# An Evaluation of Residence Satisfaction on Window Design of Mass Housing in Hot-Humid Climates: The Case of Famagusta, North Cyprus

**Soolmaz Abdali HajiAbadi**

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Prof. Dr. Elvan Yılmaz
Director

I certify that this thesis satisfies the requirements of thesis for the degree of Master of Science in Architecture.

Prof. Dr. Özgür Dinçyürek
Chair, Department of Architecture

We certify that we have read this thesis and that in our opinion it is fully adequate in scope and quality as a thesis for the degree of Master of Science in Architecture.

Asst. Prof. Dr. Pınar Uluçay
Supervisor

Examining Committee

1. Assoc. Prof. Dr. Mukkades Fasli

2. Asst. Prof. Dr. Nazife Ozay

3. Asst. Prof. Dr. Pınar Uluçay

# ABSTRACT

Windows are one of the building components, which are not only essential in terms of connecting inside and outside of the building but also for providing daylighting and natural ventilation to interior spaces. In hot-humid climates, windows' role become more prominent - especially in residences where users spend a considerable amount of time - for supplying proper daylight admittance through the control of sun and ventilation for the elimination of humidity.

Considering the increasing amount of mass housing in cities where demand for shelter is continuously up rising, there is more similar type residential buildings appearing, designed with little or no consideration of local climatic issues. This has resulted in the increase of dissatisfied users where there are major complaints relating to improperly lit interior spaces, lack of suitable shading devices to control unwanted sun during lengthy summer seasons, and necessary openings to provide natural ventilation.

The aim of this thesis is to understand the problems associated with window design and the level of satisfaction of users in relation to daylighting and ventilation issues in selected residential buildings in Famagusta, North Cyprus through observations and questionnaires with the users. For this purpose, selected criteria such as type of shading device, orientation, size, placement and ratio of windows area to floor area, glazing and opening types have been investigated to understand whether windows have been appropriately used in these apartment type buildings in hot-humid climate.

The observations and questionnaires prove that in the design of windows, use of appropriate shading devices, windows size, types of windows, placement as well as building orientation can be effective on the performance of windows and affect user satisfaction.

**Keywords:** Window design, Daylighting, Ventilation, Residential Building, Hot-humid climate, Residence satisfaction

# ÖZ

Pencere, iç mekanı aydınlatmak ve doğal havalandırmayı sağlamak yanında binanın içi ve dışı arasında görsel bir iletişim kurmayı sağlayan önemli bir yapı elemanıdır. Özellikle sıcak-nemli iklimlerde nemin ortadan kaldırılması amacı ile güneş ve havalandırma kontrolünü sağlamakta önemli görevler üstlendiğini söyleyebiliriz. Özellikle toplu konut örneklerinde doğru pencere tasarımı ve uygulamasının, binalarda enerji tasarrufu sağlamak ve kullanıcıyı memnun etmek açısından önemli olduğunu yapılan araştırmalardan da anlamaktayız.

Özellikle kentlerde karşılaşılan ve birbirleri ile cok benzeşen toplu konut örneklerinin pencere tasarımlarına bakıldığında yerel iklim verilerinin az veya hiç dikkate alınmadığı gözlenmektedir. Yanlış doğal havalandırma, uygunsuz genişlikte açıklıklar ve istenmeyen güneşi kontrol etmeyi amaçlayan uygun gölgeleme araçlarının eksikliği, kullanıcı memnuniyetsizliğini oluşturan nedenlerden sayılabilir.

Tezin amacı, sıcak-nemli iklime sahip Gazimağusa kentinde toplu konut örneklemleri aracılığı ile günışığı ve havalandırma kriterlerinin pencere tasarımında ne kadar etkili olduğunu anlamaktır. Bu amaçla, pencere boyutları ve tipleri yanında yerleşimi, pencere/taban oranı, gölgeleme araçları gibi alt kriterler belirlenerek, kullanılan pencerelerin sıcak-nemli iklim gereklerine göre tasarlanıp tasarlanmadığı gözlemler ve kullanıcı memnuniyeti üzerinden tartışılmaktadır. Bu kapsamda yapılan gözlem ve anketlerin sonucunda pencere tasarımının ve ona uygun gölgeleme elemanlarının kullanılmasının, pencere boyutları ve tipi yanında hangi yönde konumlandığının kullanıcı memnuyiteni etkilediği ortaya çıkmıştır.

