Exploring the potential of the City Information Models in Territorial Management Instruments for Urban Scale

Detail Plan of the Lisbon University City

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Abstract

The City Information Models generated by parametric modelling, combine the valences of Geographic Information Systems (GIS) capabilities and detail of a Building Information Model (BIM), facilitate information management and allow a variety of analyzes in geographic space where it belongs (Isikdag et al. 2008). The CIM is an analogy to BIM in urbanism. They are a system of elements represented by symbols in two-dimensional space and three-dimensional space. Are also seen as a three-dimensional expansion of GIS enriched with views at various levels and at various scales. The use of these models has received special attention from policy makers in the areas of management and territorial planning, sustainability, patrimonial evaluation and tourism promotion (El-Mekawy et al., 2012; Stojanovsky, 2013).

This thesis aims to study the applicability of CIM models in developing detail plans, identifying the advantages and disadvantages in solving emerging problems in the course of its realization. The study area corresponds to Detail Plan delimited by Lisbon University City.

Keywords: CIM Models; Parametric modelling; Shape grammar; Land use management plan; Detail Plan

1. Introduction

Cartography has traditionally played the role of describing the earth's surface in an accurate way according scale and goal whether natural or humanized landscape, but the recent technology developments in visualization and manipulation of geographic information level, have leveraged to develop new approaches supplemented with interactive virtual three-dimensional representations.

The Geographic Information Systems (GIS) are suitable for modelling geographic information since can integrate spatial data from different sources and allow to perform qualitative and quantitative analyzes. Separates information on different thematic layers and store them independently for their treatment and analysis is faster and easier.

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Computer Aided Design (CAD) focuses on digital representation, at a design level, but cannot work as database and information management tool (Roxo, 2012).

The BIM was originally developed to the sharing and management of information throughout the lifecycle of a building process, but nowadays has applications in many different areas such as urban management domains enabling integration, interoperability, collaboration and automating processes oriented to the building element, containing geometric and semantic information on building components and structure (Isikdag and Zlatanova, 2009). Those Systems are very powerful from the point of view of the three-dimensional display and management of information elements, but weak in terms of the geographical location.

The problem of integrating BIM with GIS occurs in transferring geometric information and the construction of geospatial models and the integration of semantic levels (Isikdag et al., 2008), sending the solution to solving the problems of interoperability among these systems.

The combination between BIM and GIS systems arise new CIM models, BIM in respect of elements considered with the geographical framework of GIS, and therefore very suitable for interactive three-dimensional modelling of urban spaces. It is in this context that makes the investigation of the applicability of CIM models in land management instruments appropriate, particularly in detail plans, which detail the geographical coverage and may justify this approach.

2. Objectives

The purpose of this dissertation is therefore to study the applicability of CIM models in developing detail plans, identifying the advantages and disadvantages in solving emerging problems in the course of its realization. The study area corresponds to Detail Plan delimited by the Lisbon University City (PPCUL) Achieving this will depend on the achievement of the following secondary objectives:

- The CIM model generation, using the CityEngine software;

- Acquire knowledge about CIM potential and follow the working group, responsible for PPCUL draft, by modelling all alternatives decided by the group in order to support the final choices;

- Identify the advantages and the disadvantages of this approach over traditional methodologies.

3. Methodology

The completion of this dissertation was based on two processes that are triggered simultaneously and iteratively: i) participation in meetings where alternatives were identified based on analysis of this information in terms of reference and meetings between the elements of the team responsible for preparing the Detail Plan; and ii) the modelling of the alternatives identified in the meetings, in order to provide a basis for decision-making in sequential meetings.

The methodology used in this thesis consists of four main steps, which interact to form a cycle, initially with the literature review, the creation of the base model, the identification of alternatives, the modelling and visualization of alternatives, and finally a discussion with the team having based on the shaped elements. The cycle is repeated several times until the alternative stabilize in solution form to submit to all involved in the plan.

