APUNTES • vol. 31, núm. 2 • Bogotá, Colombia • julio-diciembre 2018 • ISSN 1657-9763

Evaluation of Thermal Behavior in the Built Heritage of the Historical Center of the Riobamba City

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Introduction

The popular architecture of many countries shows that for a long time, by considering the natural climatic components, primarily determined by the sun, buildings could be built with the capacity of giving their occupants the maximum comfort conditions, both from the energy as well as the health point of view with a minimum of technical expenses. This truth has often fallen into oblivion throughout the history of architecture, especially in recent decades.

To achieve this objective, the organic articulation of human beings is required with the binomial nature: technology and globalization processes, with local behaviors. Currently, in conceptual terms, these processes are proposed as "sustainable architecture in the conservation of architectural heritage." In this sense, both the theoretical analysis and the strategic proposals of this research focus on how the energy variable is incorporated into the heritage architecture to determine the alternative characteristics of change towards sustainable development in heritage buildings.

The importance of this research lies in the architectural field as it needs to contemplate control techniques in the energy-environmental transmission with a non-restrictive approach. This promotes good practices in the fields of sustainable and ecological architecture by allowing more appropriate actions towards the climatic conditions that allow preserve the vocation of the historic center of the city of Riobamba to recover the sense of comfort, as well as to reverse the ill-fated process of energy transmission.

In this sense, it is important to work with users through means liabilities to improve comfort in housing conditions, and so in this way participate in the principles of saving resources and protecting the environment that demands the trends towards the sustainable development. Also, the use of natural ventilation to renew the indoor air and maintain an adequate temperature inside the building will translate into health benefits for the occupants, especially in the respiratory tract.

How to cite: Paula-Aguayo, G. M., Fuentes-Seisdedos, L., & Maldonado León, A. E. (2018). Evaluation of thermal behavior in the built heritage of the historical center of the Riobamba City. *Apuntes, 31*(2). https://doi.org/10.11144/Javeriana.apu31-2.etbb

Catedral de Riobamba, Ecuador

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Evaluation of Thermal Behavior in the Built Heritage of the Historical Center of the Riobamba City

Evaluación de la conducta térmica en el patrimonio construido del centro histórico de la ciudad de Riobamba

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Abstract

The inclusion of natural environmental conditioning systems and passive energy design becomes a necessity for the conservation of the built heritage of the Historic Center of Riobamba. Therefore, the purpose of the research is to describe and disclose the causes of the energy transmission processes and the constructive adjustments made by its users. Modernization has meant in the sociocultural field the disappearance of an environmentalist culture in the formal-spatial sphere, the loss of the sense of "sustainability" and the environmental identity of colonial architecture in the face of the circulatory chaos, parking, noise and pollution of modernity of the historic center. The methodology used is descriptive, explaining a case study on energy transmission and architecture, which shows the constructive adjustments to the environmental conditioning of homes made by its inhabitants. A selective sampling of housing typologies, location and location was used through three data collection instruments: direct observation, comfort survey, and environmental parameters registry. What revealed the distance between the needs of users and architectural programs, as well as ratify the relevance and ownership of the actions of environmental conditioning of heritage buildings.

Keywords: energy transmission, sustainable architecture, Conservation, Heritage.

Resumen

La inclusión de sistemas de acondicionamiento ambiental natural y el diseño de energía pasiva se han convertido en una necesidad para la conservación del patrimonio construido del Centro Histórico de Riobamba. Por consiguiente, el propósito de esta investigación es describir y divulgar las causas de los procesos de transmisión de energía y los ajustes constructivos hechos por sus usuarios. La modernización ha implicado dentro del campo sociocultural la desaparición de una cultura ambientalista en la esfera formal-espacial, la pérdida del sentido de "sostenibilidad" y la identidad ambiental de la arquitectura colonial de cara al caos de la circulación, los parqueaderos, el ruido y la contaminación que la modernidad le trajo al centro histórico. La metodología usada es descriptiva, explicando un estudio de caso sobre la transmisión de energía y la arquitectura, mostrando los ajustes constructivos para el acondicionamiento ambiental de las casas por parte de los habitantes. Se usó un muestreo selectivo de las tipologías de vivienda y la ubicación mediante tres instrumentos de recolección de datos: observación directa, sondeo del confort y registro de parámetros ambientales. Todo ello reveló la distancia que hay entre las necesidades de los usuarios y los programas de arquitectura y también ratifica la relevancia del ser propietario para las acciones del acondicionamiento ambiental de las construcciones que son patrimonio.

