*Article*

# Delta Project, Towards a Sustainable Campus.

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**Abstract:** The University of Guayaquil, which shares the same name as the city where it is located, faces the challenge of transforming its image for the XXI century. It was deemed necessary to identify details about the urban evolution of the historic link with the city, in relation to the changes produced by the project's siting and its direct area of influence. The goal is to integrate the main university campus within a framework which guarantees sustainability and allows innovation in the living lab. To achieve this, the action research method was applied, focused on participation and the logic framework. For the diagnosis, proposal, and management model, integrated working groups were organized with internal users such as professors, students, and university authorities, and external actors such as residents, the local business community, Guayaquil city council, and the Governorate of Guayas. As result of the diagnosis, six different analysis dimensions were established which correspond to the new urban agenda for the future campus: compactness, inclusiveness, resilience, sustainability, safety and participation. As a proposal, the urban design integrates the analysis dimensions whose financing and execution are given by the Town Hall, at the same time the Governorate integrates the campus with its network of community police headquarters.

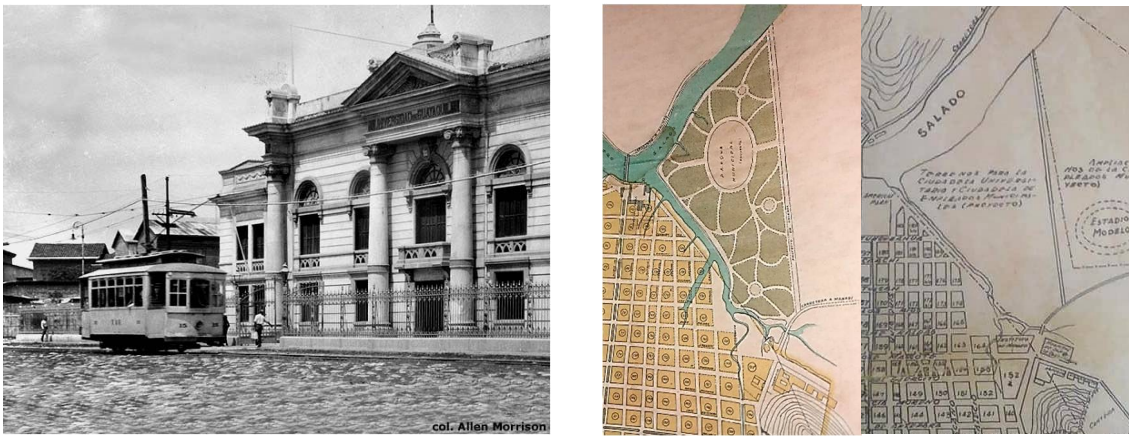
**Keywords:** delta project; university living lab; ecological corridor

## 1. Introduction

The University of Guayaquil, located in the city of Guayaquil in the Republic of Ecuador, is the country's biggest and city's oldest university. It is located at the north of the city in the Tarqui parish inside the university citadel "Salvador Allende" and waterfront "Malecón del Salado", "Avenida Delta" and "Avenida Kennedy".

This university had to pass through a foundational process that began in 1843 driven by the aspiration of the residents to receive professional training in their hometown. After several attempts to establish the university, the educative entity was finally defined in 1897. It was the first university in Ecuador to welcome the university reform initiated in 1918 at the National University of Córdoba (Argentina), that first promoted undergraduate co-government and the freedom of professorship. At

the end of the XIX century, it occupied the lots of the "University house, Pedro Carbo", but between 1949 and 1954 it began to move to its current principal campus.




(**a**) (**b**)

**Figure 1.** (**a**) First university house of Guayaquil University. Built during the principalship the Doctor Julián Coronel. The workmanship was charged to the architect Rocco Queirolo and was concluded in 1906. The property was declared Cultural National Patrimony on 26 February 1988. (**b**) The land was originally projected as a Municipal Park in 1944. On the right, in 1946, it can be seen how the land use was changed for the university citadel and municipality employees.

During its history, many characters of great transcendence in the political field and other sciences have been part of the university student body, as well as its professoriate and governing body. But through its existence, and as result of a misunderstood autonomy and the background of political instability in the country, urban limitations were established, enclosures were built that fragmented the public university space to the detriment of the university community. An urban integration proposal between the citadel "Salvador Allende" and the rest of the city through the Delta Project, which consists of a pedestrian circuit incorporating the public and natural spaces, recalls the pattern of integration of the natural ecologic corridor which existed in Guayaquil in the XVIII century, but which gradually disappeared during the XIX century.

(**a**) (**b**)

**Figure 2.** (**a**) View towards the downtown: old toilets of the estuary between 1862 and 1876, divided into two sections, the left one for women and the right one for men. (**b**) View towards the downtown in 1935: the "Puente 5 de Junio" and the American Park Spa are highlighted.

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The first phase of the project widens the sidewalk that borders the university campus, turning it into a continuous corridor with green-urban infrastructure connecting it with its adjacent spaces, a series of sidewalks and waterfront parks how: ("Malecón del Salado", "waterfront park of Guayaquil University", "Guayarte Project", and "waterfront park of Catolica Santiago de Guayaquil University" all of which have been kept historically disconnected. In this way the current perception of scattered university buildings will shift to one of a unique and broad "integrated campus", which is sustainable, resilient, inclusive, safe, and participatory in consonance with the urban area of the city that shelters it.

