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Investigation of the Sustainability Potentials in the Ten House Project Bangkok-Thailand

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ABSTRACT

The sustainability of projects has become a significant concern for temporary architecture, which refers to structures that are built for a limited period of time. This is because these structures can have negative impacts on the environment and society if not constructed and operated in a sustainable manner. However, there is a growing demand for modern techniques that can help achieve sustainability in temporary architecture. This research investigates about the sustainability of Ten House Project (THP) in Bangkok-Thailand. The research argues that sustainability can actually be achieved by applying traditional construction techniques that have been proven effective in promoting economic efficiency, as well as addressing social and environmental issues - the three pillars of sustainability. This research simulated the results using the ENVI-met application that models the environmental conditions of urban areas. In summary, the research seeks to explore how traditional construction techniques can be applied to temporary architecture to achieve sustainability. The research has proved that many of the regional architecture elements have contributed to achieving sustainability in the project; terraces, courtyards, breathable walls and many other architectural features were essential in terms of achieving sustainability from an environmental point of view, in addition to involving people in the schematic design phase, which was the social factor that contributed effectively to adding sustainability value to the project. The research aims to demonstrate that sustainability can be achieved by leveraging traditional methods, which can provide economic, social, and environmental benefits.

1. INTRODUCTION

In recent years, cities have become more and more popular as people are attracted to the many opportunities and benefits that urban areas offer. However, with more people comes a growing demand for urban infrastructure and services, including housing, transportation, and amenities. This increase in demand has made it increasingly challenging to provide a comfortable living environment for city residents, as factors such as air quality, noise pollution, and access to green spaces can have a significant impact on quality of life. To address these challenges, urban planners and designers are turning to outdoor climate data to inform their decision-making processes. By understanding how climate and weather patterns impact urban environments, planners can make informed choices about how to design and build urban spaces that are more comfortable and livable for residents.

The microclimate of urban areas refers to the local climate conditions that are created by the interaction between the natural environment and human-built structures. For example, buildings and roads can trap heat and create urban heat islands, which can make urban areas significantly warmer than surrounding rural areas. However, by making appropriate decisions around factors such as building orientation, green space design, and street layout, urban planners can mitigate the negative impacts of urban heat islands and create more comfortable environments for residents. In summary, the increasing demand for urban infrastructure and services has made it more challenging to create comfortable living environments for city residents. However, by using outdoor climate data in urban planning and design, planners can make informed decisions that lead to more livable urban spaces. The microclimate of urban areas is a critical factor in creating comfortable urban environments, and appropriate planning and decision-making can significantly improve the quality of life for urban residents [1-2].

This is important for ensuring sustainability in urban environments. This research will focus on an important example of a housing project in Bangkok, Thailand - the THP by Case Study - to investigate how traditional solutions were applied to the project, how the community was involved in the different building phases, and how these factors impacted the sustainability of the project. To gather data, this research relied on a combination of observation and archival sources. The aim of the research is to demonstrate how traditional methods and community involvement can contribute to sustainable urban development.

In summary, this research highlights the importance of using outdoor climate data in urban planning and design to create more livable spaces. By examining the THP in Bangkok-Thailand, the research shows how traditional solutions and community involvement can promote

sustainability in urban areas, thus contributing to a more comfortable living environment for city residents.

The THP in Bangkok-Thailand, was designed with the principles of traditional Thai architecture in mind, incorporating traditional solutions that contributed significantly to the project's sustainability. The aim of this research is to demonstrate the effectiveness of these traditional solutions in achieving sustainable buildings. To achieve this goal, the research evaluated the sustainability of the THP using established sustainability criteria to ensure that the main sustainability points are achieved. By doing so, the research demonstrated the crucial role that regional techniques play in achieving sustainability.

In summary, this research focuses on the THP in Bangkok-Thailand and aims to prove the effectiveness of traditional solutions in achieving sustainable buildings. The research evaluated the project's sustainability using established criteria and demonstrated the importance of regional techniques in achieving sustainability.

