Using Local Materials to Optimize the Eco-design of a Resilient Urban Environment in Sustainable Urban Project Process

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Abstract All forecasts state that in the 21st century: there will be more urban. Thus, the majority of the population will live in cities. The urbanization model and the transport system of the city inherited from the 20th century have become disarticulated. There is a new trend for reinventing the frugal and sustainable city. This takes into account all the aspects of the ecological transition, especially energy, in the face of the climate challenge. This challenge is part of the Urban Project approach, which stems from postmodernist theory. The innovative idea of this collaborative intelligence aims to redesign the connected and more ecological city. This thinking is about green growth integrated with the carbon neutrality strategy. Today, this vision of urban renewal is based on sustainability which is a fundamental criterion in the eco-design of the safe and resilient city. It supports the use of renewable energies, the issue of climate change, the

health emergency as well as the use of Green-Tech in ecological architecture and eco-urbanism, to serve strategic issues, especially environmental ones. The Urban Project will have to be multidisciplinary in the cross analysis of various themes. Moreover, this approach must be based on the judicious articulation of spatial and temporal scales. Also, this process must take into account contextual realities while favouring the ingredients of urban ecology. It is a question of supporting biodiversity, the green and blue grid, and above all the use of geo-sourced materials in the eco-construction of the low-carbon city. Certainly, this operational and interactive mode is complex. Consequently, it refers to multiple notions of transversality, partnership, governance and participatory democracy. This inclusive and concerted process is based on thinking-design, resulting from the fruitful meeting of public and private actors around an agile and acceptable city project for the

post-carbon era.

Keywords Urban Project, Post Carbon City, Ecodesign, Ecological Transition, Ecoconstruction, Geosourced Materials

1. Introduction

It goes without saying that the more urbanization nibbles away at the countryside, the more people lose the culture of living with nature. Nothing is being done to slow down or stop this growing urbanization, although it is continuing to increase on a global scale, especially in Africa. According to the United Nations projections, the world's urbanisation rate will exceed 60% by 2030 [1]. Already, a large majority of the world's population has moved to an urban lifestyle.

This change presents the city with challenges and crucial changes in the near future. The new global civilization is predominantly urban [2]. However, paradoxically, the city is losing its qualities of attractiveness, contextual and environmental identity. The gap perceived by the city dweller between his or her needs and the urban context is becoming critical. The challenge of the contemporary city is a context of multiple crises, social, cultural, and especially ecological [3].

The emergence of the postmodernist theory, in harmony with the spirit of sustainable development, has competently distinguished itself from the concepts of modernism, which has dominated artistic creation and aesthetic syncretism since the end of the 20th century [4]. This new attitude towards the design of the urban environment emphasizes a new look for the reintroduction of eclecticism and diversity. This new approach, which essentially favors the existing context and a more humane development, has given rise to the multidisciplinary and participatory paradigm of Urban Project to respond to the conjunction of strategic issues [5].

This approach allows citizens to be effectively involved in a process of continuous improvement to produce the sustainable city, and to respond to its fundamental demands, particularly in terms of socio-cultural development by engaging the future of its inhabitants [6].

Through these principles, the perspective of sustainable development targets particularly the notions of good governance, inhabitant participation, transversality and mixity. This consists of objectives that aim to preserve the natural and cultural heritage and improve social equity, which can be translated into solidarity in a defined space-time [7].

This will make it possible to increase the quality of life and promote a culture of respect for the rights and freedoms of the individual, by establishing the

participation of all urban actors in the various forms of decision-making in a fair and united city which responds to the aspirations of all in the main implementation of the urban project. This is also emphasized by Bernard Huet "the city is a matter of process" and Antoine Grumbach "the city is a great machine at the service of the collective memory". Patrizia Ingallina [8] also emphasizes this: "The Urban Project or "spatial charter" translates the economic and social development orientations of the city project into spatial manifestations".

2. Methodological Framework

The current study topic is presented in a chronological order. In the first phase, through an inductive bottom-up reasoning, our intervention focuses on the burdensome fallout of the outmoded modernist urban model. Afterwards, in the intermediate phase, we continued the essay through deductive thinking. The latter focuses on the emerging postmodernist alternative model. Then, the treatment of the theoretical corpus related to the theme was developed according to the qualitative approach and the cross conceptual analysis of key concepts and tools. At the end, the experimental work is completed by a modelling and simulation system. This process concerns the optimization of the initial targets, through a responsive digital repository.

2.1. Element of Problematic and Context

This line of research aims to show the interest and the relevance of the articulation of a synergistic approach in a systemic process. The aim is to identify the problematic of taking charge of sustainable development through the Urban Project referential while integrating the eco-design paradigm in the thematic components of urban sustainability.