The construction of the basic model starts with the collection of data in vector format, its homogenization by using the coordinate transformation models of Bursa-Wolf or Molodensky (Matos, 2011) and the generation of Digital Terrain Model (DTM), which is carried out by applying interpolation algorithms. Later was added the information about the buildings (building footprint, number of floors, uses, repair, and the time of its construction)

To generate the 3D model it was possible to verify the volumetric study area, as well as it was improving three-dimensional model was possible to introduce greater "truth" to this by detailing of facades, the tracks, urban elements, among others. For this it was necessary to conduct field work, where it was analyzed the study area and the photographs had to be taken from a strategic point (depending on the building) in order to be subsequently worked for were collected through the rules were introduced in the model.

4. Case Study

4.1. Framework

The selected study area is defined by the limit of the Detail Plan of the Lisbon University City, currently being developed by CESUR / IST, is inserted in the parish of Alvalade and is bounded to the north, Av. General Norton de Matos (2.ª Circular); the headspring, Campo Grande; south, Av. das Forças Armadas, the limit property of ISCTE, Av Aníbal Bettencourt, the rear of the National Library; the west, Azinhaga das Galhardas and Av. dos Combatentes. This polygon covers an area of about 126 ha.

This area contains the highest number of universities in the city of Lisbon, serving approximately 22 thousand students, reason why detail plan intends to address the needs expressed by students, teachers and users of the area (CESUR, 2013).

4.2. Construction of the model

For this it was necessary to collection geographic features such as contours, height points, buildings footprint, the building highest point, and street network. All data were provided by the team Detail Plan of the Lisbon University City and the Lisbon City Hall, at scale 1/10000 in Hayford- Gauss datum 73 (HGDT73) coordinate system. The DTM was built by interpolations algorithms (TIN - triangulated irregular network). Converted to raster format through a mesh with regular cells (1m) and merged with the orthophoto to improve the sense of reality to the model.

Relative to the buildings, the volumetry was initially generated based on the number of floors attributes, however due to the existence of information gaps, it was decided to extract the building heights by comparing the highest point in the building with the building footprint height .Detailed elements such as (facades, the tracks, arboreal elements, among others) were included to break the monotony and increase the "reality" of the model Then was generated a new 3D model based on the calculated height of buildings previously, to which it was adding details such as, of the model (Figure 1).

Figure 1: Details of the model

4.3. Centralities

Based on guidelines established in Proposal No. 133/2010 (from CESUR), and the characterization and diagnosis made by the plan in CESUR team report, it was identified a number of situations that should be addressed early in the process, including the interconnection of large numbers of equipment (teaching equipment, health equipment, sports equipment, social, cultural and leisure facilities), lack of interconnection between public space and the existing equipment, the daily variations in traffic flow, there is a large presence of vehicles during the day in contrast to the night and similarly between working days and the weekend. The aim of this plan still be to contribute to the improvement of connections abroad, ranking the network of local roads, as well as the reorganization of the existing scheme of circulation, also giving attention to parking in the intervention area (CESUR, 2013). In this context three centralities will be addressed in this work (Figure 2) to define an intervention strategy for contributing anchor to set the remaining spaces were identified.