2. ABOUT THE PROJECT

The current housing problems in Bangkok-Thailand inspired the creation of THP. With the private sectors and governments total provision of upper-class housing to that of the lower class, Bangkok's broad spectrum of middle classes is left without alternative housing visions.

People with middling incomes cannot afford the pricey housing, but they also are not eligible for government housing assistance. They have no other choice or option except to enter the housing dead end in Bangkok. The idea of community forms the basis of the work. What would happen if each of these helpless people started gaining strength by collaborating and cooperating with others? Will they be able to survive the harsh economic rivalry in the housing industry as a group? Each of them is still helpless on their own, but together they might have greater economic and creative power. Over time, THP Bangkok evolved into a team endeavor that demands work from all parties. Physically speaking, the project would be spread out over a single piece of land with ten smaller plots. Each subplot has the same footprint. Then, with the help of their neighbors, each occupant would take on the role of home designer. THP is not the creation of a single creative genius.

Each and every unit in this housing project must be created in concert with the others; individual designs are not possible. The dwelling criteria was established, then the actual design phase started. The cooperative house is beginning to take shape as they collaborate to frame the design. In this instance, the architects did not choose or control the architecture. Instead, cooperative design produces architecture, in which the clients and the architects are one and the same. Each design is the outcome of painstaking negotiations with other parties. As a result, every design must be cooperatively sculpted and reshaped. As the design is transformed, the dwelling requirements of each inhabitant are also reconstructed. As a result, a distinctive group project is created, one whose sense of unity is characterized by the individuality of each individual design. If the cooperative design also promotes the development of individual identity, it might succeed.

According to previous study on the urban poor housing, such type of community involvement in the different project implementation stages, is effective from different points of view, since it has shown how it can successfully encourage communities to engage in housing development, and shed the light on consideration needs to be given to the community power structure to ensure participation; and a key issue with regard to working with different groups of low-income individuals or households is conflict management, whereby each person or group may not gain the best housing option but everyone gains, and solutions are sought that provide the least adverse effects [3].

3. CRITERIA FOR SUSTAINABLE ARCHITECTURE

According to the OECD (Organization for Economic Co-operation and Development Project), sustainable buildings can be defined as those buildings that have minimum adverse impacts on the built and natural environment, in terms of the buildings themselves, their immediate surroundings, and the broader regional and global settings [4]. Sustainable buildings may be defined as building practices that strive for integral quality (including economic, social, and environmental performance) broadly. Utilizing natural resources wisely and managing the building stock properly will help conserve limited resources, cut down on energy use, and enhance environmental quality. The OECD project identifies five objectives for sustainable buildings;

- Resource efficiency;
- Energy efficiency (including greenhouse gas emissions reduction);
- Pollution prevention (including indoor air quality and noise abatement);
- Harmonization with the environment;
- Integrated and systemic approaches.

Sustainable building considers the entire life of a building, including environmental quality, functional quality, and future values [4].

Sustainable architecture combines all the specialties to create the most efficient structure while assuring minimal energy consumption, utilizing the resources already on hand, and considering the demands of future generations. During the Rio Earth Summit in 1992, the following issues were addressed:

The use of local materials and indigenous building sources;

- The incentive to promote the continuation of traditional techniques, with regional resources and self-help strategies;
- Regulation of energy-efficient design principles;
- International information exchange on all aspects of construction related to the environment, among architects and contractors, particularly non-renewable resources; and
- Exploration of methods to encourage and facilitate the recycling and reuse of building materials, especially those requiring intensive energy use during manufacturing; and the use of clean technologies [5].

This research will investigate the availability of the issues that were raised at Rio Earth Summit 1992 in the THP to prove that it can be considered a sustainable project.

