

Meeting Bioclimatic Knowledge Needs of Algerian Architects; the Contribution of Expert Systems

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Abstract— In the architectural design process, architects are confronted to problems and situations to which they have to find the most suitable solutions. Several software programs are developed to enable them find solutions to such problems. However, the majority of the architects in our case study do not use any bioclimatic device tools during the architectural design process. This is mainly due, probably, to the inadequacy of these tools to the professionals implied in the designing process, especially the architects. Here, we aimed to give the designer and various actors a practical helper tool in order to understanding and integrating the bioclimatic passive concepts regarding the desert climate. We developed a bioclimatic sketching book based on decree n° 14-27 and case based reasoning method. This novel tool offers concrete illustrations to the actors, and assists the architect in his architectural bioclimatic design. It may contribute to the decisive insertion of building in its desert area during various stages of designing.

Keywords— Architectural design process, desert climate, integration, sketching book, schematisation.

I. INTRODUCTION

The architectural project is seen as a problem solving activity, the result of a long and complex multidisciplinary process of planning [1]. It is a non-linear procedure, but it is rather a dynamic one. The emergent conceptual solution is the result of various actions. It includes several types of interactions between the actors and their fields. [2]. According to Pierre Fernandez, The major character which makes the act of modeling the design process difficult is the diversity of project elaboration methods. This diversity can be interpreted through several ways of conciliating both the objective (program, site, regulations...) and subjective (composition, reference...) parts during the design process [3]. The architect has to get the maximum of information concerning the project, and needs to draw from his own experience, knowledge and know-how [4].

Several approaches are proposed to implement this established fact in an intelligent device which would help in finding solutions to the problems encountered by architects; this could be done by providing the machine with the

necessary knowledge that would enable it find the most adequate solutions.

Among the various approaches concerned with artificial intelligence, the Case based reasoning (CBR) can be considered as the closest one to the human reasoning based satisfaction, and is the most adopted in the act of designing [5]. Indeed, it can help architects abating the lack of information related to bioclimatic field issues and find optimal bioclimatic solutions.

Following this line of thought, this paper concerns itself with:

- Collecting and conceiving a set of the different conceptual strategies related to earthquake resistance design.
- Finding a way to take them into account during the early stages of designing.

Finally, developing a support tool to help and assist architects during the designing process based on the schematization and case based reasoning method.

II. ALGERIAN CODES FOR DESERT BIOCLIMATIC DESIGN

Since 2000 in Algeria, the elaboration of code for sustainable design was one of the priorities of the public authorities in order to take into account the natural and climatic variables. This is clearly stated in the various promulgated legislative decrees (laws: 01-20; 02-02; 02-08; 04-05; 04-09; 09-99; executive decree number 14-27) [6].

However, the designer's experience has to be up to the level to interpret suitably the spirit of the code, without which a contrary result might occur especially in the case of bad interpretations [7]. Moreover, the majority of current helper bioclimatic device tools are used as enhancers, checking the feasibility of the architectural forms. They intervene at stages in which the architectural part is already done.

Beside this, the architectural bioclimatic design requires a close cooperation between the technically and the architecturally bioclimatic aspects as of the first stages of the designing process. Experience shows that this approach allows a kind of reconciliation between the architectural aspect and the technical design.

Practically, the implementation of such method is the result of the interaction of extremely complex factors such as: the current regulation, the economic situation, the technical know-how, the aptitudes, and even the different actors' behavior.

Additionally, the majority of designers do not use a decision advice tool during the early stages of bioclimatic design process. This is mainly due to the inadequacy of these tools to the professionals implied in the design process, especially architects [8]. This absence can be explained on various levels as:

- They are not used until the last phases of the design process.
- Designers are heavily short of training in terms of using these tools.
- Their knowledge about bioclimatic designing concepts is quite poor.
- Architects consider that bioclimatic active strategies are in charge of treating the sustainable aspect of buildings.
- The fact of knowing the existence of an under state control subsidy for the residences energy consumption is compulsory make designing intervenors lazy in considering bioclimatic aspects during the early stages.
- The current software devices are beyond the mastery of architects because of their highly specialized character.
- They require relatively a long training period of time, which professionals can not actually afford.

The use of these support tools varies according to the mode of implication of the bioclimatic aspects in the architectural design process:

In case of post-implication, the support tools will assume the control, validation, or sanction mission. And hence, the amendments have to be limited with regard to the schedule and project budget. Indeed, a great deal of rectifications during very advanced state of project design might imply revising a considerable work of design on various scales. On the other hand, in case of very early engagement, as of the draft stage, they will be involved as assistance in the bioclimatic design, as shown in Fig. 1.

The current simulation tools of bioclimatic aspects of building available form part of the specialized codes, and they are not usually employed in architectural practice. During the early designing phases, architects do not need any validation but rather an enriching and assistant tool ; as affirmed by the head of CLOA-Adrar (Local Council of the Architects Order), Mr. LAZRAG A. : «...when conceiving we always seek nutritive sources for the project and which stimulates the architectural creativity...»

