



المؤتمر العربي الثاني للأراضي

Second Arab Land Conference

22-24 FEBRUARY 2021
CAIRO, EGYPT

Name of the Session [Technical session 5/b: Efficient land use: tools and practices]

Title of the Paper: Reconsidering the Egyptian building code with regard to street widths and their impact on the daylight quality inside residential spaces

Date: 23/2/2021

Author(s): Alaa K. Abo Al yazeed¹, Mohamed Fikry² and Zeyad El Sayad³

¹ Teaching Assistant, Department of Architectural Engineering in Kafr El Sheikh University, alaa_abbas2010@eng.kfs.edu.eg

² Professor, Department of Architectural Engineering in Alexandria University, mfikry2004@yahoo.com

³ Lecturer, Department of Architectural Engineering in Alexandria University, Zelsayad1@alexu.edu.eg

Keywords: daylighting; Egyptian building code; land planning; street widths; energy saving; residential spaces.

Executive summary

This paper presents recommended considerations in Egyptian building code 119 for 2008, or what is called the Unified Building Law no.119 for the year 2008; for achieving optimum daylighting in residential spaces by comparative analysis methodology of the Egyptian building code with other building codes, which are Indian and Californian building codes. It aims to know the shortcomings and the gaps in the Egyptian code represented in the generality of the code regarding natural lighting, which does not consider the influence of land planning elements on the quality of interior daylighting, such as the different street widths surrounding the building and their relationship to the building height. Then increase the efficiency of the side facades located on narrower streets, as a case study by exploring simple methods, optimal street widths and external configurations of the building that meet a healthy environment and ideal lighting quality for residential spaces located on side streets and applying this in Egyptian cities with high population density. This is can be done through an analytical review of a set of available information sources. Finally, reaching a set of recommendations to the concerned authorities and opening new fields for future research.

Table of content

- 1- *Introduction.*
- 2- *Methodology.*
- 3- *Problem statement.*
- 4- *Review of different building codes concerning similar climate to Egypt.*
 - 4-1 *Historical background for codes.*
 - 4-2 *The relationship between street widths and building height.*
 - 4-3 *Results and discussion.*
- 5- *Case study: increasing side facades efficiency.*
 - 5-1 *Adaptive side façade.*
 - 5-1-1 *In case of side street 10m.*
 - 5-1-2 *In case of side street 18.3m.*
 - 5-2 *Green roof.*
- 6- *Conclusion.*
- 7- *Recommendations.*
- 8- *References.*

1- Introduction

Using natural daylight has become a priority; for saving non-renewable energy causing carbon emissions and global warming. Daylight achieves good vision that means it has illuminance, color rendering and discrimination (Boubekri, 2008; Knoop and others., 2020). Electric lighting is harmful and relying on it for long hours causes stress and discomfort (Boyce, 2014).

Building codes control the quality of lighting inside the space on two levels, the first of which is planning, where the distance between each residential land and another (street widths), and the second of them is the design that includes openings, internal finishing and the external configuration of the building.

Therefore, the research relied on the Egyptian building code 119 of 2008 as the basis for the study but at the planning level.

2- Methodology

Initially, the research problem was clarified through the available literature. Then, the unified building code was compared with two other building codes for two countries that have similar climate as Egypt, using the comparative analysis method to highlight the code gaps concerning the research point. Work was done to find a solution to one of the lighting problems related to lands planning that was neglected without explanation in the code using the available simple techniques.

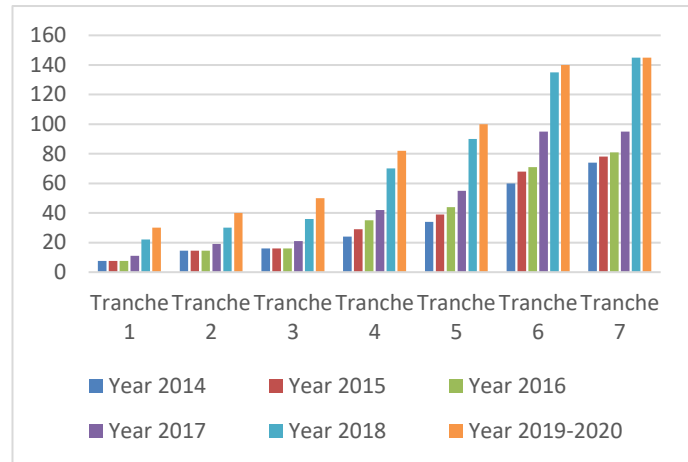
Finally, the research summarized a set of recommendations for the authorities concerned with developing the code.