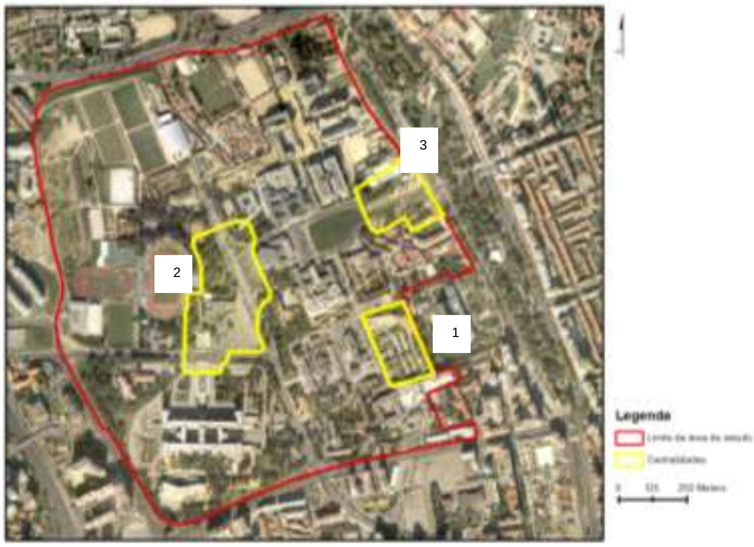

Figure 2: The study area indicating the location of centralities

Centrality 1

Current characterization: This area defined as Centrality 1, is nowadays a car park concession and the mains goal is to promote the creation of a new space allowing the articulation between the National Library and the Higher Institute of Sciences work and Business (ISCTE), across platforms with different dimensions and heights oriented to the National Library. Which may result in a student residence, since it is an effective device in solving the problem of displaced students, creating services and trade proximity.

Challenge: To analyse various scenarios in accessibility issues inside the square and surrounding streets and the ratio of the height of the building facades with the surrounding arch centrings.

Following the work: Already existed an alternative basis chosen for the first Centrality (Figure 3_a), this was modelled and added buildings that resulted from the proposed expansion of the National Library, with a drop of 15 meters. Came a new problem with this setback that caused the square to stay on a steep slope and exaggerated slopes zone, was then modelled alternative (Figure 3_b), which includes a study of ramps and stairs. That said, it creates a new problem due to the difficulty of quotas on the ground floor, its implementation has to be with different accesses the deployment of the first floor. It was thought then a reset alternative, which was scaled to could overcome the problem of slopes, and this continued in line with the turrets of the National Library (Figure 3_c). With this alternative was then studied a system of stairs, pillars and hits that resulted in a new version of the square (Figure 3_d), which was developed a study in terms of public space, through the insertion of arboreal elements and street furniture.

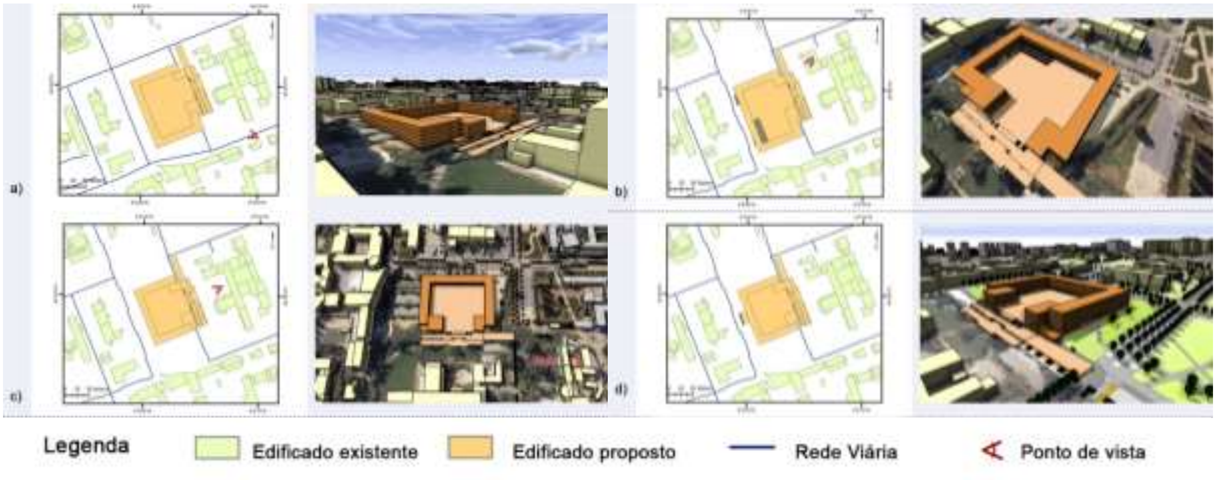

Figure 3: Centrality 1 - preferred alternative

Centrality 2

Current characterization: The Centrality 2 aims to study the creation of a link between the Great Hall and the area of Canteen, keeping it but changing the adjacent area as a liaison with the Hospital of Santa Maria in order to establish a link between these three spaces.