3.1 The use of local materials and local indigenous building sources

The project's construction cost was impacted by the project's reliance on concrete as the primary building material, in addition to using indigenous materials like wood and

bamboo. Furthermore, it was challenging for the Case architects and Patama Roonrakwit to persuade the populace of the perfection of using the available local materials because- from their point of view- using concrete is a more up-to-date and elegant alternative. As a result, the Case architects provided the community with numerous examples of how the ideal construction of the local materials will look. An agricultural association claims that bamboo and hardwood are used to build the majority of Thai homes. However, hardwood structures make about 80% of all construction. It is frequently utilized by common people, including the Royal family, as lodging. The remaining 20% is made up of a bamboo temporary building that serves as a modest shed for farmers to rest in during the day shown in Figure 1, Figure 2 and Figure 3. One of the main strategies for achieving sustainability in design is the use of locally accessible materials. However, the materials used for the THP were a mix of concrete and wood.

Figure 1. Comparing local materials used by the community (left) to low-cost materials which designed perfectly in a hotel

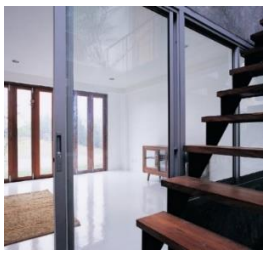

Figure 2. Applying timber for various interior aspects

Figure 3. Applying regional resources to finish the roof and elevations

3.2 Incentive to promote the continuation of traditional techniques, with regional resources and self-help strategies

The initiative was created by and for the people. The following chapter will provide an explanation of the strategy used for the project from A to Z. The cooperation was compelled to use local construction techniques in order to keep project costs as low as possible. One of these techniques included installing a flat ceiling for certain other areas of the dwellings and placing a roof structure over the spatial center.

The traditional Thai house was described by Horayangkura [6] as having unique features: a steep roof, a raised-up floor on pillars, a semi enclosed central terrace and a covered veranda, an inward sloping wall, a tapered window, an outdoor staircase, a prefabricated wooden structure and enclosing elements shown in Figure 4. To enlarge the traditional Thai house, additional structural units are attached to the terrace instead of increasing size of each unit [6].

Figure 4. 45° to 55° high roof angle for rain drainage

3.3 Regulation of energy-efficient design principles

Creating architecture which is consistent with the surrounding environment is one of the goals of case architects. Passive cooling is one form of energy conservation that could lessen the environmental burden in hot, humid locations like Thailand.

- The project includes inner courtyards, which are crucial for temperature regulation and ventilation shown in Figure 5, as well as for ensuring vertical connectivity.
- The patios located in front of the houses, can be either considered as hardscape or softscape; these areas serve both private and public purposes, and they were once utilized in the old agricultural civilization for drying goods like fish, rice, pepper, etc. They serve also as meeting spots for the neighbors.
- The tall roof that slopes from 45 to 55 degrees to drain rainwater, as well as the broad overhanging eaves that shade the homes in the afternoon.
- One of the characteristics of Thai homes is the use of timber paneling in both horizontal and vertical patterns shown in Figure 6. Through the use of conduction and convection heat transfer, the project's blend of solid and breathable walls, which is crucial to ventilation, reduces the amount of heat gained during the warm days. using the breathable walls that have been a legacy of conventional Thai architecture.
- The orientation of the ten dwellings, with their entrances facing either north or south, makes them ideal for capturing wind for practically the whole year. The ventilation system is one of the great success of traditional Thai craftsmen. In addition, the positioning of the house and roofing play a key part in a heat reduction. Ideally Thai houses face north, while the structure parallels to the eastern and the western side. In this position, the surface of the roof at any given time -even noon- will not receive direct sunlight and thus will not absorb the heat. This position allows the house to fully receive the southern wind [7].