From this point of view, the questions related to the research work concern five structuring axes:

How can we adequately articulate the Sustainable Urban Project, Green-Tech and eco-design, in order to integrate the components of ecological transition, in particular energy and carbon neutrality in the urban space in the same sense of optimizing its viability?

In what way does the Urban Project constitute an alternative approach to the renewal of urban space, particularly about the development and preservation of environmental and bioclimatic dimensions?

Why are the notions of multidisciplinary and citizen participation indispensable in the Urban Project process for producing a safe city and protect the natural and cultural heritage?

What role can participatory democracy play in decision-making to improve socio-spatial equity? What are its scales and aspects in the Urban Project?

How can we evaluate the targets of urban performance, especially the appropriation of social demand and the penetration of nature in the city, by adapting to climate change?

3. Theoretical Corpus

3.1. The Notion of Urban Performance

In the declarations of the 9th European Conference "Mannheim2020" on Sustainable Cities and Towns, the need to adapt urbanization to the requirements of sustainable development is noted. Thus, the notion of urban efficiency aims to integrate the interests of future generations into the choices made nowadays in the context of experimenting with new urban policies through the inclusive and solidary city (Table1).

In accordance with the Joint Declaration of European Cities for Sustainability (Aalborg Charter, 1994), the Lisbon Action Plan (*From Charter to Action*, 1996), states that «Sustainability is neither a vision nor an unchangeable state, but an innovative local balancing act which affects all aspects of community decision-making».

In accordance with the principles of urban sustainability, the city is committed to preserving its cultural identity and maintaining its biodiversity, the eco-management of its resources, and the integration of vulnerable groups of inhabitants [9]. This notion is linked to a citizen innovation that allows the conservation of natural and cultural capital and combines social requirements with environmental protection. For this reason, motorized mobility, global warming and the poisoning of ecosystems must be limited.

The cultural dimension is a key part of sustainable development. It inevitably constitutes a bridge between generations and between populations with different cultural backgrounds. Thus, the introduction of the participation of the city's inhabitants will encourage solidarity and co-management. At the same time, it encourages the promotion of associative activity and the creation of socio-cultural links through the eco-mobility system. [10].

The theme of the sustainable city refers to a new mode of urban development respecting the principles of sustainable development, eco-urbanism and eco-architecture. This humanistic concept must be flexible and user-friendly, as well as respectful of its biophysical and historical context, and open to the future [11]. This approach is committed to human rights to support the spirit of cultural community and optimize proximity, compactness and mixity, while limiting its impact on the environment.

One of the objectives is the vision of improving social equity through access for all to the amenities and benefits of the city (employment, education, health care, social

services,) while effectively combating all forms of social and spatial inequality. Finally, the sustainable city must give answers to socio-cultural, economic and, above all, ecological concerns.

In this sense, Table 1 illustrates the chronology of urban design in transition. In the past, the city has suffered the setbacks of modernist spatial mono-functionality. Subsequently, the contemporary city supports the functional mix. In perspective, the post-modern city will aim at eco-sustainable urban complexity. This approach focuses on the correct inclusion of environmental parameters in sustainable urban planning documents [12].

Table 1. Urban metamorphosis

Urban Transformations		
Mono- functionality	Functional mix	Urban complexity

Past	Current	Future

3.2. Inhabitant Participation

It is recalled that among the resolutions adopted by the Rio Conference (1992) "Earth Summit" on the environment and development, the concept of citizen participation constitutes a fundamental principle in the treatment of environmental issues. (UN Report, vol1, 1993).

The participation and collaborative involvement of different actors (deciders, inhabitants, consumers, and experts) especially in the decision-making process, is a major principle of sustainable development. This concept can contribute to a better sharing of knowledge and the recognition of distinct competences.

The integration of development in an urban project requires a certain level of participation at each stage of the process. The forms of participation can vary according to the stages of the urban project process, depending on the problems posed and the context. This control characteristic usually depends on the involvement of the inhabitants in the climate protection process.

3.3. From Sustainable Design to Eco-design

Sustainable urban design allows people to live well, while significantly reducing their ecological footprint on this planet of city-dwellers. In this context, eco-design gives emphasis on the principles of urban ecology. Today much importance is given by design and planning professionals to eco-urbanism, which supports solutions to challenges such as global warming, the decline of endangered species, the depletion of natural resources and the awareness of a loss of identification with the existing

and disappeared context.

Thus, in promoting sustainably developed and humanly habitable environments, the eco-design strategy is designed to integrate environmental considerations into development projects according to the principles that underpin sustainable development.

When developing an existing urban area, the aim is to design new urbanized areas, allowing the city to develop, while minimizing the impact on the environment and promoting social equity and the enhancement of natural heritage.