3- Problem statement

Artificial lighting has a significantly negative impact on its users, as relying on it for long periods causes psychological, environmental, economic and health effects (diseases that result from moisture) ... etc.

Recently, Egypt witnessed a very noticeable increase in the price of electricity as shown in Fig. i , especially in the low-income group (Hanna, 2010; Hegazy, 2015). Studies prove the aggravation of the problem in the coming years (Egypt, 2020), as the Ministry of Electricity submitted some annual reports for the last ten years. These reports indicate that the rate of consumption is increasing significantly yearly (Egypt, 2018), therefore it is necessary to research about finding solutions to avoid this in the future, especially lighting in residential buildings as it is one of the largest consumers of electricity (Hanna, 2010).

Fig. i . Electricity tranche price from 2014 to 2020 in Egypt. Source: Author depends on (Salah, 2019).



The Egyptian Building Law 119 of 2008 (and its executive regulations) include determinants that directly affect natural lighting inside residential spaces at the planning and design level. Through observation and research, it was found that there are some determinants and values mentioned in general without conditions or details (Egypt, 2008, 2009).

The side facades were highlighted as a case study in order to give it the same importance as the main facades in the code concerning natural lighting, as it must be given the same attention from the code.

The study considered that Egyptian cities have become concrete blocks that represent buildings and towers in addition to the streets, while neglecting the plant component in the city that provides visual and psychological comfort. so, the study tried to make the review of this aspect an integral part of the research objectives.

4- Review of different building codes concerning similar climate to Egypt

The two locations (India and California) have been chosen because they have a very similar climate to Egypt's climate; as they are all located in the tropical climate. Considering the other differences between them, whether social, economic, cultural, etc. Egypt and India have clear skies, while California has clear skies in areas and overcast in other regions and applies the International Building Code that does not differentiate between the types of sky (Clear Sky Chart Search – find sites with good conditions for astronomical observing., no date; Climate-Data.org, 2012; sunearthtools, 2020).

4-1 Historical background for codes

The building code in California published on October 18-21, 1927 the first version. Every three years, a new revised version of this code is published (UC Berkeley Library, 2019).

As for the Indian Building Code was first published in 1970 and then made some revisions from the competent authorities in 1983. After that, three major amendments to the copy were issued in the years 1987 and 1997. The code was issued for the second time in 2005, and minor modifications continued.

Because of the large-scale changes witnessed by the world including India in all aspects such as high-rise buildings, housing and planning, as well as changes in population density, all of this made the competent authorities to set up a special committee to issue the Indian building code for the year 2016 and still until now there are some reviews of development but not Within a new version, where 2016 is still the latest version (India, 2018).

Finally, the building code in Egypt went through three basic phases, starting with Law 106 of 1976, and then a modified version in the form of Law 101 of 1996. The latest issue was Building Law 119 of 2008 and its executive regulations (Elhadidy, 2010).

It is recognized that no new version of this law has been published yet, and this code is still being applied with its laws and penalties. Despite what is happening from the development for the world in all sectors, including the construction sector, its codes, and the problems it faces, thus searching for solutions for users and issuing new building codes to meet the needs.

In the following, the Egyptian building code 119 of 2008 will be compared to the following codes:

- California building code 2010 of Regulations based on international building code 2009.
- National building code of India by Bureau of Indian standards 2016 volume (one and two).

The first revised version after the year 2008 of each code chosen for the study, where the year in which the last Egyptian building code was issued, this is to make the comparison as fair as possible.

