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IMPACT OF ENVIRONMENTAL CONDITIONS ON LOW-COST HOUSING IN NEW TOWNS IN EGYPT: THE CASE STUDY OF NEW BORG EL-ARAB

Eslam Hamdi Elghonaimy[1], Dalia Hussain Eldardiry[2]

Department of Architecture, Faculty of Fine Arts, University of Alexandria, Egypt
1. eslam_elghonaimy@hotmail.com
2. dalia_eldardiry@yahoo.com

ABSTRACT

Because of the housing crisis in Egypt, the desperate need for new houses, and the continuously increasing housing demand exceeding its supply; the housing problem is considered one of the major contemporary problems. New Borg EL-Arab is a new town designed as a magnet, to absorb the increase of population in Alexandria by creating new job opportunities and building affordable houses to help low income people and youth find suitable houses and solve their housing problem. Also, there is a very serious problem in the structural conditions of houses in the city due to bad of the quality of building materials causing quick deterioration of these houses. Hence, low income people and youth refused to leave the big city and move to the new town. Houses are directly affected by the adverse environmental conditions of this region, such as climate and lighting. The envelope of a house prevents the effect of climatic elements. This external envelope of a building creates indoor environmental conditions which differ from that of the outdoor environmental conditions.

The research aims to assess the environmental conditions which affect the houses in New Borg EL-Arab, and to suggest recommendations which could lead to improve the housing conditions in houses built under the same environmental conditions, integrating buildings with the surrounding environment, achieving better levels of human comfort, improving residents' satisfaction and attracting more people to live in the houses.

A detailed study of housing categories, data collection for the environmental conditions (measuring air temperature, humidity, lighting and determining the wind direction) outside and inside the houses, and analyzing them with interpretation of results, To find recommendations to improve the affordable houses. Human comfort can be achieved through a good design of the house using the suitable local building materials available within the same region, taking into consideration all the environmental housing conditions.

في الماضي كانت خطة مصر تسكينية بسبب الزيادة السريعة في عدد السكان وحاجتهم الماسة للمسكن. ومن هنا كانت خطة الحكومة لتوفير المسكن المناسب وذلك عن طريق بناء مساكن اقتصادية ميسرة ومنخفضة التكاليف. وتؤثر الطريقة البنائية بطريقة مباشرة على اقتصاديات المسكن، ويظهر ذلك بوضوح من خلال العلاقة المباشرة بين العرض والطلب في المساكن والعمال والخامات. وتعتمد الحالة البيئية للإسكان على تنوع العوامل البيئية كالمناخ (الحرارة والرطوبة والرياح) بالإضافة إلي الإضاءة. لذلك يجب وضعها في الاعتبار أثناء عملية البناء والتشييد للحصول على أحسن بيئة مناسبة داخل المسكن.

يهدف البحث إلى تقييم الاشتراطات البيئية لإسكان الشباب ومحدودي الدخل ببرج العرب الجديدة واقتراح التوصيات لتطوير الاشتراطات البنائية لهذه النوعية من الإسكان. ويعتمد البحث على الدراسة الميدانية للعوامل البيئية بالمنطقة وتأثيرها على أنماط الإسكان بها، وقد تم الحصول على نتائج هيئة الأرصاد الجوية بمنطقة برج العرب الجديدة من درجات حرارة ورطوبة ورياح وتحليلها ودراسة تأثيرها من الداخل على الإسكان باستخدام أجهزة قياس الحرارة والرطوبة والإضاءة للوصول إلى نتائج البحث.

وقد وجد من الدراسة البيئية التفصيلية للإسكان أن الفترات النموذجية المناسبة لجميع النشاطات الإنسانية تمثل 41.6% من فترات العام، وهذه الفترات تتغير بتغير المؤثرات الداخلية وتصل الذروة إلى 66.6% وأدنى المعدلات إلى 33.3% من فترات العام. وهذه التغيرات تعتمد على المواد المستخدمة في البناء وتصميم الأبنية وموقع البناء.

Keywords: Environmental Determinants, Building Conditions, Low-cost Housing, New towns, Egypt

1. INTRODUCTION

The excessive urbanization in the developing countries undoubtedly has numerous drawbacks manifested in the continuous growth of major cities at rates exceeding the population growth rates in these countries. This gives rise to many problems in meeting the requirements of these ever increasing numbers in housing [Abo Aianah, 1980].

Egypt is one of the third world countries, suffers from the rapid increase of the population growth and its concentration in the Nile valley and delta. There is unbalance in the geographical distribution of the population. The housing problem is considered as one of the major contemporary problems which are caused by the continuously increasing housing demand exceeding its supply. The acute shortage of housing in Egypt has been worsened by the effects of war which consumed a considerable amount of national financial resources.

New Borg EL-Arab is a new town designed as a magnet, to absorb the increase of population in Alexandria by creating new job opportunities and building houses to help low income people and youth to find suitable houses and solve their housing problem. After more than 20 years from the beginning of the new town, It could not attract the people to live in, only the first stage houses has been already constructed, there was a great shortage in the population in spite of there were houses for youth and low income people, and the employers and employees prefer to return daily to Alexandria.

Because of the long duration of building, the houses are directly affected by the adverse environmental conditions of this region, such as climate (air temperature, heat, humidity, precipitation, and wind), and lighting. The envelope of a house prevents the effect of climatic elements. This external envelope of a building creates indoor environmental conditions which differ from that of the outdoor environmental conditions. Also, there is a very serious problem in the structural conditions of houses in the new town due to bad of the quality of building materials causing quick deterioration of these houses. Hence, low income people and youth refused to leave the big city and move to the new town.

Human comfort can be achieved through a good design of the house using the suitable local building materials available within the same region, taking into consideration all the environmental housing conditions.

1.1 Research Aim

Assess the environmental conditions which affect the houses in New Borg EL-Arab, and to suggest recommendations which could lead to improve the housing conditions in houses built under the same environmental conditions, integrating buildings with the surrounding environment, achieving better levels of human comfort, improving residents' satisfaction and attracting more people to live in the houses.

1.2 Research Plan

The plan of the research has been designed to achieve the aims which were set for the research. So, the consequential steps were grouped into three main stages:

A study of theoretical background for the housing categories of Egypt and the housing conditions of New Borg Al-Arab including construction methods and building materials.

Analytical monitoring between the surrounding environment in the new town and the internal housing conditions in the three housing categories (low cost, economic and medium) of New Borg El-Arab.

Providing conclusion of the research and recommendations to improve the housing conditions in houses built under the same environmental conditions,

1.3 Research Methodology

The methodology of the research based on the analytical approach from the field survey as follows:

Data gathering and collecting for the required information and maps for housing categories of New Borg EL-Arab from the Authority of New Communities, New Borg EL-Arab Town. Using the interview with the authorities and engineers of the new town. Acting a detailed study of housing categories.

Data collection for the environmental basis (air temperature, humidity, lighting and determining the wind direction) in the region from the Meteorological Authority of New Borg El-Arab, Analytical monitoring for the data collected using statistical Excel program.

Measuring the indoor environment in three cases study, using the suitable equipments from the department of environmental studies, institute of graduate studies and research, university of Alexandria.

Analytical Comparisons between the outdoor and indoor environmental housing conditions of the three cases study with interpretation of results, to find recommendations to improve the houses built under the same environmental conditions, to attract the people to live in.

2. THEORETICAL BACKGROUND

Throughout time, the population density was concentrated along the Nile valley and Delta, keeping million of kilometers in the desert abandoned and undeveloped. The housing problem grew and is considered as one of the major contemporary problems which is caused by the continuously

increasing housing demand exceeding its supply. Because of the housing crisis, and the desperate need for new houses, the Egyptian government introduced the new town program as a national policy. Hence, the Ministry of Development, New Communities, Housing and Utilities has designed new towns in the desert to reduce the over crowded population in urban centers and redistribute the over concentrated industrial activities outside the Delta region.

