Architectural design and environmental performance: the ADDENDA method through case study

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ABSTRACT: Nowadays, there is a challenge to achieve sustainable building design. How to consider the environmental conditions and the architectural and social-economical aspects in the design process? This issue is very important and has been discussed in several countries since the 1990s. The main focus from the current debate in Europe is on the risk to architectural quality, when attempts are made to optimize the environmental performance only (emphasizing technical aspects), instead of searching for an equilibrium with others aspects, such as architectural building quality (aesthetical), socio-cultural and economic aspects.
The French method ADDENDA seeks to reach such an equilibrium. This paper analyses the French ADDENDA method and the Procedure *HQE®* (*Haute Qualité Environnementale*), by means of a case study from a competition project. The architectural projects are confronted with the environmental programming dossier in an attempt to identify if and how the method lends itself to effectively collaborate efficiently with the for architectural concept.
This work is part of a the author's Ph.D. thesis performed in conjunction between the University of Rio de Janeiro (Brazil) and Toulouse (France). Its theme is the development of guidelines directed to help steer sustainable building design applied to the particularities of the conditions in Brazil.

Keywords: methods and tools for sustainable design, HQE – *Haute Qualité Environnementale*, sustainable architecture, green building, environmental-friendly buildings.

1. INTRODUCTION

There are many different kinds of environmental approaches that can be applied to the building design concept. Considering the universe of available methods or tools, some authors have classified them according to the project support or the intend of a performance evaluation.

In this scenario emerges the debate on the risk to architectural quality when the building design is focused primarily on performance optimization [1,2].

At the same time, we observe the criticism about some methods presented as “design-decision making tools to facilitate sustainability integration”. In reality these methods do not have “the mechanisms to facilitate the design” and “thus fall short in their application as design tools” [3]. Furthermore, the risk of using assessment tools to guide the building design can tend, “designers to focus on credits that can be earned...” [13].

Considering the presented problematic, our main question is: which method to aid the environmental approach for building design processes is feasible in Brazil? In an attempt to answer this question, existing methods were analysed.

This paper contains one part of this analysis, focused on the ADDENDA method, under the referential HQE® – *Haute Qualité Environnementale.* This study contains a confrontation and analysis of the HQE dossier program and the projects presented by the architects in a French competition.

2. ENVIRONMENTAL APPROACH FOR THE BUILDING DESIGN

2.1 The universe of methods and tools

Among the several classifications developed in the context of environmental methods and tools for sustainable building design, GOWRI [4] defines three categories: Knowledge-based tools, performance evaluation tools; and green building tools.

The first group corresponds to the design manuals and information sources and, references for design, such as “The Green Guide to Specification” [5], “Whole Building Design Guide” [6], “Sustainable Building Technical Manual” [7]. The second_group includes life-cycle assessment, analysis and simulation tools to evaluate the performance of specific parts or the whole building. And the third group comprises rating tools related to the criteria and levels of performance that are related to environmental (or sustainability) certifications and labels.

In a preliminary analysis, without trying to be exhaustive, but concerning to this scenario presented by GOWRI, we observe that whole of the tools are considered as an aid the design, but they don't present specific characteristics of a concept tool. They are limited to exposed criteria and performance levels aimed to achieve the proposed goals. As NIBEL and NOSSENT [10] emphasize, the assessment framework shall not be considered as a design-aid toll: "Design is an interactive and integrated process; assessment is more analytical and led from different points of view".

2.2 The procedure "HQE®"

The French concept called "*Démarche* HQE®" (*Haute Qualité Environnementale)*, developed since the beginning of 1990's by the HQE® Association [8], doesn't differ from the above considerations when we look at the structure of criteria and goals. But it has something that adds value: the request for an environmental management system for the project and a 'steering committee', formed by representative parts of all groups concerned (inhabitants of neighborhood, future users, designers, entrepreneur, representatives of municipality etc), to guide the main important decisions throughout all stages of the project (programming, design, construction, management - use and maintenance).