4-2 The relationship between street widths and building height

The quality of the natural light entering the residential space is affected by the distance between the window and the opposite obstacle (the facing building) and thus the width of the street between these two buildings (Elhadidy, 2012).

Table i. the widths of the streets surrounding the residential lands as stated in the building codes and their relationship to the building height. Source: Author based on (California, 2010; Egypt, 2008, 2009; India, 2016).

Comparative aspect	Egyptian building code 119 for 2008	California building code for 2010	Indian building code for 2016
Relation between Street width and Building Height	Building height = one and a half times the width of the street on which it is located with a maximum height of only (36 m). This is with respect to the main street. As for the secondary streets, they are not less than eight meters for existing areas in the city and 10 m for extension areas.	<ul style="list-style-type: none"> • Its width is not less than (18, 3 m) in the case of public streets or the yard. • In special cases, the building is surrounded by public streets, the width of which is not less than one and a half times the height of the building. 	<p>The height of the building shall not exceed (15 m).</p> <ul style="list-style-type: none"> • When a building's windows face a road where the external noise level is between 80 and 90 decibels, the building should be about (30 m) from the road and preferably (45 m) or more, • When the windows are at right angles with the noise shown above, the distance should be arranged as follows from (15 to 25 m); • In the case of a wall and trees between traffic/ home, the above distances are appropriately reduced.

4-3 Results and discussion

It is mentioned in the code that the height of the building is calculated based on the width of the main street only, as a maximum of 36 meters in height, and therefore the width of the main street will be a minimum of 24 meters, while the side streets surrounding the building may reach eight meters. This difference in street widths creates side façades of 36 meters high located on narrow streets that do not meet the façade's need for daylight. (See Article No. 15 in the Code and Article No. 53 of its implementing regulations) (Egypt, 2008, 2009). In contrast, the Californian code, taken from the international building code, sets a minimum for the surrounding streets of 18.3 meters. The Indian code at this point depends on the level of noise in the street and not because of daylight.

5- Case study: increasing side facades efficiency

According to the building code, Fig.ii shows the current situation of the main façade, side façade and layout, regardless of the location or the direction; because the code did not care about that, taking into account that the code allows the owner to have the fence at the top of the building, part of the façade is a tower and the ground floor is commercial floor. It is clear that the side façade is not the same as the main façade. As the side façade is not sufficiently exposed to natural light due to the opposite building.

Although the main facades located on wide streets, and what is stated in Code 119 is applied to them in terms of widths, heights and proportion of windows, the researcher (Elhadidy, 2012) indicated that windows need to be reconsidered to be effective in terms of daylighting inside residential rooms. Hence, it can be asked (if this is the opinion of researchers in the main facades, how is the efficiency of the side facades located on the narrow streets of the same buildings?).

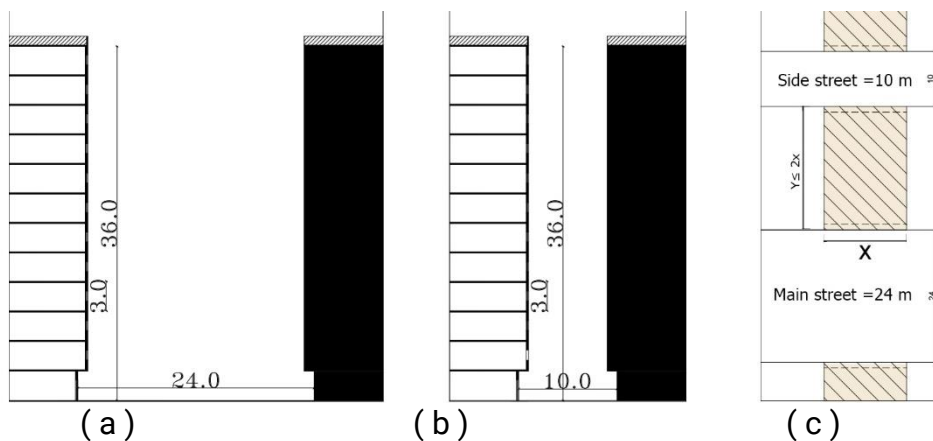


Fig. ii. The relationship between street width and building height as in Code 119. a. The main facade. b. The side facade of the same building. c. The layout.