Challenge: When modelling the proposals in CIM is intended to display the combination of the shape and the volumes to the new buildings and the articulation between the two sides of Av Teacher Gama Pinto. It is intended to create a space with conditions to accommodate a wide range of activities, the level of trade and services, directed to the flows generated by the Rectory, Canteen and the Hospital of Santa Maria.

Following work: Initially, after meeting with the team of urban design were developed on paper two alternatives for Centrality 2 (Figure 4_a and Figure 4_b), it was decided to study the alternative (Figure 4_a), which aims to create a pedestrian walkway with Av. professor Gama Pinto, through a platform that creates a "shell" look with the rectory. For reasons inherent to the metro line, there was a study due to their constraints, thus resulting in a new alternative without platform (Figura4_c). While we were analyzing this alternative we found that the buildings were far away from the track, thereby generating three new alternatives to study the removal of the buildings route (Figure 4_d, Figure 4_e, Figure 4_f). Following the study from the version shown in Figure 4_f, to which there was a study of the road system for the entire area of Alameda where it was found that due to the possible connection to the 2nd round, the blocks of the extensions of the colleges had to be resized (Figure 4_g). Taken up the study to create a level platform with a ramp system, with arcades and balconies, resulting in a new alternative (Figure 4_h). Followed by the analysis at the level of urban design, leading to adjustments of connection blocks and crossing the square (Figure 4_i). After that, it followed the study are creating a wall in order to create an internal patio to support buildings of the square, as well as the adjustment of the side arm of the square, thus leading to the preferred alternative to the centrality 2 (Figure 4_j).