**Anahtar Kelimeler:** Pencere tasarımı, Günışığı, Havalandırma, Konut, Sıcak-nemli iklim, Kullanıcı memnuniyeti

# DEDICATION

To MY BELOVED FAMILY,

who supported me in every aspect of my life.

My father and my mother (MOSTAFA and MARYAM),

my sister (SANAZ),

my brother (ASHKAN),

and my brother-in-low (MAJID).

I dedicated this study to dearest persons in my life.

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# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# LIST OF CHARTS

# Chapter 1

# INTRODUCTION

Windows have been used for centuries for the purpose of constructing a visual link between the interior and exterior space; providing daylight and sun to the users and control the indoor temperature for providing comfortable environments. Considering the amount of importance given to saving energy in buildings today in relation to rising energy costs, windows as building components contributing to heat loss and gain in buildings gained more significance. Keeping in mind that windows are responsible for 10 – 20% of heat loss in buildings in winter and 25 – 35% of heat gain in summer, it is very important to design them accordingly so that they contribute to the thermal comfort of indoor environments; help save energy in buildings and therefore contribute to the residence satisfaction.

It has been observed that due to the rising population and need for more housing in North Cyprus, there is a tendency to design and repeatedly construct similar mass housing units that do not take the local climate into consideration. In order to look into this problem in more detail, this study focuses on case studies where daylighting and ventilation issues in window design are investigated as important criteria affecting the satisfaction of residences in terms of indoor environment quality. Although windows have another important role such as providing visual contact between the inside and outside environment, this issue will not be investigated in this study.

Accordingly, the thesis is constructed on four chapters where the introduction part includes a general discussion of the topic, the research problem, limitations and methodology of the study.

In need to understand the topic more clearly chapter two includes a literature review on functional features of windows such as daylighting (e.g. shading devices, orientation, windows size, ratio of windows area to floor area, and placement of windows), and ventilation (e.g. ventilation types, control air leakage, and windows opening type) which can be effective on the quality of indoor environment and satisfaction of residences through windows design. Moving on from this information, chapter three investigates the selected cases based on the criteria presented in chapter two and discusses the findings of the analysis. This is realized through observations and questionnaires carried out in selected mass housing from the city of Famagusta which possesses hot-humid climate that presents many challenges for the design of buildings. Finally, the fourth chapter presents the conclusions and recommendations relating to this study.

## 1.1 Problem Definition

The window is known to have two essential functions in buildings located in hot-humid climates which also affect the thermal comfort of users: (1) ventilation for the elimination of humidity, and (2) appropriate daylight admittance through the control of sun. This becomes a highly important issue especially in typical mass housing units built without the consideration of appropriate daylight admittance, lack of overhangs to control unwanted sun and lack of enough ventilation. This takes place partially due to the economic reasons where construction companies target for maximum amount of flats and partially due to lack of relevant standards in Northern

Cyprus. Within this framework, this research makes use of focused questionnaire and observations as methods of analysis for understanding the general problems underlying window design in hot humid zones with specific emphasis on apartment type housing which are becoming extensively popular amongst construction companies in Northern Cyprus.

## 1.2 Aims and Objectives

In line with the specified research question, the thesis aims to carry out a study on selected housing examples in the coastal city of North Cyprus, Famagusta, where existing problems deriving from window design are analyzed based on some predetermined criteria in need to come up with an optimization of window design for standard apartment type housing in hot humid climates. These criteria have been selected carefully after a review of significant resources on the subject matter. Considering that the main function of windows does not solely involve providing visual contact but supplying enough daylight to an occupied space, eliminating any undesirable side effects; and providing ventilation for the elimination of humidity, the selected examples are evaluated through these major criteria so that further recommendations can be laid out. However, it is also known that window design should involve careful balance of heat gain and loss, glare control, and variations in daylight availability. Additionally, window size and spacing, glass selection and some other important issues should carefully be considered in the evaluation of window design in order to understand whether appropriate conditions have been met for achieving optimum performance in the given conditions. The findings will help create a guideline for optimum window design in standard mass housing units in hot humid climates.

