D modeling. Through using the VR technology, the environment where the model consists is known as virtual environment, VE. Another advantage of using VR models is to view the VE on a computer screen, projected on a large screen/more than one screen in latest applications or with head mounted displays (HMDs).

This research paper investigates an application of Virtual Reality at the large scale projects of physical planning and urban planning. The Virtual Reality has been employed in various urban and planning problems whereas creating environments to be visualized as real facilitates crucial processes. This visualization is linked to different applications and implantations of urban and physical planning. Some applications introduced VR as a collaborative, sharing tool between designers and planners on one side, and users and beneficiaries on the other side. Other applications were more related to planning and design processes.

2. Physical planning project

The physical planning project presented in this research was through an agreement between the Ministry of Housing and Physical Planning, Egypt, and the South Valley University, Egypt. The main objective of the project was to set the strategic physical planning for 2014 in order to control the developing areas and preserve the agriculture land. The proposed physical plan was through employing the available resources in the villages and sharing the potential of inhabitants. The project outputs were different reports, GIS data and maps, and CAD drawings. Nevertheless, this research paper concentrates on the project part of physical planning and how VR can be employed during the design processes of urban and planning.

The project had been conducted in 2005 and for one year by a university team consisted of 18 members. The researcher was the principle architect and planner, and was the head of university team. The project was performed on two village units. The term village unit refers to a mother village and all geographically related villages and communities. One village unit has 3 villages and the other has 5 villages and few small communities.

Both village units are at Sohag governorate in Upper Egypt. This research paper concentrates on the village unit that has three villages.

3. Created VR models and Used Programs

The building up method of the VR models was by using satellite images (provided by Google Earth Pro) Figure 1, and VR software (provided by UC Win/Road). Different models were built to visualize and assess the alternative solutions and various influential factors.

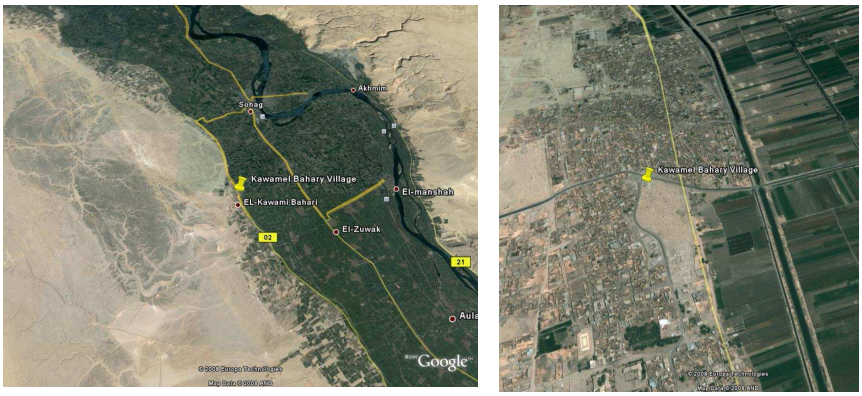

Figure 1 Satellite images of Kawamel village, Egypt (Google Earth Pro)

The UC Win/Road is a software program created by Forum8 Company. Its version 3.04 has the function of importing shp file format created by the GIS software program. Through this available function, models are created to represent the input data of shp files. Also data such as building heights can be changed forming different models through two ways, namely: changing the data of shp file, and transformation functions of UC Win/Road, Figure 2.