Palabras claves: transmisión de energía, arquitectura sostenible, conservación, patrimonio

Received: March 5th, 2018 | Accepted: October 29th, 2018 | Available: December 18th, 2018

This development will contribute to the implementation of municipal plans and policies towards the conservation of historic buildings by incorporating energy variables based on sustainable architecture and optimizing the local natural resources. This topic opens up further research in new areas, on the way the buildings will be used, their relationship with the environment and the specific behavior of construction materials depending on geographical conditions, because the World Bank already motivates it "[...] humanity will need to adapt to substantial changes in the climate—everywhere, and in many different fields" (World Bank, 2010, p.19). Similarly, the World Bank Report 2010 calls for the recursion, adaptability that communities must have in the face of increasing climatic risks in the practical aspects and urban and infrastructural changes in the cities.

In ancient times, this issue has already discussed, "We should build the southern face of the houses higher to capture the sun in the winter," wrote the Greek historian Xenophon thousands of years ago (Xenophon as cited by Sabadi, 2009, p. 9), valuable advice for his contemporaries who already wanted to save heating energy by means of solar radiation.

In Ecuador, and particularly in the city of Riobamba, the historic center has a defined area, which reflects the original configuration of the settlement, in which there are a considerable number of buildings that retain characteristics of different eras of history. However, the urban form and the architectural fact were developed based on European criteria, manifestly incoherent with its environmental and ecological reality:

> "In its initial urban-spatial configuration, the current city of Riobamba followed the guidelines of that time [...]important families were distributed around the central blocks. In this same sector were the first convents and the hospital. Around this nucleus, popular neighborhoods were settled, where Spaniards from the lower classes, mestizos and a few indigenous people lived"(Riobamba, 1992, p. 19) [Own translation].

Therefore, a critical stance is adopted with the constructive adaptations, where the value of the new environments within the house is revealed, demonstrating the user's comfort in the face of the environmental success of the justified architectural reforms with the experience and adaptation.

In this sense, the extensive and flat territories, which are presented as vast open extensions such as Riobamba, have great potential for energy to welcome new design proposals and intervention alternatives, which are radically and fundamentally different of the current architectural designs (Riobamba, 1994). This article aims to raise awareness and practice through the sustainable conservation of architectural heritage by incorporating energy efficiency with contemporaneity and comfort, which affects positively the quality of life and public administration regulations.

Through an interdisciplinary work between the field of perception, construction, physics (thermodynamics) and history, we try to protect the buildings of heritage interest with heat /space deficiency problems and make them more feasible for shelter by developing creative proposals.

Thus, we will describe and reveal the causes that have led to the loss of environmental identity in heritage architecture. The dynamic processes of informal architecture are highlighted in the "silent" transformations of historical buildings, in which the evolved forms of coherent articulation to cold spaces are recognized, and in this way define the technological incorporation linked with the environmental characteristics of the city of Riobamba.

To confront this research, we theorize concepts such as transmission, energy, and architecture since the objective is to show, standardize and define the first level of content that nurtures the architectural project process. We pretend to elaborate the necessary theoretical bases around the environmental energy problem through the socio-physical perspective, that makes it possible to develop an architecture theory with the new emerging environmental paradigms and with its connection to the social sciences.

In this sense, the "Historical Center and Environment" has a particular interest in medium-sized or even small cities that have historical urban centers, denoting a growing interest in the study of the specific mobility and accessibility problems presented by historic cities. Ensuring the mobility of the population, making it compatible with the preservation of the urban environment and historical heritage constitutes a difficult challenge in historical centers.

The constant increase of mobility and commerce has produced in these spaces a particularly serious situation of circulatory chaos, parking problems, noise, and pollution. This has generated negative effects on the quality of life of the population and on the heritage, which entails a loss of its tourist potential of "Patrimonial Architecture and Historical Center" that exist in many cities and historic towns with formal and environmental characteristics of great relevance.

The architecture, the streets, the squares, the natural environment, the archaeological monuments, all of it, in these localities, constitute an invaluable heritage and an image of enormous wealth. Paradoxically, the development of these localities has altered the character and image of the historical centers. The commercialization and the speculation of the soil, the changes of use, the vehicular concentration, the resulting contamination and the visual chaos by the commercial signage, constitute a permanent threat to the cultural and natural patrimony of the towns and cities.

In the approach of the three mentioned subjects, we verify previous investigations that already denote the concern on the energy subject and its relationship with the habitat. This is the case of the thesis "architecture, energy and environment" (Perini, 2009, p. 381) where he proposes solutions to reinvent these spaces, such as the incorporation of vegetation in the entrance gates and windows to create shade and moisture control since it indicates that it helps to improve the microclimate. Other proposals are the use of screens inside to avoid modifying the style of the facade, clear surfaces and transparent divisions in interiors, among others. The methodological scheme of this article begins in the theoretical field and bibliographic research (the presentation of concepts and the application examples), as well as tables, diagrams, graphs to end with the exhibition of results based on real environments.