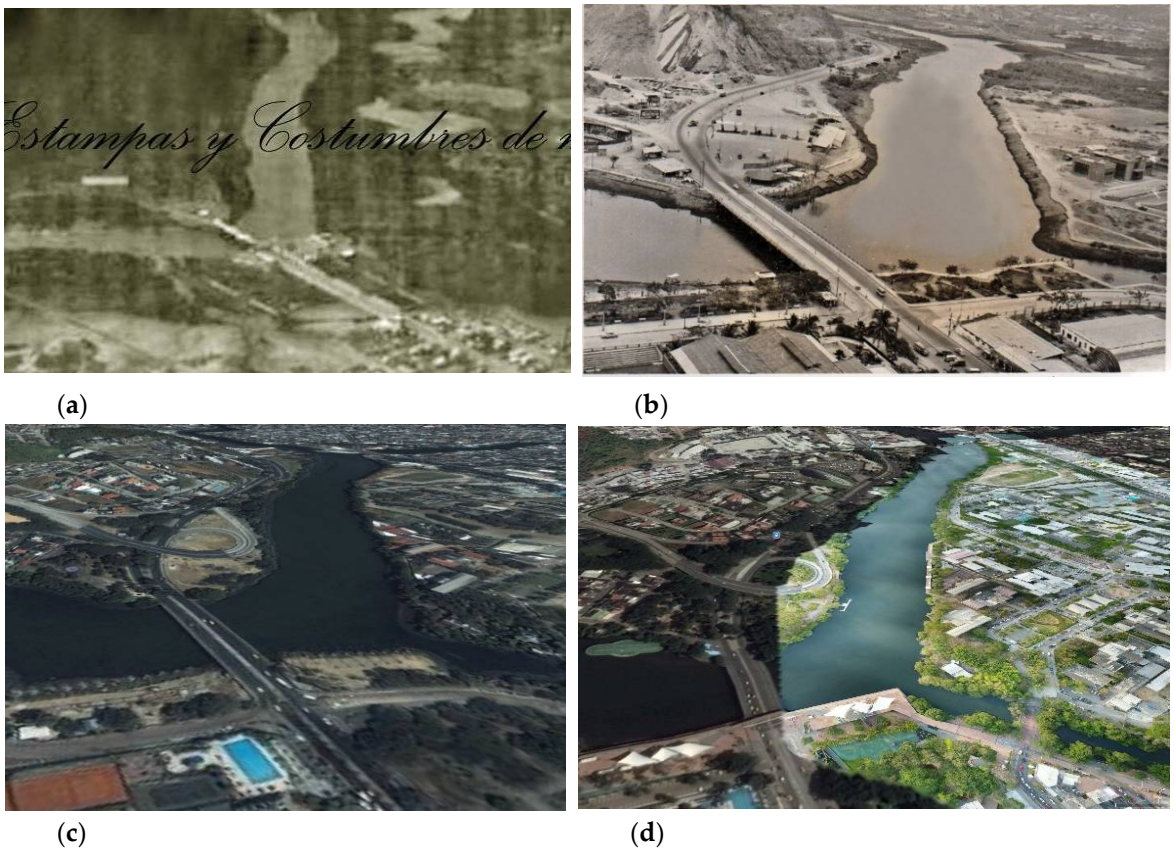


**Figure 3.** (**a**) Campus Salvador Allende, 1922; (**b**) Campus Salvador Allende, 1958 (**c**) Campus Salvador Allende, 1979; (**d**) Campus Salvador Allende, 2018.

According to the National Institute of Statistics and Censuses (INEC), until 2012, Ecuador had an average of 4,69 m² of green areas per inhabitant, whilst the WHO recommends at least 9 m² per inhabitant plus an ideal meterage of 15 m² of green area per inhabitant. The city of Guayaquil is part of the 95 % of Ecuadorian municipalities with a shortfall in green areas. The INEC, in its May 2012 report of the VII population census and VI of housing, points out that Guayaquil has 1,12 m² per inhabitant, far below the level recommended by the WHO. (MIDUVI, 2015)

The "Salvador Allende" university campus has parks and gardens where plant species (fruit and timber trees, bushes, climbing plants, and palm and ornamental trees) are conserved and maintained; these make the campus more attractive, although it does not currently have an integral plan or management model of green areas that allows efficient planning and management for its maintenance and conservation.

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**Table 1.** Green areas inventory of the Salvador Allende campus, University of Guayaquil.

| Faculty/ Dependency | # | total (m²) green areas | Timber tree | Fruit tree | Ornamental plants | Palm trees | Medicinal plant | Grass (m²) | Cane plants |
|---|---|---|---|---|---|---|---|---|---|
| Architecture | 22 | 4392. | 32 | 53 | 505 | 30 | 5 | 650 | 0 |
| Administration & Management Sciences | 10 | 0 | 8 | 30 | 232 | 6 | 1 | 0 | 0 |
| Economic Sciences | 13 | 1340 | 29 | 19 | 532 | 23 | 10 | 467 | 0 |
| Mathematics | 4 | 504 | 0 | 18 | 214 | 0 | 0 | 235 | 0 |
| Main Administration | 8 | 700 | 0 | 6 | 157 | 25 | 23 | 565 | 0 |
| Main Administration front park | 2 | 505 | 14 | 7 | 457 | 19 | 0 | 20 | 0 |
| Medicine Auditorium | 6 | 796 | 5 | 11 | 92 | 2 | 0 | 0 | 0 |
| Medicine-obstetrics | 7 | 324 | 0 | 10 | 114 | 2 | 0 | 15 | 0 |
| Medicine | 24 | 3880 | 14 | 84 | 865 | 26 | 1 | 406 | 0 |
| Odontology | 12 | 805 | 7 | 8 | 52 | 15 | 0 | 0 | 0 |
| Psychology | 6 | 2561 | 8 | 30 | 473 | 11 | 1 | 80 | 0 |
| Law | 15 | 1254 | 10 | 14 | 581 | 23 | 4 | 221 | 0 |
| Philosophy | 16 | 700 | 18 | 5 | 254 | 107 | 5 | 0 | 0 |
| Professor´s Association (APUG) | 4 | 348 | 5 | 6 | 294 | 13 | 0 | 275 | 0 |
| Agricultural Sciences | 10 | 557 | 12 | 16 | 207 | 32 | 0 | 0 | 50 |
| Chemical Engineering | 20 | 2025 | 38 | 69 | 418 | 26 | 0 | 670 | 0 |
| Chemical Sciences | 12 | 1608 | 10 | 26 | 614 | 72 | 1 | 1298 | 0 |
| University Works | 4 | 405 | 2 | 5 | 90 | 0 | 0 | 140 | 0 |
| Fixed assets and maintenance | 4 | 272 | 4 | 23 | 64 | 2 | 4 | 200 | 0 |
| Physical Education | 12 | 8873 | 15 | 41 | 266 | 5 | 2 | 6602 | 0 |
| Student Welfare | 9 | 240 | 3 | 11 | 278 | 2 | 8 | 27 | 0 |
| Rufilli Lab | 7 | 1045 | 1 | 25 | 164 | 0 | 2 | 0 | 0 |
| Central Small Square | 10 | 570 | 14 | 0 | 41 | 19 | 0 | 500 | 0 |
| Park & roundabout | 3 | 2233 | 20 | 7 | 2068 | 32 | 35 | 1359 | 0 |
| Ecological Park | 1 | 1038 | 12 | 23 | 100 | 26 | 0 | 0 | 1200 |
| Ecological Park (FEUE) | 1 | 1510 | 36 | 0 | 29 | 12 | 0 | 0 | 0 |
| Associations | 6 | 1183 | 19 | 38 | 27 | 2 | 0 | 0 | 0 |
| TOTAL | 248 | 39667 | 336 | 585 | 9188 | 532 | 102 | 13729 | 1250 |

[1] Taken from Green Areas Department of Guayaquil University.