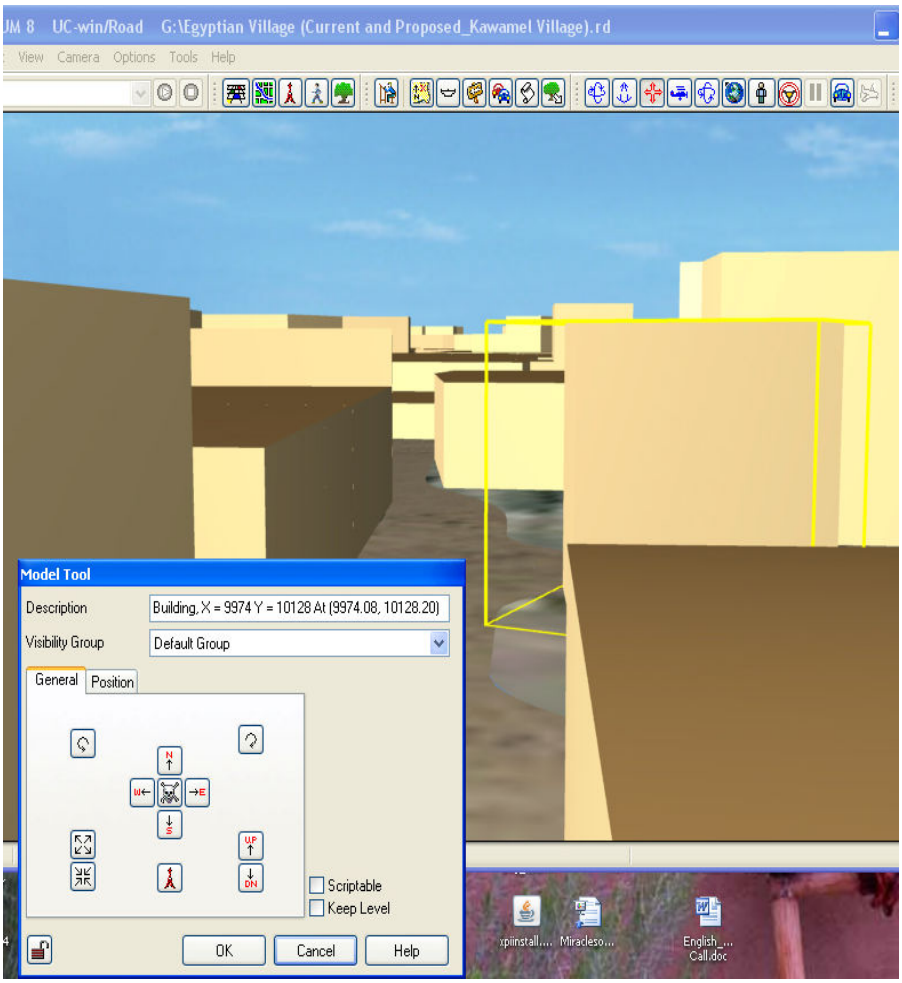

Figure 2 A screen shot of the used VR program (UC Win/Road) showing its window of transformation functions, case study of Kawamel village, Egypt

4. Assessment Areas

The focus of this research paper is to assess a part of the physical planning project that the researcher shared in conducting it. Although the assessment process not only may be investigated through various areas but also can be based on different objectives, the research paper concentrates on some areas that manifest the contribution of VR use in sharing and communicating during decision making processes.

The study presents VR models created based on different data that help in the assessment areas. The assessment areas investigated are selected according to their importance for decision making processes that are based on different factors such as economy, climate, etc. Having the background experiences of the required communication between planners, decision making authorities, and beneficiaries, the study assesses the physical planning project in terms of:

4.1. EFFECT OF THE POPULATION INCREASE

The project has proposed different scenarios to predict the number of residents. These scenarios were based on two kinds of factors; namely 1) previous statistics that were already conducted; and 2) future ratios that are expected for the population increase and in-out immigration. This population increment can be accommodated by the following methods:

- Increasing the storey number in the existed residential buildings, Figure 3.
- Adding new residential buildings in new areas.
- Replacing some old residential buildings.

The created VR models, Figure 2, help in visualizing and assessing the single and collective impact of different factors related to the previous methods. On one side, there are the expected funds provided by the government or private sectors 'housing banks', the expected donation offered by beneficiaries and inhabitants, and other sources of funding. While on the other, there are financial costs, obstacles and timetable to implement any of the previous methods.