The work "Optimization of an analysis methodology for the rehabilitation and sustainable protection of Vernacular Architecture" by Vásquez (2009), develops a Model proposal for energy rehabilitation from the cultural and ecological scope. The works and results described allowed to define the area in sustainable architecture specifying its treatment as "Energy Transmission for the Conservation of the Built Heritage" in the case of the Historical Center of Riobamba's study.

Since, sustainable architecture serve to achieve the construction of buildings whose impact on the environment is minimal or nil so as not to compromise resources for the future, it is common to develop the technological design, normally applicable to new projects, but not in the architectural heritage.

On the other hand, sustainability proposals are limited, mostly, to raise technical indicators at low cost, ignoring almost always factors of spatial perception and quality of life that gives aesthetic pleasure, to which efficient solutions should not be aliens for its diffusion and success. The work that we present pretends to impulse the use of more sustainable technologies as this concept and its application in heritage buildings has recently reappeared.

By creatively relating these two major challenges of current architecture —conservation of heritage and greater sustainability— it is postulated that there would be at least two specific long-term changes related to heritage and sustainable architecture, which would cause a synergistic transformation in cities:

- The improvement in the relationship between the heritage architecture of cities and their inhabitants (spaces of memory), promotes their maintenance and renovation with less investment than new construction, a great energy consumer. This thanks to the improvement in comfort and to incorporate sustainable design at low cost.
- The incorporation of heritage architecture (and modest heritage) gives architects an enormous field of work and extends the field of technological development of sustainability.

This background allowed us to conduct a review of the state of the art of the processes of energy transmission in the architecture of the built heritage, where the process of energy transmission in architecture has had various manifestations. The first responses in the seventies were fast, by using the concepts of bioclimatic architecture through concepts of ecological and self-sufficient housing. Then, in the dark eighties of the postmodern movement (Bermudez & Hermanson, 1997), a large part of the architecture

Figure 1.
Home with 35% deterioration, of the XX century in Riobamba city. Taken by the author
Source:
own work

was conceived as a "pastiche" of elements without hierarchy that comes from different places and of different kinds. This was a period of confusion, lethargy and immobility in relation to the environment proper to a crisis. Also, transmission and transformation of the architecture of the Built Heritage is a topic oriented to investigate how this change manifests itself and what is the scope of the energy transmission and the Transformation of the project of architecture.

When we talk about projecting today, it means: "[...]moving from a culture of doing in the absence of limits" to a culture of "doing in a limited world" (Manzini & Bingues, 1996, p. 20); a world that can no longer be explained with ideas of solidity and simplicity, today reality is manifested as fluid, complex and dematerialized. In this sense, the architectural fact and the urban event cannot continue with a conservative attitude since they are naturally vulnerable to the processes of change, substitution, and transformation related to modernization. On the other hand, we now know that "while buildings cause the greatest impact on the environment, it is the environment that has the greatest impact on buildings" (Santamouris, 2001, p. 54). In conclusion, energy transmission would then imply the redefinition of the architectural project as "a form of management of energy and materials" and "the uniqueness of the types of transmission and scope" (Yeang, 1999, p. 2).

There is no doubt that the historical error that afflicts historical centers and particularly the built architectural heritage is to segment them from their territorial reality as if they were not part of the rest of the city to which they belong. This forced us to search for new urgent strategies for the preservation of historic centers and stop their destruction in the interests of misunderstood modernity.

Methodology

It is crucial to continue with the analysis, discussion, and evaluation of experiences that allow the incorporation of preservation and improvement actions within the municipal development plans and programs.

Under these premises, the subject is to frame sustainable strategies in the conservation of the built architectural heritage. This research explores and describes architecture as an open system, from the transformations produced in heritage buildings, according to the processes of environmental conditioning of the same. This is an interrogative approach that addresses the changes occurred to the primary or original forms as a result of the "silent" appropriations and adaptations made by its users, which has led to the loss of environmental identity in the regional architecture. Evolutionary forms of coherent articulation with the buildings will be identified, and with this, define the strategies to rebuild and recreate a new architecture in the historic center of the city of Riobamba (Figure 1).