The effectiveness of eco-design involves a succession of actions. It is based on concepts aimed at the eco-management of resources to improve environmental health conditions. It also promotes environmental resilience and tends to increase biodiversity and enhance the natural landscape. As a result, eco-design would reconcile as much as possible the different environmental issues with the aim of reducing the impact of human activities and the built environment on nature. Thus, it focuses on reducing greenhouse gas emissions and better adapting to climate change. In this context, Figure 1 explains the multi-criteria approach. This is executed in a few steps (case of the life cycle loop). Indeed, urban eco design aims to integrate environmental values from the design phase of products and throughout the life cycle of goods, services or processes in the development of sustainable urban project. With this aim, it seems imperative to evaluate regularly, comfort, hygiene and health in the city, while generating fewer impacts on nature at the three successive scales of intervention, as indicated in Figure 2 [13].

Figure 1. Design for Environment DfE (Action modes)

Figure 2. DfE (Evaluation fields)

However, ecological footprint is an eco-design benchmark for assessing sustainability in cities. In conformity with the Living Planet Report (2020), the One Planet Living program demonstrates that «*The components of the ecosystem include, in addition to humans and their physical environment, plants and animals. For humans, the concept implies a balance in the satisfaction of basic needs: economic, environmental, social and cultural conditions for living in a society*» [42].

The eco-design strategy goes beyond the 'sustainable' paradigm, resilience and regeneration. It aims not only to maintain the status quo for future generations, but also to enhance the biological integrity of the existing in a new bioclimatic architecture approach [14]. The DfE aspires to generate resilience in the face of future dangerous environmental upheavals and to provide stability suitable for both humans and wildlife. It offers an opportunity to enrich biodiversity, work with natural processes, stimulate natural environments to maintain themselves, and regenerate resources to meet the needs of humans and other living species.

In 1991 and 1993, "Ignacy Sachs", [15] defined ecodesign as «*endogenous and self-reliant development, subject to the logic of the needs of the entire population, conscious of its ecological dimension and seeking harmony between man and nature*».

3.4. Multidisciplinary and Participation in Eco-design

Due to multiple problems of integrating ecology into the design process in today's social and political structures, ecodesign urban planning projects encompass several disciplines, whose multidisciplinary becomes necessary to meet complex challenges.

As an emerging discipline on interactive processes, ecodesign combines science and design while including both humans and wildlife, while applying the best available scientific theories to create a resilient and sustainable urban environment.

Thus, ecodesign proposes interventions that consider human needs and desires, support the cleanliness of natural environments, and encourage the consideration of environmental parameters in the development of the sustainable city.

In its strategy, ecodesign can also respond to both human needs and the physical and biological processes of the environment. In its strategy, ecodesign works on the interaction of the biological and physical worlds that function in time and space to improve human and natural conditions. It seeks to promote a more resilient approach to our built environments. Thus, ecodesign helps to understand the correlation between environmental processes and human needs in the city.

In the ecodesign approach, citizen participation has been defined as (Zair Kedadaouche) [16] «*a set of actions organised and finalised with the aim of involving the people most directly concerned in the design or*

realization of a complex project».

In complex urban interventions, this ecodesign framework collaborates with other tools and methods, in particular the Environmental Impact Assessment EIA approach shown in Figure 3. This approach focuses on the verification and evaluation of the importance of impacts (social, economic, biophysical, health, risks) to manage the project of the Low Carbon City.

Figure 3. The "eco-design" strategy uses EIA as a tool for eco-planning of human needs and the natural environment.

3.5. To Bring Together Multidisciplinary Views and Knowledge in Design Process

The Urban Project is seen as a way of thinking about relationships, implying an approach based on a transversal perspective. It is an open and continuous process that has emerged from the meeting of different disciplines in synergy. The implementation of an urban project implies the presence of a multidisciplinary project management team. The design requires specific knowledge, analyses to be carried out and technical and legal tools to be used. It also refers to a multiplicity of approaches. Thus, transdisciplinarity requires a coordination of know-how between public authorities, landowners, investors and distinct professionals.

It is therefore a question of promoting an approach based on various thematic diagnoses. The role is to identify the many issues at stake in various choices. In particular, we note the changes to be anticipated, spaces to be densified, landscapes to be recomposed, dysfunctions to be eliminated, assets to be amplified, revitalisation and complementarities of all kinds to be undertaken...).

However, the Urban Project is an approach based on modesty which does not set itself up as an absolute method or produce a finished model. According to Christian Devillers *«The urban project is not the responsibility of a single profession, but of skills, it is not a procedure but an approach, it is not a solution but an improvement»* [17].

Professor of Urban Planning François Ascher evokes the urban project in these terms: *«it can be defined as a complex operation for which an operator ensures the overall project management, and which brings together various projects in a program, Upland, and overall forms.*

These projects are developed and redefined in the course of a process which involves local elected representatives, developers and designers and which is punctuated by numerous negotiations between all the actors involved in the project» [18].

