Modelling Macro Scale Spatial Analysis: Location Intelligence Application

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Abstract Cities have distinctive identities that vary physically according to their geographical location, demographics, culture, environment, and economic factors. Altogether, they are targeted at a better quality of life by promoting their identity through revitalization efforts. This paper puts forwards an urban modelling application of location intelligence tool (Carto DB), and how nowadays tools could provide planners with both analytical databases and practical platforms to implement future strategies, which allow appraisal of cities' current situation, along with specific strategies, methods, and approaches for mapping and highlighting the different aspects of life to develop exercises in macro planning issues which are capable of responding to the needs of today's phenomena. This application applied diverse case studies selected from students' hometowns with different complexity, history, within recent developments. The results show that the synchronicity and growth between software and urban planning provided and tested new analytical tool, which allows spatial applications of various strategical analyses on different scales.

Keywords Architectural Education, Learning Platforms, Cities, Carto DB, Macro Planning

1. Introduction

Nowadays, urban priorities, socio-economic needs and planning itself are constantly evolving and, of course, new

challenges in terms of urban planning are being highlighted. Several cities are constantly trying to satisfy their community and establish a better quality of life for their population and above all maintain and protect a better identity of their urban core through various revitalization projects. Given the importance of cities as vital social, political and economic centres, the redesign of planning comes at a key time when urban policies must be planned for a sustainable future in relation to the distinctive needs of neighbourhoods, individuals and established urban systems.

1.1. Design Studio Education

The aim of every architect, planner, urban researcher and developer should be to optimize the proposed architectural designs and urban strategies, because cities are seeking to create better communities through revitalization efforts to improve the quality of life and consequently its identity. Therefore, proper and adequate diagnosis for these strategies must take into account the changing aspects of daily life in accordance with its location on the global geographical map. Thus, the correct diagnosis method must focus on the users to meet the needs of the community, so as to invest and implement appropriate objectives to make better future of cities. Salama (2015) believes that Design education in architecture and urban planning is the keystone of the design profession, and it helps shape the future built environment of our cities.

Besides that, the study debates that learning means focusing on the competence among students, whereas

educating is what makes future architects and planners distinct. Therefore, some questions were raised; should subjects such as sciences and arts be learnt for their intrinsic value, or should education focus on matters which are of technological benefit? The coexistence and growth between software and architecture and urban planning have led educators to test new analytical tool that can be used for spatial applications of various strategic analyses at different urban scales.

Architecture studies includes many design studios which focus primarily on design thinking, engaging students in individual and group projects, representing a large number of design problems that require practical solutions. The architectural design studio is an important process, which aims to shape the architectural sensitivities of students, developing their communicative abilities as well as their problem-solving skills (Tokman & Yamacli, 2007).

Since the studio courses offer a highly valued educational experience to students, the studio-based learning experience is a platform for interaction, creative exploration, and knowledge acquisition (Kirschner & Hummel, 1997). Experimental learning and Innovative teaching practices are among learning methods to adapt while centralizing on the practical engagement of student capabilities for better learning outcomes, which eventually prepare them for future professional life.

Nowadays, the basis of all activities is knowledge (Fross, Winnicka-Jasłowska, Gumińska, Masły, and Sitek, 2015), therewith, the distribution of urban activities and functions within cities, and the movement of users are a direct source of knowledge when proposing development strategies and architectural proposals. Therefore, the research has been conducted based on an academic learning platform in which qualitative research methods are used virtually to cover all aspects related to urban development of cities, such as functional analysis, organizational databases, economic, social, physical, and environmental issues.

Cooperation between students from different cultural backgrounds will produce innovative intelligence, because it can promote better communication between different individuals to obtain information. The multicultural environment of universities allows students from different social and cultural backgrounds to share their knowledge and skills, especially to influence each other. This can encourage creative thinking and shared design issues.

The research addresses the main aspects of negative and positive planning practices in terms of urban functionality and sustainability. These aspects include urban density, users' activities, and distribution of land use, networks, infrastructure systems and urban grids. It aims at exploring a variety of methods in order to optimize the performance of cities and redirect the negative aspects within it, in a more comprehensive vision.

