From Cold War to Global Warming: Dilemma's in Retrofitting the Modernist University Campus in Latin America. Case Study: Escuela Politécnica Nacional (EPN) in Quito, Ecuador.

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ABSTRACT: During the Cold War the Americas experienced population growth that demanded higher education facilities, amongst other social requirements. Latin America attempted to meet the demands of a fast-growing student population by adopting/adapting the North American campus model. It was a time when natural resources were considered endless, and sustainability was far from being a social concern. However, environmental concerns such as climate change are currently driving university administrators and estate managers to re-think how university campus -designed under the modern architecture paradigm- should be retrofitted and upgraded, to respond to the main challenge of our generation.

Natural, human, economic and technical resources can be used more effectively by universities, not only to make campuses appropriate settings to promote sustainability values and sustainable lifestyles in the academic communities, but also for becoming a referent in the city where the campus is hosted. In this study emblematic buildings of a university campus in Quito are taken as an example to explore the potentials and pitfalls in setting out a resilient development strategy.

The research method is case study and the methodology design is based on an adaptation of Hunt & Boyd (2017) 'Fit for the future' criteria for retrofitting existing buildings towards new uses or achieving sustainability goals.

The study attempts to find out to what extend 'Fit for the future' criteria is applicable in modern buildings towards sustainable adaptation to climate change challenges. Even though the sustainability concept has been already included in local and institutional policy, other factors such as location, organizational attributes, political structure, and communication strategies might affect universities´ response to climate change.

KEYWORDS: Climate change, university campus, building retrofit.
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INTRODUCTION

Latin America experienced accelerated social and economic transformations for almost fifty years, thanks to the demand for agricultural products and raw materials in global markets from the 1930s until the neoliberal crisis of the 1980s. Along with economic affluence, the processes of population growth and accelerated urbanization took place in most Latin American countries. To cope with the needs of society, universities increased academic offers an enlarged campus facilities to host an increasing student population (Rama and Tedesco 1979). Amongst the most remarkable examples of modern university cities and campuses in Latin America are Universidad Nacional Autónoma de México (UNAM); Universidad Central de Venezuela, in Caracas, Venezuela; and Universidade Federal de Minas Gerais (UFMG) in Belo Horizonte, Brazil; but also including Escuela Politécnica Nacional (EPN) in Quito, Ecuador.

1.0 UNIVERSITY CITIES IN LATIN AMERICA DURING THE COLD WAR PERIOD

1.1 Higher education as a regional development strategy.

During the Cold War period, higher education in general and the construction of university campuses in Latin American was seen as a response to the dependency theory, therefore, as a strategy to strengthen regional development processes. Nowadays, universities in Latin America -as well in the rest of the world- and particularly their university cities and campuses are being expected to become referential sites for facing sustainability challenges -including climate change- by improving their environmental footprint "both in campus operations (estate management, procurement, etc.), and in teaching, research, and public impact," (Sonetti, Brown & Naboni 2019, 11).

The first internationally renowned example of a university campus as a development strategy was the master plan of Universidad Nacional Autónoma de México (UNAM) designed and built between 1949 and 1952 by Mario Pani, Enrique del Moral and Mauricio Campos. Within the UNAM campus, the Central Library is one of the most iconic facilities, particularly because of the mural designed by Juan O'Gorman that encloses the upper ten floors of the building (UNESCO 2007), representing the history of Mexico's aboriginal and colonial culture (Noelle 2016). The portrayal of murals on modern building facades at UNAM has been depicted by Castañeda (2016) as *the use of architecture as a political act*. Just upon its inauguration in 1952, the UNAM campus was selected as the venue for the Pan American Congress of Architects held in México. Frank L. Wright, Walter Gropius, Richard Neutra and Carlos Raúl Villanueva were amongst the ´guests of honour of the event that included guided walk-throughs on campus (Levi 1952, November 2; Graciavelez 2014). As reported by Julian Levy:

> "The site of the Congress -- the new University City about 12 miles out from the center of Mexico City -- provided an exciting and unique setting. In this short memo it is impossible to do justice to its conception, plan, use of materials and of color. The many architects involved worked as a huge team. They said, "it is the labor of Mexican architects working for Mexico." In spite of their desire for anonymity, they all are full of praise for Carlos Lazo, who headed the group and was the president of the Congress. This was particularly gratifying to me for Lazo came to the U.S. some 10 years ago on the Delano and Aldrich Fellowship. His travels and studies here, added to his native ability, have been justified by his meteoric career" (Levi 1952, November 2).