## 1.3 Research Questions

In order to understand whether windows in these housing units are appropriately designed, the research questions:

1. Are users satisfied with current window design (size, type, location, etc.) in their units?

- What are the major criteria for assessing window design in standard apartment type housing in hot-humid climates?

- What is the optimum window design that should be applied to standard shaped rooms that residents spend most of their time (living room including kitchen/ and bedroom)?

## 1.4 Methodology

This study makes use of mainly qualitative type of methodology to realize the research which includes an in-depth literature review to understand the topic and develop criteria for the assessment of collected data; focused questionnaires with the users of the case study, as well as observations to understand the cases, and help towards the analysis of data collected. After a review of all the construction companies delivering mass housing in Famagusta, Uzun , Dovec and Noyanlar have been selected due to being well known and delivering the highest number of mass housing in the construction market. The user typology has also been influential in the selection of these examples. From each of the construction companies stated, two apartment blocks have been selected for further analysis. These examples are mainly located in Karakol, Tuzla and Sakarya areas of the city (Famagusta), North Cyprus.

Initially, books, articles and internet resources have been researched to comprehend what the characteristics of window and its primary functions are. In the case study chapter, observations, focused questionnaires are utilized to understand the residence satisfaction relating to window design, which are presented through inventories - charts and tables.

## 1.5 Limitations

In this study, the residences' satisfaction are investigated in randomly selected apartment buildings from Uzun, Noyanlar and Dovec construction companies where second and third floor flats with single and double glazed windows are taken as the focus of this study. Although window has several roles in the building such as providing visual contact, ventilation and daylighting, only daylighting and ventilation issues will be investigated in this thesis. Although, 36 flats have been analyzed in detail, users from other flats in these buildings have also been questioned.

# Chapter 2

# UNDERSTANDING THE SIGNIFICANCE OF WINDOWS IN THE DESIGN OF HOUSING IN HOT-HUMID CLIMATE

A building has several components and one of them is the window. At first, the importance of this building material has not been considered very much, but as the construction technology developed, and the building skin has become more advanced in terms of the provision of thermal comfort, window performance has also gained significance. Considering that window as a building element affect heat loss and gain in buildings to a great extent, and therefore the usage of energy in buildings, their appropriate design is important as it affects the user satisfaction.

Many aspects should be considered in the design of windows for providing comfortable indoor environment. One of these factors is the appropriate orientation of the building to respond to the local climate so that windows can let in appropriate daylight and ventilation and block the unwanted sun whenever is possible. This issue has to be underlined especially in hot-humid climates where the eradication of humidity from the indoor environment becomes a significant problem to be considered.

Daylight has essential function in terms of providing heat and saving energy in the building especially during winter seasons. However, overheating can occur in summer and this problem can be solved with the use of shading devices, and

greenery. The other issues to be considered are window area, ratio of window area to floor area, placement, and glazing in window design for providing suitable daylight to indoor environment.

The second important criterion is natural ventilation which makes it possible to let fresh air into the indoor spaces through natural and cross ventilation. This is a very important issue as it can led to sick building syndrome in buildings and affect human health. Therefore, it has great influence on user satisfaction.

The chapter follows with sub sections such as the functional features of windows which investigate ventilation and daylighting issues in more depth.

## 2.1 The Functional Features of Windows

Windows are inseparable components of façades and have various important functions such as providing view and daylight to the building and protecting the users from extremes of environmental conditions. Depending on the circumstances, windows should be designed to avoid daylight, airflow and water vapor through the addition of some other components such as insulation layers. In other words, windows are openings on building façade that allow the entry of light, air and sound, and that is exactly why they should be properly sealed and insulated. Windows are also described as glazing embedded in frames (Linera & Gonzalez, 2011). Furthermore, windows have an important role in providing air quality, well-being, and fulfillment. Many aspects should be considered in the design of windows. Some of the essential factors for window performance are listed as sunlight penetration, control of air flow and ventilation (Bülow-Hübe, 2001).

The other important aspects are overheating and glare in hot days which can be solved by controlling the solar gain and daylight. The amount of solar gain and daylight can be adjusted through the use of windows with shading devices that can help control undesirable sunlight in hot days.