The new towns contain four significant elements: economic base and self containment, land use pattern, provision of services, and commuting behaviour; The community's economic base strongly influences it's character: a community with a diversified economic base has a wide range of socioeconomic groups and provides a variety of job opportunities. The degree of these two factors sets the degree of a community's self containment. To a great extent the economic base also determines a community's range of social activities, transportation intensity, and power structure. Diversified land use largely supports the development of an assortment of socioeconomic activities.

2.1 Housing categories of Egypt

After the Egyptian revolution in 1952, the first five years plan established four different categories according to the economic class:

Public housing: It is defined as an economic housing for people with low income, it is established by the government within an area which ranges from 30 to 60 m2, and the rooms are between one to three, with the lowest cost.

Medium housing: It is established by the government within an area of 50 to 90 m2, the rooms are between one to three, with kitchen, bathroom, hall and terrace. The finishing materials are better than the public housing.

Upper medium housing: This category is established by individuals or companies. The area of this category is from 57 to 125m2, the rooms are between one to three rooms, with kitchen, bathroom, toilet, living area, and big terrace and the finishing materials are very good compared with the other two types.

Luxury housing: This category is established by individuals and the construction companies. The areas, specifications and finishing materials are in luxurious as well, and there is no maximum limit for them [Abo Aianah, 1980]

The classification which depends upon the economical class was cancelled, because there was a great socioeconomic variation through the last 25 years. The ministry of New communities established a new classification depending upon housing areas, specifications, and finishing materials.

- Low cost housing
- Economic housing
- Medium housing
- Upper medium housing

The ministry of new communities added the low cost housing category to the other three categories which are implemented by the government. There is no big difference between the low cost housing and the economic housing. Also, the ministry allows the construction companies, individuals and investors to build the super housing in the new town.

2.2 New Borg Al-Arab Town

One of the Egyptian new towns is New Borg EL-Arab. It has been created since 1979, but fortunately, it has not been completed yet. It is designed as a magnet, to hold the increasing population in Egypt. It was designed to absorb the increase of population at Alexandria and Behaira Governorates. Creating new job opportunities one of the key factor to absorb people from there original places. It was thought that it will prevent the urbanization growth of emigrants' towns over the rural area. [EL-Bannany S. A. 1986].

Creating this new town was matching with the economical policy of Egypt, which was that of habitation, i.e. a construction policy, not a development policy. This policy was necessary due to the rapid increase of population and the extreme need for housing. Therefore, the government has planned for construction new towns to absorb this increase in population and to overcome the shortage of housing in the central towns and cities.

New Borg EL-Arab is one of the industrial new towns which was built within the national plan of the government, It was established to absorb the over crowded population, aiming to habitat the youth and the low income people to establish new development communities, and directing the urban development in the north – western part of the delta with the provision of new job opportunities for the youth and the low income people of both Alexandria and Bahaira governorates.

New Borg EL-Arab location is between the two cities, Alexandria the main harbour, and Matrouh is in the west of Egypt. The entrance of New Borg El-Arab is well designed with a lot of trees and landscape. It makes a first good impression to the new visitor. Also, the streets are wide, with the presence of long green areas; The town is not completed until now. Figure 1 shows the location and Master Plan of the New Borg EL-Arab. It lies 60 km South West of Alexandria, at a distance of 7 km from the Mediterranean Sea. It is between the two cities, Alexandria and Matrouh. The gross area is 225 km2. The city has 9 residential districts and 5 industries sectors. It was planned to accommodate 500,000 inhabitants and provide 160,000 job opportunities in 20 years [Ministry of State for New Urban Communities. 1995].

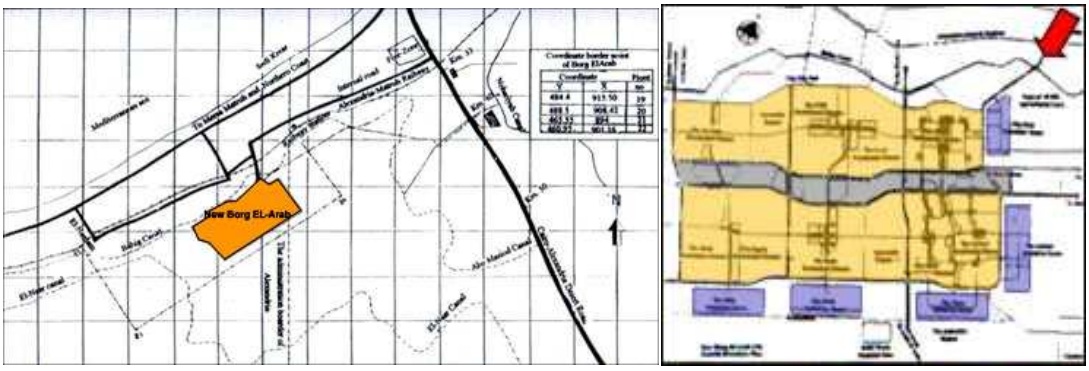


Fig. 1 The location and Master plan of New Borg El-Arab
Source: [3] Authority of new communities

After 18 years from the beginning of New Borg EL-Arab (1979-1997), the new town could not attract the people to live in, only the first stage has been already constructed, there was a great shortage in the population in spite of there were houses for youth and low income people. But the employers and employees prefer to return daily to Alexandria in spite of the presence of different kind of houses in this new town. This could be justified due to the lack of services which is a result of the long-duration of the implementation of New Borg EL-Arab town, in addition to the limited government's investments.

The defects in New Borg EL-Arab services are:

- There is no sufficient medical services and shortage of modern equipment in spite of the presence of a main hospital in the new town
- There isn't recreation area which could attract people to live in.
- There is no transportation is available at night between New Borg EL-Arab and the nearest towns.
- There are many wooden shops are constructed by some venders in a separate place in an open area, Because of the delaying in opening the main shopping center within the town, The place is called the Wednesday market. But actually these random shops are a positive action from the venders to cover one of the vital needs of them.
- The shortage of architectural consciousness and the lack of control to the construction of the private houses in the sold land, create some kind of a visual pollution for the region. This could be noticed in the difference of forms and colors of the house in the same region.

From (1997-now) Ministry of Development, New Communities, Housing and Utilities in Egypt changed its policy in the housing implementation from habitation, i.e. a construction policy to development policy because of the long duration of building according to the little financial resources. Thus, the investments and private sector was invited to share in the residential areas, also, to complete and improve the defects in New Borg EL-Arab services, to minimize the pressures on the government. The only job for the Ministry of Development, New Communities, Housing and Utilities is to complete the utilities of the land, dividing it and selling it to the people, allowing the construction companies, individuals and investors to build the super housing in the new town.

2.2.1 Construction methods

The houses in New Borg AL-Arab are implemented by the two construction methods. The first method is the traditional method of reinforced concrete It is called skeleton construction, with brick infilling. The buildings are painted externally. This method was adapted in 85% of the houses of the first stage, in New Borg AL-Arab. The conventional methods of reinforced concrete construction have been widely replaced, in many major housing and commercial developments by a variety of heavy industrialized systems of constructions, with story–height pre-cast concrete wall panels or tunnel systems using mobile form work, Figure 2. This method was adapted in the remaining 15% of the houses of the first stage in New Borg AL-Arab.

2.2.2 Building materials

Each stage for constructing a building needs its own building materials. It is necessary that, the quantities of building materials should be balanced with the demands of design and building plans to prevent and avoid any problem that might obstruct the work. Building materials must be available by the national market and if not, plans for its importation must be ready to import materials from its sources in order to have a suitable stock [Authority of New Communities, 1990].

The building materials are classified into three groups:

- Natural materials; sand, stone, and natural rocks.
- Synthesized materials; concrete, steel, bricks, wood, lime, and glass
- Complimentary materials; wooden and metallic doors and windows.