In this regional context, the university campus of Escuela Politécnica Nacional (EPN) becomes one of the most relevant examples of the development strategy through higher education in South America, and particularly in Quito, Ecuador. EPN campus was designed in the 1960s, during the time Ecuador was experiencing accelerated economic growth due to increasing international trade and the need of improving human capital for supporting industrialization processes at the national level. The campus master plan was designed by Mario Arias, and the most iconic buildings -the School of Mechanical Engineering and Administrative bldg.- were designed by Oswaldo de la Torre. Both, Arias and de la Torre not long before graduated from the first cohort of the School of Architecture and Urban Planning in Universidad Central del Ecuador.

Prior to his commissioning at EPN, Oswaldo de la Torre had the opportunity to travel to the United States of America from 1957 to 1958. While in the US he visited four practices related to the construction industry: Rader and Associates in Miami, Florida; Smith Engineering and Construction Co. in Pensacola, Florida; Tippets, Abbott, McCarthy & Stratton in New York City, New York; and William, Cole, Blanchard, and Associates in Washington D.C. (Saltos & Sánchez 2010). When De la Torre returned to Ecuador, in 1960, he was put in charge of the construction of Hotel InterContinental in Quito, designed by renowned US architect Charles Foster McKirahan (Compte 2021, Mach 24) in post-war Miami Modern 'MiMo' architectural style (The City of Miami Beach Planning Department, 2018) for the US-based Pan Am Corporation (Inter-Continental Hotels & Resorts 2021; IHG Hotels & Resorts 2021). The Hotel InterContinental Quito was meant to be in the 1960s the main venue for hosting head of states and diplomatic delegations for the Eleventh Inter-American Conference, which never took place (Reid 1968).

Figure 1: Hotel InterContinental Quito, designed by renowned US architect Charles Foster McKirahan, built by Oswaldo de la Torre. Source: Author.

1.2 Facing Climate Change in Quito, Ecuador: challenges to Escuela Politécnica Nacional (EPN).

Nowadays university campuses in Latin America, including UNAM, UCV, UFMG, and EPN, are facing both the need for upgrading and retrofitting their university campuses due to technological and demographic changes, as well as the challenge of facing climate change and embracing sustainability values.

Particularly, in Quito, where the university campus of Escuela Politécnica Nacional (EPN) is located, the impact of climate change has been reported by Barros and Troncoso (2010) and Yates, Flores-Lopez, Estacio, Depsky, Metha and Tehelen (2013) in a collaborative study of the Ecuadorian National Center for Atmospheric Research and the

Stockholm Environment Institute (SEI) for the municipality of the Distrito Metropolitano de Quito (DMQ); the findings of both studies are reflected in the DMQ Climate Action Plan, showing climate variation in a hundred years with a tendency to the increase of the average annual temperature, raising from 10.8 ºC in 1905 to 12 ºC in 2005, equivalent to 1.2 ºC in one century (Arias 2017).

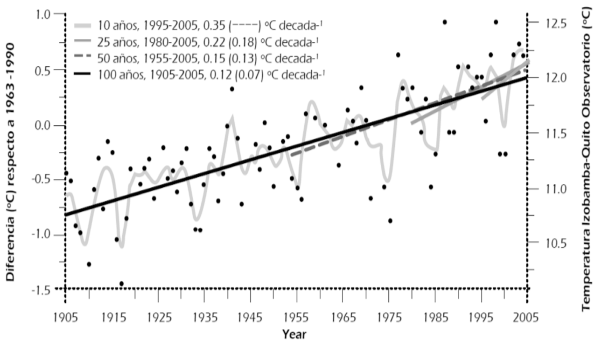

Figure 2: Average temperature variation in Quito 1905-2005. Source: (Arias 2017)

Also, the perception of Quito inhabitants is that climate patterns have changed; and, either heat during the summer or cold during the winter, temperatures are going to the extremes. A similar perception of change is reported regarding patterns of rainfall, wind speed, and solar radiation (Yates et al 2013). For instance, what Escuela Politécnica Nacional (EPN) is facing in its university campus in Quito, might be similar to the case of other universities in the region as well as worldwide. Hence, an OECD report from 2012 advised university administrators and estate managers to first consider adapting existing structures to current challenges before building new ones:

> "Place independency: due to developments in ICT, people can work wherever is best for them; [and] new life for old heritage buildings: value old premises instead of necessarily building new ones. This is also linked to sustainability goals and the trade-off between quantity and quality of space" (Den Heijer 2012, 3).