### 2.1.1 Sunlight Penetration and Daylighting

Windows in buildings have an important role in terms of controlling solar heat gains. In cold climates, windows should allow enough sunlight through to heat the interior spaces and in hot climates where sunny days override cold days the amount of sunlight entering the building should be controlled; and ventilation should be provided to help cooling. Therefore, windows should be able to control solar heating, provide natural ventilation as well as helping to prevent noise, and maintain building security. This in some cases may require the installation of complex windows with characteristics like, glazing, external shading, internal or mid-pane blinds, and operable windows (Beggs, 2002).

When windows are allowing daylighting enter into interior spaces, they should also provide visual contact with the exterior spaces without causing change in the quality of the color of light. Furthermore, the privacy should be considered in the design of the windows. Visual access and visual exposure are two issues that must be differentiated in the design of windows. If both of these issues are considered in the design of the windows, then desirable solutions can be achieved. The other important thing is to consider the geographical location and appropriate orientation of the building. Moreover, it is important to consider the climate to gain heat from the sun in cold days and avoid overheating in summer. However, UV rays as part of the solar radiation should be controlled due to the fading of color of textiles and so on. In order to control the high emissivity of glass for long-wave radiation, low-emissivity

coatings should be added to the windows. These kinds of coatings help reflect sunlight and are highly recommended for hot climates where the outdoor temperature is high. In such cases, windows with low-emissivity (LE) coating will not allow heat enter inside and when sun is low windows will not allow the heat leave the building. Furthermore, LE coatings can control the UV rays and long-wave infrared heat without preventing visible light from passing (Linera & Gonzalez, 2011).

One of the most important characteristic of the window is to provide daylighting and visual contact without changes in the quality of the light color. Furthermore, the privacy should be considered in the design of windows. In line with this, visual access and visual exposure are two concepts that must be differentiated. If both concepts consider in the design of the window is desirable. The other important thing is to consider the geographical, and location of the building. Moreover, it is important to consider the climate to gain the heat from the sun in cold days and avoid it in summer. On the other hand, UV rays part of the solar radiation should be control due to the problems that make for the color, textile and so on. To control the high emissivity of glass for long-wave radiation, low-emissivity coatings should be added to the windows. These kinds of coatings return heat back to its source where the outdoor temperature is high they do not let heat go inside and when is low they do not let the heat leave the building. Furthermore, LE coatings can control the UV rays and long-wave infrared heat without preventing visible light from passing (Linera & Gonzalez, 2011).

Although the legal provisions for providing daylight to indoor environment changes according to the building codes of countries, these buildings standards nonetheless help, enhance well-being and satisfaction of the users (Millet, 1998). According to

BBR[1] (1999) depending on the direct access of the daylight, most of the rooms and places used by residents in the home should be located in those areas. Moreover, apartment buildings should have access to direct sunlight so size of the windows should be chosen accordingly to absorb enough light. The minimum size of the glass area should be approximately 10% of the floor area. If building parts or other buildings block the daylight more than 20% of the view angle, the glass area should be increased in cold regions like Sweden (Bülow-Hübe, 2001)

In hot humid regions, windows should protect indoor environment from cold weather in winter and overheating in summer. For instance, windows should provide proper daylight in winter for heating the indoor environment and in summer they should not cause overheating. It is very important to protect windows from direct sunlight heating. In order to reduce daylight gain in hot days, it is essential to understand the path of the sun. Therefore, windows in those directions should be minimized or designed accordingly to control heat gain in summer time. In southern facade, openings should be greater than 10 – 12% of floor area for direct gain. Openings in north side should not exceed 5% of the total wall area which is an acceptable standard for natural ventilation at night (Lapithis, 2005).

In Florida for example, sunrise is from north-east and sunset is from north-west in summer time – figure 1. Therefore, it is recommended to minimize windows in those facades, which can be accomplished by the proper orientation of building and shading of windows (McCluney & Jindra, 2000).