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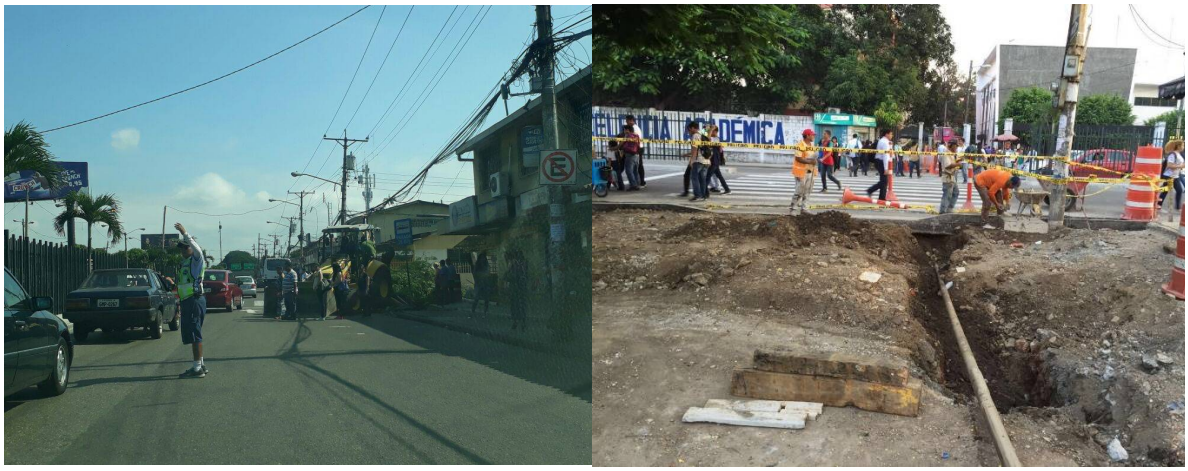
As a consequence of the segmentation of the public space and an evidently non-planned intervention of the natural area and urban landscape limitations, the idea emerged to begin the forums and interinstitutional liaison required to present the project to the Municipality of Guayaquil for support with its financing and execution.



(**a**) (**b**)

**Figure 4.** (**a**) The metal fence can be observed in the central parterre and at the right side there is machinery cutting down the last two trees on the side of the Bolivariana district; (**b**) Destruction of the trees to place a metallic post with a traffic light at the entry to the University of Guayaquil is observable at the background.

Sustainable development (SD) in university education

Higher education is fundamental and key to a sustainable future; it has the necessary tools to develop new ideas, influence society and actively participate in experimentation for sustainable living. Universities have a moral obligation to work towards sustainable societies, focused on environmental degradation, threats to society, production, and sustainable consumption for them and for future generations. As respected thought leaders, they have the opportunity and responsibility to prepare professionals focused on interdisciplinary collaboration and cooperation; with high values of conscience, knowledge, skills and values, that help to transform their places of work, society and the place where they live, becoming responsible global citizens. Higher Education Institutions (HEIs) [1]must function as a fully integrated community (Figure 5) that models social and biological sustainability in itself and in its interdependence with local, regional and global communities, where students learn from everything that surrounds them.

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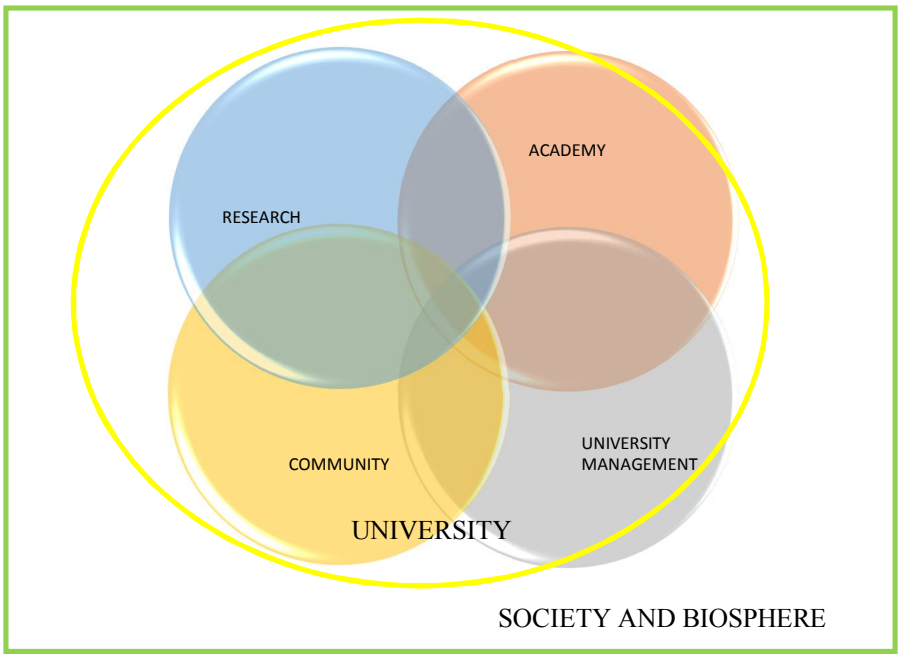


**Figure 5:** Higher Education Modeling Sustainability as a Fully Integrated System [1]

Initiatives to promote SD as statements, letters, associations, conferences, etc., can provide guidelines on how to integrate sustainability into the university system. Collaboration with other universities, making SD an integral part of the institutional framework, life experiences on campus, and "Educating Educators" are key elements that must be systematically integrated into HEIs, to provide learning and educational value. race to the participants in the transition to the DS; thus guaranteeing the SD as the "gold thread" throughout the university system [2].

How are sustainable universities? Some authors [3] consider that they should have the following characteristics:

A bi-directional, interactive and student-centered learning process, with a strong emphasis on critical thinking skills; High degree of importance in conducting interdisciplinary and scientific research;

Social orientation of problem solving in education and research, where students are able to deal with the real problems and uncertainties associated with the future; Creation of networks that can take advantage of the varied experience throughout the campus to share resources efficiently and meaningfully. Leadership vision responsibilities and rewards that promote the change necessary for the long-term transformation of the university by responding to the changing needs of society.

A comparison was conducted [3] of the strategies of seven universities around the world to identify the key aspects of the transformation of universities towards sustainability, the ideal characteristics of the sustainable university, and the drivers and barriers (Table 2) in the transformation. Three interactive dimensions (framework, level and actors) were distinguishable (Figure 6) in this process of change. The framework dimension (F) is related to intensive interactive changes in culture, institutional structure and technology (means to meet the needs). The level dimension (L) describes the change that is required. Finally, the actors dimension (A) refers to the actors or involved in the transformation process. The lack of an incentive structure to promote changes at the individual level is mentioned as the main barrier to overcome, and the presence of "connectors" with society, the existence of agencies and coordination projects and the availability of funds are presented as keys to the progress of sustainability. A common feature is the declaration of transdisciplinarity and interdisciplinarity as a strategic objective, as well as establishing and supporting networks of experience within universities. The establishment of connections with society is present as a growing trend.