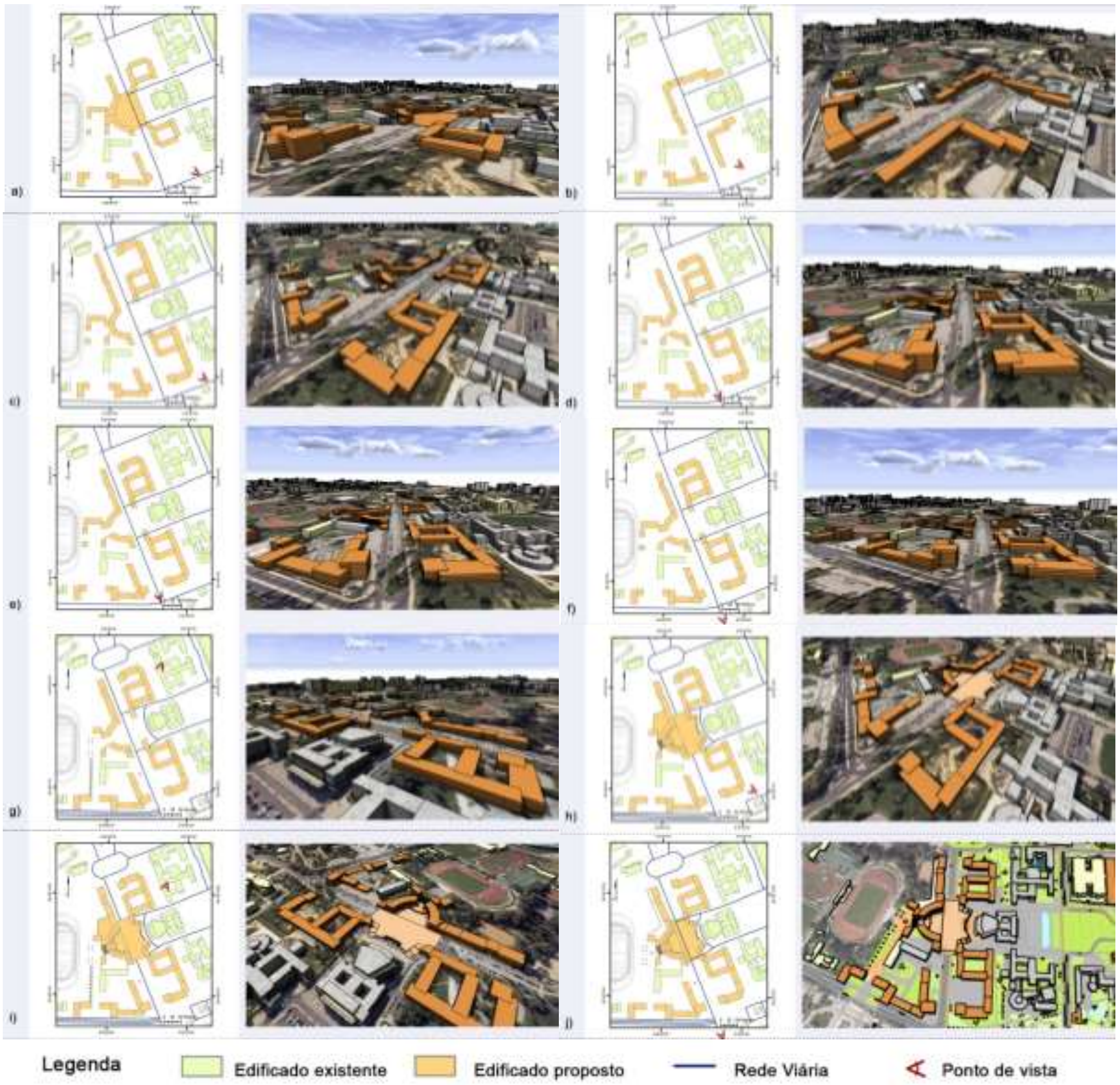

Figure 4: Centrality 2 - preferred alternative

Centrality 3

Current characterization: With the generation of Centrality 3 is intended to analyse the creation of a structure that is symmetrical about one axis so there is an entry point of the University Campus marked, but without breaking the connection to the surrounding urban fabric.

Challenge: By modelling proposed in CIM is intended to realize the visual perspective of the entrance of the University City, Alameda and Rectory and the impact that this remarkable element brings since it has characteristics very different from the surrounding, as well as the visual connection with this entry Av. Brasil.

Following the work: the first alternative arises from a schematic drawing the current status of work (Figure 5_a), when parsed drawing this arises a new alternative to the bottleneck of the angle of view in order to create a tunnel effect (Figure 5_b), which was again analysed and generated a new alternative to the accentuation of the angle mentioned above (Figure 5_c), when analysing the block entry appear two new alternatives to the deployment of this body in different locations and deployments (Figure 5_d and Figure 5_e). Continued the study of this centrality, and creates a new alternative with different configuration, and the angle of departure less pronounced (Figure 5_f). We started to study the north side arm, resulting in a new alternative for new deployment (Figure 5_g) analysing this alternative studied the implantation and the volume occupied by this version in its surroundings, it was found that it was very bulky and occupied much space, thus resulting in a new slimmer and harmonious alternative (Figure 5_h).