Figure 5. The interior courtyards with native plants for better ventilation

Figure 6. Utilizing both horizontal and vertical panels with breathable walls and solid walls

3.4 International information exchange on all aspects of construction related to the environment, among architects and contractors, particularly non-renewable resources

The THP was a crucial illustration of community involvement from the design stage through to final finishing and interior organization is shown in Figure 7. Case begins THP Bangkok-Thailand, a pilot project based on a cooperative approach. This time, the project should establish this community on its own, as opposed to being anchored in one that needs to be protected. The land that Case purchased is divided into a strip of ten adjacent plots, and Case then engages in conversation with the potential participants using the same strategies and objectives as precarious cities: a habitat that is appropriate for all, social control, and self-construction. Numerous innovations are required for this transposition, including those that are made during the planning, design, finance, and building phases. For me, THP Bangkok was such an intense program in every way! But once the project was finished in 2008, and the concept became then popular in Bangkok.

Developing the residential areas in Bangkok has focused on three areas: improving physical conditions as the core objective; supporting the financial organizing group as the economic mechanism; and promoting historical representation of the community as part of community discourse and identity [8]. The THP has depended on the mentioned areas, and was a perfect example of how the community and the architects exchanged information, and the key to its success was the architects' genuine appreciation of the local customs and needs.

CASE Thailand and CASE Japan, a group with comparable objectives and ideas, share a common vision. Conceptual collaboration as well as unofficial information and idea sharing between the two organizations bind them together. Housing options have been provided by CASE Japan for persons with significantly fewer opportunities and options. Ten different housing units coexisted on the same piece of land in THP Osaka, the nation's first organized cooperative housing complex. It is a project where the clients participate in the schematic design phase, allowing every house to express the unique ways in which they live. THP Bangkok, which strives to comparable ideals but is based on a different technique and approach, has used THP Osaka as a point of departure. Its objective is to produce distinctive and alternative housing for Bangkok's underserved middle-class [9].

This project's ultimate objective is to benefit as many individuals as possible. In an effort to find an alternative housing vision, THP established itself as an experimental project. Additionally, this creates opportunity. For individuals who support the THP working approach and philosophy, it might offer option and opportunity. THP would then be defined as the provision of housing appropriate for local needs as well as for universal uses. Our personal house transformation may be based on a re-definition of housing direction as well as the link between the design and the client, the community and the inhabitant, knowledge of changing living patterns, and changing family arrangements [9].

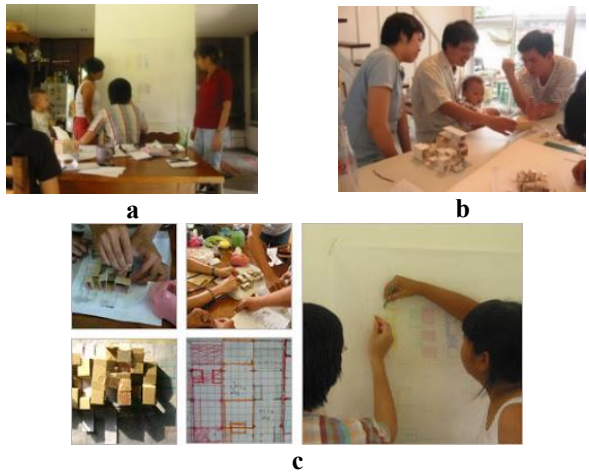

Figure 7. Involving the community in the different design phases

3.5 Exploration of methods to encourage and facilitate the recycling and reuse of building materials, especially those requiring intensive energy use during manufacturing; and the use of clean technologies

There was no clear vision for the recycling and reuse that was relevant there, despite the importance of using local materials for the interior design and for cladding in some portions of the façade. The project's main goal was to develop a harmonious relationship with the environment by taking ecological concerns into account throughout the project's many phases.

4. EVALUATING THE SUSTAINABILITY FACTORS WITHIN TEN HOUSE

4.1 Social factors

Beginning with the design stage and concluding with the areas that are crucial to everyday living in Thailand, such the terraces, the project strengthened the social links of the neighborhood. The placement of the housing amenities was in accordance with the requirements of family life as well as with inherited customs, in addition to adding certain facilities to the site for maintaining social activities such a public swimming pool, theater, and weekend art school (Figures 8 and 9).

