Palafitic Housing Prototype in Belén and environmental sustainability

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Abstract

The objective of this research is to propose a prototype of a stilt house that improves the comfort of the inhabitants, the disorderly growth of houses, the constant flooding and excessive pollution in the area; For the climate analysis, bioclimatic strategies were applied in the design (thermal, lighting, acoustic and visual comfort) of the user, in addition to the use of digital tools (Revit, Sketchup and ecotec). As a result, the proposal contemplates a use of houses, in which the use of a gabled roof has been implemented that allows the residual drainage of rainwater, the use of cross ventilation will help to reduce the temperature inside the the house, in addition the use of gutters that have a drainage and purification system for rainwater is implemented, finally the implementation of eaves will help generate shaded spaces avoiding the increase in temperature, there will also be spaces for circulation and social areas for meeting. This proposal allows the improvement of the quality of life of the inhabitants of Belén due to the present bioclimatic strategies and their contribution in the revaluation of tourism in the area.

Keywords: Palafitos, Sustainable, Tourism Focus, Thermal Comfort.

I. INTRODUCTION

The Belén neighborhood is one of the districts of the province of Maynas in the department of Loreto, considered one of the poorest in the city with homes in extreme poverty, being an overpopulated area that produced a disorderly growth of housing which do not have the correct drinking water and sewerage systems [1] cause diseases due to the lack of health they present [2], environmental contamination problems [3] due to accumulated garbage waste found in streets. These problems result in insecurity and crime [4], along with the large number of users who use the motorcycle which generates noise pollution [5] generates a poor quality of life for the residents of the area.

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This neighborhood is known as the Venice of Latin America, being a tourist focus [6][7] due to the presence of the large number of stilt houses [8] where the most used material is wood from the trees in the area [9], this housing typology is due to the fact that the Belén neighborhood is an area with flooding problems [10], where correct planning was not considered and the vast majority of the houses are self-built [11] having a deficient structural system [12]. For these reasons, the objective of this research is to propose a prototype of a stilt house that is structurally efficient and planned for flooding problems, which provide security and quality of life to the inhabitants, reducing pollution and giving greater value to the property. area making the most of the tourist focus of the Belén neighborhood [13].

II. LITERATURE REVIEW

A. Palafitic housing

Palafitic houses are buildings that are supported by wooden stakes, walls with boards and roofs with aluminum or cement tiles. There are several reasons for this type of building to rise, the main one being flood protection in swampy terrain such as mangrove forests, swamps or rivers [14].

B. Thermal Comfort

The environmental parameters are very important since they have a direct influence on the physical sensations of people and the environmental characteristics of a space. The thermal sensation also depends strongly on the expectations of the person. One of the main functions of buildings is to provide thermally comfortable interior environments [15].

C. Tourist Focus

They are attractive places due to their architecture, landscape where there is a great tourist development in which a large flow of people come, where these spaces are more important [16]. The Belén neighborhood is a popular and tourist neighborhood of the city of Iquitos, being a great tourist destination for its vernacular architecture, for the biodiversity it has. This neighborhood is considered one of the most popular and most picturesque; This tourist attraction achieves a great commercial exchange of products in the sector [17] [18] [19].

D. Bioclimatic Strategies

Their objective is to find the right comfort for the user depending on their needs in the environment they inhabit, for this they take advantage of their environment and natural resources to air-

condition a home in a sustainable way and in turn seek to reduce harmful effects on the environment [20] [21] [22] [23]. In the case of Iquitos, the established area of our project, it has various natural resources that can be used for the construction of sustainable homes.

III. METHODOLY

A. Phases of study

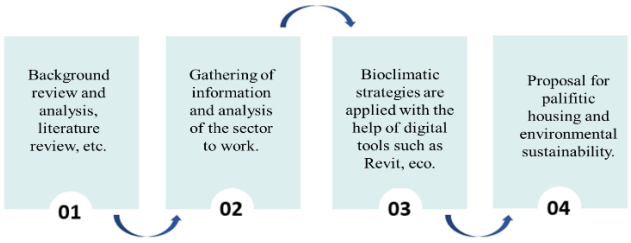

Figure 1. methodological scheme

B. Place of study

The place of study is located in the department of Loreto, province of Maynas, district of Iquitos, neighborhood of Belén. Its geographical coordinates are 3°44'57" South latitude, 73°15'314" West longitude, it has an altitude of 106 meters above sea level [24].

