

Energy Efficiency Regulations and the Process of Architecture

Design of Buildings: A Case Study

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ABSTRACT: Most developed countries have set out energy efficiency standards for buildings, and developing countries are undertaking research in this area, establishing guidelines for the project contemplates solutions for environmental comfort combined and reductions in energy consumption. This research starts with a review of the architectural design process and its relationship to both energy efficiency and to the Brazilian regulation called the 'Regulation of Technical Quality Level Energy Efficiency of Commercial Buildings, and Public Services' (RTQ-C). It was conducted a qualitative study obtained with semi-structured interviews with architects who used the RTQ-C in their designs and also with others who did not use it in their workflow, in order to establish relationships between the regulation and the design process. The interviews were analyzed using the categorization method, which we obtained information on sustainability, environmental comfort and design process; Brazilian regulation for energy efficiency and consulting service for architecture. Respondents believe that the sustainability should be incorporated effectively in architectural firms, and consulting service should not be restricted in just one project. The present work indicates that a regulation policy can help to increase the savings in electric energy consumption and finances for commercial building with a useful life.

Keywords: Architecture, Energy Efficiency, Labelling, Design Process.

INTRODUCTION

The process of the project reveals itself as the way in which the architect demonstrates his understanding of architecture and how he exercise the activity of design [1]. It works as a reading of the architect, a way to represent what idealizes and where it registers her knowledge. The initial sketches are the way to materialize the thought graphically, and it is precisely in the project design that the architect must apply the concepts of comfort, devoting attention to the weather to seek to meet the requirements necessary for the design of a building [2].

Climatic variables can be introduced in the design in a simple way, where the buildings designed are as a protective envelope around the living space and should provide the user with comfort conditions at any time [3].

Sustainable buildings are defined, among other things, as those that have a positive (or neutral) impact on the environment, contributing positively to the energy balance, producing more energy than they consume, and creating healthier and more comfortable living conditions for its occupants without negatively impacting the environment. The sustainability project is analyzed as a more specific response to the location in an attempt to provide an experimental and sensorial experience to the user, that responds to climate and location, which uses renewable energy (as possible as its use can be) and that is also compliant with building regulations [4].

Usually, all approaches to the design of projects that aim at sustainability emphasize the importance of climatic context and / or culture in which the project is part [5]. When seeking sustainable architecture, the energy used by buildings should be minimized, and control of the internal conditions of comfort should be performed by the most passive resources (such as the use of natural ventilation and lighting).

A lot of the energy spent in buildings it's related to the aspects of the building's architecture and to the use of the living spaces, being that 30% of the world's population lives and works in buildings. Almost half of the energy used in these buildings, either to build them and / or operate them, is to obtain internal comfort [6].

Most of the developed countries have energy efficiency standards for buildings and developing countries have been presenting researches in the area [7,8]. These regulations establish guidelines so that the project contemplates solutions seeking for environmental comfort combined with the decrease in energy consumption. This article comes from a review of the architectural design process and its relation to energy efficiency and to the brazilian regulation, known as Regulation of Technical Quality Level Energy Efficiency of Commercial Buildings, and Public Services, or RTQ-C [9], which is currently non-obligatory.

In the case of the RTQ-C, the Brazilian government's goal is to reduce energy consumption in Brazil, a goal for

society. When considering all parties involved in the process of production of energy-efficient buildings (professionals, construction market, users, government), it appears that it is needed a set of actions. The RTQ-C can be a mean for the architect to achieve the goal of reducing the consumption of electricity, but it is not necessarily the solution to this. The RTQ-C interferes with the design process of the architect 'cause it specifies minimum levels to be achieved for certain parameters, the architect needs to know which of the decisions taken during the design process will have a greater weight in the final equation of the RTQ-C, or how he will make decisions in order to achieve a better level of efficiency.

The regulations should not be regarded as instruments to limit the creativity of the architect, but as tools that provide the professional guidance and assistance to his ability to create [2]. The ideas and constant limitations in such documents should be absorbed as a way of stimulating creativity. When architects work integrating energy, natural light and comfort related to the design process, the balance of these variables can result in broad new standards for architecture with low power consumption [10].

METHODOLOGY

For the interviews, it was chosen an exploratory-descriptive of qualitative approach with semi-structured interviews. The research was developed in the cities of Florianópolis and Criciúma, State of Santa Catarina, Brazil, between the periods of November 2011 to February 2012. The interviews were conducted in a classroom format, with 8 architects divided into two groups, location chosen by the participants. Group 1 consists of three architects, ages between 38 and 50 years, who designed commercial buildings, of services or public in the State of Santa Catarina, and had their projects labeled by RTQ-C, according to the list available in October 2011, at the website of the *Instituto Nacional de Metrologia, Normalização e Qualidade Industrial (INMETRO)*. Group 2 consists of five architects that have designs of commercial buildings in the city of Florianópolis, Santa Catarina, ages between 35 and 60 years.