The traditional construction method increases the demand of the classical building materials; sand, stone, brick, wood and also concrete and steel. On the other hand, the industrialized construction methods are in great demand for concrete and steel with other modern building materials; aluminum, plastic and hollow block to cover the need for massive production of the formal units. The materials used in building the houses of New Borg EL-Arab are available in the region and the surrounding area. The bricks used are cement bricks and a lime stone, Figure 4 shows the different kinds of bricks used in building the houses in New Borg EL-Arab.

The external finishing materials are plaster. The internal finishing materials vary according to the housing category from low cost and economic housing to upper medium housing. The medium and upper medium houses are painted with oil based paint. And the economic and low cost houses are painted with lime. Doors are wooden and windows are with wooden frames.

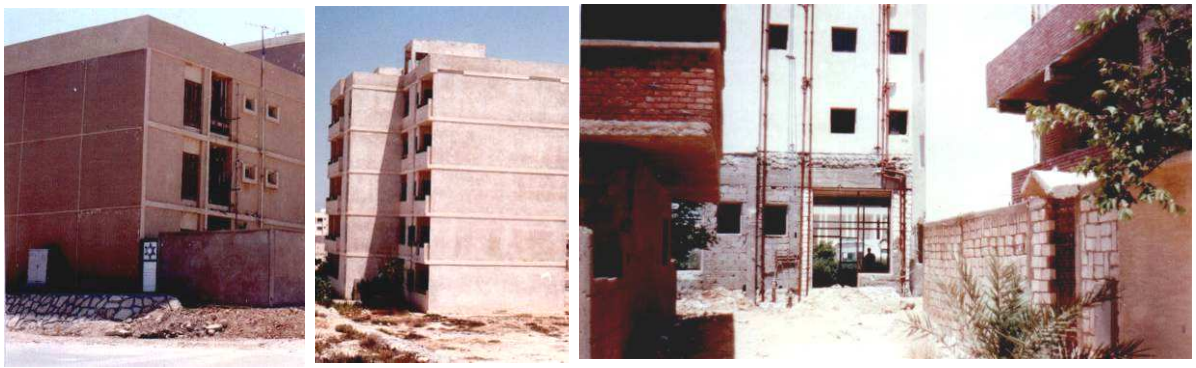
3. THEORETICAL BASES OF ENVIRONMENTAL CONDITIONS IN NEW BORG EL-ARAB

In designing and planning for the hot dry areas, it is necessary not only to understand the needs of people, but to study the indoor environment and control it to make it suitable for a healthy and comfortable living, especially in the field of housing. The environmental housing conditions depend on the quality of the surrounding environment (climate and lighting). Man has always tried to overcome the severe conditions of the weather and create a comfort environment inside his building.

Although, the comfort zone for human being is defined as a subjective assessment of the environmental conditions, the limits of the zone based on a physiological basis; the range of conditions under which the thermo-regulatory mechanisms of the body are in a state of minimal activity. Comfort, which is also dependent not only on the air temperature and that of the surrounding surfaces, but also on the relative humidity of the air and air movement, can not be expressed in terms of any one of them as they affect the body simultaneously and the influence of any one depends on the levels of the other factors [Banham, R. 1969]. The most important factor that affects the indoor climate of the house is the orientation. Most of the houses in New Borg El-Arab are perpendicular to the North West direction. The orientation of a building is determined by the climatic factors of wind and solar radiation as well as by the view, noise and requirements of privacy. [Konyo, A., 1984]

The climate in New Borg EL-Arab is characterized by an increase of temperature and a decrease in humidity with the presence of a big difference diurnal temperature. Thus, it needs a special treatment to overcome the problem of balancing the temperature in buildings to provide comfort to the occupants, beside the use of natural means which improve the internal climatic conditions and decrease the energy consumed.

New Borg EL-Arab is exposed to the direct sun rays all the year round. These sun rays generate high heat energy which could be made use of. The weather is very dry in the town as it rises approximately 60m above sea level, besides having a very small amount of precipitation in winter only. In summer, the city exposed to north east wind. The prevailing wind is from the North West direction. The four wind roses show that the amount of wind in summer is bigger than the amount of wind in winter. The wind in summer is of small speed, but the high speed of the wind in winter causes the changes of weather.



a. The tunnel system b. Different kinds of bricks used in building

Fig. 2 The tunnel system and brick types used in building the houses in New Borg EL-Arab
Source: All photos are photographed by the author unless noted

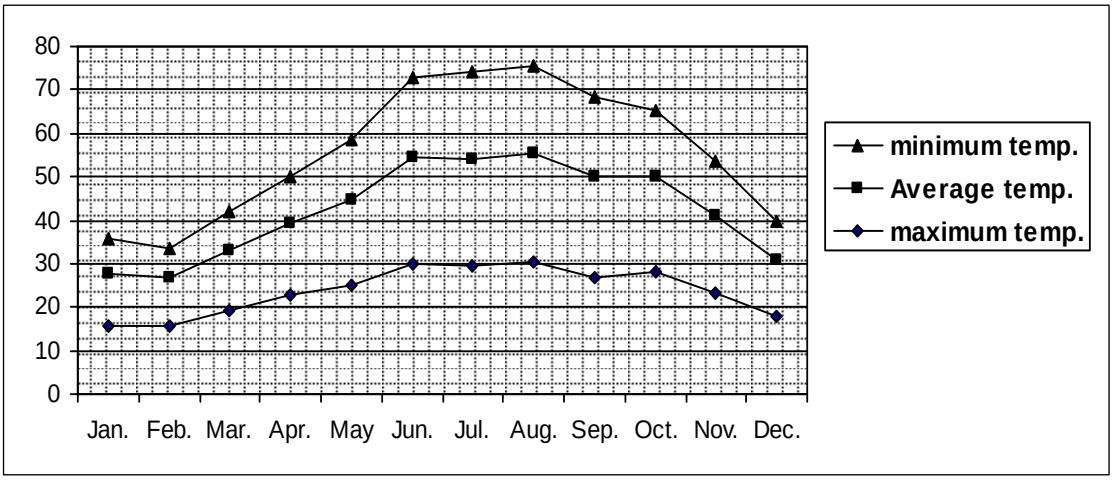


Fig. 3 The distribution of the average temperature throughout the year
Source: Figure created by the author based on : Meteorological Authority, 1992

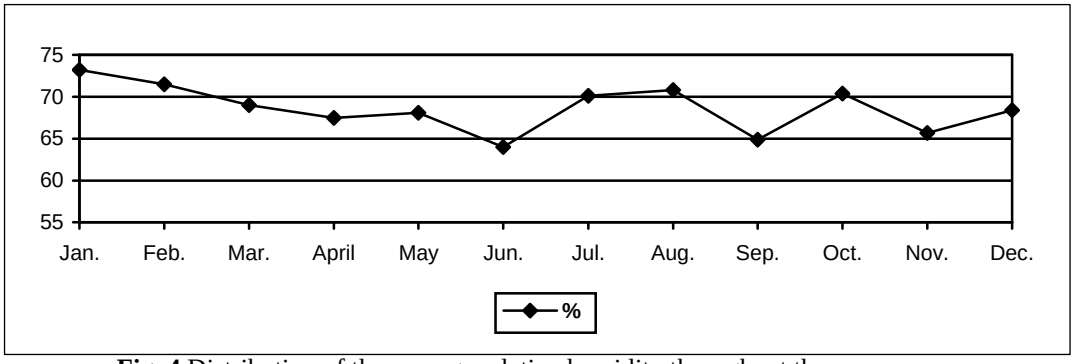


Fig. 4 Distribution of the average relative humidity throughout the year
Source: Figure created by the author based on: Meteorological Authority, 1992