When studying the side facades in two cases:

- The street width is 10 m, as in Code 119.
- The street width is 18.3 m, as in the California Code, which is based on the International Building Code.

Taking into account the results which Elhadidy reached from his research as a basis for the following study (see Fig.iii and Table ii). It was found that in the case of a street of 10 m, there are seven floors with windows that do not function properly because their angle with the opposite obstacle is completely unacceptable and needs to be reconsidered. On the contrary, the street with width of 18.3 m which has three floors only have the same problem.

Table ii. Applying the percentage of windows mentioned in Elhadidy study based on the angle of the obstacle on the side façades in the two study cases. Source: Author based on (Elhadidy, 2012).

floor	Main street(Elhadidy's results)		Side street			
	Street width=24m		Street width=10m		Street width=18.3m	
	Obstacle angle (Θ)	Window area/ room area (per cent)	Obstacle angle (Θ)	Window area/ room area (per cent)	Obstacle angle (Θ)	Window area/ room area (per cent)
commercial	-		-		-	
1 st	56°	10	76°	Unacceptable	63°	Unacceptable
2 nd	53°		75°		61°	
3 rd	50°	9	73°		58°	
4 th	47°		71°		55°	10
5 th	43°	8	69°		51°	
6 th	38°		65°		47°	9
7 th	33°		61°		42°	8
8 th	28°		55°	35°		
9 th	21°		47°	28°		
10 th	14°	35°	19°			
11 th	7°		18°	8	9°	

The Table ii shows that there are floors in the side façade that need a solution, as Elhadidy (Elhadidy, 2012) solved them in his research regarding the main façades, which are shown as unacceptable state.

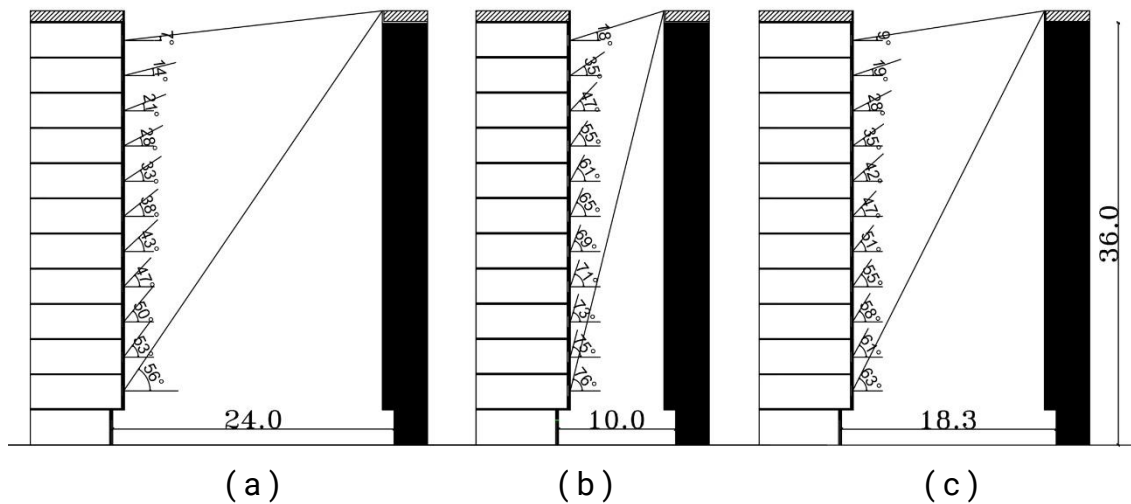


Fig. iii. The street width effect on the angle between the centre of the window and the opposite obstacle.

a. Street width 24 m. b. Street width 10 m. c. Street width 18.3 m.