Open questions were developed to characterize the research semi-structured, seeking to address the influence of the RTQ-C in design practice and the importance of consultancy service, with the completion of a pre-test data collection instrument. After its completion, the questions were defined as: "How does RTQ-C influence the design decisions in the definition of the envelope (if the RTQ-C has been considered)?" and "Regarding the use of consultancy service for labeling of buildings (if you have already made

use of this service): what have they learned by using this service? When they do other work, will they hire a new consultant? And what can be done to streamline / improve future work? ".

The analysis of the questions was made by means of categorization, which consists in classifying different elements that are part of an assembly, to then reassemble them by analogy with predefined criteria. The analysis of the open questions can be defined in three stages: Stage 1 interviews were fully transcribed from the tape, including laughter, hesitations, silences and any other manifestation of the interviewee. After the transcript of the interview, it was proceeded with a thematic analysis, through a close reading to discover the clippings of text, such as constituents ideas, will be listed, and prepositions that can be considered separately, constituting categories [11]; in Step 2 the transcript material was explored in order to understand the text from the defined categories. Classify the text in categories allow us to identify what one text has in common with the other [11]; in Step 3 the results were treated and the interpretation of the categories defined.

RESULTS AND DISCUSSIONS

Sustainability, the Environmental Comfort and Design Process. The variables of sustainability and environmental comfort in the design process were quoted by the interviewees, because they should be incorporated with its architecture and must always be considered. Even saying that, in many cases, the issues related to the function and aesthetics are priorities, respondents believe that by not considering sustainability and comfort in the design process, they may even be harmed professionally by the negative marketing that will be created on the subject.

Although some customers still understand that sustainability is effectively a simple matter of marketing, incorporate it permanently into the design process and also into the architectural offices might be a solution for the issue to be seen beyond the marketing that it represents.

For respondents, the integration of sustainability in architecture definitely has to get into the offices that feel the need to incorporate the concepts of sustainability in their work, and not make it a separate item of the design process. The incorporation of sustainability by architectural firms involves the consideration of environment and energy requirements, socio-cultural and economic projects in buildings and involves a multidisciplinary interaction with the architect serving as a mediator in this interaction [12]. The architect has the challenge of balance, in a proper way, the program requirements and restrictions of the land and laws with the variables of sustainability to be considered.

The RTQ-C evaluates buildings for their energy efficiency. It starts from the principle that the regulation itself is guided by decisions of comfort and strategies that will result in a building energy efficient. One of the respondents who used the Brazilian regulation to evaluate a project, states that he "conceived the building following the concepts of environmental comfort," without worrying exactly about the RTQ-C, but with what he believed to be correct in terms of environmental comfort.

However, it's importance to highlight the experience and knowledge of the professional in this context. If the architect does not master the concepts of sustainability and / or environmental comfort, it becomes more difficult to conceive those projects. The architect must seek, through specialization and update, to increase, or somehow to recycle his knowledge. To look for some sort of specialization It's an alternative for professionals that might have some technical difficulty, they can incorporate into their processes of architectural design concepts of environmental comfort, sustainability, energy efficiency and bioclimatic.

It is important to say that this is not about the unworthiness of the professional, but rather to add to their experience new knowledge, or knowledge that has not been consolidated during their basic training.

The Brazilian Regulation of Energy Efficiency. The Regulation of Technical Quality Level Energy Efficiency of Commercial Buildings, and Public Services (RTQ-C) was developed to evaluate the energy performance of buildings and, to the present date, has its non-obligatory use. The architects interviewed in Group 1 had buildings labeled and reached level "A" (more efficient, according to the RTQ-C).

Respondents agreed that the regulation does not hurt their projects processes and serves as a way to complement them. Many of the criteria addressed by RTQ-C are already included in the design process and the regulation appears as a way to ensure and attest what is already done. One of the interviewees demonstrated including satisfaction with the certification because it generated a second trust factor with the customer and increases the credibility of their work. According to the analysis of the respondent, the regulation made a positive impression when it certified the project.

There was influence of RTQ-C in the project process of 3 respondents who used it. However, they state that the use of the regulation didn't block them for new alternatives and much less changed the way they design. Adjustments were made to definitions after the launch of the project, in points that do not interfere abruptly with the initial idea, as color choice (minimizing the use of dark colors) and some

materials (targeting a reduction in the coefficient of thermal transmittance).