An argument to be considered during the retrofitting of university campuses, or the design of new ones.

2.0 GOALS AND OBJECTIVE, RESEARCH QUESTION AND RELEVANCE OF THE RESEARCH

2.1. Goals and objectives.

The study attempts to explore strategies towards the adaptation of the university campus of Escuela Politécnica Nacional (EPN) -designed during the Cold War period- and particularly two of its more emblematic buildings – the School of Mechanical Engineering (SME Bldg.) from 1964 and the Administration building (ADM Bldg.) from 1965- designed by modern Ecuadorian architect Oswaldo de la Torre, towards facing the challenges of climate change and sustainability. The objective is to identify key strategic considerations when potentially retrofitting two modern historical facilities of Escuela Politécnica Nacional (EPN) in Quito, Ecuador.

2.2. Research Question

What are the key considerations -from the architectural and from the engineering point of view- the SME Bldg. (1964) and the ADM Bldg. (1965), located at EPN university campus in Quito, Ecuador- during the process of adapting/upgrading those buildings to sustainability demands? The rationale for selecting the case study is primarily because those buildings, designed by Oswaldo de la Torre, are identified as one of the most iconic buildings within EPN university campus, but also as emblematic examples of modern architecture in Ecuador (Saltos & Sánchez 2010).

2.3. Relevance

The relevance of analyzing the SME Bldg. (1964) and the ADM Bldg. (1965), located at EPN university campus in Quito, Ecuador lies in the fact that natural, human, economic and technical resources can be used more effectively by universities in the region not only to make campuses appropriate settings to promote sustainability values and sustainable lifestyles in the academic communities but also for becoming a referent in the city where the campus is hosted. The potential of university campuses for becoming a living lab where sustainability issues are addressed brings hope that learned lessons and best practices could be shared with other universities in the Latin American region.

3.0 CONSERVATION OF MODERN ARCHITECTURE AND RATIONALE FOR RETROFITTING MODERN BUILDINGS TOWARDS SUSTAINABILITY PRINCIPLE: A LITERATURE REVIEW.

3.1. Conservation of Modern Architecture.

In the 20th century, the Venice Charter of 1964 is pointed out as the foundational stone of architectural conservation. However, it is ten years earlier, in 1954, that the Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict was established by UNESCO. The Hague Convention was promoted because of the destruction of historical buildings during World War II, and to prevent similar actions in the future (Zografos 2019; Grignolo 2018). Additionally, rapid industrialization processes and the real estate market are putting more pressure on the disposal and replacement of modern buildings with newer facilities. Ironically, the modern architecture movement,

> "[I]n an attempt to establish a new architectural language freed from the past, disregarded anything that dealt with historic buildings and their conservation" (Zografos 2019, 60).

However, nowadays some modern might be considered an object of conservation. The debate will be widely enriched since modern architecture buildings have been included in the historical heritage listing. Buildings from the postwar period -the 1950s and onwards- usually have incorporated 'hidden' mechanical systems whose conservation would be critical if an integral approach to restoration is taken, according to Chalifoux (2019). One of the leading initiatives in the field is driven by The Getty Conservation Institute (MacDonald, Burke, & Lardinois 2018). Also, it is important to consider that 'while many modern buildings from the postwar era were created at a time when society was still mainly industrial, they are now being used in a predominately post-industrial world' (Normandin 2018, 42). Furthermore, due to the pressures of climate change, urgent actions must be taken by the community of practitioners,

> "[T]hat deal with the built environment, (...), to apply standards and regulations for the conservation of buildings and sites in the context of new climate realities, (...), mitigate impacts from severe wheatear upon historic places (...), and adapt our built heritage to new climate-disaster realities." (Brandt & Rouillard 2020, 37-38).

Regarding modern architectural heritage, Elefante (2017, 11) argues that

> "Buildings constructed between 1950 and 2000 comprise two-thirds of the current building stock in the U.S. Many are the worst energy hogs ever constructed. While green-building practitioners may have solutions for achieving Paris Accord targets through the design of new buildings, very few have even begun to recognize the importance of mid-century buildings."