5-1 Adaptive side façade

To improve the efficiency of the side facades, as in the main case, the recommendations of the researcher (Elhadidy, 2012) were applied regarding the area of the windows as a primary method. And because these percentages were based on the facades that are located on wide streets of 24 m, but this is not enough; as the streets are still narrow and to solve this problem, the concept of backward (recessed) was applied, which is a concept that has been applied in different cases and in different forms, such as what was mentioned in the previous Building Law 106 of 1976 and includes the following (Egypt, 1977a, 1977b): The height of the building is once and half the width of the main road, with a maximum of 36 meters, subject to two conditions.

- This height should be restricted to 25 meters from the building.
- A distance of 12 meters is left from the side facade at the intersection point of the main street on the side street, then the facade turns one eighth of the highest height of the building.

5-1-1 In case of side street 10m

After setting the alternatives and measuring the angles between the windows and the opposite obstacle, it was concluded that the recessed floors will start at the 6th floor (after the number of floors that achieve a height of 1.5 street width) by 0.61 m and 1.94 m for the next five floors and finally 2.61 m for the last floor (see Fig.iv). And a Table iii has been included containing the appropriate window area for each floor.

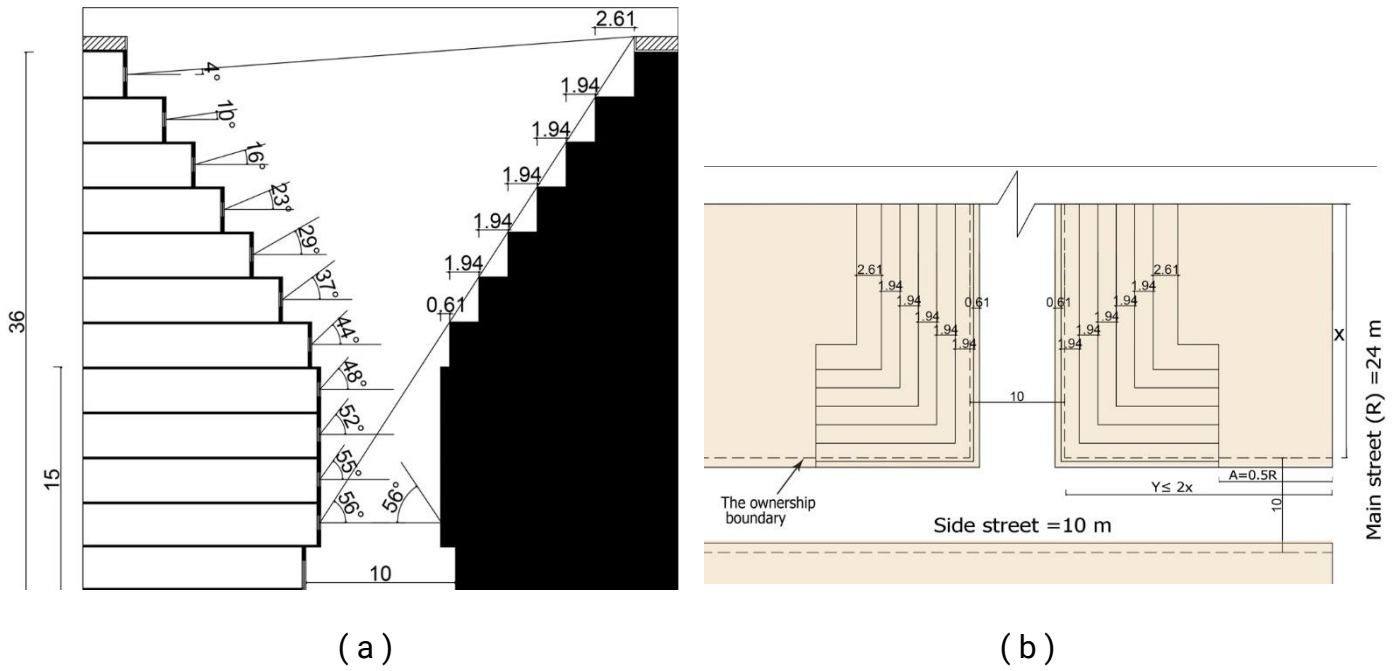


Fig. iv. The proposed model with side street 10 m. a. The section. b. The layout.