There were many factors and attributes to compare and in the same time to balance between each proposed plan, whereas the policy and trend of the ministry had a main priority. The final embraced plan was a combination of the three methods. In some areas, the decision was to replace old residential buildings and to offer inhabitants low rate residential loans from private sectors. Other areas were subject to adding new residential buildings and changing road network to accommodate the changes. The method largely covers areas was to add storey numbers as more than half residential buildings are less than four floors.

The impact of plans and their results had to be discussed and presented. The communication in this episode with decision-makers or stakeholders is highly essential to have them comprehended these results and impacts. Drawings and static models 'manual or digital' are not the best means; VR

and its interactive advantage offered by the used platform is the most effective type of communication understood by non-specialized persons.

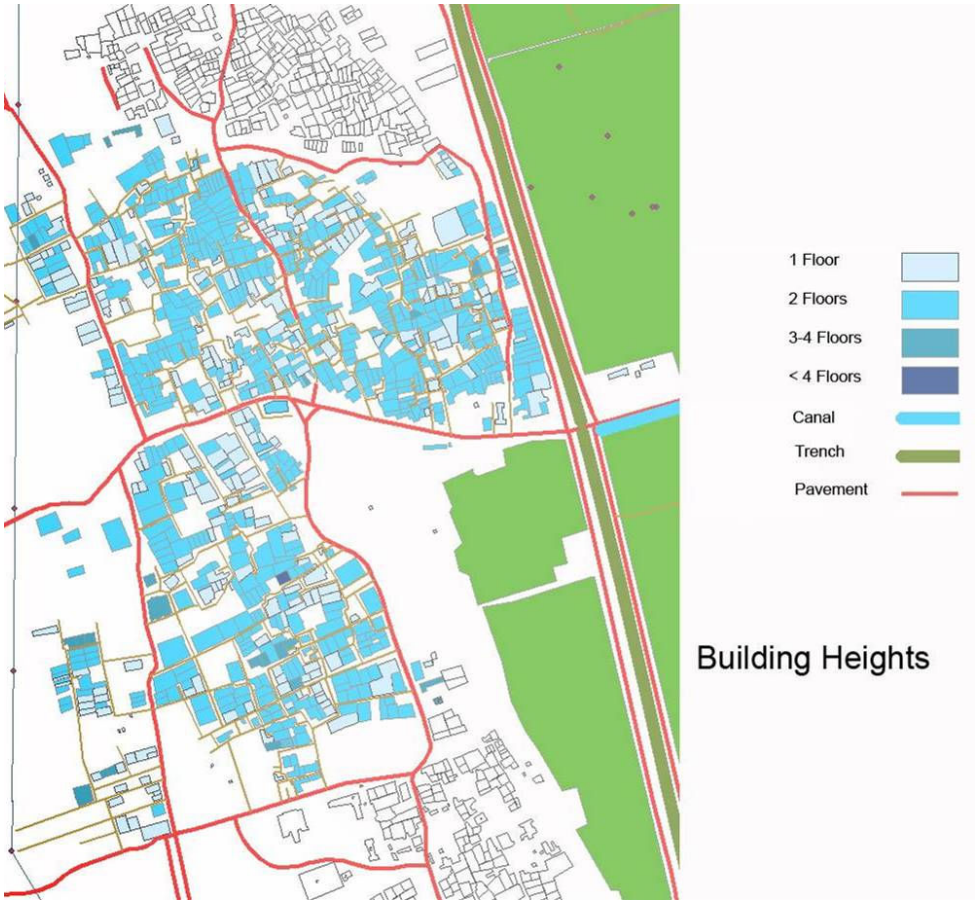

Figure 3 Image of building heights from GIS data of the physical planning project, case study of Kawamel village, Egypt

4.2. EFFECT OF THE REQUIRED RESIDENTIAL UNITS

In order to implement the plan that includes the population increase investigated in the previous part, the project has proposed to: increase some road widths (main roads) and building heights of these roads, in addition to adding new roads, Figure 4.