This being the case, problems arise. How the energy transmission was developed in the heritage buildings of the historic center of the city of Riobamba? And how was the preservation of the buildings developed during the last four decades, according to the thermal conditioning needs of its users, in the historic center of the city of Riobamba? To answer these questions, we must consider sustainable rehabilitation as a reconfiguration or adaptation process, for which it was necessary to collect and analyze as much information as possible, in order to make the decisions that lead us to the optimization of historic buildings. Therefore, we have proposed a body of hypotheses:

- The transmission of energy from the heritage buildings, driven by the control components will allow the use of energy resources in the historical center.
- The transformations of the heritage buildings, implemented by the users are supported with the necessities of environmental conditioning and an architectural intervention inappropriate to the climate of the historical center of the city of Riobamba.
- The active appropriation in the transformations and adjustments of the patrimonial constructions to improve the use of the natural energies of the historical center, are associated with the recognition of the actions of the user in the environmental control.

The research works reviewed were the support to the hypotheses, including "... The cases analyzed have been created and generated local rehabilitation parameters that obey the ecological, cultural and architectural characterization proposed by the methodology, which it is summarized that if it is possible to Caleta Tortel, carry out a rehabilitation with energy criteria, in the consumption and constructive optimization"(Vásquez, 2009, p. 381).

Therefore, rehabilitating a building can be done under criteria of sustainable energy, but the complexity is to solve a built work and keep its identity at the same time, managing to accommodate comfort parameters for its users. Previous work failed to respond to this commitment, so this research managed to fulfill its purposes, covering that space that was undefined in the advancement of science.

To achieve this, a series of objectives are proposed that allow orientation, among them:

- To specify from the theoretical field, what the new approaches in the heritage buildings are and how the energy variable is incorporated into the heritage architecture.
- To define the technological design strategies for incorporation into the heritage buildings of the historic center of Riobamba.
- To distinguish cases of transformation in the patrimonial buildings through an environmental audit in its current state.
- To select the most important proposals regarding the use and environmental control and determine good practices for the historic center of Riobamba.

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· To distinguish cases of transformation in the patrimonial buildings, through an environmental audit in its current state.
To select the most important proposals regarding the use and environmental control and determine good practices for the historic center of Riobamba.

In this sense, the achievements of these objectives will make it possible to meet the energy requirements of heritage buildings, using design guidelines that reformulate the criteria used historically in the region, to be applied in new Conservation interventions. These are solutions that meet the needs of the present without restricting the possibilities of future generations.

The problems resulting from an interrupted energy transmission, in which the loss of passive design conceptions is noticed, as well as the disuse of solar protection systems —for long time validated as appropriate practices—, followed by the implementation of active climate control technologies, have resulted in a process of regression of the solar architectural culture of the city.

An important reference, full of significance is made by Olgyay (1998) "The architectural patterns of Western civilization have too often neglected the problems and solutions inherent in the buildings of distant and different regions and climates" (p. 2). This reflection regarding topicality and validity contemplate energy-environmental transmission strategies with a non-restrictive approach, promoting good practices in the fields of sustainable and ecological architecture with a more proper understanding of doing focusing on the climatic conditions that allows "preservation". Also, helps recover the sense of "comfort", in order to reverse and reactivate the ill-fated "energy transmission" process.

Working with the premise that a bioclimatic building reduces the energy consumed and therefore, collaborates in an important way in the reduction of the ecological problems that derive from it, the bioclimatic architecture becomes a solution to the problem of sustainability (Figure 2).

RECORD OF MEASUREMENTS
ENERGETIC TRANSMISSION
PHYSICAL CONDITIONS IN PATRIMONIAL BUILDINGS

DARCHITECTURAL DESIGN- QUANTITATIVE DATA
CITY: RIOBAMBA

TYPE OF BUILDING: LIVING PLACE
HEIGTH: 2 FLOORS

ADDRESS: Street, Vicentina intersection Avenue: Sixto Duran Ballen
UBICACIÓN: CoordinatesWG584 Z17S: X (East): 98140448.00000 Y (North): 758069.000000 Z (Altitude): 2832. 000000