5-1-2In case of side street 18.3m

For side street is 18.3m as in Californian code, the recessed floors started in the 8th floor with 1.18 m ,2.71 for the next three floors after and 3.64 for the last floor, as in Fig .v. See Table iii where it includes the appropriate window area in this case.

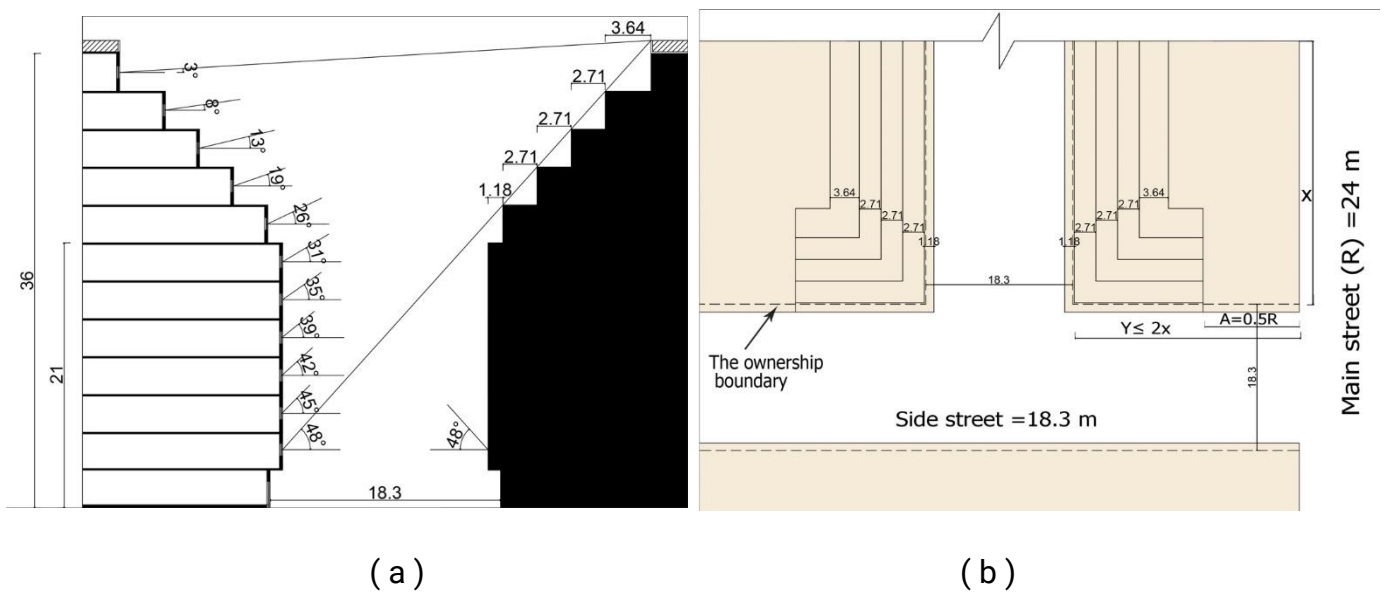


Fig. v. The proposed model with side street 18.3m. a. The section. b. The layout.

Table iii. The window area relative to room area based on the obstacle angle in the two cases.

floor	Side street			
	Street width=10m		Street width=18.3m	
	Obstacle angle (Θ)	Window area/ room area (per cent)	Obstacle angle (Θ)	Window area/ room area (per cent)
commercial	-		-	
1 st	56°	10	48°	9
2 nd	55°		45°	
3 rd	52°		42°	
4 th	48°	9	39°	8
5 th	44°		35°	
6 th	37°		31°	
7 th	29°	8	26°	
8 th	23°		19°	
9 th	16°		13°	
10 th	10°		8°	
11 th	4°		3°	

Each proposal, whether in the case of the street width as a minimum of 10 meters or 18.3 meters, has advantages, but it is noted that the last proposal provides:

- Reducing the number of rebound floors and thus increasing the built area.
- More floors with a window area that does not exceed 9 per cent of the room area and has adequate efficiency according to the law and previous research, unlike the case of the street with a width of 10 meters in which the area of windows in some floors increases to 10 per cent of the room area and thus the designer needs to solve the problem of heat that may be caused by wide windows in addition to the privacy.