In this context, the role of the built environment professionals is critical to meet not only the above-mentioned challenges but also others related to a more contemporary concern such as climate change.

3.2. Rationale for retrofitting modern buildings towards sustainability principles

While Hunt & Boyd (2017) argue the need for periodical retrofitting in buildings, when stating that

> "Buildings are constantly evolving. Daily use, subtle movement, alterations, or additions, coupled with the patination and decay of surfaces through wear and weather, are all part of this process. For a building to occupy its future place successfully, each of these elements must be considered alongside the needs of today." (Hunt & Boyd 2017, 135).

The need for incorporating mechanical systems and ICT Infrastructure in the retrofitting historical buildings, is particularly explained by Zografos (2019):

> "Change in architecture, as in life, is an inevitable fact. When the occupants of a building are not satisfied with it, they tend to move. If a building´s efficiency is compromised, certain measures are implemented to adjust it to higher standards." (Zografos 2019, 62).

Regarding the case study, applied research related to climate change and the built environment in Ecuador has been recently published by Acosta (2020), and regarding sustainability and climate change by Pérez-Pérez (2020). The latter portraying a timeline of Ecuadorian sustainability public policy, from 1992 to 2013, including one in energy efficiency and other in the use of renewable energy in buildings.

In conclusion, the conservation of modern architectural buildings is currently confluent with the retrofitting of those buildings under the principles of sustainability (Hunt & Boyd 2017; Zografos 2019). This confluence is particularly stressed because modern architecture was built in a time when the very concept of sustainability was not considered in public policy related to the built environment and the construction industry (Pérez-Pérez 2020), but nowadays it is an unavoidable consideration in retrofitting either for complying with current regulations or to meet the expectations of the public and the community.

4.0 CASE STUDY: ESCUELA POLITÉCNICA NACIONAL (EPN) IN QUITO, ECUADOR.

4.1. Method.

The method is case study. The selected case are the Administrative Bldg. and the School of Mechanical Engineering Bldg. located in the National Polytechnic School campus in Quito, Ecuador.

4.2. Methodology design.

The methodology is primarily based on qualitative analysis and expert opinion applied to an adaptation of ‘Fit for the future’ developed by Hunt & Boyd (2017), which is a theoretical approach to sustainable building retrofit, towards new uses or towards achieving sustainability goals, as claimed:

> "[I]mproving the resilience of historic buildings, energy efficiency, flood defenses, overheating and indoor air quality rank high among the issues to consider but must be matched by a determination to maintain the vital qualities that make old buildings special." (Hunt & Boyd, 2017, p. 135).

For the purpose of this research of Hunt & Boyd (2017) theoretical approach will be called ´Fit for the Future: Addressing Sustainability's Criteria; including the following: accessibility, lighting, and services. Also, for addressing sustainability, energy efficiency, daylight, ventilation, energy generation, flooding, and maintenance are considered.

5.0 CASE STUDY: ESCUELA POLITÉCNICA NACIONAL (EPN) IN QUITO, ECUADOR.

To illustrate, the ‘Fit for the Future’ criteria will be applied to both the Administrative Bldg. and the School of Mechanical Engineering Bldg. located in the National Polytechnic School campus in Quito, Ecuador. Analysis and conclusion will be drawn from the case study.

5.1. The modern campus of Escuela Politécnica Nacional (EPN) in La Floresta.

National Polytechnic School (EPN by its acronym in Spanish) is an Ecuadorian public university created by President García Moreno on August 27, 1869. EPN was devoted to educating civil engineers and architects amongst other degrees. Although EPN became a key institution in the Ecuadorian higher education system at that time, it was dissolved into the Universidad Central del Ecuador in 1935 -during the first presidential term of Velasco Ibarra- mainly due to political motivations (Espinosa 2011); a decade later, on February 8, 1945 Velasco Ibarra -now in his second presidential term- reopened EPN “as an intuitive response to the expansion of international markets after the Second World War” (Espinosa, 2011, 73). Alberto Senamate -educated in Europe and in the United States of America- was named head of the re-opened school. During his term, and thanks to a direct request from Ecuadorian president Velasco Ibarra to French president Charles de Gaulle, six French researchers arrived in Quito as visiting professors, including renowned scientist Robert Hoffstetter who stayed in Quito for more than a decade -1946 to 1953- becoming a leading researcher at EPN in the fields of zoology and paleobiogeography (Espinosa 2011; Bull. Inst. Fr. Études andines 2000). By the year 1959, Jaime Chávez -who succeeded Semanate as head of EPN- promoted the design and construction of the new university campus at the northeast fringe of Quito, in La Floresta neighborhood (Espinosa 2011). However, it was not until the 1960s -during the first term of the succeeding EPN president Rubén Orellana- that the new buildings broke ground on campus.

