

The Role of Egyptian Residential Buildings Energy Code in Enhancing Sustainable Development in Egypt: Evaluation of Nine Years of Practice

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Abstract:

Achieving sustainable development in general, and in emerging countries in particular is a challenging process that requires the contribution of various governmental, institutional, and individual entities. The role of architectural design is essential in this process as it is considered as one of the earliest steps on the road to sustainability. Residential buildings sector is responsible for 40% of energy consumption in Egypt. Egyptian Residential Buildings Energy Code (ERBEC) was established in 2006 to address the minimum requirements of energy efficient building in Egypt. This study aims to evaluate the nine years of practice of the ERBEC, based on a structured questionnaire among the architectural firms in Egypt. A case study of fifty two architectural firms in Cairo were selected and categorized according to their sizes; large-scale, medium-scale, and small-scale. A questionnaire was designed and sent to the firms via email, and personal meetings with some firms' representatives took place. The results of the study revealed that only little percentage of the large-scale firms have clear strategies for the use of the ERBEC in their design process; however, the application is limited to certain projects, or according to the client request. On the other hand, the percentage of small-scale firms is much less, and it is almost absent in the medium-scale ones. This demonstrates the urgent need of enhancing the awareness of the Egyptian architectural design community of the great importance of addressing the ERBEC starting from the early stages of the building design.

Keywords: Architectural Firms, Egyptian Residential Buildings Energy Code, Energy Efficiency, Sustainable Development in Egypt.

Introduction

Achieving affluent human environment with the less demand on resources such as materials and energy, is one of sustainable development aims, which consists of three dimensions, namely economical, social and environmental. Therefore energy has a crucial effect on these factors such as increasing demand on energy due to rapidly population growth and their spending in addition to fossil fuel production and consumption impact on the environment, (Johansson, 2002) (Annual report, 2015).

In developing countries electricity is the predominant consumer in energy sources therefore energy policies have to consider efficiency and conservation issues (Martínez, 2015) particularly the last five decades (Baniassadi, A., et al, 2018) moreover it is one of major aims of the Egyptian sustainable development vision 2030. Shaikh et. Al, (2016), mentioned that reducing energy consumption in building sector decreases the dilemma of energy resources deficiency, while residential sector is responsible for more than 27% of global electricity consumption (IEA, 2017).

In a local context 99% of households in Egypt connected to the electricity system, this in addition to socio-economic development led to significant increasing on electricity

demand in recent years (Razavi, 2012), sales ratio of air conditioner in Egypt the past decade could be taken as an evidence where it increased about 14 times where reached 54000 units in 1996 and 766000 in 2010 (Attia et. al., 2012) and (Attia and Evrard, 2013) what expected to increase under the impact of global warming, thus there is a necessity for codes to provide frameworks and guidelines to adapt the relation between building and its energy consumption and sustainability in general. In this context Egyptian government established energy codes as one of its strategies to develop energy sector.

Housing and Building National Research Center (HBRC) established the Egyptian Residential Buildings Energy Codes (ERBEC) in 2006 to achieve the minimum requirements to improve energy efficiency in existing and new residential buildings for each climate zone in Egypt (HBRC, 2008), Hanna (2004, 2011 and 2015) investigated the development and procedures criteria of ERBEC, however the research team argue that it misses accuracy because each climatic region covered wide area which has a vast various between microclimate and macroclimate. Furthermore, (Mahdy and Nikolopoulou, 2014) enhances this argument where they suggested a development achieved much better results than the ERBEC, Nevertheless it should be applied during design or retrofitting processes in Architecture, Engineering and Construction sector, what reflected the importance of designers' role to contribute in solving this problem.

Several studies investigated the awareness level of codes and rating systems which include related issues to the energy. (Shamseldin, 2015) pointed out to that about 80% of construction makers in Egypt do not know the existence of a local rating system, namely Green Pyramid Rating System (GPRS) which provides environmental assessment method of buildings, and she concluded that the the government is responsible of increasing local building sector awareness, to encourage professional stakeholders to apply it and to enforce it within the building permits, as well as policy makers have the ability to increases efficiency of energy codes implementation systems (Evans et al, 2017).