3.6. Collaborative Process for Designing Sustainable City

The Urban Project can also constitute the spatial framework, the framework for negotiation and even contractualisation between public partners and private operators. The Urban Project is conceived through the initiatives of all those (elected representatives, economic actors, associations and inhabitants, etc.) who make the city for its permanent enrichment and its setting in order. It is supposed to represent the threefold reality of a city: socio-cultural territory, constructed space and institutional structure.

The Urban Project must also encourage its development through participation and local management. Its characteristics include transversality, articulation of scales and co-production between different actors. In its principles, the Urban Project is thought out and negotiated in relation to all the actors in the city according to a consensus rather than authority or conflict, in partnership rather than the addition of disjointed initiatives. Patrizia Ingallina [19], it is *«a global and negotiated action to create a quality environment»*.

In a political will, the Urban Project integrates the principle of governance on a city-wide scale: a participatory approach which mobilizes inhabitants and users. It also develops partnerships as essential factors for the implementation of projects.

In fact, consultation, or even the widest participation of the actors of urbanization in the elaboration of the Urban Project is obligatory to make a collective work, outside the technical or bureaucratic sphere. Youssef G D, the Urban Project brings together the public and private sectors in the definition of a global future for the city. The aim is to order the space, forms and social practices [20].

François Ascher emphasizes that the notion of the Urban Project is at the heart of a renewal of urban planning *«based on approaches that are less regulatory, less compartmentalised, more participatory and better adapted to a complex urban society»*. Indeed, *this process is piloted and concerted with a view to transversality* [21].

3.7. Stakeholder System and Consultation

The process of developing an urban project involves different categories of actors. These include decision-makers and elected representatives, professionals, economic agents, the urban development operator, other specific actors who carry or convey opinions, and residents and users. The urban project is a collective project by nature.

In order to be sustainable, the sustainable urban project is built on the objective logics of the agents and the convergence of the various actors.

Remark: We note that in this system of stakeholder groups, the perspectives of the participants on the issue of the city are diverse, even opposed or complementary.

Figure 4. Levels of the Stakeholder System

Taking into account these different scales implies a multiplicity of actors. The inhabitants participate in the development of their urban project and they are part of a sociable life and cultural diversity. Thus, the urban project is an issue of democracy which seeks to design the city for all. In the French context, the urban project recommends the EAUP2 method, which is recognized for its ability to involve and bring together actors, according to the Method of the (5Ws1H) tool of the quality approach, relating to the evaluation of various impacts.

So, the urban designer Alain Avitabile declares that this logic of agents and games of actors is a key to action through the Urban Project approach. «*The Urban Project goes hand in hand with public debate ... with a project approach conducted in consultation with the inhabitants, through neighbourhood councils*» [22].

3.8. Scales of Participation

According to the European standard, the participation of inhabitants is at the heart of the Urban Project approach. It concerns a renewal, which allows the inhabitants to be involved in the responsibility of the choices upstream of the project. The main objective is to elaborate a common diagnosis, which will lead to the definition of the issues and priorities for the district [23].

With the aim of strengthening the social and cultural link, this approach focuses on improving social cohesion

and the participation of inhabitants in decisions concerning their neighborhood project. These include: involvement of residents and users in the process of sustainable development; north-south solidarity; link with the planet; participation of residents in the development of a local economy; and strengthening of community life.

In this context, the urban planner Catherine Charlot-Valdieu indicates six levels of participation with precise terms in the urban project approach [24]:

1. Coercion, which is the regal right, submission, decision without reference to anyone;
2. Information on sustainable urban planning projects, which is necessary but requires prior (in) training on sustainable development;
3. Awareness raising, which is the action of motivating the inhabitants so that their behaviour can be consistent with the project;
4. Consultation of the inhabitants is requested which can enlighten the decision-makers;
5. Concertation, which is the commitment of the project owner to negotiate with the inhabitants (it is compulsory in the French SRU law) [25];
6. Cooperation, which is the involvement of the inhabitants in the decision-making process itself.

3.9. Socio-Spatial Equity

In the urban context, social equity takes many forms, two of which seem essential:

Reducing ecological inequalities (pollution, noise pollution and acts of vandalism are more likely to affect the most vulnerable in the city, especially children);

Reducing social and urban violence, particularly in the suburbs of large cities. For example, the socio-professional categories are affected by the precariousness of jobs, which creates permanent instability in the housing estates and which are often abandoned by the public authorities. These points can be the subject of reflection and negotiation during diagnoses as well as in the modalities for carrying out the urban project process; for example, the identity of the district defined by its inhabitants. In the French context, the response is formulated in the law on social cohesion and in the urban renewal projects [26].