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**Table 2.** Barriers and internal and external drivers in the universities for the change towards sustainability.

| | | |
|---|---|---|
| Barriers | Internal | Academic freedom. - Individual decisions about the best way to achieve research and education objectives; It is difficult for an administrator to propose changes and achieve consensus among groups of teachers at any level |
| | | Incentive structure. - Lack of recognition and compensation to teachers and staff involved in the transformation of the university. |
| | | Conservative administration. - Lack of desire to change. |
| | External | Pressure of the society. - Lack of demand on the part of society, of the desired characteristics of graduates and research for their development. |
| Impellers | Internal | Champions. - They are the innovators or defenders of sustainability, who can be important agents for change. By failing to provide them with institutional support to fuel continuous work, universities run the risk of losing their most valuable supporters. |
| | | Visionary Leadership. - Leaders with appropriate assignments and responsibilities, who promote cooperation and collaborative efforts instead of inter-unit competition. |
| | | Connectors. - These are the networks or groups of interdisciplinary research people that come through the university to include a critical mass of actors on the campus, who can interact between departments or with society in general. |
| | | Size. - The complexity of the organization (more than 10000-12000 students) can reduce the possibility of rapid transformation. |
| | | Sustainability Coordination Unit. - Its creation is important to keep the process of change alive and distribute responsibility. |
| | External | Pressure from similar institutions. - Pressure from peer institutions or top-level universities can serve as examples to promote change. |
| | | Sources of financing and availability of employment. External financing through corporations or government agencies willing to pay for sustainability-oriented research, and employers that require graduates with sustainability strengths. |

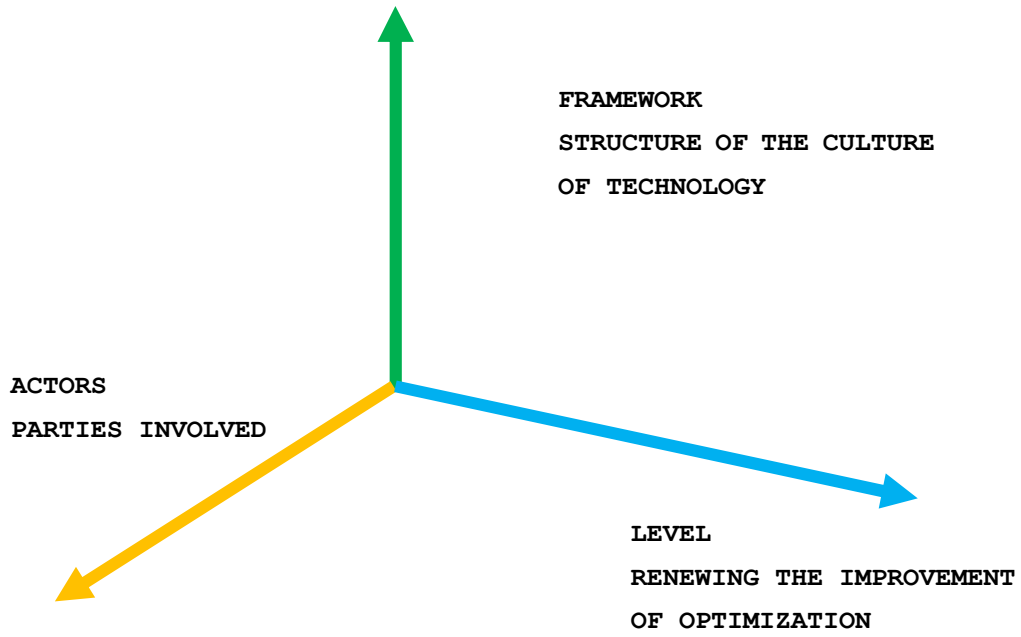


**Figure 6.** Framework, Level and Actors - "FLA approach": three dimensions of change interaction to achieve sustainable development.

Source: Jansen (2002)

Interconnecting sustainable development as a concept, within and between different disciplines and schools, adapted to its specific nature, could help universities move towards a more balanced, synergistic, transdisciplinary and holistic academic system, thus helping graduates contribute to better way to the development of more sustainable societies [4].

Sustainable development in architecture schools

Architecture has not been left out of the evolution towards a dependence on non-renewable energy resources; it has had a limited evolution both because of the restrictive framework of the survival of the traditional city and because of the technical elements that sustained it. The set of elements that unites architecture with the territory and especially with the city, have hindered its articulation in the new productive system [5]. The material with which the visible city is conformed, has endowed this transformation with inertia, at the same time as it has been continuously stressed to adapt. The new city, the new buildings, the new forms of production of materials, the changes in the organization and ends of the process of production of architecture, are decisively altering the traditional technical systems to start a different architectural technology with an absolute redefinition of its conception. At present, traditional materials such as stone, wood or earth, which were examples of closed material cycles, have altered their production systems. The traditional technical system[5] in architectural technology is affected mainly by the transfer of production materials to the industry, aligning the work as the production conditions permit, fighting against the physical location of the architecture that limits this transfer

The control of the strategic aspects of architectural technology has also been transported from the work of industry. This displacement is not only a spatial transfer but is also the segregation of obtaining materials from other activities, thus eliminating the extensive chains that involves its management. The social meaning of architecture is configured in livability, which is nothing other than the provision of basic services. With the new paradigm, a series of resources, functional systems that guarantee the habitability of architecture and that are now assumed by new resources of the new technical culture, are abandoned; where the use of energy has become a determining factor in the air conditioning and lighting of spaces, the control of the water cycle inside the building, the vertical movement of people and materials. In this line, the architecture has been changing, allowing new configurations of forms and functions to be addressed, achieving very high occupancy densities in minimum volumes, ensuring not only survival, but the theoretical [5] comfort of the occupants. Current architecture largely focuses on systems of dependence on energy consumption in order to be habitable. The global environmental system can no longer support the high carbon density buildings and the high energy consumption they represent.

Sustainability in the design of the built environment is a key factor to address sustainability in response to limited availability of resources, ecological deterioration and climate alteration. In order to respond to the demands of the current market, a pedagogical methodology must be developed that overcomes existing educational and professional barriers and acts as a communication platform that facilitates the transfer of knowledge between the construction sciences related to sustainability and creative design. in the architectural curriculum [6].

The achievement of a "sustainable" curriculum really oriented to design is one that is still difficult to achieve, composed of the nature of the theme itself. Most of the time, design study projects are complex and time-consuming, as students are not able, within the span of a semester, to reach a level of mature and deep analysis that includes awareness and integral implementation in the design of technical and environmental mandates[7]. Cognitive discrepancies are not only related to students but also to their study tutors, who rarely master the technical aspects of environmental design, while academic staff teaching technical subjects are often not associated with the study team design [13]. Architects generally employ a solution-centered teaching strategy rather than a problem-centered design development approach, where students focus more on achieving a desired result than on a critical investigation of the complexity of the problem they face, favoring the acquisition of information and hindering the development of critical thinking.

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Students should be encouraged to emphasize reflection and critical self-assessment, should be able to balance the integrity of design and environmental responsibility, considering environmental design as a basic, essential and integrated requirement of the design exercise itself. A good theoretical base is essential in teaching; however, it has to be supported by empirical knowledge and evidence-based learning to understand how different principles can be applied in practice and by analytical tools and simulation techniques that can facilitate the testing and comparison of different hypotheses and make performance forecasts from the early stages of design. Skills such as concrete experience, reflexive observation, abstract conceptualization and active experimentation could help the development of critical thinking, which together with interdisciplinary paradigms are the basis of education for sustainability [6].

Living Labs

In this sense, we must promote horizontal systems, to create a collective based on collaboration, so that we must learn to collaborate, to promote the collective versus the individual, to achieve shared success and distributed merit. The development of transdisciplinary strategies is not only of undoubted interest for contemporaneity, but also brings very interesting values to collective work. When an excessively homogeneous community is created, it produces flat ideas. "Teaching Sustainability through Living Labs in Architecture: The case study of the UPC-LOW3 prototype solar house". The article bases its content on the LOW3 Living Lab, defining it as a project in execution, which aims to innovate in education for sustainability, through user-centered research and collaborative learning within the university campus. The author indicates that specific disciplinary knowledge should be taught by adopting a holistic, transdisciplinary approach to the environmental, economic and social aspects of sustainability. The analysis aims to leave its results and lessons learned as examples for similar activities in other universities[8].