5.2. Modern buildings for a modern campus.

Rubén Orellana commissioned the design of the School of Civil and Industrial Engineering (1961), the School of Hydraulics and the Hydraulics Research Institute, the School of Mechanical Engineering (1964), the Administration bldg. (1965), the Graduate Program of Industrial Engineering bldg. (1965); the Technology Research Institute bldg. (1966); and the School of Computer Technology bldg. (1977) to local architects. Also, during the uninterrupted 30 years of consecutive presidential terms, Orellana managed to build most of the planned academic facilities. (Espinosa 2011). The architectural design and construction of both the School of Mechanical Engineering (SME Bldg.) in 1964, and the Administrative Building (ADM Bldg.) in 1965 was trusted by Rubén Orellana to Oswaldo de la Torre (Saltos & Sánchez 2010). Interestingly, both the School of Mechanical Engineering (figure 4B) and the Administration bldg. (figure 4C) at EPN campus, designed and build by De la Torre, are arguably fortress shaped, quite opposed to Hotel InterContinental Quito designed by McKirahan and built by de la Torre in a prior commission.

The School of Mechanical Engineering, 1964, is a four-story building where the sense of a fortress is stressed by the metallic outer skin. The building´s outer skin is a regular and repetitive composition of 3 by 32 framed vertical rectangles that entirely cover the three upper floors on both east and west sides of the building, preventing sunlight from overheating classrooms, laboratories, and administrative offices; a particularly smart decision for a city like Quito, located in latitude 0º, and in the country region with the higher level of average sun irradiation per year.

Figure 3. Escuela Politécnica Nacional (EPN), School of Mechanical Engineering, designed by Oswaldo de la Torre.
Source: Saltos & Sánchez, 2010.

The Administration bldg. -which also served as a classroom building in the early years of EPN´s La Floresta campus-, is a twelve (12) story building that portrait a fortress-shaped façade as well. However, in this case, it is not an outer skin added to the structure, but the concrete structure itself. Additionally, the façade is divided into two sections by a central feature that holds the stairs. Each section is an irregular matrix of seven by twelve vertical windows with alternated sequences that prevent the façade to look repetitive, even more, when sunlight created a wide variety of shadows. As in the School of Mechanical Engineering, de la Torre designs thinking in avoiding overheating by sunlight in the facility.

Figure 4. Escuela Politécnica Nacional (EPN). Administration Building (tall building in the back), designed by Oswaldo de la Torre. Source: Saltos & Sánchez 2010.

Floor plans, technical drawings, and additional images of both the School of Mechanical Engineering-SME and the Administration Building-ADM included on Annex 1 thanks to Saltos, X. & Sánchez, H. (2010) in a compilation of modern architecture in Ecuador edited by María A. Hermida and published by Universidad de Cuenca.

5.3. Old-modern buildings in the old-modern campus of Escuela Politécnica Nacional (EPN) in La Floresta.

A half-century after the opening of the university campus of Escuela Politécnica Nacional (EPN) in the Floresta neighbourhood, buildings designed by de la Torre stand in good shape, despite the fact there have been several shakes and earthquakes in Quito during the period of analysis. Furthermore, both buildings have been able to preserve intact their morphology despite small interventions to respond to transitory needs in academia, if it fits within what Hunt & Boyd (2017) suggest:

> "The goal for those living and working with old buildings must be to create and maintain structures and places that are accessible, enjoyable, comfortable and sustainable. In fulfilling these aims, challenges and dilemmas abound. Traditional skills and materials should be cherished and embraced but new technology and thinking must not be discounted" (p. 135)

However, to prevent them from detrimental interventions or neglected maintenance, EPN administrators have filed a request in the Heritage Department of the municipality of Quito (DMQ), for some of its buildings to be included in the modern heritage listing (Instituto Nacional de Patrimonio Cultural 2019a, 2019b, 2020; Ministerio de Cultura y Patrimonio, 2020). This request includes other buildings in the Floresta neighbourhood and has become an urgent matter in Quito since modern heritage is being threatened by the real estate industry. Particularly, Hotel Quito, no longer InterContinental, has become the target of China-based real estate developers that pretend to build high-rise towers in both extremes of the hotel, not before partially demolishing the building (Compte 2021, Mach 24).