Figure 5 shows a VR model through which the relationship between building heights and road widths were investigated and assessed based on

different options and proposals that were argued and analyzed during conducting the physical planning project. The impact of adding new roads or changing their width on the residential areas is also investigated and assessed.

There were different communications among the project's authorities to calculate and then accommodate the required residential units inside the village unit. These communications helped to draw and point out the whole portrait with each authority's point of view and justifications, which were not clear to some limits for other authorities. The communications lead to the clarity of the requirements and potentials.

The VR model enables visualizing the impact of each scenario on different factors of physical planning, such as area traffic amount, traffic capacity of each road and pedestrian routes. A large number of residential areas and the center area of the village needed to be provided with some pedestrian routes and to isolate the main roads apart from the houses. In some areas, the physical solution was not effective due to the directions of these houses and their entrances. Traffic solutions were proposed, such as reducing speed limits, and adding traffic lights, stop signs and bumps, etc.

The road network and its proposed modifications resulted from the physical plan took a major part of the planning process on the time scale, as the existed network do not provide the essential goals to the village although the ratio of car ownership is not high. The proposed plan with its required residential units has to rectify the problems originated from the existed network of roads. Mediating the authorities' stands and arguments, the proposed physical plan was able to implement and emphasize a balanced solution approved by all authorities.

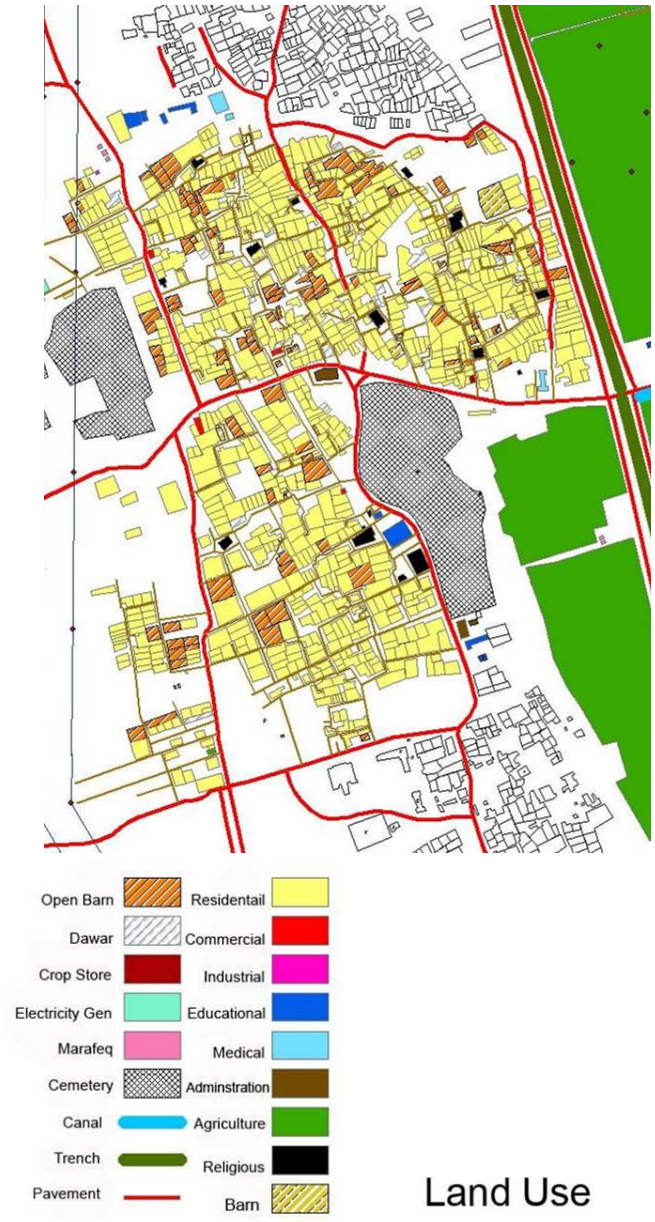

Figure 4 land uses from GIS data of the physical planning project, case study of Kawamel village, Egypt