TRIP WITH MEASURING DEVICE

No	SPACE INS/ EXT	AMBIENT	THERMOMETER ° C 8h:00	10h:00	12h:00	14h:00	16h:00	18h:00	THERMOGRAPHER	THERMO FLASK HIGROMETER % 8h:00	10h:00	12h:00	14h:00	16h:00	18h:00	SONOMETER dB 8h:00	10h:00	12h:00	14h:00	16h:00	18h:00	LUXORMETER lux 8h:00	10h:00	12h:00	14h:00	16h:00	18h:00	20h:00	THERMOS FLASK ANEMOMETER m/seg 8h:00	10h:00	12h:00	14h:00	16h:00	18h:00	20h:00
1	INSIDE/ LL	entry hall							element through which energy is transmitted																										
2		livining room																																	
3		dinning room																																	
4		kitchen	7	12	17	16	13	9	energy leak through the inner courtyard door	60	54	53	54	55	56	49	48.3	48	48	48.5	47	80	80	85	85	83	200	200	1	0.8	0.8	5	3	8	1
5	INSIDE/ TF	stairs																																	
6		bedroom 1	8	12	17	16,5	14	10	energy leak through the street window	56	55	54	54	55	56	48	49	50	50	49	50	149	149	150	150	148	250	250	0	0	0	0	0	0	0
7		bedroom 2																																	
8		day room																																	
9	EXTERNAL	street La Vicentina	6	13	18	16	14	8	energy leak through the door and hall to the inner courtyard	55	51	50	50	50	53	50	55.5	55.7	55.8	55.7	55.8	4800	5000	5500	5500	5400	2500	800	2.5	2.2	2	1.5	1.5	2.7	2.7
10																																			
			observation						observation	observation:						observation: housing located in commercial area						observation: from 18:00 the lighting is artificial							observation: direction of wind parallel to the building						

PERMANENT RECORD WITH MEASURING DEVICE

AMBIENCE — BEDROOM 1 request of the user for major thermal comfort

		06h:00				07h:00				08h:00				09h:00				10h:00				11h:00			
DATA LOGGER		_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45
	temperature																								
	moisture																								

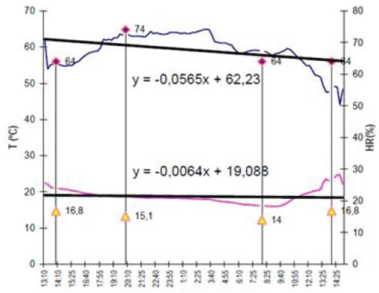
		12h:00				13h:00				14h:00				15h:00				16h:00				17h:00			
DATA LOGGER		_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45
	temperature																								
	moisture																								

		18h:00				19h:00				20h:00				21h:00				22h:00				23h:00			
DATA LOGGER		_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45
	temperature																								
	moisture																								

		00h:00				01h:00				02h:00				03h:00				04h:00				05h:00			
DATA LOGGER		_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45	_h00	_h15	_h30	_h45
	temperature																								
	moisture																								

observation

Instrument: DATA LOGGER Buildings: No.1 date: 04-07-2011
Interval of sampling: 15 minutes T° (c) y HR hour of beginning
Ambience: Bedroom 1 Values: 96 hour ended



hours / days 03, - 04 - 07-2011

interior temperature
exterior temperature
temperature equation
interior relative moisture
exterior relative moisture
relative moisture equation

Figure 2.
Record of energy transmission in heritage buildings
Source: own work

For the results of this research, we obtained constructive bioclimatic design techniques to be applied to heritage buildings, contributing to obtain comfort conditions for users through passive means, thus, participating in the principles of saving resources and environmental protection environment that demands trends towards sustainable development, as well as improving the health benefits of the occupants.

Discussion and results

Under these considerations, we limited the topic of sustainable strategies in the conservation of the built architectural heritage; to the energy transmission and conservation of the built heritage in the historical center of the City of Riobamba, for the study of the case.

This allowed us to decipher the behavior of natural energy agents (temperature, humidity, wind, sound) of building materials in historic buildings, in the process of rehabilitation under the practice of sustainable architecture. It also helped us to verify the architectural work regarding its significance for the advancement of science, learn how to reduce energy consumption costs without resorting to modern technologies that incur high costs in the "environmental control" for the comfort of its users.

Results were obtained through a representative selection of heritage buildings of the historic center, and in the *amanzanamiento* (urban drawing) around it, including cases of transformed and untransformed buildings. The latter were used as models of comparative analysis. To understand the passive environmental performance of housing, three instruments were proposed for data collection:

- Direct observation: which involved assembling the photographic record and planimetric survey of the case studies, which also includes a sketch of the most relevant spatial aspects and which was summarized in a *cadastre* sheet that includes axonometric drawings of the heritage buildings, site and specific comments of the case.
- Comfort survey: it was a basic survey, concerning quantitative aspects of consumption and qualitative perception of the interior comfort of the architectural object.
- Record of environmental parameters with electronic instruments, measurements of temperature, relative humidity, sound, wind, thermal leakage among others.

Main section

The study contemplated the analysis of 17 Patrimonial Buildings of the Historical Center of the city of Riobamba, which show the different degrees of environmental energy transmission, among which are incorporated the buildings that have undergone transformations over time and others that have not suffered any alteration.