To dispense with the old methodologies, it will not be enough to create dynamic networks, we must generate laboratories that investigate in a distributed and connected way, going beyond the communication that technology facilitates. Not only should it be an organism with different coordinated devices, we must reinvent the way we investigate, overcoming separation and individualized concentration, in order to seek unique and innovative results that exceed the sum of the parts.[9].

Collaboration is more beneficial; in addition, it is presently very difficult to handle all knowledge, since the speed at which it occurs makes it impossible to control all the necessary dimensions. However, it is not enough to manage teams that sectionalize information too much, but rather it is necessary that the components work together as a single body, so that the results benefit from an authentically collaborative process.

In this framework, the Project Delta was formulated as an applied research project and approved by the University Council in 2017. It is integrated by research professors and students that belong to different academic faculties, whose main objective is to carry out the urban-architectonic study of a sustainable campus for the University of Guayaquil; a living-lab integrated with the public space, to be developed in three stages.

Circuit with green urban infrastructure in Av. Delta and Kennedy, bikeways and security integration with a community police station.

University Technological Park and urban-architectonic intervention inside the campus.

Parking lot Building, Multipurpose Stadium and Aquatic Complex.

The first stage of the project is presented in this paper.

## 2. Materials and Methods

The complexity of the problems faced require an enormous effort to redesign the existing processes, discarding the obsolete and creating new systems that will make it possible to attain the

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new objectives demanded for a contemporary environment. Therefore, new structures must be built so the research can continue and be able to bring the future closer.

In this sense, the standardised and enclosed structures should be substituted for others which are more flexible and open, favouring the evolution of individual work towards a collective effort.

The Delta Project does not respond to classic research standards since the UG Campus is a model of cumulative results; there is no evidence of integral planning processes.

The inductive research process began to define the pedestrian-road system, with the collection of traffic accident records along the Kennedy and Delta avenues. It was necessary to know the street's geometric characteristics and the volume of the vehicular and pedestrian traffic that circulated along Delta Avenue. Pedestrian traffic is distributed on both sidewalks, one of them adjacent to the university and the other adjacent to the Bolivariana district, where most of the complementary services which are required by the students, such as restaurants or stores selling stationary are located. It is therefore necessary to raise the activities' plan and citadel's soil usage in order to integrate it to the zone's functional dynamics.

On the other sides of the campus, the UG is surrounded by a system of spaces and natural estuaries with low or null accessibility. Even though the municipality has control over the riversides, the works that have been implemented were not integrated to the students´ lives. Pedestrian systems are not connected to the natural systems, which requires research to identify the species that configure these natural and green areas of the campus and to know the projection for pedestrian movement within a growth plan.

As indicated at the beginning, the UG's physical planning process has been incremental and slow, requiring an infrastructure upgrade which has taken more than 60 years. It was indispensable to know or to evidence the UG's planning system and the actions within the campus by various departments in areas such as road tracing, soil usage, grouping of buildings parking lots, development areas, existent necessities, future necessities, etc.

Another guiding aspect in the research process was the city's planning system, adopted by the local Town Hall. The municipal projects in the study zones were studied, especially the impacts of Project Delta connected to the rest of the city, emphasising the urban infrastructure such as roads, parks, and others, that are close to the university.

In order to address these tasks, it was necessary to connect these four big systems in a dynamic way, requiring the adoption of a methodology that allows building fast and integrated knowledge, using research and formulating a Collaborative Investigation System in a living-lab environment, thus, granting a higher student participation, as well as teacher participation. This lab was shaped by students of different semesters, from the beginning to the tenth, whilst the professoriate was comprised of the project director, general adviser, and some other experts.

The main concept was focused on the user (the students) emphasising the thought of design where the students learn and exchange their knowledge, developing new ways of working. They develop new designs, new work mechanics, they work together for the development of their territory.

The interest which the project generated in the university, allowed this methodology to be adopted, with the selection of students with some expertise, as well as the configuration of expert groups of teaching staff or external professionals that would communicate with each other during the dynamic interdisciplinary forums.

The Collaborative Research System in a Living-Lab environment needs to be developed in a well-defined process protocols room.

The standardised physical planning protocols require addressing a big number of simultaneous processes, unlike the approach of Delta Project that emphasises an inductive system, beginning from the flow system or, rather, pedestrian-road system; then system of natural spaces and estuary, so they could finally mix together with the UG's physical planning system and city's planning system.

The most general tools for this kind of project were the Urban Regulations of Public Spaces, which were developed by Jan Gehl, the Municipal Urban Regulations, the Ordinance of the Land Use Plan, the Traffic Rules, the Territorial Arrangement Planning's annexes 5a and 5b, and the AASHTO standards, there were even reviewed pedestrian simulators such as SIMULEX, PEDgo, Legion,

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Exodos, Gridflow, but in the end, there was concluded in using VISSIM Simulator, polls, ecosystem nomenclature, especially the link between social and natural sciences of Eugene P. Odum and the EPA's Handbook Urban Runoff Pollution Prevention and Control Planning.

In the physical planning area, the project had several technological tools that allowed researchers to obtain first-hand on-site information using a drone.

The knowledge integration protocols allowed students in the lab to integrate different knowledge simultaneously in one place, while the professors' forums enabled the students to integrate this knowledge while they worked, differentiating from the academical speech which usually proposes a pyramidal classes' system in the different classrooms.

The protocols used required a mapping of possible knowledge blocks that the project should support, from the blocks of the STEM (Science, Technology, Engineering, and Mathematics) to the blocks of Humanities. That combination would allow a quick resolution of problems.

The first protocol was to define the modality of student participation. The time used in the project was considered as part of pre-professional work experience which all undergraduate students must complete.

The student tasks were divided into different activities, which allowed the project to be divided into parts, from the identification of the problem, the establishment of solution paradigms, the formulation of concepts to solve the problem, the updating of knowledge about the project, the implementation of a work method for the coupling of the software that the project would use, then each student was responsible for a development block, which was then submitted to the integral refining committee. The participation of the students in the project was of different faculties.

The professionalisation protocols will allow the design standards demanded by the professors to be those required in the professional market. The professors who joined the laboratory had extensive professional training, having carried out many professional projects, this would guarantee that the students integrate high design standards in the proposal, which would make a big difference with teachers who did not have professional hours.

The most relevant protocols were created by professionals in specialised forums and interdisciplinary forums. Counting with the participation of students, the key forums considered software, public space, ecology, green areas, transit and transport, art, budget, infrastructure, networks and facilities. The practical action of the professionals in the design allowed the students to find answers with high standards. The forums could be from the university or outside it, such as, for example, the faculty of mathematics forum, the faculty of agricultural sciences forum, the botanical garden forum, the university planning department forum, the paving stone companies' forum, etc.