Figure 8. Model displaying both the ground level and upper level terraces

Figure 9. The project floor plan displays the different facilities in the community

4.2 Economic factors

According to Case Studio Official Website: The THP, which addresses the concepts of community and individualism, was inspired by Bangkok's present housing shortage. The housing paradox in Bangkok is that, despite the fact that the majority of real estate developers target high-income residents with their products, it is not low-income city dwellers who are adversely affected by a scarcity of homes.

Low-income people are now compensated with government aid after being deprived of all kinds of rights, leading to a variety of housing projects throughout the city. As a result, we are left with individuals who fall into the economic demographic between high and low earnings. Ironically, this demographic now has the most serious housing issues. People with middling incomes cannot afford the pricey housing, but they also are not eligible for government housing assistance. They have no other choice or chance except to invade the residential streets of Bangkok.

Bangkok's diverse middle classes are left with no other options due to the private sector's complete provision of upper-class housing and the government's assistance for that of the lower class [8]. As it appears that every single helpless person with a medium salary is left without any housing options, THP started to turn its attention to the idea of community.

4.3 Environmental factors

The appropriate architecture form has significant potential for passive cooling of buildings via solar control and natural ventilation. The strategies of controlling building form and shape for passive cooling have been proved effective by the architectural practices of vernacular tradition buildings and contemporary buildings [10].

In order to reduce energy consumption and create a comfortable zone, the concept of energy conservation in architectural design employs integrated technology as well as scientific and local wisdom. Many architectural features have contributed effectively to achieve the thermal comfort, which -in turn- to achieve sustainability, since they reduce the need for air conditioning systems:

- The patio played a key role in keeping the interior spaces cool.
- During the summer, courtyards were crucial in channeling the breeze and reducing the impact of the intense sun.
- Since they served as welcoming areas in front of the entry and served to calm the hot, humid breeze before it was directed inside the home, the outer terraces had social and environmental significance.
- Installing breathable walls with horizontal and vertical panels to offer greater privacy and improved ventilation since they permit heat gains through conduction and convection heat transfer.
- Concrete and local resources worked together to create an environmentally sustainable structure.
- The gabled roof, which helps to spread out the shaded areas and drain rainfall, shading is a major key for reducing the solar gain, shading also can prevent visual discomfort. Solar gain through windows is a major component of the total heat gain of a building. Minimizing this heating source through the use of shading devices is therefore of primary importance in all types of hot climates [11].
- The building's north-south orientation, which will help it capture wind throughout both the chilly and warm seasons.