[1] BBR: Boverkets Byggregler. (Building regulations of the National Board of Housing, Building and Planning)

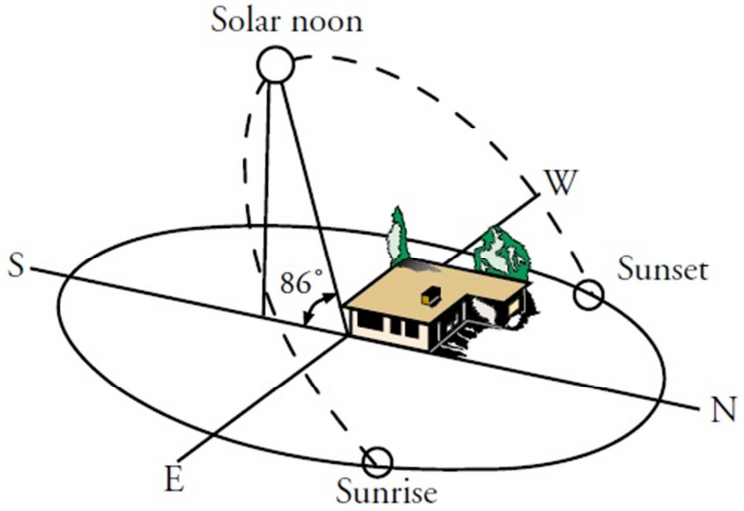


Figure 1: Summer Sun path. Source: (McCluney & Jindra, 2000)

Therefore, orientation in general is a very significant issue to be considered in the design of buildings as it is a major criterion affecting the performance of windows.

**2.1.1.1 Orientation**

Benefits of a properly oriented building includes provision of heat in winter and blocking of sunlight in summer which help control heating and cooling loads and therefore, the overall energy consumption of the building (Albanese, 2010).

Windows on the east and west facades of the building, may cause overheating in spring and fall months due to the low angle of the sun. Consequently, reducing window area on the east and west sides of the building maximize the solar orientation of the building. Furthermore, windows performance should be enhanced with the use of energy efficient windows with proper insulation that standard windows cannot offer.

If sunrise is from the east and sunset from the west, for absorbing the sunlight more in the cold days the length of the building should be orientated towards north and south. Moreover, shape of the building should be rectangular and compact to increase

heat gain in winter in the Northern hemisphere. The sunlight is absorbed more on the south side of the building and in cold days, it is absorbed with the lowest angel of the sun. If the glazing dimensions are increased in the southern facade, the south side of building absorbs more light. However, in hot days, absorbing the sunlight creates some problems and it must be reduced, because the sun is higher in the sky. In order to control and decline the heat loss, shading devices and greenery that provide shade may be used to reduce the heat gain (Albanese, 2010); (Wollos, 2013).

The orientation of the building should be away from south up to 5 degree and it has essential role on the saving of energy in the building. For example, if the angle of the building is 30 degree to the south the potential for saving energy is only 5 percent. A building with just consideration of the orientation has the potential to save the energy 10 – 20 percent in heating and 10 – 40 percent in cooling. Building with other features can decline the use of energy around 30 – 40 percent (Wollos, 2013).

In order to gain proper daylight, orientation of the building is important and it should be according to the sunrise and sunset, and amount of sunlight during day (Phillips, 2004). Furthermore, orientation of the building is different for northern or southern hemisphere, position of sun and length of daylight during the year. For example, to gain proper daylight in summer and winter difference of sun height in sky should be considered - Figure 2.

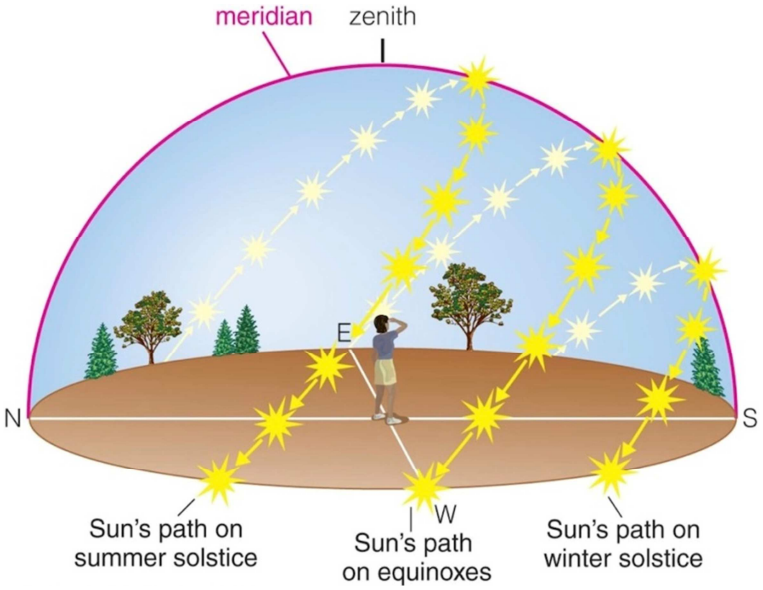


Figure 2: Sun path during the year. Source: (URL1, 2012)

In hot humid climates, windows on southern side has significant role for daylight gain. However, it creates some difficulties for residences in hot days which can be solved by proper orientation of building, integration of shading devices and greenery.. Furthermore, to provide suitable daylight, windows on southern facades provide more of a proper choice despite of east and west windows (Lapithis, 2005).