Concerning to these special features observed in the French approach, many authors consider that an important difference between conventional and sustainability practices lies exactly in this feature, relied to the inter-disciplinary project approach: "...enabling improved integration of buildings, community, natural and economic systems and therefore is a key to sustainable design" (Read and Gordon, 2000 in [3]).

Related with the environmental quality, a group of 14 targets has to be analyzed in order to establish priorities due to the specific characteristics of each project. The Table 1 presents the 14 targets of the procedure HQE®.

Table 1: 14 HQE® Targets [8,9,10].

EXTERIOR ENVIRONMENT
ECO CONSTRUCTION
1. Relation between the building and its immediate surroundings 2. Integrated choice of construction products, systems and processes 3. Low-impact construction site
ECO MANAGEMENT
4. Energy management 5. Water management 6. Activity waste management 7. Maintenance and cleaning management (Environmental performance conservation[10])
INTERIOR ENVIRONMENT
COMFORT
8. Hygrothermal Comfort 9. Acoustic Comfort 10. Visual Comfort 11. Olfactive Comfort
HEALTH
12. Health quality of spaces 13. Indoor air quality 14. Sanitary quality of water

For each of these targets, there are more specific and detailed recommendations.

Due to the 14 targets, the steering committee has to establish the hierarchy of priorities [10,11], between: **Very good level** - level of the maximum performances recently evidenced in buildings with high environmental quality; **Good level** – levels of performance better than the usual practices; **Basic level** – regulative level or usual practices. It is necessary to reach at least 3 environmental targets, of a very good level; at least 4 environmental targets of a good level and a maximum of 7 environmental targets of Basic level. Considering the buildings that have to accomplish thermal regulation, the target 4 must be treated in a very good or good level [12].

Related to the procedure HQE® there is a technical reference framework, which is regularly updated and improved, in order the performance criteria to be met. Also, to assess of building project, there is a specific assessment framework.

2.3 The ADDENDA Method

According to the HQE® referential, the ADDENDA method has the aim to help the architectural conception by integrating the environmental HQE® targets to the specific aspects concerned to the conception process, "allowing the architect to adapt this environmental logic in order to integrate it in its own mode of conception" [11].

Due to ADDENDA method, the environmental approach is analyzed through four generic architectural problems: location, morphology, materiality, spatiality.

These architectural problems gather a set of almost twenty "architectural concepts" for which are identified more than fifty "significant parameters" of analysis. These concepts and parameters synthesize the whole of the architectural and technical essential topics of a project. The ensemble of these architectural concepts with the environmental targets, establish a matrix of analysis shown in the Table 2.

Table 2: Part of the analysis matrix between environmental targets and architectural concepts [11]

		EXTERIOR ENVIRONMENT						
		ECO CONSTRUCTION			ECO MANAGEMENT			
		Target O1	Target O2	Target O3	Target O4	Target O5	Target O6	Target O7
LOCATION	Distribution							
	Limits							
	Microclimate							
	Landscape							
	Resources							
	Inconvenients							
	Uses							
MORPHOLOGY	Form							
	Occupancy							
	Scale							
	Basement							
MATERIALITY	Composition							
	Construction							
	Porosity							
	Protection							
SPATIALITY	Distribution							
	Partition							
	Comunication							
	Regulation							
	Very Good Level Targets							
	Good Level Targets							
	Basic Level Targets							

This matrix permits detaching the strong interactions between architectural concepts and environmental targets, and helps the steering committee establishing the priorities and the hierarchy among all of them (very good level, good level and basic level).

Related to each "architectural concept"; the addenda method considers some "significant parameters", as shown below, to the "Location" architectural problems:

Table 3: List of "architectural concepts" and "significant parameters" related to "Location" [11].

1 – Distribution system	**4 – Landscape insertion**
Transports	Constructions
Ways (Streets)	Pavement
Accesses	Vegetation
Parking	**5 – Management of resources**
2 – Treatment of limits	Renewable energies
Materialize the limits	Nets
Orientation	Local availability
Topography	**6 – Management of trouble**
3 – Climatic control	Pollution
Insulation	Risks
Winds	**7 – Distribution of spaces**
Rains	Views
Humidity	Internal ways
	Connections

For each "significant parameter" specific recommendations to achieve the environmental quality in the project are generated. After having listed the "significant parameters" and generated the recommendations, the hierarchy analysis considering the environmental specific targets for the project (as shown in table 2) is conducted and defined which aspects will be treated in as very good, good and basic levels.