A fourth protocol but no less important is that of project management, which began with discussions in the different university governmental levels: the students, the community, the press, the city, the region, and the country. Through that management, principal agents were identified that would achieve the required level of feasibility for the project´s execution; the project was never considered as an academic project from the outset as its main objective was to be deemed sufficiently viable to be implemented.

The main proposed tools included:

The consultation and student community agreements process with local residents and businesses;

Press briefings;

Presentation of the project to numerous authorities, especially to those of the Town Hall;

Presentation of the project in international conferences and workshops to coordinate collaboration with universities and other partners.

## 3. Results

### *3.1. Physical Planning*

The project was concluded with the urban proposal, the road proposal, the pedestrian proposal, the proposal and the taxonomy of the trees, the proposal of lights, the proposal of higher steps and

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level. These proposals were based on multipurpose surveys, vehicular and pedestrian traffic counts, national and international technical standards, INEN, AASHTO, streets and roads manual of the public works ministry, Ecuadorian construction code, NEC CODE - SE - GCE, Standards NEC-SE-DS, NEC 15.

**Table 3.** Contribution of public space for the delta project at Salvador Allende campus, University of Guayaquil.

| Items | Faculty of Architecture | Faculty of Administration & Medicine | Faculty of Dentistry | Total | Unidad |
|---|---|---|---|---|---|
| Existing trees | 26 | 22 | 8 | 56 | U |
| Proposed trees | 27 | 61 | 12 | 100 | U |
| Green Area Proposal | 1460,10 m² | 990,87 m² | 294,15 m² | 2735,12 m² | m² |
| Paving stone | 4565,73 m² | 4137,37 m² | 1152 m² | 9855,10 m² | m² |
| Furniture A1 | - | 9 x (módulo de 4U) | - | 36 | U |
| Furniture A2 | - | 8 x (módulo de 12U) | - | 96 | U |
| Bus Furniture | - | 6 | - | 6 | U |
| Ciclovia | - | - | - | 555,23 ml | ml |
| Current Enclosure meters | 180,24 ml | 272,57 ml | 134,50 ml | 587,31 ml | ml |
| Reform of the closing meters with the Delta project | 88,48 ml | 149,47 ml | 20,39 ml | 258,84 ml | ml |

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**Figure 7.** First stage, Delta Project and its context area.

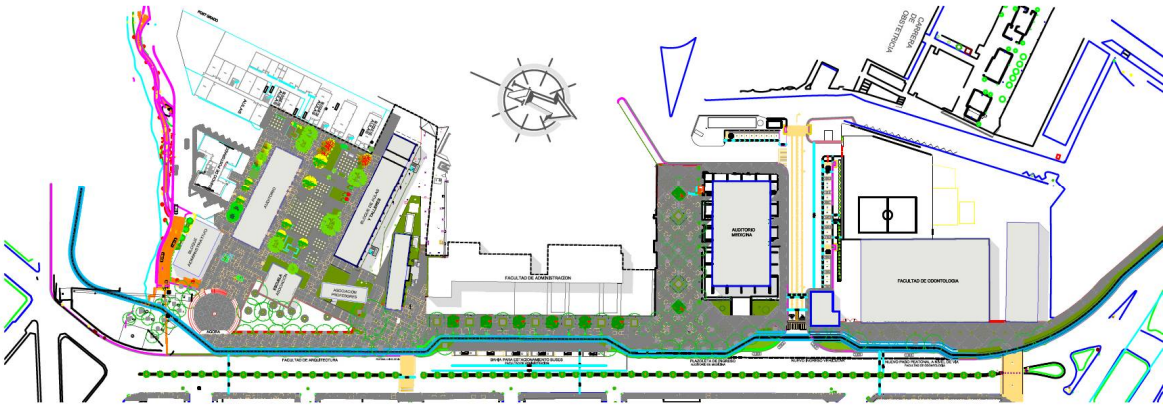

**Figure 8.** Architectural plan of the Project's first stage.

(**a**) (**b**)

**Figure 9.** (**a**) Ecological circuit proposal in Av. Delta; (**b**) Bus stop outside the Faculty of Administration and Management Sciences.

(**a**) (**b**)

**Figure 10**. (**a**) Pedestrian and bikeway circuit render, with bus stops and street furniture observable. In the figure it is possible to see there is not a front wall since the goal will be to open the space leaving the existing buildings as limits. Each faculty will be divided with an enclosure that does not impede visibility. An interposition between the historic facades of the existing buildings and the modern additions will enhance the visual impact fronting the street. (**b**) This section corresponds to the University of Guayaquil's current vehicular entry from the Av. Delta. This has been transformed into a small square. The vehicular entry is relocated.

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*3.2. Integration of knowledge*

The pre-professional work experience played an important role, it is a binary indicator because it allows measuring the degree of effectiveness and participation of the students in the project, besides it measures the collective participation in the resolution of the problems. To this end, reports or records of compliance with goals and group and individual tasks were used, concluding that the tasks were fulfilled to a level of 80%.

Participants reached 80% of learning goal, mainly through simultaneous knowledge (learning from different fields simultaneously). This analysis considers the teaching staff who formed part of the study, working in the multiple fields previously identified.

(**a**)

(**b**)

**Figure 11.** (**a**) Students participating in the project. Faculty of architecture and urbanism, August 2017.; (**b**) Topography students and professors participating.

(**a**)

(**b**)

**Figure 12**. (**a**) Math & Physics Sciences Faculty dean office; (**b**) Experts, analysing the project together with the students.

*3.3. Professionalisation*

Twenty-five forums were organised with the participation of 32 professionals from 12 specialized fields: technological, agricultural, ecological, urban, road, transit and transport field, pedestrian. Twelve interdisciplinary forums were finalised.

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(**a**) (**b**)

**Figure 13**. (**a**) Participation of Civil Engineers and agronomists with extensive professional experience.; (**b**) Participation of the Executive Director of the Association of Municipalities of Ecuador.

(**a**) (**b**)

**Figure 14.** (**a**) Participation of surveyors of the Siglo XXI Foundation and Malecón 2000; (**b**) Participation of authorities and technicians of the Municipal Transit Authority (ATM).

*3.4. Project Management*

In this field the participation with different parties was carried out through meetings, calls, and surveys, meetings with students, the local business community, meetings with the wider community, for this purpose minutes, photos and videos were recorded.

(**a**) (**b**)

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**Figure 15.** (**a**) Participation of the leaders of residents of the Bolivarian district in the construction of public space. Faculty of architecture and urbanism, August 2017; (**b**) Participation of students and professors from various faculties, as well as external building experts for the Urban Project.

The meetings with the university authorities were recorded in minutes, photos and videos, concluding in the approval of the project in the University Council, having held meetings with the rector of the University of Guayaquil, deanships of each faculty, financial management, management of university works, direction of art and culture, direction of green areas.

(**a**)

(**b**)

**Figure 16.** (**a**) Construction and briefing of the Delta project with the Vice-Rector for Research.; (**b**) construction and briefing of the Delta project with the members of the university council.

The meetings with the Government of Guayas were recorded in minutes, photos and videos, the project was explained, as well as the security problems to which the university community is exposed, and the need to create a sustainable campus, concluding in the assignment of a mobile Community Police Unit. Now the police elements are mobilised by bicycle inside the University Campus.