On the contrary, (Khodeir and Nessim, 2017) highlighted that large architectural firms in Egypt are recently being oriented towards the adoption of Building Information Modelling and Building Energy Modelling in order to conserve energy, however their result employed among employees of 20 firms was not limited to AEC sector only, what could be considered in their findings. In the same context (Mohamadin et al (2018) mentioned that uses of environmental software among architectural firms are increasing in terms of energy and competitiveness aspects.

From the above literature a contradiction blowed up about environmental awareness in AEC sector, therefore there is a need to investigate to what extent designers in AEC sector in Egypt apply the code limitations during design residential projects of any level, which are classified economically according to Egyptian Housing Minister Decree no.37 in 1977 into four categories based on area, firstly economical, which shouldn't exceed 60 m², secondly middle from 50 m² to 90 m², thirdly upper-middle from 75 m² to 125 m² and finally high which is higher than 125 m², specially several codes and systems are spreading in Egypt which aims design or construction processes either well-known global systems such as LEED, or local such as GPRS and TARSHEED which developed recently (<http://www.tarsheed-eg.com>).

In the context of energy issues awareness, authors argue that there is a factor affects ERBEC implementations in practice in Egypt. For instance, postgraduate education in Cairo University could be taken as an indicator where registered post graduate candidates in Environmental Design program - under Architecture program- accounted by the large

amount between 2011-2016 this argument popped-up based on a personal experience of one of the authors, where ERBEC is one of core courses of the program.

Given the above, several factors should be considered during the investigation, namely residential projects types, postgraduate education, in addition to investigate designers' point of view about codes implementation responsibility and obstacles.

Research Design and Methodology

A quantitative research method was employed through a survey among architectural firms (respondents) in Egypt. A structured (close-ended) questionnaire was designed by the research team for this purpose, and it was distributed in three stages between October and November 2017, and between March and May 2018. The first stage was a pilot test stage applied to real respondents in order to investigate responses to questions and to verify if there are incomprehensible terms or ambiguities, and the second stage was the full-scale study stage.

In the pre-testing stage, six respondents were contacted through direct phone call followed by e-mails to complete the questionnaire, these firms were as following; one well-known large-scale firm, one medium-scale firms and four small-scale firms, and it was then modified and the problems of unclear wording, conflict on understanding and questionnaire length were corrected. Then in the full-scale study, the questionnaire was distributed through the online platform (Google Forms) on a number of fifty two firms -including the pre-testing samples- practicing architectural design in Egypt. Where firms' size classified according to the American Institute of Architects (AIA); where it has been frequently measured in terms of employment numbers where it divided into three size where small firms as 1-9 employees, medium firms from 10-49 and large firms as 50 or more.

The selection criteria of the architectural firms included in this study was based on several aspects as follows; firstly all the study group should be of licensed firms that have a professional working practice in the Egyptian market not less than five years, secondly led by registered architects and located in Greater Cairo which corrected later to be Egypt due to pre-testing stage's feedback. Those firms either provide architectural service as standalone architectural firms, or design department in AEC firms.

The Investigation

Firms' representatives (owners, principals and design engineers) were asked to fill out the questionnaire that is consisted of seven questions, which is divided into two categories, firstly from question 1 to 4 to verify firms' characteristics, namely; firm size, employees' academic qualifications, and the economic level of their residential projects and client, secondly questions from 5 to 7, to verify how often they make ERBEC part of their design process, what are the factors that led them to decide not to be guided by the ERBEC, and who is the responsible to apply the code.

Firms characteristics

Patterns throughout the firms cohorts of the study group were looked at and trends were outlined. First set of questions, the respondents accounted for fifty-two firms; 24 small firms(SF), 9 medium firms (MF) and 19 large firms (LF), the academic qualifications the

results show that 63% of respondents have a post graduate employees, as well as the majority of LF while MF and SF are equally as shown in figure 1.