Accordingly, this studio-based learning experience suggested an urban modelling application of location intelligence tool (CARTO DB) as an experimental interactive and student-friendly GIS instrument, and how

such tools could offer architects and planners both theoretical data bases and practical platform to implement proposed strategies. Carto DB is used in this study as a user's experience focused online Location Intelligence platform application that enables spatial analyses without having to learn coding or complex modelling software. The platform provides a wide range of analytical tools, and allows appraisal of cities' current situation, along with specific strategies, methods and approaches for mapping and highlighting the different aspects of life in order to develop exercises in macro planning issues which are capable to respond to the need of today's phenomena.

Learning Intelligence (LI) is a type of training program based on a strategic learning that is tightly connected to reporting and analysis by defining learning goals and understanding all the different ways of linking learning and training activities to those goals. This method facilitates the process of virtual learning by assigning a wide set of data bases to students, as well as allocation of a practical mapping platform. Therefore, it creates a flexible location solution which may be used as comprehensive platform where students and professionals can get the required data, integrate it, manage it, and run user side analysis and design custom maps on a single platform, instead of the traditional methods of collecting geographic information such as coordinates and other data bases, and then apply the proposals in a different platform.

The rich technical capabilities of this tool have allowed the students to perform a variety of analysis for the design studio with the following objectives.

- To provide a better knowledge of the use of technology
- To support spatial land planning by using a new analysis tool
- To influence decision-making of the students in regard to the problematic of their city.

Therefore, the methodological agenda used in this design studio combines the analysis of city with the application on CartoDB to define the most effective scenarios in order to determine priorities for future regeneration. The significance of such tool at this specific scenario-based-studio is that the data and maps remain available for public use and future development after the completion of course objectives.

1.2. Intellectual Mapping

Nowadays, the complexity of city structure due to several reasons such as the rapid growth of urban population in large cities, requires powerful communication tools between planners and urban activities to better analyses, propose, manage and design long-term and sustainable strategies. Thus, virtual modelling becomes a vital tool for urban development. The use of mapping in planning processes is the focus of in-depth analysis. Integrated spatial land planning schemes at the municipal and regional levels can profit from the use of

accurate intelligent tool information in making more clear decisions.

Technological software can offer a variety of digital tools to address mapping and modelling issues, in order to identify problem areas in cities, thus improving the urban environment and the quality of life of people. With the help of digital tools, it is also possible to promote available existing assets or model and forecast environmental risks, as well as perform other new essential functions to cities (Bratuškins, U & al. 2020).

Digital technologies are now an integral aspect of the university student experience. As such, the architecture curriculum has comprehensively focused on the potential of various digital technologies to enable, extend, and even 'enhance' student learning. Accordingly, In the fourth-year design studio of Fall 2016, a new digital mapping tool were introduced to students as a way of integrating computer software with education, with the main aiming to increase the knowledge and understanding of ways in which digital technology and artificial Intelligence can enhance education, through the application of deeper and high-quality research, which would extend the link between theory and future practice.

Visualization Software applications provide stimulating tools with different perspectives to which can develop analysis of different developments. Applied and theoretical contributions demonstrate the scope of computer-based analysis fostering a better understanding of urban systems, the synergistic relationships of their dynamics between built and natural environments as well as their spatial scope. Application areas include infrastructure and facilities management, physical planning and urban design, land use and transportation, business and service planning, coupled human and natural systems, urban planning, socio-economic development, emergency response and hazards, land and resource management. Examples of methodological approaches include decision support systems, geo-computation, spatial statistical analysis, complex systems and artificial intelligence, visual analytics and geo-visualization, ubiquitous computing, and space-time simulation.

Contributions emphasizing the development and

enhancement of computer-based technologies for the analysis and modelling, strategy formulation, planning, and management of environmental and urban systems that enhance sustainable futures are especially sought.