The criterion of choice of the sample was intentional since it was interesting to highlight the most representative cases. Therefore, after a complete recognition and detection, the most notable cases of all the original models or typologies were selected. Subsequently, the interview phase with the owners or users of the houses was carried out along with the application phase of instruments, that is, the taking of information through the survey and direct observation (sketches, photographs, among others) on a Real Estate registration form (Vásquez, 2009, p. 401).

The mentioned card includes the description of the property as a cadastral key, location in the region and the space, the schematic drawings of the architectural plants, a compilation of the construction period, the state of conservation, the recommended emergent actions, and the degree of vulnerability. The volumetric description was also added, as is the case of style and influence of the façade, type of façade, auction, portal, formal typology, functional typology, physical construction description, construction materials, and the state of conservation.

For each patrimonial building a registration form was made (García, 2008), with the graphic aspects that include a spatial observation of each one, as well as a description related to energetic aspects of comfort obtained through an interview with the user. These aspects were, for example, temperature, humidity, sound, lighting and wind speed inside. A record of the measurements of energy parameters made with instruments (See Figures 3, 4, 5 and 6).

The information obtained was in a table of analysis for its evaluation (Table 1), where the actions developed by the users for the "shelter" of the constructions concerning to the energy com-

VARIABLES Why is it preserved? ENVIRONMENTAL		CONSERVATION OF THE BUILT HERITAGE					Architectural elements of greater energy transfer
		To be preserved?	What is preserved?	How is it preserved?	When it is preserved?		
		FUNCTIONAL	FORMAL	CONSTRUCTIVE	TEMPORARY		
ENERGY TRANSMISSION	Temperature	for environmental protection and climate control requirement	to cavity space requirements	concerning typological	Windows sealed inside	climate changes	Windows
	Humidity	good lighting and sunlight to environments	to improve the habitability	functional design	central courtyard with adjustments	air purification	Central courtyard
	Lighting	good lighting and sunlight to environments	to raise the temperature and reduce insects and microbes	concerning typological	size of doors and windows in original state	presence of diseases caused by pathogens	Doors and windows
	Ventilation	by environmental renewal requirement	to improve the habitability	functional design	environments in original state	volume of air to exhaust odors	Inside environments
	Sound	upon request of acoustic control	noise pollution	functional design - construction	Windows in original state safety doors	hours of high level of commercial activity in the sector	Windows safety doors

Table 1.
Variables and Indicators associated with the energy transmission and the Conservation of the Built Heritage
Source:
own work

fort variables are summarized, and from which the causes and effects were deduced.

The study carried out on the natural physical factors of the Historic Center of Riobamba allowed us to know the thermal, hygrometric and acoustic comfort ranges and to define the type of architectural requirements for the area. Besides, we defined the schedules of thermal comfort, hygrometric comfort, and the schedules of the dominant directions and wind speeds that were used to achieve passive ventilation, values that allowed us to reveal that:

GOBIERNO NACIONAL DE LA REPÚBLICA DEL ECUADOR

INSTITUTO NACIONAL DE PATRIMONIO CULTURAL
DIRECCIÓN DE INVENTARIO PATRIMONIAL
BIENES CULTURALES INMUEBLES
FICHA DE REGISTRO

INPC

CÓDIGO/ CODE: B1-06-01-50-000-000004

1. DATOS DE IDENTIFICACIÓN /IDENTIFICATION DATA

Denominación del inmueble /Name of the property: Living place

Clave catastral /Cadastral key:

Registro (Registry) N°. 1/1

2. DATOS DE LOCALIZACIÓN /LOCALIZATION DATA

3. RÉGIMEN DE PROPIEDAD/ REGIME PROPERTY

4. USOS/ APPLICATIONS

Provincia /province:	**Cantón**/municipality:	**Ciudad** / city:	**Público /public:**		**Original /Original:** Living place
Chimborazo	Riobamba	Riobamba			
Parroquia/ parish:	Calle principal/main Street: Street, Vicentina	**No. s/n**	Estatal /state:		
Riobamba	Intersección (Intersection): Avenue: Sixto Duran Ballen	**Mz.**	**Privado /private:**	X	**Actual**/current: Living place
Urbana/ urban X	**Recinto**/ enclosure	**Comunidad**/community	Particular /Particular:		
Rural/rural: □	**Sitio/site**	**Otros/others:** San Vicente neighborhood	Religioso religious:		

CoordenadasWG584 Z17S: X (Este) Y (Norte) Z (Altitud)
CoordinatesWG584 Z17S: X (East): 98140448.00000 Y (North): 758069.000000 Z (Altitude): 2832. 000000