3.10. Objectives of Urban Project

As part of the innovation strategy of the frugal city, the urban project approach aims to achieve these objectives over time:

- To integrate the strategic objectives of sustainable development at all levels of urban intervention;
- To create social cohesion in neighborhoods in the sense of social development in the city [27];
- To include new democratic requirements;

Encouraging ecodesign and eco-urbanism to improve

the quality of life and health of inhabitant [28];

- To ensure that inhabitants respect the natural environment, the sobriety of energy consumption, and exchange spaces;
- To preserve the cultural and natural heritage, and the identity specifications of the context;
- To encourage the integration of nature as an essential function in the city, in particular the concept of the Green and Blue Belt for the health of citizens;
- To consider social demands and expectations in urban planning, urban development and architecture;
- To develop multifunctional urban space and urban mix for social comfort.

3.11. Ecodesign Indicators and Operational Aspects

It is recalled that the quality of the urban project is achieved through the joint contribution of the inhabitants and users. Some indicators help to simplify the operational execution. In particular, we note:

- Achieving the appropriation of the project by the inhabitants with the help of their participation;
- Strengthening the link between public space and collective space related to housing and leisure;
- Developing natural infrastructures and link ecological corridors [29];
- Establish a participatory governance of the operation and adapt the project to better respond to the orientations and needs [30];
- Combat the urban heat island and increase number of cool islands by linking urban planning and transport tools [31];
- Offer a variety of cultural facilities associated with local historical events [32];
- Integrate the cultural and architectural heritage into urban uses;
- To ensure that the inhabitants respect the natural environment and the sobriety of energy consumption [32];
- Make the inhabitants aware of their essential role and responsibilities in civil society;
- Promote social, functional and intergenerational diversity by creating meeting and exchange spaces;
- Successfully involve everyone: get the actors concerned by this theme to work together beforehand;
- Optimize the use of geosourced materials in the eco-construction process of low-carbon city [34];
- Mixing, mixing through multifunctionality and for urban compactness mixing through urban multifunctionality according to the following formula:

$$- \sum_{i=1}^n (P_i \times \log_2(P_i))$$

- To develop natural infrastructures and (green and blue grids) connect ecological corridors.

- To combat the urban heat island and increase the number of cooler areas.
- To propose developments of spaces that take into account the sustainability of resources in terms of quality and quantity.
- To preserve, to restore, to reinforce and to enhance biodiversity according to the to the following equation:

$$100 \times \frac{\text{Area on which biodiversity has been inventoried}}{\text{total area}}$$

- Bringing nature into the city (according to the principle of mineral-vegetal balance) by applying the ratio, according to this linear formula:

$$100 \times \frac{\text{Area of nature spaces under differentiated management}}{\text{Total area of nature spaces}}$$

- (n): is the number of activity types
- (Pi): is the relative abundance of activities (proportion of an activity to the total number of activities)
- (Log2(Pi)): is the logarithm (base 2) of the relative abundance of each activity.

4. Materials and Methods

4.1. Eco and Sustainable Paradigms in Urban Project

The Urban Project is a global and negotiated action, and therefore an indispensable tool for prospective reflection on the city. Christian Devillers states that the urban project *«is not a solution but an improvement, a mode for composing the city... »*. Similarly, Alain Avitabile wrote (2005) [35] wrote *«Design is not an isolated process but is necessarily linked to the overall strategy. The effectiveness of the approach in terms of operability requires that the Urban Project be linked to the overall urban strategy of the community, and to manage the different levels of action in a permanent process. The design of the content integrates the articulation of scales and registers of action... »*.

Thus, in the process of continuous evaluation and monitoring, this Urban Project reference framework is applied with other tools and labels, in particular the use of the most widely recognised international pioneering labelling BREEAM Ecohomes (Building Research Establishment Environmental Assessment Method) in Table 2 [36].

The latter aims to preserve and describe the environmental performance throughout the intervention cycle at the relevant scale of an Eco-neighbourhood. Furthermore, this approach is made concrete through the analysis of the main environmental themes. These are Eco-Energy (consumption and CO₂ emissions), Eco-Mobility (Transport: distances and CO₂ emissions), Pollution: (air and water), Eco-Architecture and the use of eco-materials (Environmental impact of materials), Water

consumption, Ecology (Ecological enhancement of the site), Health and well-being of the inhabitants, and Management (Eco-management). The assessment of the environmental behavior of buildings is based on ratings assigned according to a set of performance criteria, as indicated in Table 2.