3. ANALYSIS OF ADDENDA METHOD THROUGH CASE STUDY

3.1 The HQE® public competitions

In France, public competitions for architectural projects are common place. In recent times, however, the scope of the HQE concept has been added to the requirements of such competitions.

These competitions comprehend in general the phase of pre-programming where the significant parameters are essentially architectonics and related to the site of location.

In this section we will discuss one such competition involving HQE® , presented in WEKA [9]. We will try to verify the efficiency of the ADDENDA method to aid the architectural conception, relating concepts and environmental objectives. The analysis will be performed by comparison the HQE programming dossiers with the project recommendations, competitions requirements and the resulting projects developed by the architects.

3.2 The case study project

The HQE® architectural competition case is related to a general education and technical college, of 4500 m^2 (expandable to 9000 m^2), in a site of 3 hectares, in a small city in France. The competition was organized by regional council and competition's committee (the steering committee of competition) was aided by an HQE® assistance, in this case, the ADDENDA society, applying the ADDENDA method according to the HQE® referential.

After the public presentation of a number of candidates, 4 teams were selected to participate in the competition. These teams would present their propositions anonymously, according to the rules pre established by the jury. The HQE assistance was asked to analyse the propositions with respect to the environmental quality and in accordance with the HQE® programming recommendations presented in the documentation for the competition.

The HQE® programming dossier presented in the competition contained the site analysis, the environmental recommendations related to specific architectural concepts and the hierarchy of priority targets. In this paper we show the confrontation between the HQE® recommendations and project propositions for some aspects related to the site "Location", which are the "distribution system", "treatment of limits" and "climatic control".

3.3 The site analysis

This point "is one first approach to the understanding of the potentialities and the constraints of the site". It will help to construct the reflection concerned to the harmonious relation between the building and the environment and will detach the specific priorities for the general location in the site".

Among the several aspects of the site analysis, it is mentioned in the analysis document, that in this specific case, the location has a very strong importance, as the site is situated in a very difficult central area of the city, with lack of transport and needing a new public way to lead to the site. Thus these aspects need to be considered in the project in order to reduce disturbances.

3.4 HQE® programming recommendations

In the scope of the competition (pre-programming phase), due to each "significant parameter" related to the 'Location' there were made the required environmental recommendations.

The table 4 shows a small resume concerning to the "distribution system", "treatment of limits" and "climatic control" related to the "Location" in the site , extracted from the extensive recommendations presented in the competition's documentation.

Table 4: Summary of HQE® programming recommendations (ADDENDA in [9]).

1 – Distribution system	
Transports	- Fluid circulation in the proximity and accesses; - A functional and secure discharging;
Ways	- internal functional ways preserving the acoustic comfort ;
Accesses	- An identifiable principal access, which qualifies the building; - functional secondary accesses;
Parking	- A secure parking, integrated in the site;
2 – Treatment of limits	
Materialization of the limits	- Use of the site limits in sequences of transition (access roadway system/building) and/or to control of the sound harmful effects between building and site; - Conceive visually permeable limits but however, correctly safe;
Orientation	- Organization of quality sights / useful zones;
Topography	- Manage of the rain water draining;
3 – Climatic control	
Insulation	- Make profit of the useful zones (in particular rooms of course) from the Southern sunning of the site; - integrate natural devices for solar protection into the buildings; - Guarantee the maintenance of the right to the sun of the various entities of the project;
Winds	- Integrate natural devices or mechanisms for wind and rain protection;
Rains	- Manage rainwater and drainage on the site.

3.5 Hierarchy of environmental targets

After conclusion of the environmental recommendations related to architectural concepts and corresponding "significant parameters", an analysis is performed establish a priority sequence. It is possible that one aspect affects negatively one other. Thus, it is important to identify which one is the leader and which one is secondary and so on. As mentioned before, they are qualified to be treated in: very good ; good or basic levels.