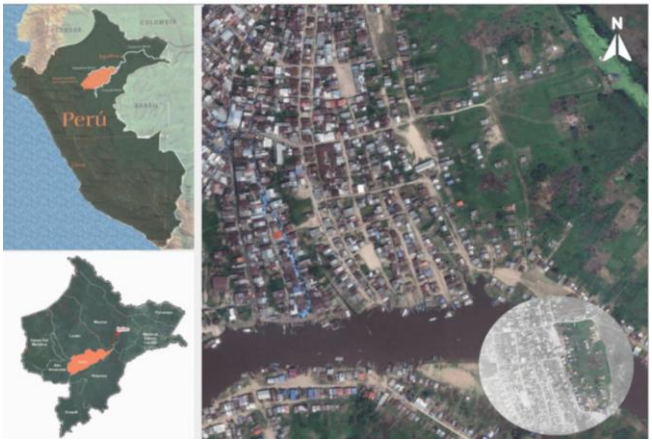

Figure 2. Place of study

C. Climatology

In Iquitos, the summers are warm but cloudy, the winters are short, hot, and it is wet for most of the year.

Table 1. Climate Summary of Weather Components.

Average		U	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
Temperature	Max.	C°	31	31	31	31	30	30	30	31
	Med.		26	26	26	26	26	25	25	26
	Min.		23	23	23	23	23	22	22	22
Relative Humidity		%	88	88	88	89	88	84	77	77
Precipitation		mm	158	161	185	145	121	115	104	67
Cloudiness		%	81	83	83	76	62	47	39	43
Wind speed		km/h	2.8	2.7	2.7	2.7	2.8	2.8	2.9	2.9
Solar radiation		hrs	6.8	59	6.4	5.7	6.1	6.5	5.7	7.8

1) Temperature

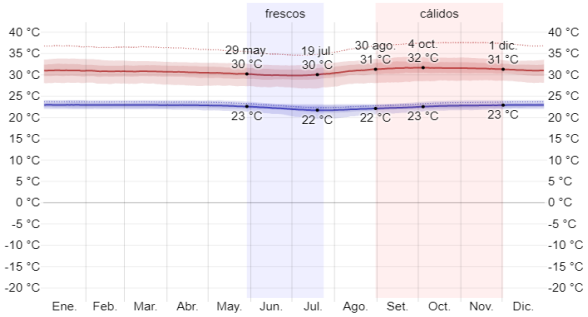

Figure 3. Temperature - monthly average climatic data.

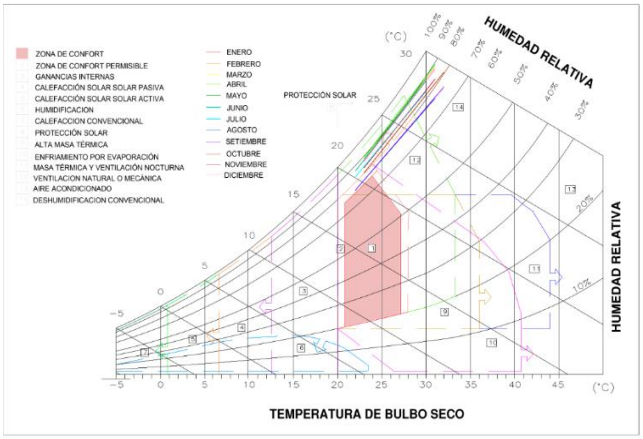

Figure 4. Psychometric Abacus.

Figure 4 shows that in the summer months the days are sunny, tropical climate with an average of 30°C. The high temperatures are 30 °C and average 32 °C. In addition, heat waves reach more than 37°C with a wind chill of 45°C.