Table 2. The award of BREEAM certification depends on the sum of the points obtained in the 08 environmental themes (Energy), (Transport), (Pollution), (Materials), (Water), (Ecology), (Health), and (Management). Source: Breeam

	Rating	Score (%)
*	Pass	36
* *	Good	48
* * *	Very good	58
* * * *	Excellent	70

4.2. Dredged Vase Brick in Eco-Construction to Fight against the Urban Heat Island

The research concerns the geosourced raw material used in the manufacture of this new Dredged Vase Brick "DVB". This material comes locally from the Bouhanifia dam in Algeria. It is therefore the dredging mud.

Consequently, this new material "DVB" illustrated in Figure 5 hereafter, requires few transformations. Thus, its carbon balance indicates that it is energy efficient. Likewise, it contributes to the reduction of carbon

emissions

- b/- "DVB" characteristics:
- CaCO_3 Carbonates (%) = 12.59
- Activity index <1

It should be noted that the choice of this ecomaterial "DVB" of construction was also operated in an environmental optics to minimize the carbon footprint of the local urban project in the sense of an effective ecological renovation in the perspective.

Figure 5. Prismatic brick based on dredging sludge [37, 48].

A priori, the nature and the landscape, and the culture of sharing, are claimed elements of the quality of life of everyday urban life. (Autodesk Ecotect Analysis –(Figure 6)

Figure 6. Wall covered with BVD material with insulation (Si Glass wool). Simulation realized by the Ecotect digital tool

The choice of this eco-building material was also made with the environment in mind, in order to minimize the carbon footprint of the urban project, in the sense of a high-performance ecological renovation in perspective.

Figure 7. Prismatic brick based on dredged material. Simulation performed by the digital tool Energy2D.

- Material: Glass wool, [37, 43].
Density: 30 kg/m³
Thermal conductivity: 0.032 W/m.K
Specific heat: 950 J/Kg.K
Phase shift time for a material thickness of 0.06 m: 1.303h
- Material: Clay brick, [44, 45].
Density: 1850 kg/m³
Thermal conductivity: 1 W/m.K
Specific heat: 1000 J/Kg.K
Phase shift time for a material thickness of 0.24 m: 7.5h
Phase shift time = 8.8h for a wall thickness of 30cm,

4.3. Interpretation of the Results

The Dredged Vase Brick DVB provides excellent protection against the cold in winter. This material, together with the SWI Sheep Wool Insulation, is more effective in protection against summer heat. Due to its

high density and thermal mass capacity, (DVB+SWI) stores the heat when the temperature is at its highest, preventing it from penetrating the wall. (DVB+SWI) releases it in the cooler hours of the night when it can be vented.

(DVB+SWI) are also very open to water vapor diffusion and protect against condensation problems (See Figure 7).

In addition to their thermal and acoustic performance, (DVB+SWI) are environmentally friendly, recyclable, and contain no additives that are harmful to health. By storing CO₂ in (DVB+SWI), they have a negative carbon balance, I.E., they store more CO₂ than they emit during their production.

In addition to their thermal and acoustic performance, (BVD+ILM) are environmentally friendly, recyclable, without any additives that are harmful to health. Through their CO₂ storage, (StockC), (DVB+SWI) composites have a negative carbon balance. Therefore, they store more CO₂ than they emit during their production.

- StockC: environmental value related to biogenic carbon storage, e.g. *StockCbâtiment* = Biogenic carbon storage indicator of the building (expressed in kg C/m²)

Finally, the geosourced material (DVB) has an efficient carbon index (Ic). The latter is necessary to optimize the indices (Building Carbon Index (BCI), and Construction Carbon Index (CCI))

- Ic: carbon index, it replaces the component greenhouse gas emission index (ex-EgesPCE),
- $I_{cbâtiment} = I_{cconstruction} + I_{cène\&\&gie} + I_{ceau}$
- *Icconstruction*: carbon index of the construction represents the sum of the indices:

$$I_{cconstruction} = I_{ccomposants} + I_{chantier}$$

- $I_{cbâtiment} = I_{cconstruction} + I_{cénergie} + I_{cwater}$
- *Icconstruction*: carbon index of the construction represents the sum of the indices:

$$I_{cconstruction} = I_{ccomposants} + I_{chantier}$$

4.4. Modelling of the Optimal Use of Geo-sourced materials in the Referential of Sustainable Urban Planning and Development RSUPD

This empirical part demonstrates the implementation of a device for the verification and evaluation of the sustainability of the urban environment "RSUPD". This numerical tool has recorded the urban planning and development of the metropolitan city of Toulouse (France). The objective is to propose a multiscalar analysis by transposing the "RSUPD" model on the city of Constantine to meet the needs of the inhabitants, suitably to the objectives of SD. Thus, the procedure is divided into four successive phases:

1. The qualitative assessment is done according to a scale ranging (from 1 to 4) with color-coding in shades appropriate to the indicators. The data has been filled in (see table) with justifications and adjustment measures. The boxes without color-coding concern indicators for which thresholds are not yet defined.
2. Data collection is carried out by the competent city services. The information concerns each target of the urban situation. They are necessary to calculate the indicators.
3. The application of a matrix to calculate the multifunctionality indices is carried out based on the nomenclature of activities present in the operation.
4. The spreadsheet systematically displays the results of the indicators once the data have entered in the previous sections. At the end, the radar diagrams are drawn to define the situation of the eleven "RSUPD" targets at the scale of the urban project. Their weighting system indicates limited values from (0 to 4)

(see diagrams A and B). However, the indicators for each target reflect the appropriate needs and interests of the inhabitants of the analyzed city.