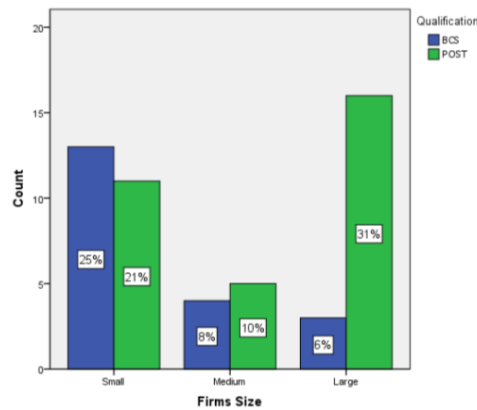


Figure 1. Academic qualifications in different firms' size

On the other hand, the majority of samples work in private sector projects accounted for 93% while 7% work in governmental projects. For the economic level of the residential projects. For economic level of the residential projects investigation, the result of multiple choices question shows that high-income projects represented the significant amount accounted for 44 responses followed by upper-middle, middle and low income housing accounted by 15, 11 and 2 respectively, as shown in figure 2.

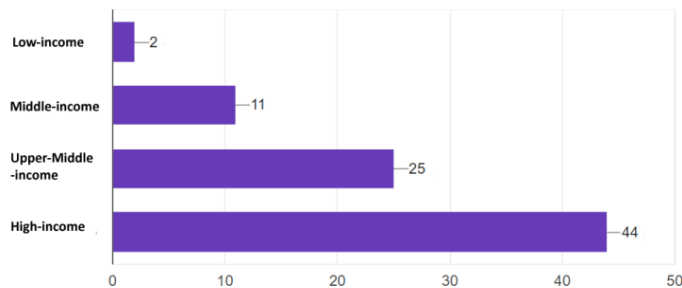


Figure 2. Housing projects economical levels

ERBEC Implementation

Study population was asked to state to what extent they apply ERBEC in their design process in any housing projects. The responses showed that 40% of the study population have never used the code before. On the other side, only 8% very often used the code, while 35% and 17% used the code sometimes and rarely respectively.

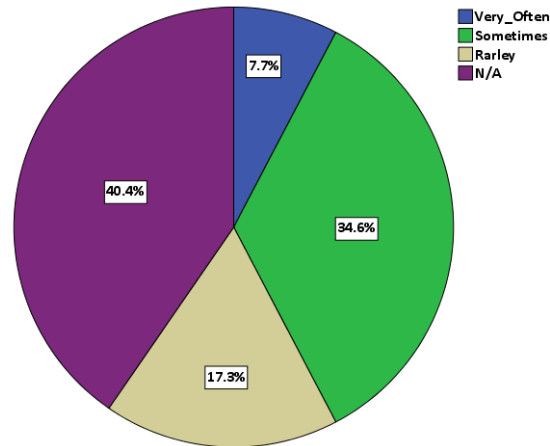
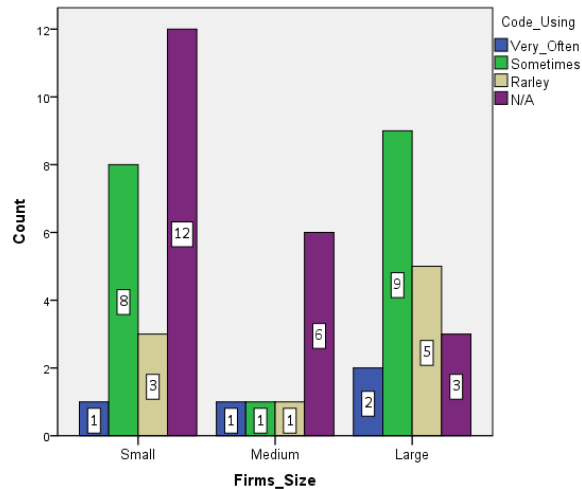


Figure 3. ERBEC Implementation in design process

In the same context, figure 4 shows the relation between firm size and code implementation, firstly, in LF about 47% sometimes follows the code, while 16% didn't use the code, then 26% and 11% use it rarely and very often respectively. On the other side SF result shows that 50% never use the code before, followed by 33% sometimes then 13% and applied the code rarely and 4% very often. While in MF the majority -67%- never use the code before while the rest answers are equally by 11% for each.