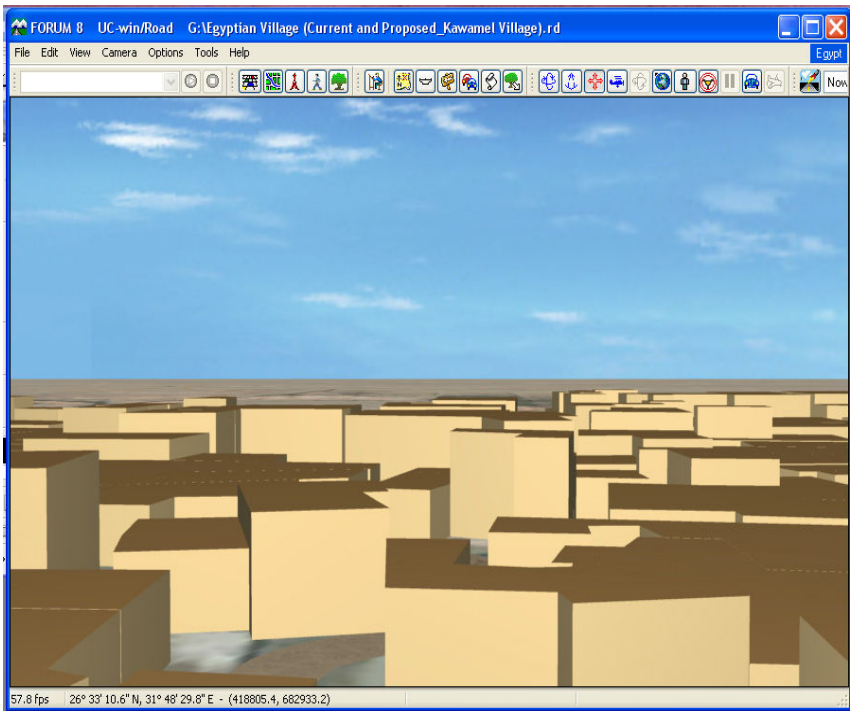

Figure 5 A VR model of Kawamel village, Egypt to help in evaluating the relationship between building heights and road widths

4.3. QUALITY ASSURANCE FOR THE CURRENT SITUATION AND FUTURE SITUATION,

This assessment concerns with services and infrastructure of the physical planning project, regarding the following:

- Educational Service, distance between schools, serving area of each school … etc.
- Health Service, served area of each health center, medical branches and their served area … etc.

Although there are many areas can be used in the quality assurances, the research focuses on only the two main services of education and health. These two services can be evaluated according to main indicators, such as distance between schools, the school coverage area for each category of age, served area of each health

center, and the medical specialization coverage area of each health center. The previous areas were investigated and evaluated through drawings, models, and maps during conducting the project, Figure 6.

Studying both situations, current and future, and comparing the initial plans lead to effectively choose the proposed plan.