5. PLANTA ESQUEMÁTICA /SCHOOL PLANT

6. UBICACIÓN /LOCATION

Área construida /Built area: 112	Área del terreno /Area of the land: 97

Figure 3.
Real estate registration form
Source:
INPC, 2011

- The air conditioning by passive means such as orientation, solar heating, and ventilation mainly, that when related to the time use of the space, a particular technological proposal for each project is achieve.
- The results of the architectural and comfort assessments showed that the bioclimatic architectural project meets the aesthetic and functional requirements from the architectural point of view. On the comfort side, the evaluations showed that the buildings have the necessary conditions to reach the optimal comfort levels for their users. Besides, the use of assisted design programs and physical scale models expressed the operation of the building. The analysis indicated that the levels of natural lighting are adequate for the function developed within the architectural space, but not artificial lighting.
- Using the theoretical values of thermal conductivity, recommended by the norm for the construction components, the energy saving of the projected building was 19.90% while using the thermal conductivity results obtained from the experimentation carried out by Hernández (2006) the energy saving is 28.01%.
- In the economic evaluation, energy savings due to a decrease in heat gains translated into a reduction in financial expenses of around USD 204.15 per month. In addition, the use of natural light to illuminate the classroom contributes a savings of USD 145.34 per month, making a total of USD 349.49 per month.

Conclusions

The results obtained to validate the hypothesis since the application of the energy design strategies achieves optimal comfort conditions for the user. In addition, the bioclimatic design of the building contributed to compliance with the requirements of international standards

Figure 4.
Continue. Real estate registration form
Source:
INPC, 2011

7. ÉPOCA CONSTRUCCIÓN / CONSTRUCTION TIME

Siglo/ century	Fecha / Década Date / Decade
Anterior al Siglo XVI Previous to the Century	
XVI (1500 - 1599)	
XVII (1600 - 1699)	
XVIII (1700 - 1799)	
XIX (1800 - 1899)	
XX (1900 - 1999)	1950-1960
XXI (2000 en adelante / onwards)	

11. FOTOGRAFÍA PRINCIPAL / MAIN PHOTOGRAPH)

8. ESTADO DE CONSERVACIÓN /STATE OF CONSERVATION

Sólido/ Solid		%
Deteriorado /Deteriorated	35	%
Ruinoso/ Ruinous		%

9. ACCIONES EMERGENTES RECOMENDADAS/ RECOMMENDED EMERGING ACTIONS

Consolidation of the gypsum ceiling and timber structures

10. VULNERABILIDAD /VULNERABILITY

Riesgos naturales/ Natural risks

Erupciones /Eruptions		Inundaciones / Floods	
Sismos / Earthquakes	X	Fallas geológicas /Geological faults	
Remociones en masa/ Mass removals		Otros/others: NO	

Riesgos antrópicos / Anthropic risks

Conflictos herencia/ Inheritance conflicts		Abandonado/ Abandoned	
Intervenciones inadecuadas/ Inadequate interventions	X	Otros/ others: NO	

Descripción de la fotografía/ Description of the photograph:

Código fotográfico/ Photographic code:

12. DESCRIPCIÓN DEL INMUEBLE

The site on the ground is continuous with subsequent withdrawal. It has a bay, the entrance is developed where vertical circulation starts, the patio is the one that distributes the rooms in ground floor

13. DESCRIPCIÓN VOLUMÉTRICA/ VOLUMETRIC DESCRIPTION													
Época / Estilo o influencia de la fachada/ Age/Style or influence of the facade					**Tipo de fachada/ Type of facade**		**Remate de fachada/ Facade finish**		**Portal o soportal/ Portal or Arcade**				
Colonial		**Republicano**			Recta/ straight line	X	Alero/ eaves	X	Portal PB		X		
Manierismo/ Mannerism		Neoclásico/ neoclassical			Ochavada/ eight-sided		Antefijo		Soportal PA / Arcade PA				
Barroco/ Baroque		Ecléctico/ Eclectic			Curva/ curve		Antepecho /sill		Portal y soportal / Portal or Arcade				
Rococó/ Rococo		Neorrománico/ Neo-romanesque			Retranqueada		Cornisa/ cornice		**Balcones/ Balconies**				
Neoclásico/ neoclassical		Neogótico/ neo-Gothic			**Portada/ carriage door**		Balaustrada / balustrade		Incluido/ included		X		
Vernáculo/ vernacular		Modernismo/ Modernism			Simple/ simple		Cimera/ crest		Volado/ blown				
Número de vanos abiertos/ Number of open spans		Moderno/ modern			Compuesta/ compound		Cornisa y alero/ cornice and eaves		**Zócalo/ baseboard**				
PA		Vernáculo/ vernacular			Monumental/ Monumental		Frontón/ pediment		Liso/ flat		X		
PB		Tradicional/ traditional		**X**	Inscripciones/ registration	**X**	**No. de pisos/ Floor No.**		Rugoso/ rough				
Molduras y ornamentación/ Moulding and ornamentation							2		Liso – Rugoso/ flat - rough				
							Color/ color		**Textura/ texture**				
							White, Cream, smooth stone		Lisa/ Smooth		X		
									Rugosa/ Rough				