6.0 ANALYSIS AND FINDINGS

6.1. The ‘Fit for the Future’ criteria, applied in the case study.

The analysis under the ´Fit for the Future' criteria (Hunt & Boyd 2017) of the proposed case study -the School of Mechanical Engineering-SME (1964) and the Administration Building-ADM (1965), designed by Oswaldo de la Torre in the Floresta campus of the Escuela Politécnica Nacional (EPN)- will be divided into two sub-criteria groups (A) addressing sustainability with engineering, and (B) addressing sustainability with architecture. For each sub-criteria group, a qualitative assessment will be conducted from two different approaches (I) technology approach (low tech, average tech, and low tech), and (II) aesthetics approach (sympathetic to the original building, minimal visual intrusion, or significantly disruptive). All the results will be portrayed in a single matrix that includes criteria, sub-criteria groups, and the assessment approaches listed above.

To begin with (A) ‘addressing sustainability with engineering’ through (I) ‘technology approach’, the level of technology required for retrofitting both SME bldg. and ADM bldg. is, as follows, A-I: ‘low-tech’ for ‘lighting’; and, ‘average-tech’ for ‘energy efficiency, M&E services, energy generation, electronic equipment, and maintenance’. While for (A) ‘addressing sustainability with engineering’ through (II) ‘aesthetics approach’, it has been reported in A-II that retrofitting 'sympathetic to the original building' could be met in 'underfloor heating systems'; retrofitting with 'minimal visual intrusion' in 'energy efficiency (LED lighting), lighting (guiding lights and room lights), and electronic equipment (desktop computers, data projector, acoustics, and Wi-Fi routers)', while 'significantly disruptive' retrofitting might affect 'M&E services, ventilation, energy generation (PV-panels and air-source heat pump unit); plus, 'info-screens' amongst 'electronic equipment' (interview with former administrative from EPN, Quito, November 12, 2021).

´Fit for the Future' Criteria - based on Hunt & Boyd (2017).

	Addressing Sustainability with:	I. Technology approach			II. Aesthetics approach		
A	**Engineering**	Low Tech	Average Tech	High Tech	Sympathetic to the original building	Minimal visual intrusion	Significantly disruptive
A.1	**Energy Efficiency**						
A.1.1	· LED lighting		SME / ADM			SME / ADM	
A.2	**Lighting**						
A.2.1	· Guiding lights	SME / ADM				SME / ADM	
A.2.2	· Room light	SME / ADM				SME / ADM	
A.3	**SERVICES**						
	M&E Services						
A.3.1	· Mechanical		SME / ADM				SME / ADM
A.3.2	· Electrical		SME / ADM				SME / ADM
A.4	**Ventilation**						
A.4.1	· Mechanical ventilation system		SME / ADM				SME / ADM
A.5	**Energy Generation**						
A.5.1	· PV panels		SME / ADM				SME / ADM
A.5.2	· Underfloor heating systems		SME / ADM		SME / ADM		
A.5.3	· Air-source heat pump unit		SME / ADM				SME / ADM
A.6	**Mainteinance**						
A.6.1	· Maintenance program		SME / ADM				
A.6.2	· Staff training		SME / ADM				
A.7	**Electronic equipment**						
A.7.1	· Desktop computers		SME / ADM			SME / ADM	
A.7.2	· Data projector		SME / ADM			SME / ADM	
A.7.3	· Acoustics (microphone and speakers)		SME / ADM			SME / ADM	
A.7.4	· Info screens		SME / ADM				SME / ADM
A.7.5	· WiFi router		SME / ADM			SME / ADM	
B	**Architecture**	Low Tech	Average Tech	High Tech	Sympathetic to the original building	Minimal visual intrusion	Significantly disruptive
B.1	**Accesibility**						
B.1.1	· Ramps	SME / ADM					SME / ADM
B.1.2	· Lifts		SME / ADM				SME / ADM
B.2	**Daylight**						
B.2.1	· Windows	SME / ADM			SME / ADM		
B.2.2	· Roof dome	SME / ADM					SME / ADM
B.2.3	· Inner court	N.A.					N.A.
B.2.4	· Solar gain and overheat	SME / ADM			SME / ADM		
B.3	**Ventilation**						
B.3.1	· Passive ventilation system	SME / ADM			SME / ADM		
B.4	**Flooding**						
B.4.1	· Flood-proof external shutters	SME / ADM				SME / ADM	
B.4.2	· Free standing furniture	SME / ADM				SME / ADM	
B.4.3	· Rain gardens	SME / ADM			SME / ADM		