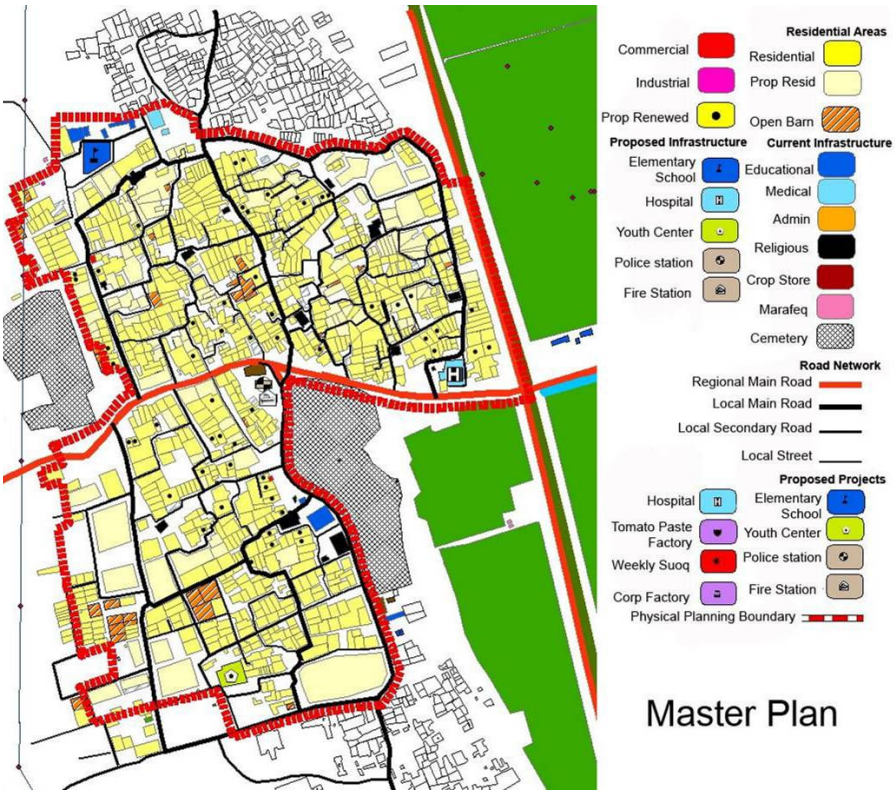

Figure6 Master plan from GIS data of the physical planning project, case study of Kawamel village, Egypt

Using VR during evaluations contributes in a way that facilitates communications and eases assessments, Figure 7. Potentials of the third dimension, interactive modifications, and visibility from different angles become important in the physical planning projects.

Using VR in this part of assessment help not only in measuring the quality of provided services and infrastructure whether of the current situation or of the future situation requires but also in making comparisons between different proposals and how factors can have reciprocal influences,

for example the distribution of the required residential units is related to these services and infrastructures and how they are serving certain areas and certain numbers of inhabitants.

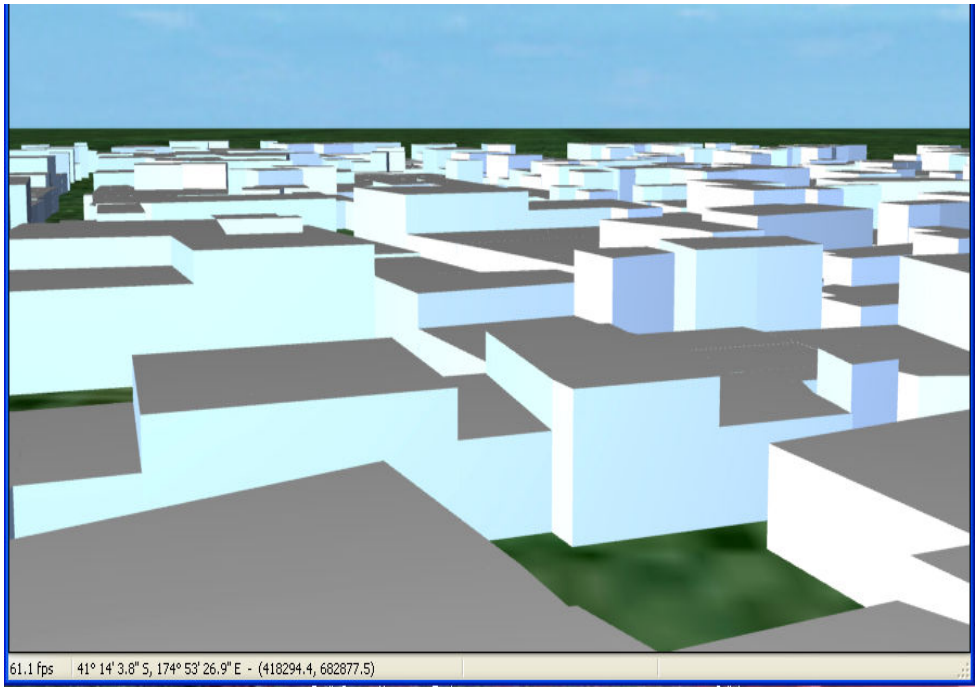

Figure7 A VR model of GIS data reveals that the effective analysis of service areas need the visibility of third dimension for the residential areas, case study of Kawamel village, Egypt