The recessed part of the floors can be used as roof gardens, integrating nature with buildings in the city, and moving away from the concrete blocks that affect the city dwellers psychologically, visually and healthily (see Fig.vi).

5-2 Green roof

This part deals with the plant element in architecture for two reasons, which are to achieve what was previously mentioned regarding the visual comfort of the city settler, in addition to find a better form of the building recesses that were proposed in the case study.

Since old times there were green roofs, where they appeared in the form of stepped stone pyramids and were called ziggurats of ancient Mesopotamia in the fourth millennium to about 600 BC (Wark and Wark, 2003).

Fig .vi shows an example of a residential building with stepped terraces on 26 Vavin Street designed by Henri Sauvage in 1912-1914. When applying the same methodology in buildings, one must take into account when choosing plants, their types, heights, and soil layers appropriate for this, in addition to the irrigation method.

Fig. vi. The Henri Sauvage's Stepped-terrace Apartment Building. Source: (Wark and Wark, 2003)



6- Conclusion

The research deals with one of the problems that the user faces inside the building, and it may seem to the reader that its solution is limited to interior design, but it is strongly linked to the initial planning stages of plots of land in terms of street widths and the ratio of built land to others, etc. From here it can be said that planning and design influence each other.

Regarding electricity, an increase in its prices is observed, and therefore the research tried to find some solutions through the building code because of its effective effect to reduce electricity consumption, especially lighting, as it is the largest consumer of electricity in the low-income group.

When the building codes of different countries are reviewed with similar climatic zones, the research concluded that there is no integrated building code, as some aspects are achieved in one code and vice versa in another code and so on.

It is possible to use the available information sources from other codes or previous research to reach the best proposals after they have been adapted to be effective in various other cases without the need to reuse complex simulation programs and professional calculations, as in the case study.

7- Recommendations

Through the research, it is possible to reach a set of recommendations that matter to planners and those who improve the code, in order to achieve optimal natural lighting within residential spaces. These recommendations can be summarized in the following points:

- Reconsidering the code articles that relate to planning residential lands and have an effective impact on the user's comfort aspects, especially Article No. 15 in the Code and Article No. 53 of its implementing regulations.
- The possibility of benefiting from some of the previous Egyptian code materials that have been canceled, as some of them may be valid for application now, but by adding some modifications to make them more efficiently, as the Building Law 106 of 1976.
- Giving the side facades of the building; the same importance that the main facades have regarding natural light, as it is one of the most important requirements of the user.
- Merging the plant component with buildings and giving it an importance not less than the importance of construction, so that the result is cities that are visually and psychologically comfortable.

- Finally, the researcher recommends preparing a similar study to raise the efficiency of facades in other public buildings.