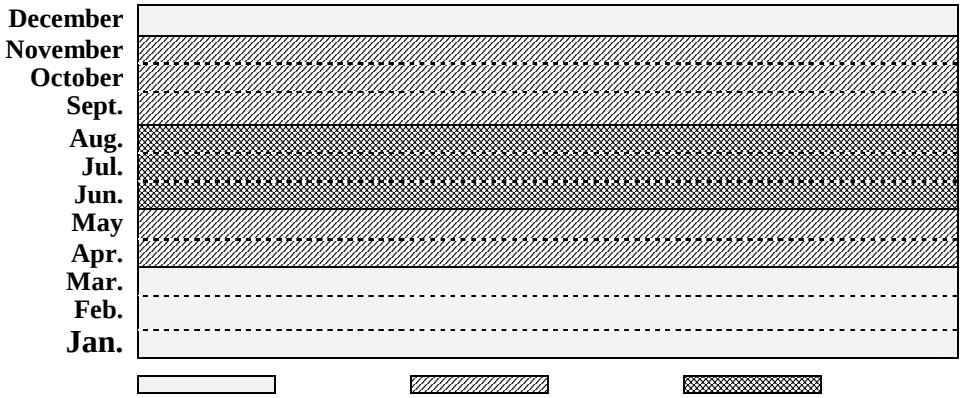


Fig. 5 Distribution of the cold, moderate and hot periods all over the year
Source: Figure created by the author based on references from Meteorological Authority, 1992

Human comfort was taken as a standard to be followed in the study as a parameter to evaluate the climate in New Borg EL-Arab. The cold, moderate and hot periods are determined in relation to human comfort region 21-28oc (Soliman, B. 1986] which are the effective periods for the human beings. Figure 3 shows that the effective periods in New Borg EL-Arab are in the months, April, May, September, October, and November. It is approximately 5 months (41.6% of year). This period may extend to include one or two of the summer months by using a good design to minimize bad environmental conditions. So, the effective periods may extend to be approximately 7 months (66.6% of year). Figure 4 shows the distribution of the average relative humidity throughout the year, Figure 5 Shows the distribution of the cold, moderate and hot periods all over the year.

Along this period air conditioning by mechanical methods could not be needed in the inner spaces, thus, decreasing the energy consumed and provide comfortable conditions without the use of expensive. That the choice of suitable building materials, well designed houses and the landscape around the house can protect the inhabitants from climatic changes Also, the energy-consuming mechanical equipment.

4. ENVIRONMENTAL HOUSING CONDITIONS OF THE CASES STUDIES

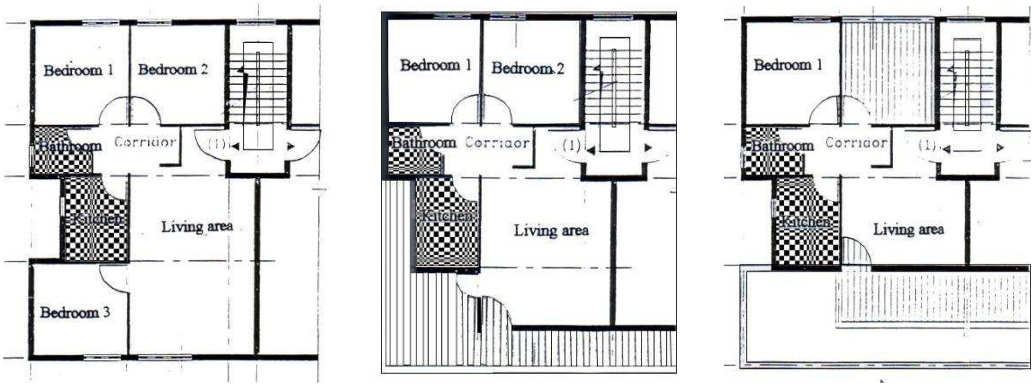
Three cases were chosen to be studied in this research. Cases were chosen related to the type of housing, which are classified according to the house's area, construction methods and finishing materials; Case no.1 Example of low cost housing, case no.2 Example of economic housing, case no.3 Example of medium housing.

4.1 Low cost house

In the low cost house, there is a variation in the areas of the low cost house. The floor has only one apartment. These areas are the total gross areas; they include the building service (stairs and building entrance …ex) which is approximately 10-12m2. That means the apartment in the third floor is too small to live in for a family, approximately 32 m2 [Authority of new communities, 1990]. Figure 6 shows the plans of case no.1 and table 1 shows their total gross areas.

The external finishing material of low cost house is plaster and the internal finishing materials vary according to the housing category, the low cost houses are painted with lime. The ratio of window's area to room's area (from 14.77% to 16%) in bed rooms, It is a large area for the windows. All the glazing materials for the windows are sheet glasses, the glazing bars from wood, the cell height is 1.00m in the entire apartment except in the services areas (kitchen and bathroom) the surrounding areas are empty with no green areas, and the ground cover with Asphalt and sand. Table 2 shows the housing variations affecting the environmental conditions inside the house.

The construction methods are traditional methods; Construction methods directly affect the building economy. This appears through the direct relation between demand and supply of building, workers and materials. From the measurements of the air temperature inside low cost house, it was found that the apartment of the first floor, rooms no. (1) And (2) have the same temperature (27.5oc) because they have the same room's area, window's area, and orientation. Room no. (3) has a higher temperature (30oc) because of its orientation (to the South East). At the second floor the living room has a lower temperature (29oc) than that of the first floor (29.5oc) because of its good ventilation through the terrace. Table 3 shows the difference between interior and exterior temperature in a low cost house. At the third floor, rooms have a greater temperature (29.5oc) than the same of other floors because their roofs are not covered by reflective or insulating materials. On the other hand, the living room has a lower temperature (28oc) than that of other floors because it has two windows with different orientation, one is to the North East direction and the other is to the South East direction. This dual direction of windows leads to good ventilation, increase air movement and decrease the interior temperature. Figure 7 exemplifies the environmental housing conditions in first, second and third floors of low-cost house case No. 1.



a. Plan of First floor b. Plan of Second floor c. Plan of Third floor

Fig. 6 Plans of the floors of low-cost house case No. 1
Source: [3] Authority of new communities

Table 1 The areas of low cost house (case no. 1)

	First floor	Second floor	Third floor
Total area	79.19 m^2	61.19 m^2	43.63 m^2

Source: Created by the author based on **[3]**

Table 2 The housing variations affecting the environmental conditions inside Low cost house

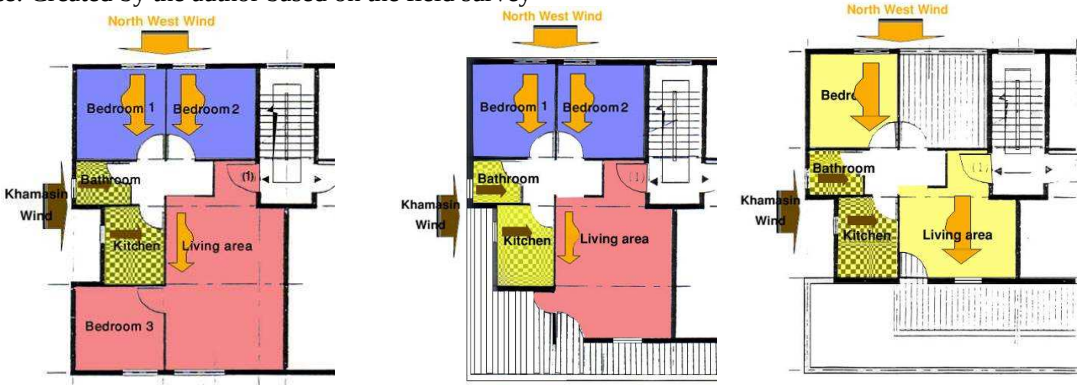
First floor	Bedroom (1)	Bedroom (2)	Bedroom (3)	Living area	Kitchen	Bathroom
Room's area	9.75 m^2	9.75 m^2	9.00 m^2	23.20 m^2	4.76 m^2	2.70 m^2
Room length.	3.00 m	3.00 m	3.00 m	5.80 m	2.80 m	1.50 m
Room depth.	3.25 m	3.25 m	3.00 m	4.00 m	1.70 m	1.80 m
Walls and ceiling painting	lime	lime	lime	lime	lime	lime
Window's orientation	N.W.	N.W.	S.E.	S.E.	S.W.	S.W.
Ratio of window's area to room area	14.77%	14.77%	16.00 %	7.76%	16.80 %	13.30%
Window's area	1.44 m^2	1.44 m^2	1.44 m^2	1.80 m^2	0.80 m^2	0.36 m^2
Window width.	1.20 m	1.20 m	1.20 m	1.20 m	0.80 m	0.60 m
Glazing materials.	Sh. glass	Sh. glass	Sh. glass	Sh. glass	Sh. glass	Sh. glass
Glazing bars.	wood	wood	wood	wood	wood	wood
Cill height.	1.00 m	1.00 m	1.00 m	1.00 m	1.20 m	1.30 m
Clean lines of site location.	Clean area	Clean area	Clean area	Clean area	Clean area	Clean area
Ground cover.	Asphalt	Asphalt	Sand	Sand	Sand	Sand
Finishing materials of the external obstruction.	Yellow plaster	Yellow plaster	Yellow plaster	Yellow plaster	Yellow plaster	Yellow plaster