To investigate the respondents' point of view about the aspects which led them not to be guided by the code and the obstacles see questionnaire in Annex 1. The choices designed not only to cover both extremes of answers but also to check the reliability of respondents, for instance, several responses were excluded due to conflicts in answer such as "I sometimes use the code" but in following response "I have never heard about it".

Overall, as shown in Figure 5. And annex 1, the answers could be categorized in two categories; first group, those whom know the code requirements, where 38% from respondents mentioned it is unimportant in the real experience due to market demands, second respondents category accounts by 13% didn't try to follow it or to provide the idea to the client, then 8% referred to clients' responsibility to refuse the code, then 8% mentioned they used another codes, and finally only 2% stated they already apply ERBEC.

Second category those whom did not hear about the code, 17% mentioned that they have never heard about ERBEC before, and followed by 13% whom will take it into consideration later.

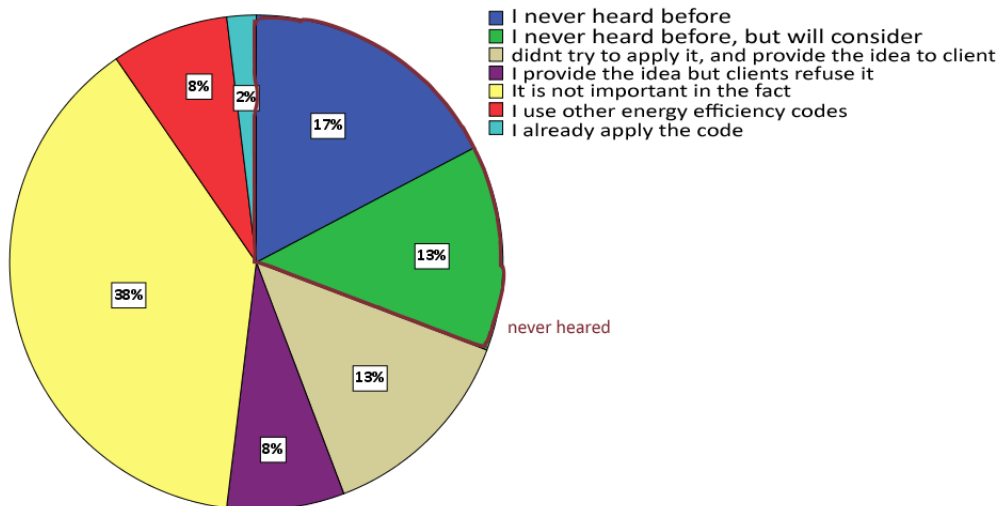


Figure 5. Question no.6 response percentage

In the same context, figure 6 depicts the relation between firm size and ERBEC using/non-using.