Windows were able to control solar heat gain in the past, and now with the design of new generation windows it has become easy to control the entry of solar heat gain in hot-humid climates. In hot climates, the strategy is to face most of the windows in the north side, where there is no direct exposure to sun or locate most of the windows in the south side if shading devices such as overhangs are used to block the inconvenient sunlight in hot days. Windows in west side have essential role in the gain of afternoon sun, when temperature climbs to the peak; and east windows have the same problem in the morning time when air temperature decrease. In the past, designers used to avoid locating windows in west and east yet. These days, there is

not any problem in locating efficient windows in west and east faces (Fosdick, Judy; Homes, Tierra Concrete; Energy, U.S. Department of, 2012).

Consequently, design of buildings present challenges for the architect in how to orient the building, how much glazing area to provide, the insulation and material selection and consideration of shading devices to help save energy in buildings and satisfy the residence.

#### 2.1.1.2 Glazing Area and Placement

Glazing area is another essential factor that has influence on amount of daylight gain income. The common glazed fractions are in range of 20 - 60%. Moreover, size and placement or location of windows in the facades is an area of design that should be given careful attention to with regard to the amount of daylight provided; the distribution of daylight, and the interaction with other design requirements, for example heat loss/gain or ventilation (Millet, 1998).

When the height of the windows is high and the window is strip, it helps to get deeper daylight - figure 3. The other essential issue that may help for good daylighting and ventilation is to use minimum sill height in the windows design. Moreover, the head height should be between table and level head of a user that is between 0.3 – 1 m - figure 4. Furthermore, for suitable daylight and glare prevention separate apertures may be used on the façade of the building (ECBC Envelope for Warm & Humid Climate, 2012).

Area of the glazing to the floor area in the south facade of the building is essential, if the ratio of glazing to floor area is 8 to 10%, the building is called Sun-Tempered and

the ratio of the glazing to the floor area is 15 to 20% of the floor area, a building known as passive solar (Wollos, 2013).

Figure 3: Strip windows in Villa Savoye. Source: (URL2, 2006)

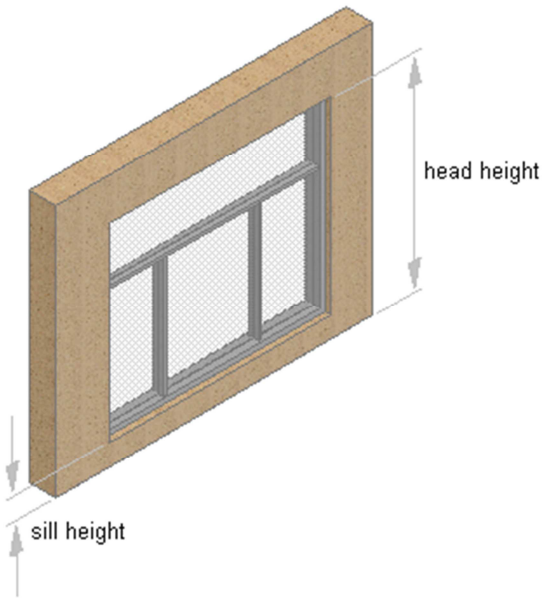



Figure 4: Sill height and head height. Source: (URL3, 2014)

There are different types of openings in buildings, and each have a different influence on the heat loss and gain in buildings. Yet, glazing type is also important.