The table 5 below shows the crossing of the sensible conception parameters with the 14 environmental targets (HQE® targets) and the level classification for priorities, concerning to the environmental recommendations and specific characteristics of the project and the site case.

Table 5: Hierarchy of targets due to site analysis (ADDENDA in [9]).

PROBLEMS	ARCHITECTURAL CONCEPTS		SIGNIFICANT PARAMETERS		ENVIRONMENTAL TARGETS 1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 LOCATION	1.1	Distribution System	1.1.1	Transports			○						○		○	○		
			1.1.2	Ways			O			○			O		○	○	O	
			1.1.3	Accesses	x		O			○	O		○			○		
			1.1.4	Parking	x		O			○	O		O		○	○	○	
	1.2	Treatment of Limits	1.2.1	Materialization of the limits	x		O	○		○	O	O						
			1.2.2	Orientation		○		○				x	○	O				
			1.2.3	Topography					○			○				○		
	1.3	Climatic Control	1.3.1	Insulation		x		x				x		O				
			1.3.2	Winds		x		○				O			○		O	
			1.3.3	Rains		○			O									
			1.3.4	Humidity		○												
	1.4	Landscape Insertion	1.4.1	Construction	x	x					O	x						
			1.4.2	Pavement	x				O			○						
			1.4.3	Vegetation	x				O			x						
	1.5	Management of Resources	1.5.1	Renewable energies				○			○							
			1.5.2	Nets			○	x	○	○	○							○
			1.5.3	Local availability		○												
	1.6	Management of Trouble	1.6.1	Pollution	x		O		○	○			○		○		O	
			1.6.2	Risks														
	1.7	Distribution of Spaces	1.7.1	Views										O				
			1.7.2	Internal ways	x								○			O		
			1.7.3	Connections	x					○			○			○		

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Very Good Level Treatment	x	x		x				x						
Good Level Treatment			O		O		O		O	O			O	
Basic Level Treatment						○					○	○		○

The table 6 shows the general hierarchy of targets, made in sequence of the former one, concerning not only the site analysis but also the program's, entrepreneur's and the steering committee's priorities.

Table 6: General hierarchy of targets (method ADDENDA in [9]).

		HIERARCHY OF ENVIRONMENTAL TARGETS						
		Site Analyse	Entrepreneur's and Steering Committee's Wishes			Final Selection		
TARGETS		Implantation	Very Good Level	Good Level	Basic level	Very Good Level	Good Level	Basic level
1	Relation between the building and its immediate surroundings							
2	Integrated choice of construction products, systems and processes							
3	Low-impact construction site							
4	Energy management							
5	Water management							
6	Activity waste management							
7	Maintenance and cleaning management							
8	Hygrothermal Comfort							
9	Acoustic Comfort							
10	Visual Comfort							
11	Olfactive Comfort							
12	Health quality of spaces							
13	Indoor air quality							
14	Sanitary quality of water							

It can be observed that in the consensus between the site analysis, the entrepreneur's wishes and the 'steering committee', the result has defined the targets bellow should have a 'very good level' treatment:

- **Target 1.** Relation between the building and its immediate surroundings
- **Target 2.** Integrated choice of construction products, systems and processes
- **Target 4.** Energy management
- **Target 8.** Hygrothermal Comfort
- **Target 10.** Visual Comfort

3.6 Project propositions

Now, it will be shown two of the four projects propositions, putting in relief their responses to the recommendations previously presented. The Projects "A" and C", selected to be analyzed, were not the competition's winners. Figures 1 and 2 show the implantation, accesses and distribution system of Project "A" and "C". Figures 3 and 4 detail their respective climatic controls.