2) Winds

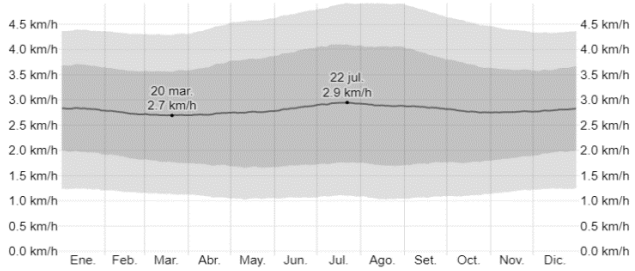

Figure 5. Average wind speed.

D. Flora and fauna

Belen is located in the Peruvian Amazon, which is why it has an ecological landscape with great biological variety. It presents a very varied flora with more than 850 species. Likewise, in Iquitos we can find animals such as the otorongo, black lizard, otorongo, boa, etc. However, there are species that are in danger of extinction, which are located in reserves for their protection [25].

Figure 6. Flora of the study site.

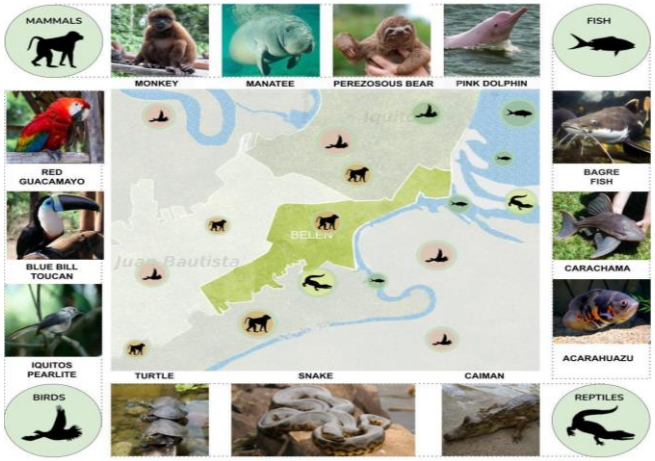

Figure 7. Fauna of the study site.

IV. RESULTS

A. Place of intervention

The study area was chosen because of its connection and proximity to the Itaya River, with the aim of establishing a housing proposal that will help enhance tourism in this area and also improve the quality of life of the users. It is located at the geographical coordinates 3°45 '45.5 " South latitude and 73°14' 42.1" West longitude.

Figure 8. Place of intervention.

B. Topography

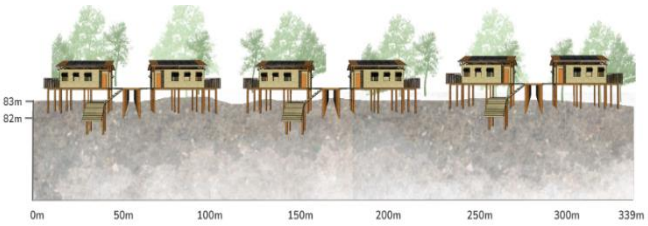

Figure 9. Topography of the terrain, cross section sample.

C. Zoning of the proposal

The approach of the plot of the entire housing complex seeks to take advantage of the connecting axes of the streets surrounding the land to generate various entrances that will aim to generate connections between the surrounding neighborhoods and the project to be carried out, also seeks to incorporate meeting points between the houses in order to improve the quality of life and comfort of the user within the area.

Figure 10. Zoning of the proposal.

D. Volumetric Design

For the design of the volumetry, bioclimatic strategies that adapt to the area were taken into account, seeking in turn to have a relationship with its surroundings, not only volumetrically but also taking into account the materiality of the area.

Figure 11. Volumetric Design

Figure 12. Volumetric cutting.

E. Spatial distribution of housing

The house typology is designed for a family of 6 members of 60m2, with 2 bedrooms, living room, kitchen, sshh. and an outdoor social area.