Accordingly, the design studio integrated LI (Learning Intelligence) applications through the online platform (CARTODB) as a way to reinforce sharing capacities, create a better learning environment among students, and provide them with a large set of data base that would support their interventions and widen their perspectives. The exercise is a type of training program based on a strategic learning that is tightly connected to reporting and analysis by defining learning goals and understanding all the different ways of linking learning and training activities to those goals.

This method facilitates the process of virtual learning by assigning a wide set of data bases to students, as well as allocating a practical mapping platform. Therefore, it creates a flexible location solution which may be used as a comprehensive platform where students and professionals access the required data, integrate it, manage it, and run user side analysis and design custom maps on a single platform, instead of the traditional methods of collecting geographic information such as coordinates and other data bases, and then apply the proposals in a different platform.

The significance of CartoDB, which is an intelligence platform, is that it can be used on different scales. Thus, the technical capabilities provided by the platform enable students to keep up with several measurements and areas of the selected city, so that the city can be analysed and understood on a large scale and then prioritize and re-orient the different factors on a smaller scale. However, the student can change the scale when changing from urban to architectural perspective, or vice versa. This depends on the total area of the city and the area covered by the project.

Depending on the type and method of analysis, the platform offers several options that can be used together or separately. The choice of these options depends on the desired results. If a student needs to graphically present statistical studies, special customized tools are available, or if the study is based on qualitative data, they also have different tools.

Figure 1. CARTODB Mapping (Source: Authors, 2021)

2. Materials and Methods

Design education is basically about learning the knowledge of the trust discovery process, the end of which process cannot be known or predicted at first (Ochsner, 2000). In this research, together with students from the Department of Architecture, an experimental studio for the four-year architectural design course was introduced. These students were directed to a new methodology using location intelligence tool, CartoDB, which was considered most appropriate for the development of an urban planning studio.

The main objectives of this architectural design studio are based on an urban contextual design that introduces a better understanding of urban discourses to students. This design studio represents the most extended and developed design exercise in macro planning issues. Priority is given to the urgent needs of our environment in terms of regeneration projects in a much holistic manner. Therefore, students are required to propose design solutions to a master plan which includes all interrelated aspects of an existing urban fabric, including but not limited to the historical and political environment that determines the site conditions, the existing physical situation of the site, the natural and cultural environment and the social background

of their contexts. The learning outcomes are assessed on students' ability to translate environment needs and decisions into a more powerful and prosperous city through analysis and ideally proposing urban strategies that will comprehensively improve the environment. The site location of the project particularly selected respectively their hometown city in all its complexities, history and fast developments processes.

The Design Studio V is the last design studio before graduating. Therefore, the students have used different computer-aided design courses in advance, thus they have experienced using different software, and most of them have the use of Photoshop and SketchUp capabilities with CorelDraw and Illustrator primarily used for rendering design presentation purposes. In general, students choose the programs to use based on what they want to do in their design projects (Agirbas, 2018). Nonetheless, within the context of this architectural design study, the students were asked to implement CartoDB into their mapping analysis.

Therefore, for research purposes, this article proposes the application of the location intelligence tool CartoDB in urban modelling, and how this simple means of communication, which is not exclusive but experimental; it offers architects and planners a theoretical database and a practical platform to implement strategies. This feature can

perform spatial analysis without learning coding or complex modelling software. The platform provides a wide range of analytical tools that can assess the current situation of the city, and provide specific strategies, methods to map and highlight different aspects of life in order to develop macro-planning issues that can be addressed and respond to the necessity of today's phenomenon.

Cities are different due to their demographics, culture, economy, politics, environment and other social factors. Therefore, dealing with different cities means solving different factors, so different analyses must be carried out to get a clear result. Therefore, students have used different methods to write and analyse the selected cities, including the following analysis:

- Areas and scales
- Mass & Void
- Users' activities
- Green and public areas
- Population Density analysis
- Physical density analysis
- Commercial actives
- Industrial zones
- Land use
- Historical, cultural places and buildings
- Education Institutes
- Governmental places and buildings
- Hotels and medium scale activities
- Infrastructure analysis
- Transportation
- Networks and parcelization
- Urban grids
- Feasibility and accessibility

One of the most important goals of this research is to understand sustainability and integrate it into every element of life in order to improve the spatial qualities in future. Therefore, the three elements of sustainability are prioritized for individual analysis, and in addition to these three elements which are the most important in architecture and urban design; aesthetics, physical and functional analysis are paired to complete the overall study.