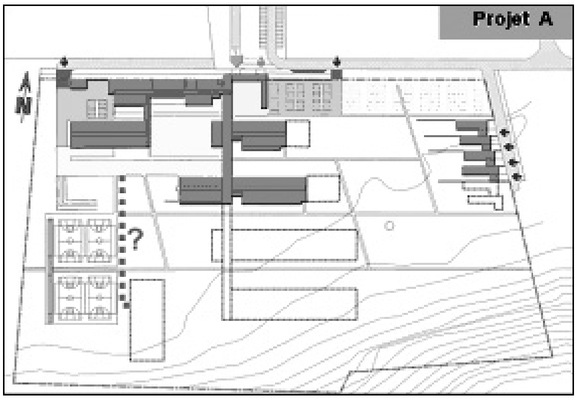

Figure 1: Implantation of Project "A" [9].

Project "A" shows a good answer in what concerns to the external flows, accesses and internal distribution. In a brief description, the following elements related to these items are distinguished [9]:

- Creation of secondary passages and accesses, liberating the main urban circulation;
- Placing of a bus stop located near the junction between two ways, near the main entrance and without disturbing the transit;
- Main access correctly identified, adding value to the construction, without ostentation;
- Concentration of all accesses in the northern portion of the land, allowing for the preservation of the interior, reduction of internal passages and allowing for intense landscaping;
- Parking located near the accesses and close to the site limits, reducing the need of internal driveways;
- Minimum surface of internal passages, reducing noise pollution and pollution in general on the site;
- School location as a main building, valued in the new square;
- Forecast of future constructions in the site without the need of changing the internal ways.

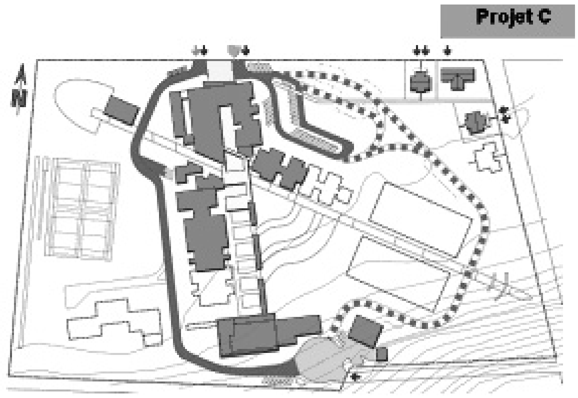

Figure 2: Implantation of 'C' project [9].

Comments on Project "C":

- It doesn't give a solution for external circulation;
- The accesses are distributed between north and south of the site (main/service accesses), which leads to an excess of internal passages, encompassing the buildings and dividing the land, what can cause sound pollution and pollution in the interior of the site;
- As internal passages pass through the entire site, we can observe the crossing of pedestrians passages with driveways, causing unnecessary risks for the user and visitors of the college;
- The strong presence of passages and vehicles in the site reduces the possibility for landscaping;
- With respect to the addition of future constructions, still more internal passages and driveways will be required, thus increasing the negative impact on the site.

In relation of the implantation option, we observe the adoption of widely different options between the two projects, which caused opposing results:

- Project "A" is located along the northern limit of the site, creating an urban front, next and in direct bonding with the external circulations, what offers a series of advantages:
  - Reduction of passages in the interior of the site, limiting possible disturbances;
  - Allows the concentration of the parking areas next to the northern limit;
  - Avoids excess of paved surfaces , leading to a more natural character;
  - Facilitates pluvial water management;
  - The implantation along the northern limit helps to structure the urban front.

- Project "C" is located in introversion in the site, in the direction of the interior of the site, causing some disadvantages:
  - Excess of passages in the interior of the site which increases the sonorous bothering and pollution;
  - Excess of paved surfaces, making pluvial water management more difficult
  - Reduction of natural character of the land;
  - The introverted orientation in the land reduces the force of the building image in the block.

In reference to the climatic control, the main elements to be detached in Project "A" are:

- The arrangement of the constructions in the East/West axis makes for a North-South alignment of the main façades which facilitates the management of the natural illumination and summer comfort.