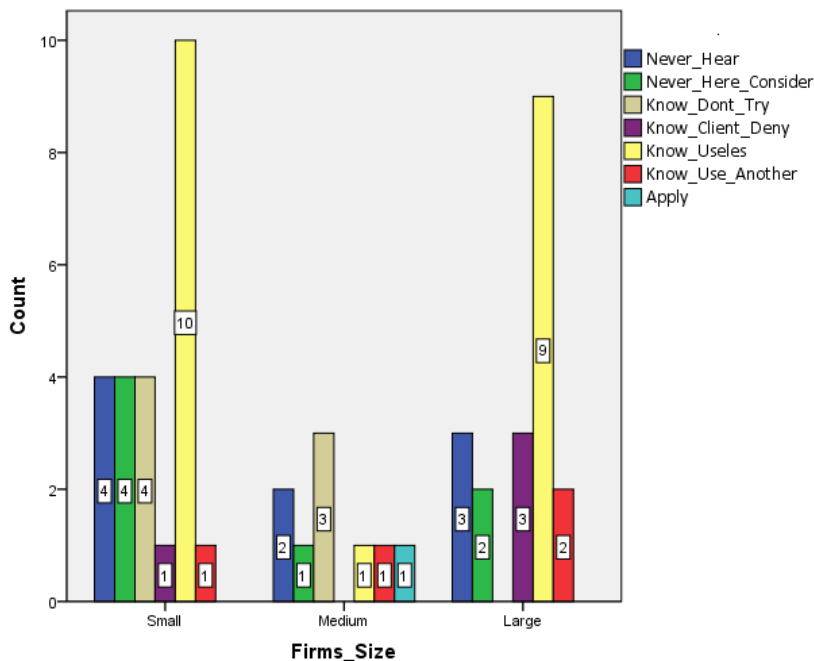


Figure 6. firm size and code implementation

The result shows that in LF the large amount account by 47% emphasized on ERBEC not in market's interested area, and 11% use another codes and 16% through the responsibility on client, while 26% never hear about it. On the other hand, SF recorded

similar percentage to LF with quite difference that 18% of samples did not try. Eventually MF where 33% didn't try to apply the code, while there is not any respondents put the responsibility on the client, and 22% mentioned they never heard about the code, finally the following answers distributed equally by average 11%.

On the other side, to investigate respondents' point of view about who is the responsible to apply the code, the result shows that 42% mentioned policy makers then by owner and architects by 33% and 25% respectively, as shown in the figure 7. This ordering is similar to LF and SF , while MF proceeded the responsibility as following; policy makers, architects and owners, as shown in figure 8.