3. Results through Case Studies

Fundamentally, design education is about learning to trust the knowledge of the discovery process, where the end of these discoveries is initially unknown or unpredictable (Ochsner, 2000). As an experimental process, the studio-based learning experience provides a good platform for interaction and exploration due to the variety of student cultural backgrounds. Students show a strong sense of identification with their hometown, in part because this

attachment encourages everyone to actively participate in decision-making.

The main standard of the study is to introduce students to different characteristics of urban situations within our contemporary cities, whether inland or related to bodies of water, and try to understand their specific dynamic forces. Accordingly, a total of 45 cities were investigated during this process, where the development of the students has played an active role in the design studio.

LI is a powerful sharing platform. Not only did students share their views on the state of their city with their peers, but also understood what others were doing and shared them online at the same time. A list of mapping analyses was offered to them, but they had the freedom to select and choose from different tools in order to define their own strategies according to their own city needs. The Cities that were selected are varied in geographical location, so the difference of identities added a good interest in the topic, which gives rise to different scenarios.

In the preliminary phase, some criteria based on the main characteristics of the selected cities emerged, namely their junction with water bodies, special geographical location (canal, river, or ocean), or only hinterland areas. These features have guided research to divide cities into 4 categories:

- a) Coastal and port cities,
- b) Rivers and lakes,
- c) Special sea/canals and rivers integrated contexts,
- d) hinterland cities.

The cities of origin of students are mainly distributed in 3 continents: Africa, Europe and Asia with the largest number (Table 1).

Cities are a complex and multi-layered systems where various social, cultural, economic, environmental processes interact constantly with and within its physical structure (Bratuškins, U & al. 2020). In this study, the cities analyses varied in geographical location. Therefore, they have very interesting identities distinction leading to different problematics, questions and study scenarios. From the United Kingdom, Cyprus, Turkey, Egypt, Yemen, Syria and Belarus, the analysis highlights their respective values and uses the CartoDB method to formulate relevant strategies to finalize the short, medium and long-term master planning proposals.

This article introduces the analysis and research results of some selected cities through the application of the location intelligence platform, as well as the proposed sustainable urban development strategies. These proposals are the result of the student projects at the school of Architecture at Girne American University, where the authors developed various methods of acquiring knowledge about the built environment of their city of origin.

Table 1. Selected Cities and Water Interfaces

Continent	AFRICA	ASIA																												EUROPE																	
es/Water Interface	Abuja	Lagos	Lusaka	Akasaray	Alanya	Alexandria	Amasya	Antalya	Antakya	Avanos	Bursa	Çerkezköy	Erbil	Eskişehir	Diar Bakir	Fethiye	Gebze	Isparta	Izmir	Jeddah	Kahramanmaraş	Kartal	Konya	Kuwait	Mardin	Mersin	Orhangazi	Osmaniye	Salihli	Sana	Shahba	Srinagar	Sohar	Tekirdag	Tepepasi	Van Lake	Zeytinburnu	Cologne	Golden Horn	Kadriye	London	Minsk	Nicosia	schiedam	Vordonosi		
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Figure 2. Density Analysis of Izmir City, Turkey (Source: Authors, 2017)

3.1. Port-Cities

Coastlines function as an interface in which the relationship between ports and cities is formalized. These regions have evolved into integral global social and economic components as they have become one of the most important urban elements of our days. In fact, ports influence the structure and development of the surrounding environment. It plays a major role in the economic improvements that will be incorporated into the master plan of the surrounding cities (Enrico, 2001). Consequently, this context was seen as an important key factor for students to identify and broaden their visions of contemporary cities through the renewal of historical cores.