4. Discussion and Conclusion

The VR models were created by importing the satellite image of the village unit from Google Earth Pro, and shp files of the building heights and land uses from ARC View (GIS program), to the UC Win/Road (VR program). Based on the shp file used, each model presents certain data. Also, there is an option in the VR program to create cars and persons as intelligent objects that respond to the traffic lights and road intersections. These details of road designs can be implemented in the study and investigation of road network, which was not among the concern of either the project or the research paper whereas car numbers, road widths, and road capacities do not represent an obstacle for the physical planning. Different models were built up to

visualize and assess the alternative solutions and various influential factors, Figure 8.

Although the study classifies the assessment process into three main areas, there are reciprocal impact between these areas and their factors in a way that almost all of these factors can not be evaluated or assessed solely by themselves without including other factors' impact. This is evident in the relation between the population increase, the required residential units, and the required services and infrastructures: how the first factor affects the second one, then how both of them affect the third factor. It is important to investigate and visualize these relationships on the small levels of the village, sections and neighborhoods, not as the whole unit, where each section varies in the population increase, and the required residential units, which consequently affect the factors of infrastructure.

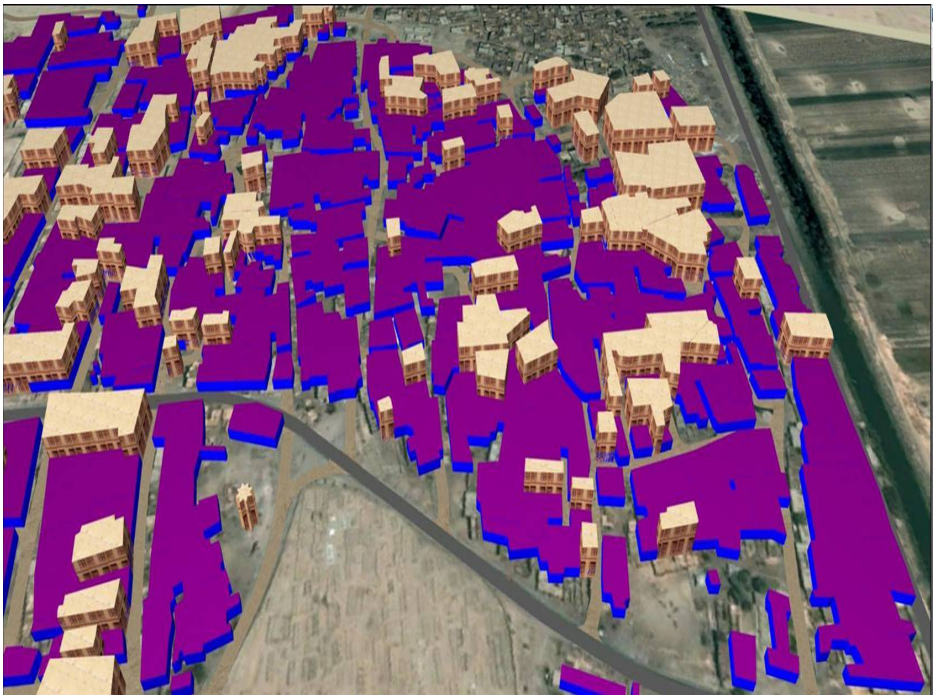

Figure 8 A VR model presenting an alternative of the relationship between the proposed heights and the land uses, Kawamel Bahary village, Egypt

During conducting the project, there were several meetings with the inhabitants of these villages and the members of village councils in order to allow them to share in the physical planning and the decision making

processes whenever it is possible and approval by planning authorities. At that time we as the university team who conducted the project, used modeling, drawings, and maps as tools of communications among the different partners. Having these experiences gives the enough background to maintain that yet there is a need to share planning information in a more effective way than of provided by the static models. Consequently, it can be stated that using VR not only eases the visualization of different factors and proposals among planning authorities but also enables them to conceive and perceive the impact of these factors collectively.