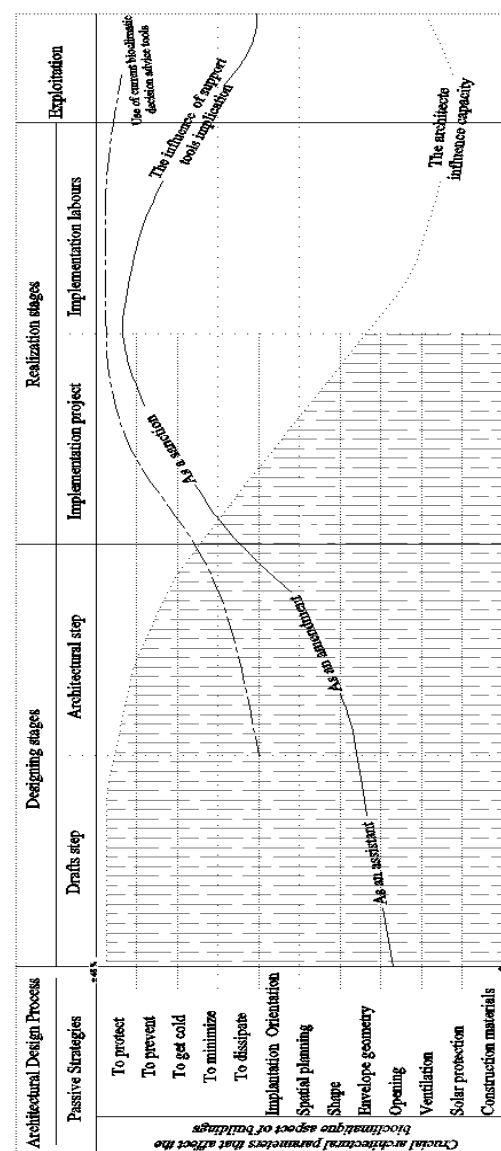


Fig. 1 Implication of current helper bioclimatic device tools in bioclimatic design process (Algerian case study)

III. PROPOSED DESIGN PROCEDURE

The designing act is a highly complex activity; it is technical and emotional at the same time. It often requests a search for ideas and information which can assist the designer in the development of his project. This idea has been developed by several researchers and designers, such as Bignon, Halin, and Kacher in his article « A method to index images in the wooden architecture domain » [9], and S. Kacher in her doctoral thesis [10] among others..., they explain that during the conceptual process the need to return back to visual illustration (images, pictures, drawings, etc.) is essential. They consider that the information transmitted by image is easy to understand if compared to written passage.

This results from the fact that the image necessitates a limited number of interpretations. The image also presents information which can be directly integrated in the corpus of

the ideas, constraints or solutions for the project. In other terms, the image is that which supports the architectural creation before and after the design of the project in the conceptual, architectural and even economic order. It clarifies the various situations "analysis / development" of the designing process, and also simulates the comprehension of the bioclimatic architectural concepts. Moreover, it gives a concrete illustration to the actors so they can include the formal relationships between the various attributes influencing the bioclimatic aspects of the building. [11].

In this paper, our objective is to propose a methodological tool which allows a kind of reconciliation between the objective and the subjective design parts, and this to facilitate the exchange of communication between the different actors, and hence ensure a tight collaboration between them which is the fundamental principle of the architectural design. The method suggested consists of two different structures: a linear structure and in loop one.

The vertical linear structure defines the requirements, the bioclimatic design concerns, as well as the various developing phases of the project. The loop structure generates alternative solutions and allows the repetition of all activities and phases of linear structure in an iterative way. The loop structure divides the vertical linear one into loops of five successive stages. The first one examines the project candidates. The second stage selects bioclimatic concepts from the given data.

Next, an analysis phase takes place in order to suggest possible conceptual solutions. Then a synthesis step generates a candidate solution through the exploration of various combinations of the primitive elements. And finally at a later stage the obtained results are evaluated and possibly readjusted and reused. These phases are repeated until a satisfactory designing solution is obtained.

IV. DESIGNED SKETCHING TOOL BASED ON 14-27 DECREE

In the design process, the architect always calls upon the references and the schematization preceding cases to advance and feed his activities. He does not have predetermined ways of resolution. But he knows a certain number of procedures and useful methods, and can rely on previous treated similar projects or existing prototypes, but it is necessary each time to reinvent and to recombine some strategies to elaborate an adequate solution.

The need for the bioclimatic design expert rules proves to be essential. They can offer to the architect the conceptual bases of his project, and they enable to guarantee an integration and insertion of climatic variables as of the early phases of the design process. The reasoning based case seems to be the nearest resolution approach to the problems adopted in the act of designing. Indeed, it implies the artificial intelligence "AI" which can be used to help the architect in the bioclimatic design and to find optimal solutions.

The designed bioclimatic sketching book results of superposition of the obtained (urban, architectural, and functional) bioclimatic indicators, by analysing of executive decree n0 14-27, and the synthesis of bibliographical study

which fixes the various actions defining the bioclimatic cold passive strategy.