Izmir, Turkey

Izmir is a metropolitan city on the Aegean Sea with a main port for exports. In this case study, the student focused on several analytical tools, such as compactness and density studies. The focus was mainly on the ratio between city growth, population distribution, land use and activities, and the most important is the relationship between these factors combined, with the function of the port. These analyses focused more on a density study in

regard to the unpopulated port and over densified highlands.

The results show a dangerous drop in the development rate between the growth of the city and the neglect of development around the port. Therefore, the student proposed various strategies to reconnect the city with the port and promote social integration with the coast as a major component of the new master plan.

Alexandria, Egypt

Alexandria city is a city of high importance to the national economy of Egypt as it is the second largest city and was once the capital. It is also one of the 70 Alexandria around the world as they were all founded Alexander the great. In the 18th century, Alexandria became a major centre of the international shipping industry and one of the most trading centres in the world because of the easy overland connection between the Mediterranean Sea and the Red Sea as well as the lucrative trade of Egyptian cotton. The main factor here was selected by the research to understand and analyses the potential of green spaces in relation to its coastal line.

Figure 3. Green Areas in Alexandria, Egypt (Source: Authors, 2017)

Figure 4. Accessibility of the City of London (Source: Authors, 2017)

3.2. Rivers

The origin of cities started with people gathering around water sources such as rivers in search of permanent settlement that consists of basic life elements. The importance of river-development is the linear domination on lands, which create a sustainable expansion along two opposite waterfronts, which also gives a great aesthetic appearance to the city, besides the economic importance. Therefore, the settlements on river banks gradually expand in area and density to form an attractive area where inhabitants visit on a daily basis. Accordingly, this context was introduced to students to enrich their urban background and provide them with sufficient knowledge about multi-dimensional urban elements.

London, United Kingdom

London is a megacity, the capital of England and the largest city in the UK. It has a population of 854 661 people, 40% of which are of foreign ethnicities making London one of the world's largest cosmopolitan cities. Over 19 million tourists visit London each year making it the most visited city in Europe. It is mostly known as the financial capital of the world boosting 22% of the UK's GDP with many businesses and banks based in the city; an

infrastructure to match. A Carto DB land use analysis shows that even though many businesses and banks are based in the city, the worker population greatly outnumber the resident population; however, it is an incomplete cycle as when work hours end so does the life of the district of London. The city has grown around the river with smaller settlements formed around in a ring showing that the city Density decreases from central London. Other complementary analysis of different layers mainly circulation, green spaces, connectivity try to offer urban strategies to exploit the river Thames to increase tourism in the area and to link and balance both sides of the river.

Antakya, Turkey

Antakya is in the Hatay province and a city on the Turkish border with Syria; it was known as Antioch and was for centuries one of the largest cities in the Roman Empire. Antakya is situated in a well-watered and fertile valley and located on the banks of the Orentes River which separate the new city from the ancient forming a natural border. The main focus was on how the river was analysed and visualized through its Strengths, Weakness, Opportunities and Threats.

Figure 5. SWOT Analysis of Antakya City, Turkey (Source: Authors, 2017)

Figure 6. Growth of the city of Minsk, Belarus (Source: Authors, 2017)

Minsk, Belarus

Minsk is the largest city of the Republic of Belarus and the capital. The carto DB analysis concentrated on the urban growth that have kept a strong linear centrality of the river within the core of the city. Accordingly, the proposed master plan emphasized the potential of the ring roads as urban borders, creating a margin for sending industrial activities outside them, and upgrading the urban qualities within the city by integrating public spaces into the new vacant lands along the river, after relocating unnecessary elements on the outskirts of the city.

3.3. Hinterlands

Nicosia, Cyprus

Nicosia is the last divided capital city in the world and the largest city on the island of Cyprus. The capital city is currently divided east-west by a buffer zone implemented by the United Nations following the 1974 Turkish invasion of Northern Cyprus which led to the complete separation of the two major ethnic groups on the island; the Greek Cypriots now in the southern part and the Turkish Cypriots residing now in the northern part.