4.3.1 Analyzing the thermal performance of the project using ENVI-met simulation

Figure 10. ENVI-met model details

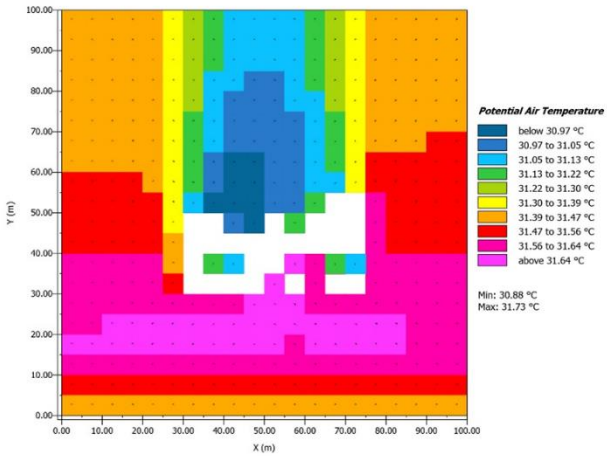

Figure 11. ENVI-met analysis for the THP

ENVI-met model has been widely used in many fields of climatic research, including thermal comfort and urban heat island effect, and microclimate [12, 13]. Using the ENVI-met model, shown in Figure 10 and Figure 11, looking at the thermal comfort situation with different scenarios is very useful in determining which is more appropriate for energy-intensive urbanization. The ENVI-met version 4.4.6 was used for evaluating the climate data. On the micro-climatic scale, the ENVI-met creates 3D models and has a horizontal resolution of 0.5–10m shown in Figure 10. Based on the master plan of the house, a model domain was built. The image was obtained from the house and uploaded into the area input file to determine the location of all the sites in (Bangkok, Thailand), the location of the house, street, and sidewalk and the details of the location is shown in Table 1. The model was created based on the actual master plan and landscape coverage. The height of the building was manually counted from the house and converted into the model domain. The result shows the thermal performance of the house that is affected by changing climate conditions on the human thermal comfort of the house that is affected by air temperature and humidity and any type of soft scape surrounding the house. As this study shows, green spaces, which are normally considered to help improve human thermal comfort by reducing air temperature and reflected radiation that can develop sustainability potential for improving human thermal comfort of the house.

Table 1. Details of the location

Parameter	Value
Location	Bangkok, Thailand
Climate type	Tropical monsoon climate
Simulation period	23/06/2020
Total simulation duration	24 h
Spatial resolution	2 m× 2 m× 2 m
Domain size	90 m× 90 m× 30 m
Model rotation	0°
Basic meteorological input	Shaded
Wind speed (m/s)	1.1
Wind direction (°)	SE
Air temperature for 24 h	31 °C
Relative humidity for 24 h	78%
Lowest in air temperature (°C)/h	28 °C
Highest in air temperature (°C)/h	32 °C
Lowest inner humidity	50%
Highest inner humidity	80%
Sky condition	Partly sunny
Vegetation information of the proposal situation	
Type	Different types of trees
Tree height (m)	10 m

The Study of Thai traditional architecture as a resource for contemporary building design in Thailand.

4.4 Recycling factor

As what has been discussed, the prior concerns effectively ensured the greatest use of locally available resources and reduced construction waste both during the construction phase and throughout the lifetime of the structure. The sustainability factors are shown in Figure 12.

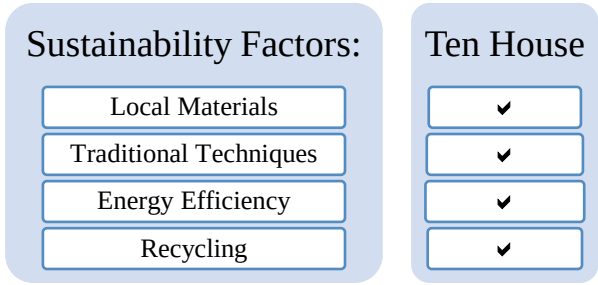

Figure 12. An analysis demonstrates that THP has achieved the sustainability main factors

5. CONCLUSION

In the 21st century, the construction industry has exerted a considerable negative impact on environmental conservation and sustainable development worldwide. According to the report of the Global Alliance for Buildings and Construction, the building sector accounted for 36% of global end-use energy consumption and 37% of global energy-related CO_2 emissions in 2020 [14].

For that reason, achieving the sustainability in the building industry can be a major key for achieving sustainability and preserve the planet resources. The sustainability building concept can be described as the relation of the users' values to environmental factors [15]. The THP has responded to the needs of the inhabitants on one hand, and to the environmental conditions on another, and that have led to a harmony with the society and environment, and contributed to achieving sustainability. The architectural elements of energy conservation for inheritance are: elevated floors, terrace or semi-indoor area, planting big trees in terrace, planting trees around building, natural materials, and modular or knock-down system. These architectural elements allow the occupant to remain in the building without air conditioners [16].

The research has proved that integrating the suitable items of regional architecture within the contemporary project; was a major key for achieving sustainability factors, and such approach can be applied for the current architecture smoothly, and can lead to a very pleasant, harmonious, and sustainable architecture. Also, the research validated that many of the regional architecture elements have contributed to achieving sustainability in the project; terraces, courtyards, breathable walls and many other architectural features were essential in terms of achieving sustainability from an environmental point of view, in addition to involving people in the schematic design phase, which was the social factor that contributed effectively to adding sustainability value to the project.

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