V. PERSPECTIVE AND DISCUSSION

The main aim of the experiments was to contribute to our reflection by supervising two essential points. First is to check that association concept-image allows a correct interpretation and a performance appropriation of the bioclimatic concepts; second is to validate the practical, economic and creative benefits of a schematized navigation in standard referential of bioclimatic architecture of the Algerian southern provinces.

The experiments are supported by 42 architects from CLOA-Adrar (Local Council of the Architects Order) who have follow lesson in master academic in architecture within African university of Adrar in partnership with university of Sciences and Technologies of Oran. Work proceeds in exercise form of design before and after the use of the developed sketching book. All drawn and written traces produced during the experimentation are also reserved.

Thanks to this experimentation we managed to improve our sketching book, determine bioclimatic knowledge needs of architects, and also the main features of the suggest approach. They enabled us to check our assumption :

- The presence of several loops of feedback makes it possible to return back in order to take into account the new information generated during the designing process.

- The distinction between the various phases of the design process, a beginning and an end with loops between them, implies the existence of objective criteria. This illustrates the fact that the objective and its properties guide the mechanism of assistance to generate bioclimatic forms as of the early phase

The recourse to the CBR concept and to the graphic demonstrations at each level of the design situation gives the possibility to express the idea of the project one wishes to carry out, and to communicate it.

VI. CONCLUSION

The architectural form is incontestably the most significant part in the bioclimatic aspect of buildings. The requirements of bioclimatic design can appear during a first examination as an impoverishing constraint. In fact, in the professional space, we should seek shape of buildings adapted as possible with naturel variables, as well in architectural as of technical aspects. Many successful projects on the aesthetic level prove however that a bioclimatic architecture of quality is possible.

Thus, beyond the "thermomechanical behavior" aspect, we can integrate the bioclimatic concerns within the architectural intention, and it is possible to use the bioclimatic concept as an element of architectural expression.

Our model reveals two types of information structuring the representation and the progress of the architectural project; the first answers the semantic question: « what is to be done? ». The answer could be considered as a source of bioclimatic conceptual ideas. And the second is an esthetic answer to the question: « how it will look like? ». Its role is to seek

conceivable solution forms. Proposal tool can be considered as a tool of assistance and decision-making during early stages of design process, and even a tool of communication with the common public.

REFERENCES

- [1] K. pal SANKAR, SIMON c.k.Shui, Foundation of soft case-based-reasoning, vol 2, 150, 2004.
- [2] R. Prost, "conception architecturale une investigation méthodologique," l'Harmattan (ed), French, 1992.
- [3] P. Fernandez, "stratégie d'intégration de composante énergétique dans la pédagogie du projet d'architecture," Ph.D. dissertation, école des mines de Paris, French, 1996.
- [4] M. Benabdelfattah, Y. Kehila, H. Khelafi, and N. Djarfour, "Integration du "RBC" à la prise de decision pour assister l'architecture parasismique; contribution méthodologique," African Review of Science, Technology and Development, vol. 3, no. 1, pp. 07-17, 2018. [Online].
- [5] S. Mazouz and M. S. Zeouala, "The integration of environmental variables in the process of architectural design; the contribution of expert systems," Elsevier, J. Energy and Buildings, vol. 33, pp. 699-710, 2010.
- [6] S. Hamrani, "L'insertion passive des bâtiments dans un climat désertique ; État de lieu et recommandations ; Cas de la wilaya d'Adrar – Algérie," M.D. dissertation, University of Sciences and Technologies, USTO, Oran Algeria, 2017.
- [7] Benabdelfattah M., Kehila Y., Makhloufi A. (2018) Meeting Paraseismic Knowledge Needs of Algerian Architects. In: Kallel A., Ksibi M., Ben Dhia H., Khélifi N. (eds) Recent Advances in Environmental Science from the Euro-Mediterranean and Surrounding Regions. EMCEI 2017. Advances in Science, Technology & Innovation (IEREK Interdisciplinary Series for Sustainable Development). Springer, Cham.
- [8] L. Khelifi, "Contribution méthodologique à la conception bioclimatique en architecture; développement de modèles génériques," M.D. dissertation, Ecole polytechnique d'architecture et d'urbanisme, EPAU d'Alger-Algérie, 2006.
- [9] S. KACHER, "proposition d'une méthode de référencement d'images pour assister la conception architecturale : Application à la recherche d'ouvrages," Ph.D. dissertation, l'Institut National Polytechnique de Lorraine Discipline, Sciences de l'architecture, 2005.
- [10] M. BRET, "Image de synthèse : méthodes et algorithmes pour la réalisation d'images numériques," St-Jean/Richelieu, Dunod (ed), Bo-Pré, Paris, French, 1988.
- [11] J. P. JUNGMANN, "L'image en architecture : de la représentation et de son empreinte utopique," Éditions de la Villette (ed), Paris, French, 1996.