Source: Created by the author based on the field survey

Table 3 Relation between temperature, humidity, illumination and human comfort in a low cost house

Floor	First floor			Second floor			Third floor		
Environmental basis	Temp.	Hum.	Lighting	Temp.	Hum.	Lighting	Temp.	Hum.	Lighting
Bedroom (1)	-0.5 °c	-1.5%	Normal	-0.5 °c	-1.5%	Normal	1 °c	-0.5%	Normal
	comfortable			comfortable			semi-comfortable		
Bedroom (2)	-0.5 °c	-1.5%	Normal	-0.5 °c	-1.5%	Normal			
	comfortable			comfortable					
Bedroom (3)	2 °c	2%	High						
	uncomfortable								
Living area	1.5 °c	1%	High	1 °c	0.5%	High	0	0	adequate
	semi-comfortable			semi-comfortable			comfortable		
Kitchen	2 °c	2%	High	2 °c	2%	High	2 °c	2%	High
	uncomfortable			uncomfortable			uncomfortable		
Bathroom	2 °c	2%	High	2 °c	2%	High	2 °c	2%	High
	uncomfortable			uncomfortable			uncomfortable		

Source: Created by the author based on the field survey



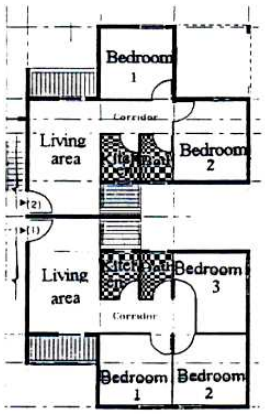
a. Plan of First floor b. Plan of Second floor c. Plan of Third floor

comfortable Semi-comfortable uncomfortable

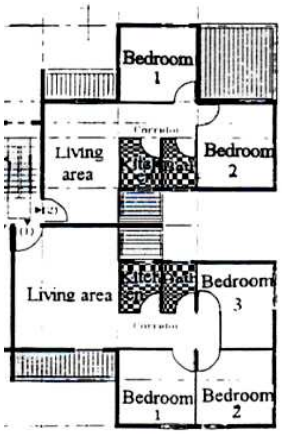
Internal air movement Bad smells and odours

Source: Created by the author based on the field survey

Fig. 7 Environmental housing conditions in first, second and third floors of low-cost house case No. 1



a. Plan of Ground floor



b. Plan of Typical floor

Source: [3] Authority of New Communities.

c. photo of Economic house

Source: photographed by the author

Fig.8 Plans of the ground and typical floors and a photo of low-cost house case No. 1

Table 4 The areas of economic house (case no. 2)

	Ground floor		Typical floor	
	Apartment 1	Apartment 2	Apartment 1	Apartment 2
Total area	73.04 m^2	62.17 m^2	79.33 m^2	62.17 m^2

Source: The author based on Authority of New Communities. New Borg EL-Arab Town, 1990

It was found that the temperature and the ventilation inside the room affect the percentage of relative humidity. At first floor, The percentage of humidity in the Southern East room, bedroom (3), and the living area (62%) are higher than the percentage of humidity in the Northern rooms (58.5%), Because they have a high temperature and bad ventilation. Also, for the same reason, the percentage of humidity in the living area at second and floor (60.5%) is higher than the percentage of humidity in the Northern rooms (58.5%). Table 3 shows the relationship between the relative humidity in the house and the human comfort, the comfortable zone is less than 59%, the semi-comfortable zone is from 59% to 62%, and the uncomfortable zone is more than 62%.

The position of low cost house is perpendicular to the prevailing wind (North West) direction. The house receives the full sweep of the velocities. This type of layout is desirable for avoiding winter wind affects. Houses planned in row arrangements. Wind shadow is caused over the subsequent units and passed by the later units. Also, the speed of the wind inside the house depends on the main orientation of the window, the room's area, and the presence of the window and the door in the opposite direction. The orientation of the house assists achieving well ventilation and refreshing the interior air of the house. But, the odours and bad smells would enter the rooms and the living area through the passage with the air moving out from the kitchen and the bathroom.

It was found from the results of a simplified computer program which is used to calculate the day lighting levels inside the house, that there are too much glare all areas, except the illumination of the living rooms are adequate.

4.2 Economic House

From the field survey, it was found that there is a variation in the areas of the economic house. The floor has two apartments. These areas include the building service (stairs and building entrance…ex) which is approximately 10-12m2. The total gross areas of the apartments in economic houses are similar as the total gross area of the low cost house except the 3rd floor [Authority of New Communities. New Borg EL-Arab Town, 1990]. Figure 8 shows the plans and a photo of economic house of case no.2. Table 4 shows their total gross areas.

In the finishing materials of the apartment 1 in economic housing; the external finishing material is plaster and the internal finishing materials are painted with lime too like the low cost houses. Also, The ratio of window's area to room's area (from 13.63% to 14.90%) in bed rooms, It is a large area for the windows. All the glazing materials for the windows are sheet glasses, the glazing bars from wood; the cell height is 1.00m in the entire apartment except in the services areas (kitchen and bathroom). The surrounding areas are empty with no green areas, and the ground cover with sand, the construction methods are traditional methods like the low cost houses. Hence, there is no big difference between the low cost and the economic houses. They have same areas, finishing materials, construction methods.

From the measurements of the air temperature inside an economic house, it was found that the ratio of window's area to the room's area is high at this house. So, the penetrations of the high heat energy inside the house are increased specially in the Southern rooms. The temperature is higher in apartment (1) than apartment (2) on the same floor, because the windows' orientation of apartment (1) is to the South East where there is not too much air movement, and the windows' orientation of apartment (2) is to the North West where there is the prevailing wind. So, apartment (1) is too cold during winter time while apartment (2) is comfortable, and visa versa. Also, the temperature of the last floor is higher than the temperature of the other typical floors. Table 6 shows the relation between air temperature, the percentage of humidity, illumination and human comfort in the house.

It was found that the percentage of relative humidity in apartment (1) is higher than that in apartment (2) at the same floor. This is because of the different windows directions for both of them; at apartment (1) the orientation of windows is to the South East and at apartment (2) the orientation is to the North West.