Moreover, the interactive modifications through the VR allow to visualize the impact of these modifications and to link them to other factors. The evaluation and assessment of the influential factors and their impact in an interactive VR environment help not only urban and physical planners but also the associated partners.

The research paper uses an abstract style for the created VR models where the researcher maintains that the building details are not important in the large scale projects of urban and physical planning. The focus on these cases should be directed to the surrounding environment rather than buildings and their details.

5. Summary and Future Research Work

The research concludes to an application through which VR can be employed effectively in physical planning as an assessment tool. VR models are improving the practice of urban environmental planning and design. The visual display capabilities illustrated in this study enable the explanation of the development plans or alternatives to the public.

Although the research paper concentrated on some factors of assessments, there are other areas and factors that were important during conducting the project. These areas and factors that can be considered crucial urban planning issues present focuses of future research papers to be investigated.

One of these focuses is to find a traffic solution for a high way that crosses one village from the surrounding residential areas, and to provide more comfortable and convenient pedestrian networks in this intersection area. To seek greater pedestrian safety and security and to improve access to activity locations and public transit is one of the future research objectives.

Another area is to investigate the building code of new residential areas that was proposed in the outputs of the physical planning project in terms of the relation between the road widths and building heights. In this kind of

investigation, VR models presenting building details are required as the concern of study will be focused on buildings rather than the surroundings.

Acknowledgements

I would like to thank the university team members who shared in conducting the practical work for their hardworking and dedication. My appreciation is for Forum8 for their valuable assistance I had in using UC Win/Road. Also, I would like to thank Christopher Grasso, Arizona State University, for his valuable help in creating VR models.

References

Batty M. Chapman D. Evans S. Haklay M. Küppers S. Shiode N. Smith A. & Torrens P.M., 2001. Visualizing the city: communicating urban design to planners and decision-makers. *In:* BRAIL R. & KLOSTERMAN R., eds., *Planning Support Systems*. ESRI Press and Center Urban Policy Research, Rutgers University Press, New Brunswick, NJ.

Bourdakis, V., 1997, *Making Sense of the City*, Centre for advanced Studies in Architecture (CASA), University of Bath, UK.

Bourdakis, V. and Day, A., 1997, A VRML Model of Bath. *In:* R. Coyne, M. Ramsar, J. Lee & K. Zreik, eds., *Design and the Net*, europIA Productions,13-22.

Dodge, M., Doyle. S., Smith. A. & Fleetwood, S., 1998. *Towards the Virtual City: VR & Internet GIS for Urban Planning*, Birkbeck College, UK.

Institute Of Environmental Assessment And The Landscape Institute (IEATLI), 1995. *Guidelines for Landscape and Visual Impact Assessment*. First Edition. London: E&FN SPON, and imprint of Chapman & Hall.

Mitchell, William J., 1999. Prologue: Urban Requiem, and March of the Meganets. *In E-topia*. Cambridge, MA: MIT Press.

Batty, M., 1992, Urban modeling in computer-graphic and geographic information system environments, *Environment and Planning B: Planning and Design*, 19, 663-688.

Frenchman, Dennis, and Francisca Rojas. 2006, Zaragoza's Digital Mile: Place-making in a New Public Realm, *Places*, 18(3).

M. Sinning-Meister, A. Gruen, H. Dan, 1996. 3D City models for CAAD - supported analysis and design of Urban Areas, *Photogrammetry and Remote Sensing* (51) 4, 196-208.

Shiode, N., 2001, 3D urban models: recent developments in the digital modeling of urban environments in three dimensions, *GeoJourna*l, 52(3), 263-269.

Forum8, www.forum8.co.jp/english/english0.htm. (10-1-2009).