Once the project is executed, the security management will also include citizen security, through the integration of the different groups of stakeholders, in order to guarantee a sustainable security over time, through the appropriation of public space.

(**a**)

(**b**)

**Figure 17.** (**a**) Delivery of urban and architectural studies of the Delta project by the rector of the University of Guayaquil to the governor of Guayas, Francisco Cevallos. Governorate of Guayas, August 2017; (**b**) Exhibition by the project director to the provincial authorities, within the framework of the campus security proposal.

(**a**) (**b**)

**Figure 18.** (**a**) Police officers with sustainable transportation, Faculty of Architecture and Urbanism; (**b**) Abril, 2018. Inauguration of the Security Plan in the Salvador Allende Campus.

The meetings with the municipality were recorded in minutes, photos and videos, concluding in the allocation of the budget for the work, having held meetings with the local mayor, Malecón 2000 and Siglo 21 foundations, Municipal Transit Authority - ATM.

(**a**) (**b**)

**Figure 19.** (**a**) Delivery of the urban and architectural studies of the Delta project by the rector of the University of Guayaquil to the city mayor, Jaime Nebot Saadi. Guayaquil Town Hall, August 2017; (**b**) Definition of commitments and sharing by the project director, the architect Héctor Hugo, to the mayor of the city of Guayaquil and the managers of the municipal foundations.

The socialization and validation of the project in international events, to feedback and establish joint collaborations. In this case the Delta project was taken into account for the main conference in the Workstation modality, also included the presentation of the poster on Technological park for the University of Guayaquil.

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(**a**) (**b**)

**Figure 20.** (**a**) welcome to the sustainable campus conference in charge of KTH and main conference aperture; (**b**) speaker at poster of Guayaquil University, about Technological park.

(**a**) (**b**)

**Figure 21.** (**a**) Guayaquil University, speaker at workstations group 1; (**b**) Guayaquil University, speaker at workstations group 2.

(**a**) (**b**)

**Figure 22.** (**a**) Guayaquil University, speaker at workstations group 3; (**b**) participation of the delta project at workshop about living lab, led by Julie Newman, Ph.D of MIT.

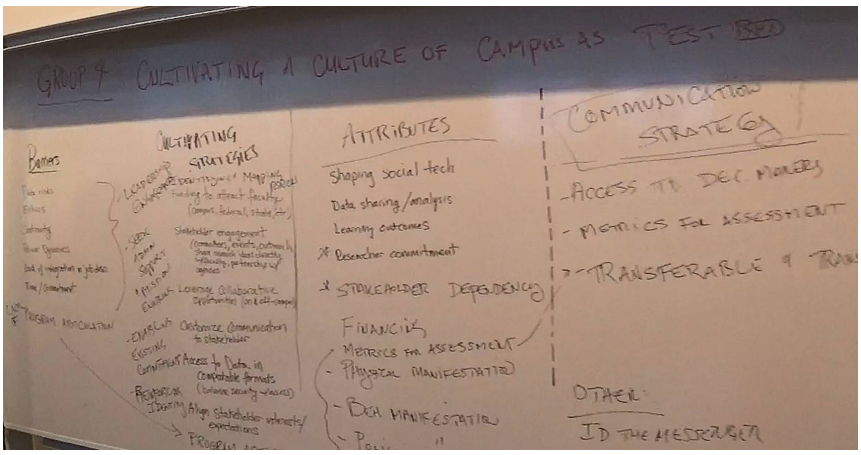


**Figure 23.** Participation of the delta project at workshop about living lab, led by Julie Newman, Ph.D of MIT.

The press plays an important role, starting from an independent management oriented to the dissemination of the project in a massive way to public opinion. With the taking of statements activates the cycle that allows the empowerment and commitment of the actors involved in the project: the one that finances, the one that proposes the studies, the users to whom the project was destined.

The press agents are the external equivalents, who share and contrast information by taking statements from those involved being an important link in inter-institutional coordination. At the same time, the population becomes aware of the results and benefits provided by the project.

This was achieved through several interviews and reports, such as: "Los pequeños negocios y estudiantes se quejan por reja en la avenida Delta"[10], "Comerciantes piden más pasos peatonales frente a la Universidad de Guayaquil"[11], "Un sueño para la Delta"[12], "La esperanza llega a la Delta"[13], "MIDUVI Guayas se suma a iniciativa para romper barrera de la discapacidad- Ministerio de Desarrollo Urbano y Vivienda"[14], "Video de Proyecto Delta"[15]. Likewise, the Delta Project has a Fan page called "Proyecto Delta UG"[16]. "El proyecto urbano de la Delta viaja a Estocolmo" [17].

## 4. Discussion

Authors should discuss the results and how they can be interpreted in perspective of previous studies and of the working hypotheses. The findings and their implications should be discussed in the broadest context possible. Future research directions may also be highlighted.

Regarding the objective of the work, it is important to show that the Faculty of Architecture, aims to implement a strategy for the management of public space based on the use of four dynamic systems that interact, evaluate, minimise, project and make feasible urban solutions. These are the physical planning system, knowledge integration system, professionalisation system and management system.

From the field of urban design, a design response has been achieved that overcomes the difficulties posed by traditional urban design standards, in terms of the revitalisation of deteriorated urban areas, which has overcome the way of addressing the issues of urban revitalisation. In the past, this was always oriented to physical planning, from an academic dimension, and away from the profession. It can be said that public space was elusive for university pedestrians, existing pedestrian areas represented environmental risks, which were evaluated and minimised by implementing the strategy.[18]

In general, the strategy consists of using new tools, which allows them to be joined, since in the academical field they are used in an isolated and dispersed way. The only way to connect them was

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to use a new tool called living lab, a live operations laboratory, configured for students who require professional internships.

The physical planning system in general terms is responsible for considering the design, financial and regulatory variables. The system of integration of knowledge was responsible for adopting a scheme of knowledge clusters in situ, a different environment to that promulgated by the routine academic meshes. The variables of this system were shaped by the variables of fields of knowledge that were taught through of instructions of blocks of tasks. The professionalisation system had an important impact, so much that it was inserted to the professionals and specialists in the evaluation processes, to minimise, project and make the solutions viable. The variables of this system were established to implement the highest standards used in the professional market, suggested by the specialists, and configured by the variables of fields of knowledge with standards and standards of design, programming and costs. Many of the specialists who were part of the project, were not necessarily academics. The management system for the implementation of actions for the resolution of the components, the processes, the availability of resources, the coordination of activities, the project to materialise, the configuration of the variables of the student component, professional, managers of the university, executives of the municipality, the community, the press, &c.

Other ways can be indicated to show that the systems adopted have allowed the necessary results to be achieved and to integrate the four levels of the process: the associations of the affected or public actors for the public sector for public spaces. the integration of knowledge for professional practices, and the design strategies that are applied in the Delta project area. All measures include aspects of the development and implementation of a sustainable approach.

The general approach that was adopted began with the integration of four key priority evaluations.