### 2.1.1.3 Windows and Glazing

Nowadays, glazing systems have a significant role in controlling heat and light which have substantial impact on the thermal comfort and energy saving in residential buildings. Another issue that needs to be considered when selecting windows is the U-value[2]. The below chart demonstrates thermal efficiency of seven different types of glazing material (Smith, 2003). Accordingly, double glazed window is one of the best materials for saving energy (Milne & Boardman, 2000) – Figure 5.

| **Glazing** | **U Value (W/m²K)** |
|---|---|
| Single glazing | 5.6 |
| Double glazing | 3 |
| Triple glazing | 2.4 |
| Double with Low E | 2.4 |
| Double with Low E and Argon | 2.2 |
| Triple with 2 Low E and 2 Argon | 1 |
| Double with Aerogel | 0.5-1.0 |

Figure 5: Heat transfer through different type of glazing. Source: (Smith, 2003)

In every climate, large glazing should be oriented to the equator. Windows in west and east side can lead to overheating and decline solar gain easily. Proper designing of windows is important for the absorption of heat; therefore, local climate should be considered carefully (Feist, 2014). There are some standard materials used for glazing of well-insulated windows such as soda lime glass, PMMA (polymethylmethacrylate) and polycarbonates.

- **Soda-Lime Glass** (SLG) is a combination of 70% silica (silicon dioxide), 15% soda (sodium oxide), 9% lime (calcium dioxide) and some different materials with low proportion. SLG is a suitable material with some benefits as cheap,

[2] U (-value): Heat transfer coefficient, describes how a building element transports heat. [W/m².K]

reasonable hard, chemically stable or steady, and extremely workable. The thermal conductivity is 1 W/(m.k) and value of density 2500 kg/m³ (Linera & Gonzalez, 2011).

- **PMMA** (polymethylmethacrylate) is a type of colorless polymer used for optical applications with composite $C_5H_8O_2$ that has some advantages like being water proof and scratch resistant. Strength and poor chemical resistance are the weaknesses of the PMMA. Thermal conductivity is 0.18 w/(m.k) and density of PMMA is 1180 kg/m³ (Scott, 2001).
- **Polycarbonates** are a special type of polyester which is used as an engineering plastic. Due to the structure of Polycarbonates, this material possesses some characteristics such as high strength, transparency; moreover, it can be injection-molded, blow molded and extruded. Thermal conductivity is 0.2 w/(m.k) and density of the Polycarbonate is 1200 kg/m³ (Scott, 2001).

#### 2.1.1.4 Sun Protection Systems

Integrating shading devices to windows is a good strategy for controlling solar radiation. In the design of shading devices, the latitude of place, azimuth of the sun and angle of the altitude are important issues to be considered. There are different categories for the shading devices; and these can be classified under two and three groupings (Energy and Resources Institute, Institut Catalá d'Energia, Asia Urbs Programme, 2004).

First one is external sunshade which can be named as fixed and movable types. Fixed one includes horizontal, and vertical louvers and egg create types. The horizontal louvres control the high altitude sun in summer and vertical ones protect the windows from the southwest and northwest solar radiation. The last one is the egg create type that is suitable for the west facade of the building. The benefit of movable

one is more than stable one due to adjustments depending on the climate and circumstances. For example, it can allow the winter sun and block the solar radiation in the summer. The second one is internal sunshades which can be fixed or movable. These include; vertical blinds, roller devices, and curtains. The performance of the internal sunshades is related to reflective index, color, air tightness, and fabric (Energy and Resources Institute, Institut Catalá d'Energia, Asia Urbs Programme, 2004). The third type is the sunshade that comes in between two layers of openings, which can be fixed, movable, or automotive.

Additionally, sunshades can be classified as overhangs, louvers, light shelves, and fins as can be seen in - figure 6. Advantages of sunshades include blocking of direct gain in summer whereas disadvantages of fins are blocking of the desired light, view, and lack of durability (Robertson & Athienitis, 2007). In hot humid regions, windows on the southern facade should be designed with overhangs to control direct sun light during summer and early fall. On western façade, windows should be minimized, shading devices should be installed and appropriate trees should be located. Movable or stable shading devices may be integrated in southern facades.