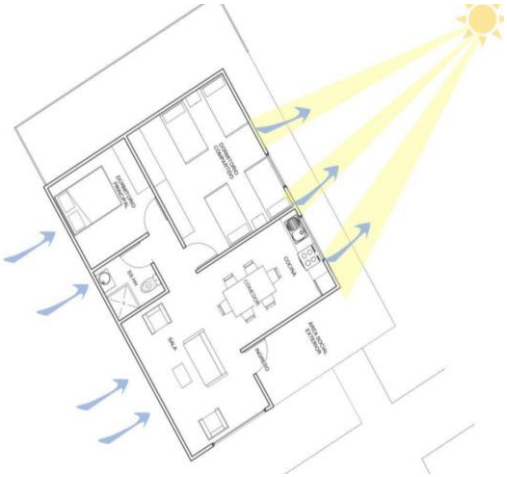

Figure 13. Spatial distribution, showing the spaces and how they receive sunlight and the direction of the winds that blow through them.

F. Solar path

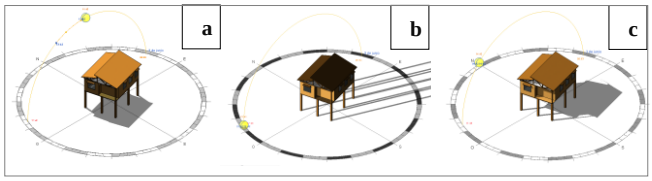

Figure 14. Temperature and sunshine hours. (a) Month of June at 11:46 am, (b) Month of June at 14:42 pm, (c) Month of June at 21:41 pm.

G. Bioclimatic strategies

1) Vertical Gardens

Vertical gardens will be implemented because they regulate room temperature and improve air quality for people [26].

Figure 15. Vertical garden and its composition.

Figure 15 shows the composition of the vertical garden: 1 is the support structure, 2 is a waterproofing layer that serves as protection, 3 is a geotextile and 4 is the desired vegetation, this vertical garden will serve to purify the air of the house and also as a means of harvesting certain foods thus benefiting the economy of the user.

2) Gable roof

A system used in areas with high intensity rainfall, it consists of 2 sloped roofs that, unlike a traditional flat roof, helps drain wastewater from rainfall and also helps to reduce solar radiation in the house [27].

Figure 16. View of 2 pitched roofs, you can see how the roof helps to prevent water from seeping into the house.

3) Gutters

It is a drainage system that helps to remove water from roofs and keep structures dry [28].

Figure 17. Gutter system with filter for rainwater purification.

4) Retractable eaves

The implementation of eaves on the windows is proposed, in order to prevent the accumulation and entry of water in times of rain, as well as to serve as a means of protection against the sun.

Figure 18. View of window eaves.

5) Solar panels

It harnesses solar energy by means of mirrors that follow the sun and concentrate its heat in one point, thus generating energy for a house [29][30].

Figure 19. Solar panels.

Figure 19 shows the use of 8 solar panels, 1 represents an aluminum frame, 2 is a tempered glass that protects the solar cells, 3 is a polymer layer that provides greater protection, 4 is composed of solar cells, 5 represents the back cover and finally 6 represents the junction box.

Table 2. Calculation of modules and number of batteries.

Theoretical system consumption (Wh/day)	**7448,000**
Peak panel power (W)	**320**
Peak solar hours	**4,000**
OVERALL PERFORMANCE	**0,784**
DAYS OF AUTONOMY	**5,000**
DEPTH OF DISCHARGE	**0,5**
Total number of modules	**7,728**
Battery bank operating voltage (V)	**12,000**
Voltage of batteries	**12,000**
Battery capacity (Ah)	**140,000**
Total number of batteries	**46,161**

Table 3. Calculation of total energy used in the home.

TOTAL ENERGY					
Equipment	**Quantity**	**Consumption C/u (W)**	**Consumption Gral (W)**	**Dayly use (h/day)**	**Maximum consumption, CT (Wh/day)**
TV 32"	1,00	60,00	60,00	8,00	480,00
Led lights	6,00	36,00	216,00	8,00	1728,00
Cell phones	3,00	10,00	30,00	8,00	240,00
Refrigerator	1,00	500,00	500,00	10,00	5000,00
Total Energy					**7448,00**

6) Cross ventilation

It generates natural air currents inside closed spaces, which allow not only to ventilate, but also to renew the air. Cross ventilation is key for closed environments with the presence of several people or for homes located in areas with high temperatures.