Table 5 The housing variations affecting the environmental conditions inside an economic house

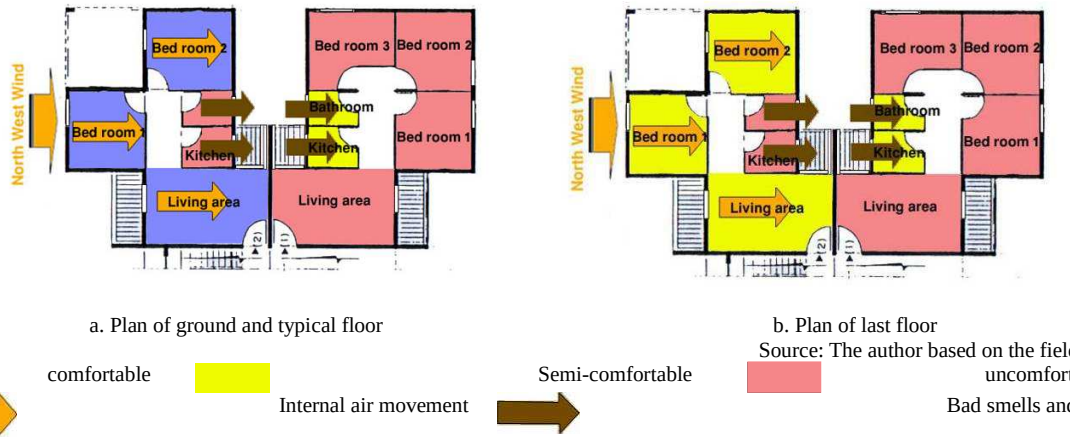
Apartment (1) in typical floor	**Bedroom (1)**	**Bedroom (2)**	**Bedroom (3)**	**Living area**	**Kitchen**	**Bathroom**
Room's area	10.56 m^2	10.56 m^2	9.66 m^2	17.06 m^2	3.82 m^2	3.15 m^2
Room length.	3.25 m	3.25 m	3.25 m	4.25 m	1.70 m	1.40 m
Room depth.	3.25 m	3.25 m	3.25 m	5.25 m	2.25 m	2.25 m
Walls and ceiling painting	lime	lime	lime	lime	lime	lime
Windows orientation	S.E.	S.E.	N.E.	S.E.&N.E.	N.W.	N.W.
The ratio of window's area to room's area	13.63%	13.63%	14.90%	10.55%	20.94%	11.42%
Window's area	1.44 m^2	1.44 m^2	1.44 m^2	1.80 m^2	0.80 m^2	0.36 m^2
Window width.	1.20 m	1.20 m	1.20 m	1.20 m	0.80 m	0.60 m
Glazing materials.	Sheet glass	Sheet glass	Sheet glass	Sheet glass	Sheet glass	Sheet glass
Glazing bars.	wood	wood	wood	wood	wood	wood
Cill height.	1.00 m	1.00 m	1.00 m	1.00 m	1.20 m	1.30 m
Cleanliness of site location.	Clean area	Clean area	Clean area	Clean area	Clean area	Clean area
Ground cover.	Sand	Sand	Sand	Sand	Sand	Sand
Finishing materials of the external obstruction.	Yellow plaster	Yellow plaster	Yellow plaster	Yellow plaster	Yellow plaster	Yellow plaster

Source: The author based on the field survey

Table 6 Relation between temperature, humidity, illumination and human comfort in an economic house

Floor	**Typical floor**						**Last floor**					
Apartment	**(1)**			**(2)**			**(1)**			**(2)**		
Env. basis	Temp.	Hum.	Light	Temp.	Hum.	Light	Temp.	Hum.	Light	Temp.	Hum.	Light
Bedroom (1)	1.5 °c	2%	high	-1 °c	-1.5%	high	2 °c	2%	high	0	1%	high
	uncomfortable			comfortable			uncomfortable			semi-comfortable		
Bedroom (2)	1.5 °c	2%	high	-0.5 °c	-1.5%	high	2 °c	2%	high	0	1%	high
	uncomfortable			comfortable			uncomfortable			semi-comfortable		
Bedroom (3)	1.5 °c	2%	high				1 °c	2%	high			
	uncomfortable						uncomfortable					
Living area	1.5 °c	2%	Adeq.	-1 °c	-1.5%	low	1.5 °c	2%	Adeq.	0	1%	low
	uncomfortable			comfortable			uncomfortable			semi-comfortable		
Kitchen	-0.5 °c	0	low	1 °c	1%	low	0	1%	low	1.5 °c	2%	low
	comfortable			uncomfortable			semi-comfortable			uncomfortable		
Bathroom	-0.5 °c	0	high	1 °c	1%	high	0	1%	high	1.5 °c	2%	high
	comfortable			uncomfortable			semi-comfortable			uncomfortable		

Source: The author based on the field survey



a. Plan of ground and typical floor

b. Plan of last floor

Source: The author based on the field survey

comfortable

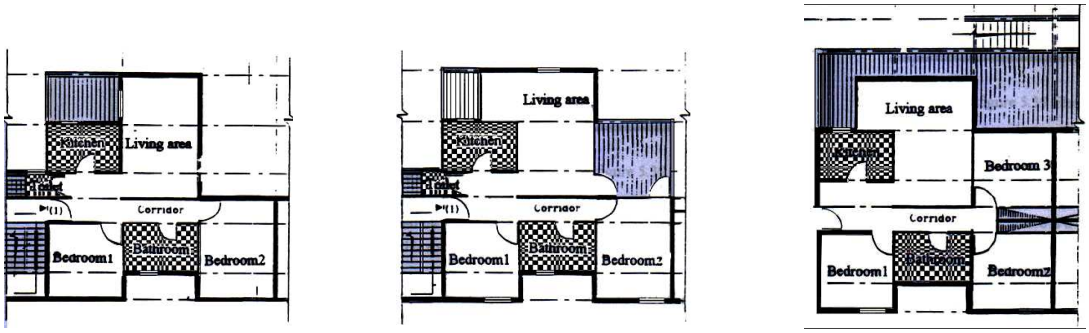
Semi-comfortable

uncomfortable

Internal air movement

Bad smells and odours

Fig. 9 Environmental housing conditions in typical and last floor in economic house



a. Plan of Second floor b. Plan of First floor c. Plan of Ground floor

Fig. 10 Plans of Ground, first and second floors of case no. 3
Source: [3] Authority of New Communities.

Table 7: The areas of medium house (case no. 3)

	Ground floor	First floor	Second floor	Third floor
Total area	94.00 m^2	82.20 m^2	79.54 m^2	54.00 m^2

Source: The author based on Authority of New Communities. New Borg EL-Arab Town, 1990

The position of case no. 2 is perpendicular to the direction of the prevailing wind. The house receives the full sweep of the velocities. The houses are planned in row arrangements, and wind shadow is caused over the subsequent units and passed by the later units. The orientation of the house differs from one apartment to another. These different orientations cause some problems in terms of levels of ventilation of the house. The orientation of apartment (2) has good ventilation at all its areas. Also, the window of the kitchen and the bathroom is to the South, so, the bad smells could not enter the apartment. But, the orientation of apartment (1) causes bad ventilation at the Southern bedrooms. In spite of the kitchen and the bathroom have good ventilation, but they are on the wrong direction, because the odours and bad smells would enter the bedrooms through the corridor via the air moving out from the kitchen and the bathroom (Figure 9).

It was found from the results of a simplified computer program which is used to calculate the day lighting levels inside the house, that there are too much glare at bedrooms and bathrooms. The illumination of the kitchen and the living areas of apartment (2) is low. And the illumination of living areas of apartment (1) is adequate.

4.3 Medium House

From the field survey, it was found that there is a variation in the areas of the medium house. The floor has only one apartment. The total gross areas include the building service (stairs and building entrance…ex) which is approximately 12-15m2. The total gross areas of the apartments in medium houses are different from the total gross area of the low cost and economic house. Figure 10 show the plans of case no.3, table 7 shows their total gross areas. Table 8 shows the housing variations affecting the environmental conditions inside a medium house.

In the finishing materials in medium housing; the external finishing material is plaster like the low cost and economic housing, but the internal finishing materials are painted with oil which is different from the two previous housing categories. It is different from low cost and economic houses. The ratio of window's area to room's area is (13.63%) in bed rooms. All the glazing materials are sheet glasses, the glazing bars from wood. The surrounding areas are empty with no green areas and the ground cover with sand and Asphalt, the construction methods are industrial methods, and this is clearly appearing between the previous housing categories and the medium housing. Table 9 shows the relation between air temperature, the percentage of humidity, illumination and human comfort in an economic house.