The format of the content of the RTQ-C was approached by one of the interviewees, who asked about factors such as no assessment of natural lighting and bonus system. Although this evaluation system has not effectively damaged the development of the work, some changes in the criteria of the RTQ-C may contribute to the use of the regulation. Project definitions in order to take advantage of natural lighting don't add points in the process of labeling and don't grant any subsidy for calculating energy efficiency, according to the respondent, may be detrimental to the labeling process.

It is clear from the interviews that the application of the concepts and strategies of comfort favors the use of the regulation, at least from the standpoint of design, so that we can reach a favorable label. Knowledge of criteria such as solar orientation, shading, absorptivity and thermal transmittance, are essential for the architect to answer the RTQ-C without necessarily mastering it.

All respondents from Group 2, who did not use the RTQ-C, know of the existence of the Brazilian regulations for energy efficiency of buildings, but are virtually unaware of its use and how its application and implementation is. There is an evolution in terms of knowledge of the issue, but this evolution it's not enough to be seen with emphasis on the process of design and construction industry.

What could be ascertained through the conversations is that there are factors that can be considered responsible for this slow progress in using the RTQ-C, such as disclosure and enforcement. The mandatory application of the regulation, according to one interviewee, is a way to make clients and contractors use the RTQ-C. For the respondent, if it's not mandatory, the feeling is that there is no immediate benefit, and the regulation is not necessary. This argument became clear in an example, the client discards using RTQ-C because it would not affect the approval of the project by the City. Therefore, it is not necessary that the Architectural Design has, for example, all elevations, and the details level is greatly reduced, which in some cases may discourage the client to label the building with a misperception that he will spend more to do something that in the bureaucratic point of view it is not necessary.

On the other hand, the fact of receiving an energy efficiency label may ultimately stimulate the customer to have their building as a reference forward the press or public opinion, especially from the point of view of marketing. The political factor can be an outlet for disclosure, since governments can take advantage of that by having executed work labeled and energy efficient.

The question of the limitations of regulations, standards and certifications, has also been mentioned in the conversations. In the opinion of one interviewee, the architect must incorporate the regulation in their design process, so that it can assist him and also guide him in finding solutions. It was suggested a reduction of taxes according with the investment and the energy reduction achieved as sort of an incentive to customers.

Only one respondent of Group 2 stated that he knows the regulation because it was applied to one of his projects, assisted by a consultant. Even though the labeling process did not occur, the experience was positive. The regulation influenced the project mentioned, because after being made the calculations of sun inclination and sunlight, the inclination of the brises was changed and the solution to the zenithal openings modified. However, this does not harm the creation process precisely because the concepts of comfort and bioclimatic architecture were already incorporated. The regulation served as asses for the solutions found.

Note also that energy efficiency had a predominant role and was even supported by the economic factor. The option for the issue of energy efficiency across the aesthetic and context occurred due to the economy that would be generated in a building with a considerable area and public character. The respondent quotes flexibility in some of his beliefs, weighted on alternatives that may emerge and are analyzed and discussed. The same respondent also says that in considering the question of energy efficiency since the beginning of the process steps can be overcome and the result will be interesting. This statement is consistent with what was seen in Group 1, which considers energy efficiency as a result of a project guided by requirements of comfort.

The interviews shows a lack of appreciation of the professional when their design decisions are compared to the processes of computer simulation by software in the sense that the professional has a knowledge that gives the necessary experience to design thinking in energy efficiency. According to them, the architect cannot be dependent on a certification or a software which verifies if a building is sustainable or energy efficient.

The Consulting Service for Architecture. The use of the consultancy service is an activity in which a professional makes a diagnosis and / or point solutions on a subject or specialty. In Architecture this professional can be an expert in the area of Environmental Comfort, Energy Efficiency, Air Conditioning, among others. The intention is to share their experience and point solutions that can add better

alternatives on a project. All participants of the two research groups used Consulting Services in their work.

The buildings labeled by RTQ-C, involved the consultancy service in all cases since the beginning of the project, facilitating the progress of it and making design changes for labeling almost all punctual. The result was seen with great satisfaction by the architects, who confirmed the need to use the service more frequently and in a greater number of jobs.

The constant use of the Consultancy would add a higher quality to the project and would assist the architect in matters which may not be in his domain. The service can be complementary to the design process by the fact that, when inserted at the beginning of the work, modifications and adjustments can be lessened and even avoided. Respondents said that work with a consultant can expedite the steps of the design process and reduce deadlines. This analysis is bolstered by the former category, which affirms that the project should be based on decisions of comfort: thus, the consultant can pass on information so that the designer will get better results in energy efficiency, without the need of proceeding with adjustments that compromise the initial idea.