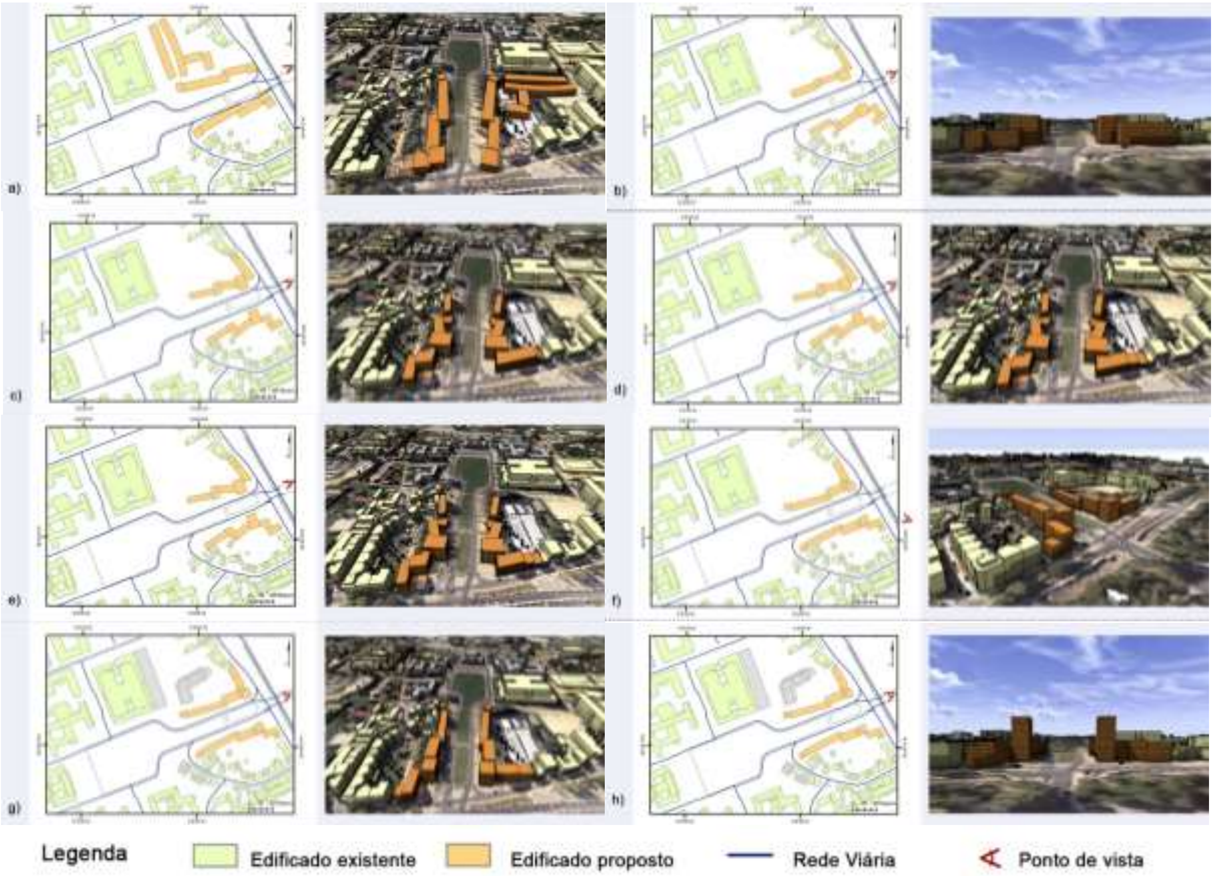

Figure 5: Centrality 3 - preferred alternative

5. Conclusions

The increasingly appear online tools that change the way we interact with spatial data in light of the new 3D environments. 3D city models prove to be quite suitable for the handling and visualization of 3D spatial information, have a very broad spectrum of needs, values and uses in diverse areas such as urban planning, virtual reality, tourism, property management, maintenance of infrastructure infrastructures, disaster management, among others. These models offer a true and real image of the planet earth as much as possible, which allows planners / engineers / architects visualize all aspects of easy and objective way, and even the ability to archive, manage, and analyze large amounts of information either at the building level, as the level of urban space.

This work discusses an innovative theme and set out to explore these new tools in urban planning, have therefore been very challenging its achievement. Emerged some counterparts, such as learning the software that was totally unknown, the programming language that must be used to create the models, as well as discovering the best methodology to be applied in order to explore their contribution to the preparation of plans. Given this, some decisions were made during its execution so that it was possible to meet the needs of the development of the detail plan team.

Through building the 3D model was possible to integrate the components of BIM, with data relating to the building, with the GIS, the appropriate spatial geographic information, and using procedural modelling (based on rules of shape grammar), allowed the construction scale models of the city much faster and interactive way than in traditional approaches, overcoming issues of repetitive and time consuming work. Connecting to a database in GIS format allows to perform spatial analysis, viewing and editing operations by providing building dynamic models that allow editing and automatic creation modelling of buildings, roads, etc., constituting an asset the automatic generation of alternatives, which are often equated but are not displaying in the urban context due to the difficulty of construction. It was possible to analyze and visualize all decisions made during the process always taking into account the surrounding area, both in terms of volumes as the urban space, in encouraging public participation, through visual analysis of alternatives equated himself, without losing the georeferencing component of urban space and appealing other approaches do not consider. These can also be posted on the internet and analyzed without requiring knowledge of the tool, helping the experts, the general public and decision makers.

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