The ratio of windows area to the rooms' area is high. The penetration of heat energy inside the house is increased specially in the Southern rooms. On the ground floor, there is a big difference in the temperature of the bedrooms (1) and (2) (29.5oc) and the other areas of the apartment. On the first and second floor, the bedroom (2) has a lower temperature (28.5oc) than the other areas because it is characterized by the presence of two windows with two different orientations. The temperature of the rooms on the third floor (30oc) is high like the same temperature of the other floors. But the living area has good temperature because it has a limited area with inadequate ventilation in comparison to the other floors.

Table 8 The housing variations affecting the environmental conditions inside a medium house

Second floor	Bedroom (1)	Bedroom (2)	Living area	Kitchen	Bathroom	Toilet
Room's area	10.56 m^2	10.56 m^2	10.56 m^2	14.81m^2	6.50 m^2	6.50 m^2
Room length.	3.25 m	3.25 m	5.25 m	3.25 m	3.25 m	1.60 m
Room depth.	3.25 m	3.25 m	3.25 m	2.00 m	2.00 m	1.00 m
Walls and ceiling painting	Oil	Oil	Oil	Oil	Oil	Oil
Windows orientation	S.E.	S.E.& N.W.	N.W.	N.W.	N.W.	N.W.
The ratio of window's area to room's area	13.63%	13.63%	13.63%	12.15%	12.30%	5.53%
Window's area	1.44 m^2	1.44 m^2	1.44 m^2	1.80 m^2	0.80 m^2	0.36 m^2
Window width.	1.20 m	1.20m&1m	2*1.20 m	0.80 m	0.60 m	0.60 m
Glazing materials	Sheet glass	Sheet glass	Sheet glass	Sheet glass	Sheet glass	Sheet glass
Glazing bars.	wood	wood	wood	wood	wood	wood
Cill height.	1.00 m	1.00 m	1.00 m	1.20 m	1.30 m	1.30 m
Cleanliness of site location.	Clean area	Clean area	Clean area	Clean area	Clean area	Clean area
Ground cover	Sand	Sand	Asphalt	Asphalt	Sand	Asphalt
Finishing materials of the external obstruction.	Yellow plaster	Yellow plaster	Yellow plaster	Yellow plaster	Yellow plaster	Yellow plaster

Source: The researcher from the field survey.

Table 9 Relation between temperature, humidity, illumination and human comfort in a medium house

Floor	Ground floor			First floor			Second floor			Third floor		
Env. basis	Temp.	Hum.	Light	Temp.	Hum.	Light	Temp.	Hum.	Light	Temp.	Hum.	Light
Bedroom (1)	2 °c	2%	high	2 °c	2%	high	2 °c	2%	high	2 °c	2%	high
	uncomfortable			uncomfortable			uncomfortable			uncomfortable		
Bedroom (2)	2 °c	2%	high	-0.5 °c	-1.5%	high	-0.5 °c	-1.5%	high			
	uncomfortable			comfortable			comfortable					
Bedroom (3)	-0.5 °c	-1.5%	Adeq.									
	comfortable											
Living area	-0.5 °c	-1.5%	low	-0.5 °c	-1.5%	Adeq.	1 °c	-1.5%	low	-0.5 °c	-1.5%	low
	comfortable			comfortable			comfortable			comfortable		
Kitchen	-0.5 °c	-1.5%	low	-0.5 °c	-1.5%	low	-0.5 °c	-1.5%	low	0	-1.5%	low
	comfortable			comfortable			comfortable			comfortable		
Bathroom	1.5 °c	2%	high	1.5 °c	2%	high	1.5 °c	2%	high	2 °c	2%	high
	uncomfortable			uncomfortable			uncomfortable			uncomfortable		
Toilet	-0.5 °c	-1.5%	high	-0.5 °c	-1.5%	high	-0.5 °c	-1.5%	high	0	-1.5%	high
	comfortable			comfortable			comfortable			comfortable		

Source: The author based on the field survey

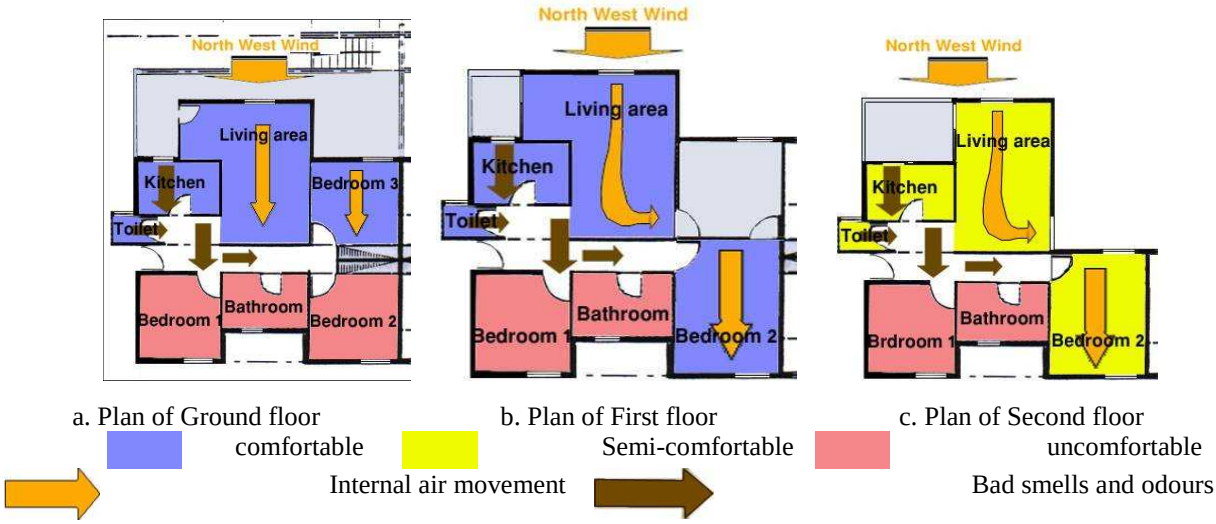


Fig. 11 Environmental housing conditions in ground, first and last floors of case no. 3
Source: The author based on the field survey

Table 10 the environmental housing conditions in the cases studied of New Borg El-Arab

		Temperature	Humidity	Wind	Daylighting
Low cost house	First floor	Semi-comfortable	Semi-comfortable	uncomfortable	uncomfortable
	Second floor	comfortable	comfortable	uncomfortable	uncomfortable
	Last floor	Semi-comfortable	Semi-comfortable	uncomfortable	uncomfortable
Economic house	Apart.(1) Typical floor	uncomfortable	uncomfortable	Semi-comfortable	uncomfortable
	Apart.(1) Last floor	uncomfortable	uncomfortable	Semi-comfortable	uncomfortable
	Apart.(2) Typical floor	comfortable	comfortable	comfortable	uncomfortable
	Apart.(2) Last floor	Semi-comfortable	Semi-comfortable	comfortable	uncomfortable
Medium house	Ground floor	Semi-comfortable	Semi-comfortable	Semi-comfortable	uncomfortable
	First floor	comfortable	comfortable	Semi-comfortable	uncomfortable
	Second floor	comfortable	comfortable	Semi-comfortable	uncomfortable
	Last floor	Semi-comfortable	Semi-comfortable	Semi-comfortable	uncomfortable

comfortable Semi-comfortable uncomfortable

Source: The author from the resulted of the analytical studies

It was found that the percentage of relative humidity in the Northern side of the house is low because the high speed of the air movement in this direction. On the ground floor, the relative humidity of bedroom (1) and (2) (62%) is higher than bedroom (3) (58.5%) in the same apartment, because of the rise of temperature and the slow of air movement in it. On the first and second floor, the relative humidity is decreased in bedroom (2) (58.5%) because of the presence of two different orientations for the windows.