It should be remembered that this "RSUPD" sustainable urban planning and development reference system contributes to achieving the city on the SD platform. As much, it aims to promote in sharing the requirement of sustainability through the approach of Urban Project. It is recalled that this process encourages the good practices of citizen participation and preservation of natural heritage in the city.

In practical terms, we would like to point out that this "RSUPD" qualitative evaluation approach concerns environmental and social issues. The evaluation is carried out following multiple contacts and interviews, which we carried out with the various multidisciplinary services of the city, in particular (URBACO, BETUR, Prefecture, Municipality, the directions of town planning, transport, environment, also of public works, and the associations of the inhabitants).

This fieldwork aims to better inform the data and indices necessary for the calculation of indicators related to the selected targets.

In this case study (city metropolis of Constantine), the analysis focuses particularly on the target (n° 03). This one is adapted, as it was chosen among the 11 of the "RSUPD" in transposition.

We recall that these eleven targets are: (1. Location of development operations. 2. Energy, air, climate. 3. Density, urban and architectural quality. 4. intermodality and travel 5. Public space, heritage and landscape. 6. Water cycle. 7. Nature in the city. 8. living together (functional, social and intergenerational mix). 9. Social demand and appropriation. 10. Cost control and financing. 11. Management in project mode.

It is noted that each target has characteristic indicators. Thus, the evaluation is made on the local urban context reported. The document contains a few pages, of which we have summarised just the tables and diagrams. However, the evaluation is defined on the grid (A), accompanied by a radar diagram, containing indicators to help urban ecodesign.

Indeed, the RSUPD qualitative assessment, illustrated in graph (A), shows the weak points, especially in terms of: Aiming for energy efficiency in buildings; Developing urban amenities in the city. Some sub-targets have values below the reference standards. Therefore, they may constitute development issues, and need to be taken into account in a feasible process of renewal and improvement of the environmental quality and the living environment.

As much as on the grid (A) with its radar diagram, we note that the sub-targets (Develop the multifunctional city.

As well, on the grid (A) with its radar diagram, we note that the following sub-targets: (Develop the multifunctional city; Minimize and better manage the production of waste), record evaluation scores acceptable

to the inhabitants of the city. Certainly, these strengths can constitute levers of development in urban actions conceivable in an ambitious local urban project. The latter concerns the realization of a future sustainable eco-city in the Algerian context.

Likewise, the results related to the following sub-targets: (encourage participatory approaches; encourage collective management; encourage the transformation of practices), with their indicators, are shown on the grid (B), also on its radar diagram. We note that these sub-targets record low scores and are below the reference standards. However, their totals reveal the vulnerability of the local urban situation. Formally, these weak points will be improved in ambitious urban actions to meet the needs and expectations of the inhabitants in the framework of the sustainable urban project, adjusted to the specifications of the urban context of Constantine. Indeed, the scores (n°3 and n°4) perfectly meet the expectations of the inhabitants and constitute the primary objective to be reached in a potential future sustainable urban development scenario.

Target 3: Architectural, Urban and Secure Ecological Transition RSUPD

a/- RSUPD Qualitative Monitoring and Evaluation Grid:

On this smart grid (Table 3), we note that the five sub-objectives targeted: (Developing the multifunctional frugal city and environmental health; Integrating nature in any redevelopment of transport flow areas; Limiting the

impact of the construction operation on the environment; Aiming for energy efficiency of ecological materials; Management of water resources) with their indicators, register low scores and are below the reference standards. Certainly, these weaknesses will be improved in an ambitious local ecocodevelopment programme (Local Agenda21). This powerful tool can meet the needs and expectations of the inhabitants in the framework of a sustainable urban project in the local context [37].

Target 3: Architectural, Urban and Secure Ecological Transition

b/- Radar Diagram:

- In this scheme (Figure 7): We note that the three sub-targets indicated on this radar diagram record low scores. This situation of environmental vulnerability requires the charge of the indicated elements in a potential process of urban renewal by targeting the improvement of the environmental quality in the city in the ambition of the safe ecological transition.