LEGEND: **ADM:** Administration Building. **SME:** School of Mechanical Engineering Building. **N.A.:** Not applicable

Figure 5: 'Fit for the Future' criteria applied to the case study. Source: (Author, 2020)

In regards to (B) 'addressing sustainability with architecture' through (I) 'technology approach' the level of technology required for retrofitting both SME bldg. and ADM bldg. is, as follows, B-I: 'low-tech' for 'accessibility (ramps), daylight, ventilation, and flooding'; and, 'average-tech' exclusively for 'accessibility (lifts)'. While (B) 'addressing sustainability with architecture' through (II) 'aesthetics approach', it has been reported in B-II that retrofitting 'sympathetic to the original building' could be met in 'daylight (windows, and solar gain and overheat), ventilation (passive ventilation systems), and flooding (rain gardens)´; also, retrofitting with minimal visual intrusion in 'flooding (flood-proof external shutters, and free-standing furniture); and, 'significantly disruptive' retrofitting in 'accessibility (ramps and lifts)', as well as in 'daylight (roof dome)'. Retrofitting in inner courts is not applicable (N.A.) since any of the case study buildings has an existing inner court (interview with former administrative from EPN, Quito, November 12, 2021).

Finally, findings of the analysis show that there is no single approach for retrofitting modern architectural facilities at EPN, that has become a legacy from the Cold War period. Due to the architectonic and engineering characteristics of both the School of Mechanical Engineering-SME and the Administration Building-ADM., the required approach might be one that includes specific decisions in each area of analysis: sustainability, energy efficiency, daylight, ventilation, energy generation, flooding, and maintenance, as reported in Figure 5.

CONCLUSION

To conclude, the challenges of climate change that university campuses face worldwide, have been also experienced by administrators of the Escuela Politécnica Nacional (EPN) in Quito, Ecuador. It is not only the challenge to become a sustainable institution that promotes sustainability values and sustainable lifestyles amongst students, faculty and university staff; furthermore, universities face the responsibility before the community, of becoming -at the scale of a university city- a good referent of a sustainable built environment.

To assess and evaluate, from all facilities within a university campus, what should be preserved as modern architectural heritage and what should be demolished; and, to decide what is the most appropriate approach to building retrofitting, is not going to be an easy task for university administrators. However, it would be -in the coming years- a necessary one.

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ANNEX 1

A

B

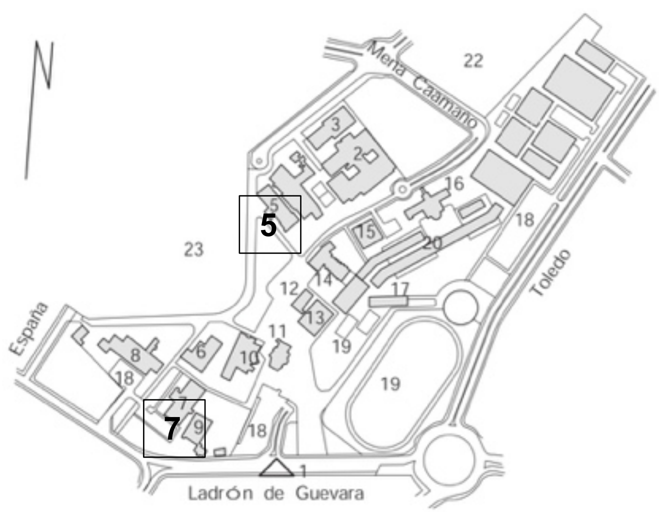

Figure 1. A. Ecuador Physiography Map (US CIA, 2011); B. Escuela Politécnica Nacional (EPN) campus map (Ortiz, 2004). Master plan designed by Mario Arias Salazar; School of Mechanical Engineering in number 5; Administrative Building in number 7, both buildings designed by Oswaldo de la Torre.