The position of medium house is perpendicular to the prevailing wind (North West) direction. The house receives the full sweep of the velocities. This type is desirable for avoiding winter wind effects. Also, houses are planned in row arrangements. Wind shadow is cast over the subsequent units and passed by the later units. The orientation of the living area of this house is North West. It cannot avoid the North West wind in winter. But, this orientation assists achieving a good ventilation and for the interior of the house. But, there are problems in the ventilation of the kitchen and toilet, meaning that the wind blowing from the North West window passes to the living area and the Southern rooms carrying the odors from the kitchen and the toilet covering the whole area of the house.

Also, table 9 shows that there is too much glare all areas except the living area and the kitchen. The illumination of the living areas and the kitchens are low.

From the detailed study of the environmental housing conditions in New Borg El-Arab, it can be summaries as it is shown in table 10.

5. CONCLUSION

In the past, the economical policy of Egypt was that of habitation, i.e. a construction policy not a development policy. May be that was due to the rapid increase of the Delta and Nile valley's population and their extreme need for housing. That is why the government has planned for the construction of new houses in new towns to overcome the shortage of housing in the central towns and cities and to habitat the youth and the low income people who can't find suitable houses in their existing cities. But, Gaps * appear in reaching the main aim of establishing the houses in New Borg El-Arab, because off un-cooperation and un-coordinate between the ministries in this field. From the field study, it could be observed that the employers and employees commute daily to Alexandria in spite of the presence of the different kind of houses. This could be attributed to the lack of services which is a result of the long duration of the implementation of New Borg El-Arab, in addition to the small governmental investments.

The construction methods are classified into traditional and industrialized methods. Construction methods directly affect the building economy and building conditions. This is clearly appearing through the direct relation between demand and supply of the building, workers, and materials. The building materials needed in the different stages of building differs according to each stage.

From analysing the meteorological data of the environmental housing conditions in New Borg El-Arab, it could be observed that the climate is characterized by an increase of temperature and a decrease in humidity with the presence of a big difference in diurnal temperature. The humidity is suitable for human being activities. Rain occurs in winter only. Prevailing wind in New Borg El-Arab is from the North West direction. There is too much glare most of the housing areas in New Borg EL-Arab.

The temperature, the ventilation and orientation of the house are the most important factor that affects the indoor climate and affect the percentage of relative humidity inside the house. Also, the results of the simplified computer program show that glare is detected inside all the case study houses. The effective periods for the human being outdoor are about 41.6% of year. These periods change internally. They could be increased to 66.6% of the year or decrease to 33.3% of it. This change depends on the building materials, the design of the house elements, and the site of the house.

Table 11 shows the relationship between the environmental bases; temperature, relative humidity, precipitation, wind, and day lighting and the housing external and internal elements.

5.1 Air Temperature

The temperature measuring show a great difference between the temperature of the southern and the northern rooms of the same apartment in the three cases of the study. Ventilation plays a great role in controlling the interior temperature, so the bad orientation of the house leads to insufficient ventilation, improper air currents speed and increases the interior temperature.

5.2 Humidity and Precipitation

There is harmful effect of the humidity and precipitation to the exterior and the interior finishing materials of the low cost and economic houses, that because there is no maintenance for the government houses. Rehabilitation of the building must be put into consideration to keep the building in a good comfortable shape.

5.3 Wind

The position of the three examples of the house is perpendicular on the North West wind. The wind velocity is 100%. This position is not the best position. They could not avoid the North West wind in winter and could not get the benefit of the good north wind all over the year. Houses are planned in row arrangements causing a wind shadow over the subsequent units. Also, the windows of the kitchens, bathrooms and toilets in the economic houses are oriented to the south. So, the bad odors do not spread in the house. But, in the low cost and medium house, the odours and bad smells would enter the living area with via the air moving out from the kitchen and bathroom.

5.4 Day Lighting

The sky is almost clear blue all the year round. Glare is detected inside the bedrooms of the low cost, economic and medium houses. But, the living areas have lower illumination than the bedrooms. That means that the fenestration is unsuitable whether in size or treatment. This problem could be solved by many ways.

6. RECOMMENDATIONS

When designing Affordable houses for youth and low income people, it should be done within developing policy not habitation policy. That mean services and job opportunities should be established at the same time with the habitation to attract the youth and the low income people and support them to live in. The architects should integrate the affordable housing with the surrounding environment in terms of human comfort. That can be achieved through a good design for the house using the suitable building materials available within the same region, taking into consideration all the environmental housing conditions.

Table 11 The relationship between the environmental conditions and housing elements

Housing elements			Temperature	Rel. Humidity	Orientation	Day lighting
Layout	compact with groups					
Orientation	rooms	north				
		north east				
		south east				
		south				
		south west				
		north west				
	services	north				
		south east				
		south				
		south west				
		north west				
outdoor areas	sandy area					
	green area					
Roofs	humidity insulated		No		No	No
	non heat insulated			No	No	No
Walls	concrete				No	No
	bricks				No	No
openings	large dimension					

comfortable Semi-comfortable uncomfortable

Source: The author from the resulted of the analytical studies

From the detailed study of the environmental housing conditions in New Borg El-Arab, it could be observed that the well designed houses, the choice of suitable finishing materials and the landscape around the house can protect the inhabitants from climatic changes and much glare. Also, they can provide comfortable conditions without the use of expensive, energy – consuming mechanical equipment.

The three main recommended criteria of houses design resulted from the conclusion of the study are:

- The house design
- The finishing materials
- The landscape around the house

6.1 The House Design

- Layout: Compact planning for groups of buildings to provide mutual shading and minimum exposure to the sun. The most suitable buildings should have inner courts.
- Orientation: The large dimensions of the building and the windows of the house should be perpendicular to the North South direction. The best position of the house is at 45 degree to the North West wind. The wind velocity is reduced to 50%. This position is better than the other positions because it could avoid the North West wind in winter and get the benefit of the good north wind all over the year.
- Rooms: Should ideally open onto an inner court and should be characterized by a large size area.
- Services: Kitchens should be insolated against heat, separately ventilated and oriented well.

6.2 The Finishing Materials

- Roofs: The upper roofs surfaces should be covered with reflective or heat insulating materials, The roofs could be designed as a double roof with an air gap between them, The under surfaces of the external roofs must be covered with heat absorbing materials, Domes and vaults could be used to cover some buildings to minimize the area exposed to the perpendicular rays.
- Walls: The simplest solution is to follow the traditional thick walls, Double wall could be used to prevent the penetration of the heat inside the building, the surfaces must be chosen from smooth surfaces with light colors, to reflect heat.
- Openings: An air draft should be created by opening a lantern in the upper roof of the staircases; furthermore, small fanlight should be also located in the door of the apartment.
- Horizontal louvers could be used especially in the Southern facades to decrease the heat pressure on the walls and windows by shading them during the day when the heat energy is very strong.

- The windows should be placed in the direction of the suitable wind to direct hot air away before affecting the temperature of the room.
- Use long narrow windows, as they give evenly distributed light over the room, and prevent pools of glare.
- Use the above windows at the corner of the room, as this will throw light onto the adjacent perpendicular wall surface thus providing a large apparent source of a lesser luminance than the window, which will enhance the daylight level within the space.
- Use heat absorbing glass to reduce heat and glare, but on account of reducing illumination levels.
- Use light shelves instead of the traditional overhang, with its upper part painted white or mirrored, to reduce glare and reflect daylight deep into the room, thus balancing the light gradients.
- Use Venetians blinds with vertical slats, which can be adjusted as needed, thus preventing glare while still reflecting light into the interior.

6.3 The Landscape Around the House

- Green areas around the building have a moderate reflections factor; it is better than sandy lands.
- Buildings must be surrounded by trees and shrubs which are evergreen for obstructing the sun rays before reaching buildings by making shadows and acting as an air filter to sand and dust.
- Providing areas of water pools around the buildings, to decrease the heat pressure on the buildings.

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