According to testimonies, Consulting assisted in understanding the regulation and its application, and it was of fundamental importance for the architects so they could set the project in order to get the label to the desired level. By using the regulation, one respondent reported the problems identified with the help of a consultant, for example, the non use of natural lighting and proper orientation of facades. According to him such issues should be better addressed and require analysis in order to be incorporated into the RTQ-C.

Again the experience and professional knowledge appear in the statements, now as a way to streamline the work process between the architect and consultant. According to the respondent, to dominate and to use the concepts of bioclimatic and comfort in their design processes, architects will achieve better results and a greater dynamic at work with the consultant. As previously reported, the mastery of these concepts and the correct application will refer them to an efficient building that can achieve a better label, and facilitates interaction among professionals, streamlining and minimizing the work deadlines.

In interviews with the architects that did not use the RTQ-C, interesting solutions have emerged, with prospects for integration not only interdisciplinary, but also corporate. Incorporating a professional involved with the dynamic aspects of technical and other area in the office environment would be ideal to create the necessary interaction from the

beginning of the process. According to respondents, the participation of the consultant after the initial stages of the process will not be enough to reverse a wrong solution and will only serve to accentuate any possible problem. The modifications that invariably arise in a consultation process and are discussed and evaluated, must effectively contribute to the desired result by both the architect as the consultant, modifying or improving troubled spots in search of a more satisfying alternative. With the presence of the consultant in the office, the information tends to be transferred more quickly to the team in a dynamic process of continuous consultation in decision-making.

However, for the two groups of respondents the cost of consulting should also be considered when using the service. The service can become unwieldy if the architect or architectural firm needs to afford the fees of a consultant without obtaining support from the client to execute the contract. One respondent believes that the service still appears as an extra cost, which needs to be sold to investors or clients.

Nevertheless, the results of the interviews show the use of consultancy service early in the process as a positive trend, at least on the issue of energy efficiency.

CONCLUSION

The architects that used the RTQ-C consider that it relies on variables present in the routine of a project, making the regulation a way of supporting and assessing the design decisions. There for, to base these decisions on the concepts of comfort and bioclimatic strategies makes it unnecessary to dominate the RTQ-C to achieve a label 'A' of energy efficiency; you simply introduce these concepts from the beginning of the design process. With this, its use has been approved by all the architects that have used it. These think that its application helped them obtain data and settings targeting the energy performance of a building. The impact of regulation was considered positive, serving as an instrument of adjustment and calibration of the design strategies that have been applied. The regulation influenced the way these architects design but, according to them, did not interfere in their design processes. The architects that didn't use the regulation; say they do not know it because of the inefficient disclosure and not mandatory application. The non-obligation use of the RTQ-C is seen by architects as an obstacle to the regulations implement, as clients and entrepreneurs still see it as an extra expense. It is not considered the savings that can be generated with electric bills, costs of operation and maintenance over the life cycle of the building. There seems to be a barrier preventing the architect get to the regulation, limited on one side by the client (or the amount of money that the customer is willing

to invest), and across the fear of having to change their beliefs, been projective, aesthetic or techniques. Ignorance and lack of encouragement to apply the RTQ-C is related to a weak disclosure and not the application of the regulation. It is not enough to educate only the architect, but also public opinion, the construction market and public agencies. Regardless of the Brazilian regulations to be mandatory or not, this article shows that, when incorporated in the initial stages of the project, the concepts of bioclimatic and comfort can effectively improve the energy performance of a building, and measurement tools can and should serve as support to the acquired knowledge.

The research also pointed to the importance of this knowledge on the issues of sustainability and environmental comfort applied in architecture. When this knowledge is not consolidated, the support of a consultant can be decisive, contributing to more significant results in the development of a project, whether labeled or not. The use of the service needs to be incorporated into architectural offices, either in a particular way for a single project, or effectively, with a consultant that is part of the work team, being able to minimize possible corrections and adjustments in the advanced phases of the project. However, even been considered essential and sometimes critical, the cost of the consultancy service is still seen as a problem because clients and companies sometimes need to be convinced to hire a consultant, leaving to the architectural firm the decision to hire and bear the costs or not to use the service.

ACKNOWLEDGEMENTS

Thanks for the financial support provided by Fundação Norte Rio-Grandense de Pesquisa e Cultura (FUNPEC), through the Rede de Eficiência Energética de Edificações (R3E). Thanks for the technical support provided by the Laboratório de Conforto Ambiental (LabCon) of Universidade Federal de Santa Catarina.

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