14. TIPOLOGÍA FORMAL/ FORMAL TYPOLOGY		15. TIPOLOGÍA FUNCIONAL/ FUNCTIONAL TYPOLOGY		16. DESCRIPCIÓN FÍSICO CONSTRUCTIVO					
Arquitectura monumental civil/ Monumental civil architecture		Vivienda/ living place	X	**Elementos constructivos/** Construction elements	**Materiales de Construcción/** Construction materials	**Estado de conservación/** State of conservation		
Arquitectura monumental religiosa/ Monumental religious architecture		Culto/ worship		Cimentación/foundation	stone	**S**	D	R
Arquitectura civil/ civil architecture		Educativa/ educational		Estructura/ structure	stone	S	**D**	R
Arquitectura religios/ religious architecture		Comercio/ commerce		Muros -tabiques /Walls - Tables	adobe	**S**	D	R
Arquitectura tradicional/ Traditional architecture	X	Servicios/ services		Pisos/ floors	cement	S	**D**	R
Arquitectura vernácula/ Vernacular architecture		Salud/ health		Entrepisos/ mezzanines		S	**D**	R
Cementerios/ cemeteries		Funeraria/mortuary		Cielos Rasos/ Skies Ceilings	reed	S	**D**	R
Haciendas/ haciendas		Productiva/ productive		Cubierta/ Cover	Clay tile	S	**D**	R
Rutas/ routes		Recreativa/ recreational		Escaleras/ stairs	wood	S	**D**	R
Molinos/ mills		Administrativa/ administrative		Ventanas/ windows	wood / glass	S	**D**	R
Puentes/ bridges		Cultural/ cultural		Puertas/ doors	wood	S	**D**	R

Figure 5.
Continue. Real estate registration form
Source:
INPC, 2011

(Department of Energy of United States of America, 2000).

The search for these answers already generated interest in the 70s and the early 80s, although they did not reach a wide acceptance. The current trend towards more sustainable technologies has generated a resurgence of interest in the concept of sustainability, energy saving and the search for solutions for the reuse of historic buildings, as modern constructions and the use of modern technologies make projects more expensive and degrade the environment.

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Parques/ Parks		Otros/ others:	Portales -Galerías/ Portals -Galleries	Wood	S	D	R
Plazas/ squares			Barandales/ railings	Wood	S	D	R
Industrial/Industrial			Instalaciones/ facilities	Drinking water, electricity, sewage	S	D	R
Túneles/tunnels			Otros/ others:		S	D	R
Otros/ others:					S	D	R

17. FOTOGRAFÍAS COMPLEMENTARIAS/ COMPLEMENTARY PHOTOGRAPHS

Descripción de la fotografía/ Description of the photograph:

18. INTERVENCIONES ANTERIORES/ PREVIOUS INTERVENTIONS

Elementos constructivos/ Construction elements	**Tipos de intervención/** Types of intervention				**Alteraciones/** Alterations	
	Consolidación/ Consolidation/	**Restauración** / Restoration	**Liberación/** Liberation	**Sustitución/** Substitution		
Cimentación/foundation					Tipológicas/ Typologica	
Estructura/ structure					Morfológicas/ Morphological	
Muros -tabiques /Walls - Tables					Técnico-constructivas/ Technical-constructive	X
Pisos/ floors					Añadidos/ Added	
Entrepisos/ mezzanines				X	Faltantes/ Missing	
Cielos Rasos/ Skies Ceilings					**Descripción/ Description:**	
Cubierta/ Cover				X		
Instalaciones/ Facilities						

19. ESQUEMAS GENERALES/ GENERAL SCHEMES

20. OBSERVACIONES/ OBSERVATIONS

21. DATOS DE CONTROL/ CONTROL DATA

Identidad registradora/ Research entity**: Universidad Nacional de Chimborazo**		
Registrado por/ Registered by**:**		**Fecha de registro/**Registration date**:**
Revisado por/ reviewed by: Tene Sananay Fauto		**Fecha de revisión/** Date of revision**: 10/8/2010**
Aprobado por/ Approved by**: Muy Cabrera Nelson**		**Fecha de aprobación/** Date of approval**: 10/08/2010**
Registro fotográfico/ Photographic record: Arq. Geovanny Paula Aguayo		

Figure 6.
End. Real estate registration form.
Source:
INPC, 2011

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