Figure 20. Wind direction inside the house

H. Construction systems

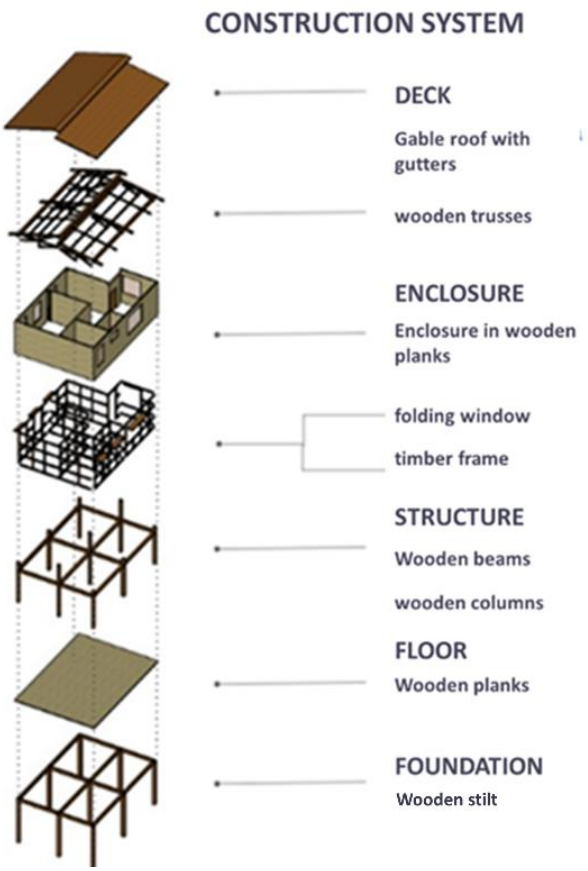

Figure 21. Construction systems

I. Materiality

Figure 22. Materiality.

Figure 22 shows that (1) the roof is made of Palmiche leaves and wood; (2) the walls are made of black carob wood because it is resistant and serves as sun protection; (3) and (4) the floor and piles are made of Luma wood because of its high resistance to humidity; and (5) the cladding is made of bamboo polycarbonate because it has thermal insulation properties.

J. Views

Figure 23. Project view.

Figure 23 shows the design of the gable roof, the retractable eaves and the bridge that serves as a common route to the houses.

Figure 24. Housing complex.

Figure 24 shows the group of houses and how they are connected by pile bridges to avoid the risk of flooding.

Figure 25. Meeting areas are areas for social interaction among users.

V. DISCUSION

1. This research has the objective of proposing a structural design that keeps the houses elevated and safe in order to avoid the entry of water into them produced by the constant flooding in the area. In the article "The Selection of the Anchoring System for Floating Houses by means of the AHP Method" it mentions several types of anchoring systems, each one presenting different characteristic, among them are the mooring piles, which were implemented in the present proposal of a prototype of a stilt house in Iquitos [31].

2. In the article "Experiences of Housing Adapted to Sea Level Rise and Applicability for Housing in Can Gio District, Ho Chi Minh City, Vietnam" has as a result the implementation of a crawl space that plays the role of leveling reservoir, where the waters where it is sought to take advantage of wastewater from flooding. On the contrary, the present research seeks to take advantage of wastewater from rainfall through a gutter system, which together with a filter helps to purify the water in order to be reused by the users of the houses [32].

VI. CONCLUSION

Thermal comfort was an important factor when designing the prototype of the stilt house, which is why it has bioclimatic strategies that seek to improve ventilation, lighting and comfort. in order to provide a better quality of life for users, eco-friendly materials were also used and originating from the area to generate a low cost in the construction process of the house. The implementation of drainage systems will help provide a better use of the residual rainwater, since it will undergo a purification process and thus can be reused for the users' use. In conclusion, the project will improve the quality of life of the residents, reduce environmental pollution, and provide a more orderly image of the area that will attract the tourist sector.

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