8- References

1. Boubekri, Mohamed (2008). *Daylighting, Architecture and Health*. Elsevier, pp. 1–8. doi: 10.1016/b978-0-7506-6724-1.00025-7.
2. Boyce, Peter R. (2014). *Human factors in lighting*, third edition. United State: Taylor and Francis. doi: 10.1201/b16707.
3. California, California Building Standards Commission. *California Code of Regulations: California Building Code 2010*. CBSC, 2010.
4. Clear Sky Chart Search – find sites with good conditions for astronomical observing. (no date). Available at: https://www.cleardarksky.com/cgi-bin/find_chart.py?keys=California&type=text&Mn=Solar%2520Power&doit=Find (last seen on 16 August 2020).
5. Climate-Data.org (2012) Climate data for cities worldwide. Available at: <https://en.climate-data.org/> (last seen on 26 March 2020).
6. Egypt, Ministry of Housing. Decision of the Minister of Housing and Construction 237 of 1976 to implement Law 106 of 1976, *Al-Wakaea Newspaper*, 5 May 1977a.
7. Egypt, Ministry of Housing. Decision of the Minister of Housing and Construction 268 of 1996 to implement Law 106 of 1976, *Al-Wakaea Newspaper*, 1 August 1977b.
8. Egypt, People’s Assembly. Unified Building Law no.119 for the year 2008, *Al Wakaea Newspaper*, p. 2. 2008.
9. Egypt, Ministry of Housing. Utilities and Urban Development: Executive Appendix of the Unified Building Law 119 for 2008, *Al-Wakaea Newspaper*, p. p.78. 2009.
10. Egypt, Egyptian Electricity Holding Company. *Annual reports of the Egyptian Electricity Holding Company*. Cairo, 2018. Available at: http://www.moee.gov.eg/test_new/report.aspx (last seen on 27 March 2020).
11. Egypt, Central Agency for Public Mobilization and Statistics. *Statistics 2020: Population Censuses*. Cairo, Available at: <https://www.capmas.gov.eg/HomePage.aspx> (last seen on 10 August 2020).
12. Elhadidy, Khaled (2010). *Natural Lighting Study Accordingly to the Variation of Building Codes in Egypt*, Fifth International Conference for Development and Environment In Arab World. Assuit: Egypt: Assiut University. Available at: <https://www.researchgate.net/publication/277890852> (last seen on 27 April 2020).
13. Elhadidy, Khaled (2012). *The Impact of Front Barrier’s Heights on the Intensity of Natural Lighting in Residential Buildings According to Local Building Codes in Egypt*, Sixth International Conference for Development and Environment in Arab World. Assuit: Egypt: Assiut University. Available at: https://www.researchgate.net/publication/277890841_The_Impact_of_Front_Barrier’s_Heights_on_the_Intensity_of_Natural_Lighting_in_Residential_Buildings_According_to_Local_Building_Codes_in_Egypt.
14. Hanna, George B. (2010). *Energy Efficient Residential Building Code for Arab Countries*, the 10th International Conference for Enhanced Building Operations (ICEBO). Kuwait, pp. 1–7. Available at: <https://oaktrust.library.tamu.edu/handle/1969.1/94111>.
15. Hegazy, Karim (2015). *Egypt’s Energy Sector: Regional Cooperation Outlook and Prospects of Furthering Engagement with the Energy Charter*. Egypt. Available at: <https://www.energycharter.org/what-we-do/knowledge-centre/occasional-papers/egypts->

- energy-sector-regional-cooperation-outlook-and-prospects-of-furthering-engagement-with-the-energy-charter/ (last seen on 30 November 2019).
16. India, Bureau of Indian Standards. *National Building Code of India 2016*. New Delhi, 2016.
 17. India, Bureau of Indian Standards. *National Building Code of India 2016 (NBC 2016)*. 2018. Available at: <https://bis.gov.in/index.php/standards/technical-department/national-building-code/> (last seen on: 27 April 2020).
 18. Knoop, Stefani, and others (2020). *Daylight: What makes the difference ?*, Lighting Research and Technology. SAGE Publications Ltd, 52(3), pp. 423–442. doi: 10.1177/1477153519869758.
 19. Salah, Mohamed (2019). *From 7.5 piasters .. stages of increasing electricity prices since 2014*. Masrawy online newspaper, 25 April. Available at: https://www.masrawy.com/news/news_egypt/details/2019/5/25/1573888/-من-5-7-قرش-مراحل-زيادة-أسعار-الكهرباء-منذ-2014-تسلسل-زمني (last seen on 11 July 2020).
 20. sunearthtools (2020). Calculation of sun's position in the sky for each location on the earth at any time of day. Available at: https://www.sunearthtools.com/dp/tools/pos_sun.php?lang=en#top (last seen on 26 December 2019).
 21. UC Berkeley Library (2019). *Building Codes and Regulatory Resources: Names, History, and Guidebooks - A guide to locating building codes, especially for California and the San Francisco Bay Area.*, UC Berkeley Library. Available at: <https://guides.lib.berkeley.edu/codes/history> (Accessed: 8 June 2020).
 22. Wark, Christopher G., and Wark, Wendy W. (2003). *Green roof specifications & standards establishing an emerging technology*, Construction Specifier, 56(8), pp. 76–82.