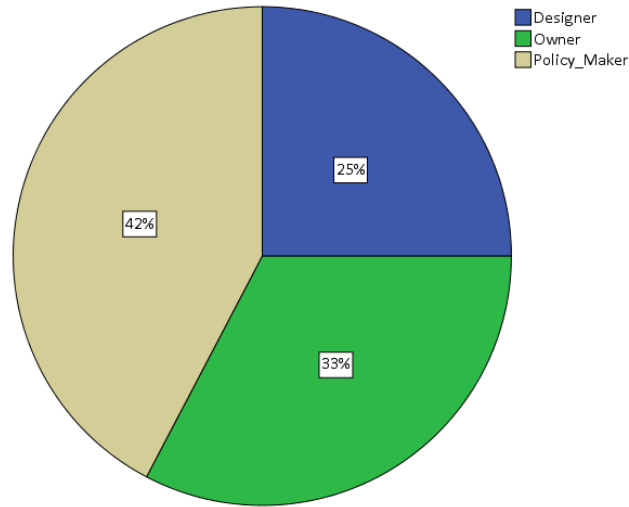


Figure 7. Responsibility

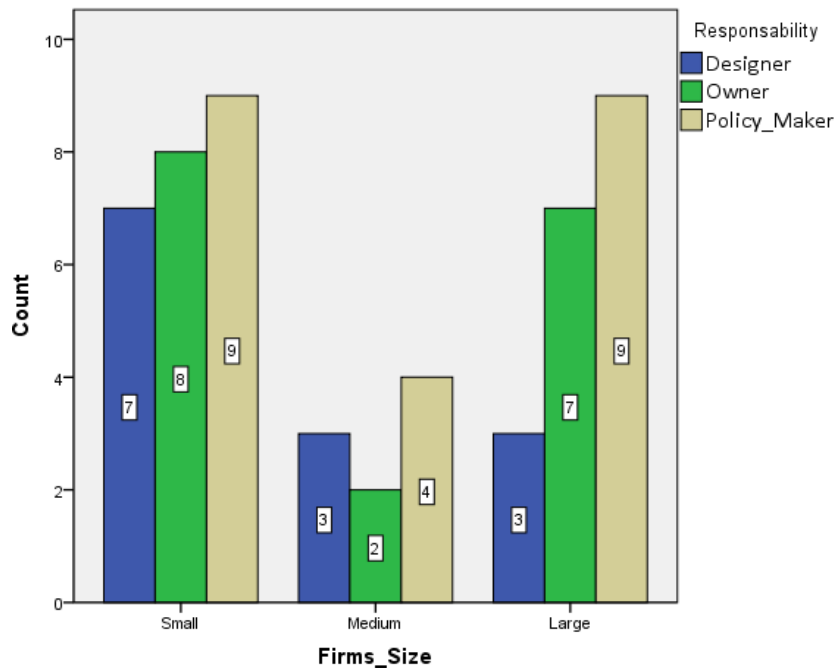


Figure 8. Firm size and responsibility

Conclusion

The study confirms a number of the assumptions that are set previously in this paper; that only little percentage of the large-scale firms have clear strategies for the use of the ERBEC in their design process, however the application is limited to certain projects, or according to the client request. On the other hand, the percentage of medium-scale firms is much less, and it is almost absent in the small-scale ones. This shows a correlation between the firm size and the application of the ERBEC. Although large-scale firms have the highest positive responses, the number of firms in terms of implementation of ERBEC is still few where positive responses of large-scale firms accounted for 17% of the study population indicated that they use it sometimes, 25% rarely use it, and only 4% use it very often. The respondents justified this in their answers to the next question about the reasons, where the majority chose answered that it is not important for their business. This describes the high responses regarding the responsibility of implementation, where the majority see that it is the policy makers responsibility to apply regulations of the code. In this context, the authors agree with that point of view that policy makers have great responsibility regarding this matter following precedent experiences in other countries such as UK and UAE. In addition, the authors support the point of view of the big role of AEC firms in encouraging the stakeholders for a better consideration to the energy efficiency aspects in building sector.

In addition to this, the academic level of the design team was confirmed to be an essential factor for the attendance or absence of the ERBEC within the firms' design process due to the knowledge gained in post graduate studies regarding building codes in general and the ERBEC in particular. Moreover, the economic aspects seem to be essential in the decision making on whether to be guided or not by the ERBEC in the design process, where the majority of the projects held by the firms are in the private high income category. Additionally, the competitive nature of the Egyptian design market forces all the stakeholders to produce big quantities of design production in limited time without having sufficient time to add the environmental aspects into consideration, consequently, the use of building energy codes is usually a hard decision to make in such a rush of time.

This demonstrates the urgent need of enhancing the awareness of the Egyptian architectural design community of the great importance of addressing the ERBEC starting from the early stages. The benefits to promote taking in consideration the energy efficiency aspects in building design sector and its advantages on the running costs of buildings should encourage the stakeholders to adopt it in their projects.

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Annex 1. The Study questionnaire

<p>Q1. How many employees work in your firm?</p> <p>1.1o 1 - 9</p> <p>1.2o 10 - 49</p> <p>1.3o 50 or more</p>	<p>Q2. What are the academic qualifications of the members within the design team of your firm?</p> <p>2.1o Bachelor's degree</p> <p>2.2o Bachelor and Post graduate degree</p>
<p>Q3. Which economic level of the residential projects does your firm work in? (select all applicable answers)</p> <p>3.1o Low income housing</p> <p>3.2o Middle income housing</p> <p>3.3o Upper-middle income housing</p> <p>3.4o High income residential</p>	<p>Q4. For which sector your firm design most of the housing projects?</p> <p>4.1o Private Sector</p> <p>4.2o Governmental Sector</p>
<p>Q5. Has your firm ever used the Egyptian Residential Building Energy Code in any of the firm's residential projects?</p> <p>5.1o Very often</p> <p>5.2o Sometimes</p> <p>5.3o Rarely</p> <p>5.4o Not applicable</p>	<p>Q6. What are the obstacles that may prevent applying code requirements?</p> <p>6.1O I have never heard about it before.</p> <p>6.2O I have never heard about it before, and I will reconsider it.</p> <p>6.3O I know code's requirements, but I have not tried to apply it or provide the idea to clients.</p> <p>6.4O I know code's requirements and I present the idea to the client, but they refuse it because of the high cost or other reasons.</p>
<p>Q7. From your practical experience, who is responsible for taking the decision of using or</p>	

not the ERBEC?

7.1o Architect

7.2o Client

7.3o authorized authority to issue licenses

6.5O I Know code's requirements, but in fact it does not fall into the attention of the market.

6.6O I know code's requirements, but we use another energy efficiency codes and references in residential buildings.

6.7O I already apply code's requirements.