In Project "C" it can be observed:

- The arrangement of the constructions along a north-south axis, causes the main and bigger façades be aligned East-East , what leaves them extremely exposed in the summer and demands a bigger investment in control devices for the natural illumination and the excess of sun exposition,

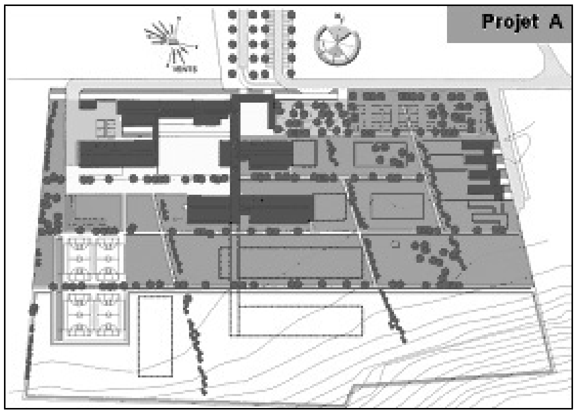

Figure 3: Climatic control of Project 'A' [9].

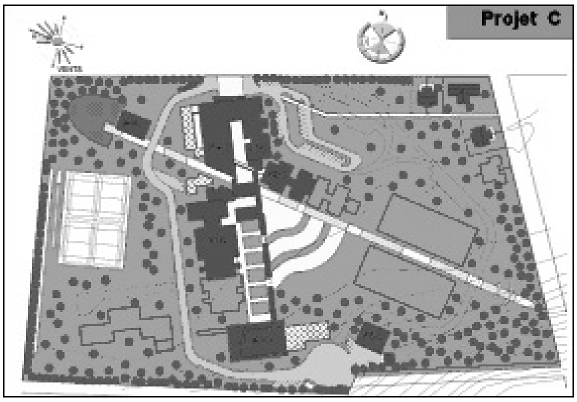

Figure 4: '**:** Climatic control of Project "C" [9].

3.7 Analysis between projects and environmental recommendations

The final hierarchy of the priority targets (table 6) highlights the targets described in table 7 below for a "very high level" treatment.

Table 7: Targets for a very high level treatment

Target	Description
1	Relation between the building and its immediate surroudings
2	Integrated choice of construction products, systems and processes
4	Energy management
8	Hygrothermal Comfort
10	Visual Comfort

In relation to the site analyse, when crossing the sensible project parameters with the 14 HQE® targets (table 5), we can observe that some parameters of architectural project present higher importance for the general performance of the building, giving good answer better than the one, of the 14 environmental targets. The parameters that best answer to the priority targets are presented in Table 8 below.

Table 8: Best sensible parameters to HQE® targets

Significant Parameters	Targets								
	1	2	…	4	…	8	…	10	…
1.3.1 insulation		x		x		x			
1.4.1 building	x	x				x			
1.4.3 vegetation	x					x			
1.5.1 natural resources				x					

The recommendations of HQE® programming in the competition documentation make reference not only to the priority targets, but also to all "significant parameters" of "architectural concepts" related to "Location" (Table 3).

Each one of the four competition participant projects possess strong and deficit points. In this document focused in the most strong and deficient points detached of projects "A" e "C".

Project "A", was the one that gave the best answers for the principal sensible parameters and environmental targets from the HQE® recommendations. The planned orientation for the buildings, their location on the northern part of the site, and the access and distribution of passages and circulations, lead this project to exhibit the best environmental performance:

- It has a good answers to the exploitation of the insolation potential, reducing expenses with energy and favouring the hygrothermic comfort (targets 4 and 8);
- it promotes an harmonious relation of the construction with the surrounding environment (target 1), facilitating access and flows in the external passages, giving value to the buildings image and structuralizing the urban front;
- it reduces the internal passages facilitating the pluvial water management, reducing air and noise pollution and favouring plantation in the interior of the land (targets 5, 9, 10, 11).

4. CONCLUSION

The HQE® referential is based in the analysis and hierarchy of priorities, considering 14 environmental targets. Many times the attendance to a specific target can affect the performance of another one.

Through the analysis of the presented HQE® competition projects, based in the application of ADDENDA Method, it is verified that this method supplies instruments that allow to identify the most important sensible parameters for architectural conception to lead the attendance the priority targets, and, therefore, leading to a better general architectural performance.

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