- Establishment of priorities based on the current risks presented by the current pedestrianisation conditions of university students;
- The natural conditions of public spaces;
- The direct participation of the actors;
- The design of the solution: to comply with all requirements in a sustainable manner, including environmental effects, space and available facilities, local perceptions and other problems.

That work can contribute enormously to four essential aspects.

a. Increase the public spaces of the city [19], since the local municipality lacks a policy of public spaces[20], a situation that is not foreseen in the land use plans, nor is it a component articulated in the Organic Code of Land Use.
b. Public spaces such as pedestrian areas are not registered in the Organic Law of Land Transport, Traffic and Road Safety, only in a very indirect way are mentioned in articles 4 and 9 of said law, when there must be a whole chapter dedicated to pedestrian areas and their relationship with the road system.[21]
c. According to the results achieved, present a new way of teaching architecture and urban design[22], which goes beyond the traditional and routine education of the current mesh of subjects[23], so it would be advisable to reform the academic regime regulations established by the Council of Higher Education (CES), allowing an education of blocks of subjects in a design laboratory[9], which must be discussed in the Organic Law of Higher Education.[24]
d. From the environmental point of view, urban ecological corridors, are not part of the classification system for a healthy environment, regulations such as Book IX of the Unified Text of Secondary Legislation, and other standards are only devoted to quality control of the resource, so that urban ecological corridors can be part of the environmental planning system, as elements that improve the life and health of people in cities, and these planning systems can be included in the environmental planning of cities.[25]

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## 5. Conclusions

The ecological corridor of the Delta project is an urban rehabilitation project and, as such, its crystallisation has depended on three key factors: the academic approach, plus the professional approach with a significant amount of urban management. The proposal consisted in proposing a corridor of public space for pedestrians, imitating the ecological corridors of the adjoining estuary with a participative environmental management. Agreements and alliances have been relevant to sustain conservation actions. The meetings and negotiations with public and private organisations, local communities, students, residents, merchants, research centers, botanical centers, universities, schools, owners, authorities allowed to generate consensus about the importance of imitating the ecological corridor of the estuary around all the university campus forming a circuit in the manner of a linear park endowed with walkways, native wooded areas, squares, bus stations, cycle tracks, etc.

The participatory work with the municipality, with the students, and with the local business community deepened this relationship to develop a pedestrian corridor that the university does not have, guaranteeing the right to public spaces, serving as a distribution of the student population to the intern and external to the university, in addition to ensuring the protection of biodiversity. For this purpose, surveys and technical and administrative consultations were carried out.

The results obtained point to several fronts:

On the academic front, a different approach to the teaching of urbanism is proposed through the living labs, which integrate knowledge in a group of subjects and not in isolation, as stated in the current curricular meshes of Ecuador; In the same way, this form of teaching and learning could well be applied to the Research and Degree projects, such recommendation affects the reform of the Academic Regime Regulation (RRA) proposed by the Council of Higher Education of Ecuador. This would imply a substantial reform in the form and substance of the presentation of the curricular meshes. Clusters of comprehensive knowledge fields included, from the use of basic software to draw, vehicle traffic counts, to the use of specialised software for the simulation of pedestrian and vehicular traffic, climate simulators, use of drone for planning and photography in real time, plant taxonomy, reforestation practices, artistic guidelines, budgets, soil studies, site visits, population needs, &c.

From the urbanistic point of view, it is concluded that the municipality could adopt a second front. In a systematic way, the criteria of an integral pedestrian corridor for the development of public spaces in the form of an Ordinance will be considered strategic within the units of the land use plan, given that it corresponds to existing facilities at the time of execution, in particular, the characterisation of the nearby natural resources and, therefore, is considered as a component of the landscape of the project area. These resources should be promoted and connected throughout the city, thus revitalizing and integrating the urban landscape rather than simply paving cobblestones without providing space for the flourishing of life, as has occurred in the past[26].

Such policy takes advantage of the existing infrastructure invested in the city, raising the quality of public spaces and the surplus value of urban sectors. The characteristics of the urban perspective incorporate with great relevance the zoning of the units of reforestation and conservation; these enabled researchers to determine that the passive techniques of recovery are the best alternatives for the increase of the biomass and the conservation of the environments influenced by mangroves or mountain ranges. The area of study is very close to the mangrove and mountain areas that were exploited as quarries in the past. The zoning merits a special emphasis to be placed on the management of soil, planting and planting of native species, erosion control (trenches) and monitoring of plantations. The infrastructure for conservation stands out. Support infrastructure was implemented, such as a network of trails, recreational sectors, overnight stays, recreational activities, cycling trails, tourist trails, educational and research areas in this environment of mangrove ecological corridors.

From the relationship point of view, the municipality must perform is the intervention for the recovery of public spaces, a policy that cannot be explicitly seen in municipal policies, nor in land use plans nor in the partial plans, to such an extent that the public spaces in the city of Guayaquil are meagre; they do not reach 3,000 m², and neither the sidewalks nor the parks are included here. In this regard, it should be noted that the Delta project contributes 22,754.54 m², seven times more than that contributed by the local municipality[27].

Finally, this methodology should be incorporated into territorial planning plans, and into other planning instruments, especially the management and participation system. The city of Guayaquil requires an administrative mechanism that takes charge of the planning, organisation, direction and control of the area, and that includes political support, inter-institutional and intersectoral coordination and the participation of owners and the community in the integral corridor projects [28].

Many of the urban interventions such as Puerto Liza, Estero Mogollón, Estero Salado, were not conceived for the continuity of the concept of the ecological corridor, which could well serve as forms of education and preservation of natural resources; on the contrary, they covered them with fillers.

Finally, it can be said that the project took eleven months to be developed, 30% of the time was used for the initial phase, that of preparation and forums. The project was developed in a short time using this collaborative system; in this sense the living lab methodology fulfilled its mission, to achieve academic and professional results with a large input of management.

The vision described in this paper was presented to the International Sustainable Campus Network in Stockholm and the discussions conducted there with experts from different universities and associated fields generated the determination of the University of Guayaquil to establish a model of development and gain accreditation as a living lab, setting an example for other cities in the world with similar aspirations. The full implementation of this project will enhance the experience of many different users who study, work, visit or reside and work within the area of influence of this urban campus of the largest public university in Ecuador.

**Author Contributions:**

Conceptualization and project Administration, Héctor. Hugo.; Methodology and formal analysis, Felipe. Espinoza., Héctor. Hugo and Saul. Pérez.; Software and visualization, Saul. Perez whit the support of student volunteers and pre-professional practices in the living lab.; Validation, Héctor. Hugo., Ivetheyamel. Morales. and Galo. Salcedo.; Investigation, Felipe. Espinoza and Hector. Hugo.; Resources and Funding Acquisition, Elias. Ortiz.; Writing-Original Draft Preparation, Héctor. Hugo.; Writing-Review & Editing, Ivetheyamel. Morales.; Supervision, Galo. Salcedo.

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Press: Blanca Moncada- Expreso.ec, Antonio Ruiz. Teleamazonas and Carlos Velez of the university press.

Community leaders: Ana Herrera, Marcelo Santillán, Manuel Mera, bishop Miguel Matilla.

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