The analysis tried to understand the balance between the

north and the south regarding its circulation network. Within the walled city, most of the roads are quite narrow and are used mostly in a one-way system. The political situation due to the division shows clearly a discontinuity

between the two sides. Therefore, in this study, the proposed strategies were targeted at new transversal connectors with the creation of new commercial corridors.

Figure 7. Land use and Space Typologies of Nicosia City, Cyprus (Source: Authors, 2017)

Figure 8. Streets Hierarchy of Isparta City, Turkey (Source: Authors, 2017)

Isparta, Turkey

In the case of Roses Isparta, the analysis focused on the compactness of the city and the domination of vehicles network over pedestrian. Several analyses were done to evaluate the situation, such as infrastructure networks, public areas, environmental studies, densities, and ratio between mass and void. Accordingly, in the proposed master plan, the student tried to understand the current land use distribution and re-arrange the urban function to balance the densities and usage of cars at different cores.

Sana'a, Yemen

Sana'a is the capital of Yemen, located in the Yemeni mountains at an altitude of 2300 meters, making it one of

the highest capital cities in the world. It is distinguished as one of the oldest continuously-inhabited city that is mostly known for its old core city, which has been listed as a UNESCO world heritage site since 1986.

The main problem stated in this case was that the city was un-safe and that the destruction of cultural properties in the times of war was an alarming issue. In spite of the efforts made to fight this deplorable phenomenon, the reported cases of incidental/intentional damages against cultural and humanitarian property were numerous. The student decided to establish a damage analysis mapping using cartoDb through a period of 7 months and establish an evacuation scheme in order to keep the civilians safe and sound.

Figure 9. Air strikes and Damage analysis, Sana'a (Source: Authors, 2017)

Figure 10. SWOT Analysis of Sana'a City, Yemen (Source: Authors, 2017)

Figure 11. Development of a Master Plan & Final Design Decisions, Sana'a City, Yemen (Source: Authors, 2017)

Finally, the strategies outlined in this Emergency Evacuation Plan are based on a viewpoint of evacuation and rearrangement within the limits of Sana'a city, the systems have achieved the proposed outcomes through the analysis of Sana'a crisis to give an evacuation plan for the community. The trial of destruction encircling Sana'a city and its civilians needed an instant response to evacuate the city according to the evaluated threat that appries Sana'a. This paper delivered the responsive strategies in specific to clear the methods that could be held to keep the civilians safe in times of war.

Shahba, Syria

Shahba is located 87km south of Damascus in Syria. From an archaeological point of view, it is the only city in the Roman Hauran built on a grid pattern surrounded by walls forming a square. As a way to preserve and revitalize the four still-known entrances leading to the city center, the master planner attempted to strengthen infrastructure planning, formalize building policies, and preserve open spaces from abusive behavior, thus redefining the urban structure of the city.

Figure 12. SWOT Analysis of Shahba City, Syria (Source: Authors, 2017)

4. Conclusions

An attempt has been made in this design studio to explore some of the prospects that LI application can offer in urban and regional planning education through shared learning processes. Analysing these trends through different urban complexities with the elaboration of spatial strategies for the selected case studies has initiated the scholars to finalize master plans proposals for different scenario. In this experimental Design Studio, well-illustrated urban strategies combine personal knowledge of individual cases, graphical information and suggestions for future challenges of urban planning. After all, it was possible to observe an outline of some of the best-practices and guidelines while introducing cartoDB into our design studio research.

The method of documentation and assessment of social, cultural, economic, environmental and spatial processes were fundamentals for an integrated approach to urban regeneration for every case studied. Through the formulation of the SWOT analysis organized with CartoDB tool, proposed strategies were very responsible for the complex challenges of the development of today's urban environment. The application of the software has shown a clear involvement for skills development, knowledge acquisition and students' engagement in real tangible projects.

This experimental design studio aimed to initiate students in future research to the potential of one important foundation of visualization which can be further exploited

to comprehend city's problems in the future.

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Conflict of Interests

The Authors declare no conflict of interest.

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