Otherwise, the enhancement of the sub-targets with equal scores 3, finally, the achievement of the scores (4) constitute the overriding objective to be achieved in a potential scenario of sustainable urban development, which is aimed above all at carbon neutrality on the long-term timeframe (2050).

Table 3. Qualitative Monitoring and Evaluation Grid. Target 3: Architectural, Urban and Secure Ecological Transition. [45].

N°	Criteria	Evaluation (to be completed) (drop-down list)	Justification (to be completed)
TARGET 3. ARCHITECTURAL, URBAN AND		SECURE ECOLOGICAL	TRNAsITION
Criterion 1. Combating the urban heat island and encouraging low-carbon		mobility	
3.1.1.	Optimising the use of geo-sourced materials in the eco-construction of the Intense City	3	
3.1.2	Seeking mineral-vestigial balance	2	
3.1.3	Developing the multifunctional frugal city and environmental health	1	
Criterion 2. Urban atmosphere and environmental quality			
3.2.1	Supporting the eco-design of green urban developments	2	
3.2.2	Developing urban amenities and air quality	3	
3.2.3	Integrate nature into every redevelopment of transport flow areas	1	
3.2.4	Limiting the use of the car in a reasonable way	2	
3.2.5	Minimizing CO ₂ emissions and better managing waste in the manufacture of building materials	3	
Criterion 3: Eco-construction and Carbon neutrality			
3.3.1	Limit the impact of the construction operation on the environment	1	
3.3.2	Promoting multimodality in travel	3	
3.3.3	Aiming for energy efficiency of environmentally friendly materials and water resource management	1

Figure 7. Radar Diagram. Radar Diagram. Target 3: Architectural, Urban and Secure Ecological Transition. [45].

5. Conclusions

The postmodernist paradigm of the Urban Project is confirmed as an alternative, multidisciplinary and participatory approach, especially in the experiences of developed countries. In this global hybridization process, it is preferable to choose the systemic approach of eco-design, which crosses the disciplines of eco-urbanism, Eco-architecture, and even eco-fabrication of geo-sourced materials from the perspective of the safe ecological transition. This reasoning targets in priority the eco-construction of the frugal and agile city, integrated to the carbon neutrality strategy in the future horizons. According to APRUE (2015), Algeria records 25.3 million tons Mteq CO₂ and 13 million tons of waste. Its residential sector consumes 46% of the energy resources.

This urban movement of global reconciliation promotes resilience, the maintenance of biodiversity and the safeguarding of natural heritage. This process of renewal builds on the collaborative intelligence approach to design a carbon-neutral urban environment that is sustainable for humans and the species that live there [37]. This enables the inclusive city to contribute to strong sustainability, and to evolve towards the inclusive 'eco-city' in the post-carbon era, adapted to a cognitive millennium of urban reinvention.

This emerging urban culture attempts to diversify the modes of intervention to co-produce the city attractive and friendly, supportive and eco-systemic. This polycentric urban entity aims jointly at social equity, economic efficacy and environmental efficiency. This urban model is in vogue, which values the cultural identity of the context [38]. The main objective is to increase the quality of life and health and thus the well-being of citizens. This translates into intervention on different levers, which participation and co-elaboration, multidisciplinary, transversality and sharing. Consequently, frugality in the urban project appears to be an effective model in the fight against global warming. Thus, the ecological issue becomes above all a matter of economic performance [39].

This intervention is carried out in the sense of the ecological and social frugal transition. It is about thinking in 3D (urban, human and nature), thus limiting inequalities, preserving the urban and natural heritage in an appropriate environment offering good prospects.

This approach also shows that there is an interdisciplinary debate on a territory that is united and respectful of its history and, above all, of its contextual identity.

The implementation of digital evaluation and monitoring tools is likely to produce the sustainable city through an Urban ecodesign aid document (UEDAD). This is defined in the collaborative Urban Project approach. This document concerns the adaptation of behaviour and support for good citizen practices. It encourages theorists and practitioners to adopt the "Thinking design" paradigm integrated with Artificial Intelligence (AI) and (Data and Digital Platforms) (DDP), to jointly manage the eco-construction of the low-carbon city.

The contribution of this research work concerns the optimization of adequate use of geo-sourced and biosourced materials in the performing building. Thus, this hybrid process decision concerns the context of preventive urbanism and adaptive architecture to climate change.

Certainly, the sustainability is linked to the improvement of the energy performance of the built environment [46].

Indeed, this innovative approach allows designing a frugal and resilient urban environment where we live well.

This efficient urban paradigm is a lever to establish a culture of carbon neutrality in the building and climate solidarity.

We recall that urban areas were home to more than half of the world's inhabitants at the beginning of the third millennium [47].

In the end, the sustainable urban project fits well with the citizen and ecological transition approach. This alternative is conveyed by the hypermodern theory to think the future of the city metropolis hypertext.

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