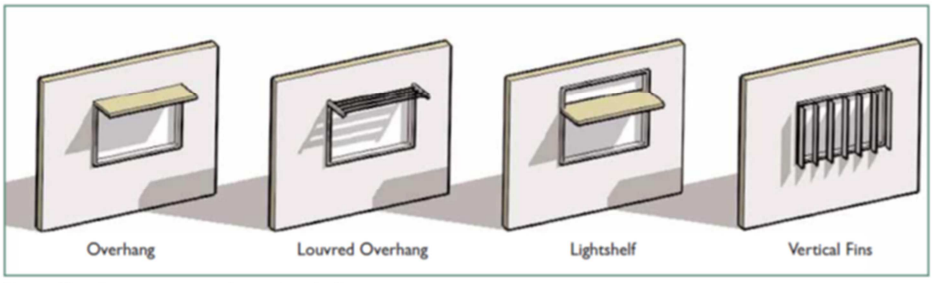



Figure 6: Four models of exterior sun shading.
Source: (Robertson & Athienitis, 2007)

Another benefit of integrating sunshades to the windows is the positive effect on the energy consumption of the buildings and increasing protection of the residences from sunlight in summer. For instance, according to the research done by the (Efficient Windows Collaborative (EWC), 2013) energy saving of buildings with shading devices integrated on the east and west side of the building is two times more than buildings without any shading devices. The other benefits of sunshades are the impact they have on cooling loads of buildings in summer; and possible allowance of integration of high percentage of glazing in buildings.

The preferable type of internal sunshade for controlling summer sun is the movable one. However, the disadvantage of internal sunshade is such that it absorbs heat, and therefore transmits heat into the building, causing too much need for cooling in summer and undesired heat gain in winter. They also have advantages such as providing protection from dirt, pollution and they are easy to install. Some elements can be added to enhance the performance of shading devices like; micro-grid and prism systems (Schittich, 2001).

Improving the windows with integrating shading devices has important role on increasing the residence satisfaction, energy saving and increasing of human comfort levels. The best type of shading device is the exterior ones which have more impact on blocking of sunlight for longer periods. For instance, the popular types of the exterior sunshades are the exterior overhangs. Overhangs have effective role on the control of solar radiation and glare prevention especially on the southern facades of buildings in hot summer days without reducing the possibility of outside views. There are the other types of the exterior sunshades such as; grills, awnings, shutters, roll-down shades/shutters, and canopies. However, use of the different types of the

shading devices is related to the availability, local use and design of building. In some regions, interior common sunshades such as drapes, blinds, or sunshades on windows are used extensively to control the privacy, daylight; decrease overheating; fading of fabrics and add to the quality of interior decoration. However, interior shading on its own is not enough to control the overheating due to the capacity of interior spaces absorb heat by the interior shading elements. It is therefore necessary to integrate other types of shading elements to the windows to control the entry of sunlight to the interior spaces. Yet, it is also important to control the sunshade for receiving proper light, shade and view in appropriate times. Therefore, additional technologies to shading devices can improve their performance for controlling sunlight entry in summer or allowing sunlight entry in winter.

Landscape elements such as broad-leafed trees can also help provide cool shade, and reduce the exterior temperature by least 5˚C through evaporation of moisture. Generally, trees and bushes located on proper direction help towards shading and ventilation of the building. In addition, they are able to provide shading, even with low angle of east and west sun (Efficient Windows Collaborative (EWC), 2013) – Figure 7.

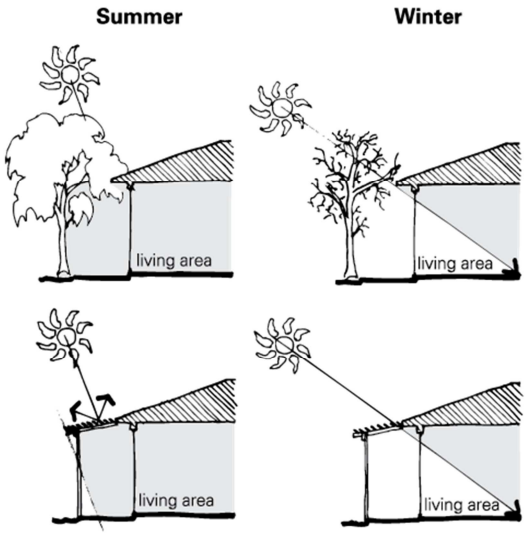


Figure 7: Role of the landscaping element in the control of sun through the windows. Source: (URL4, 2013)

In hot-humid regions, solar gain through windows is often a major component of the overall heat gains of a building. Also, solar radiation on the opaque parts of the building envelope raises the surface temperature of the envelope and contributes to the heating of the interior environment. A number of investigations highlight the importance of providing effective shading as part of the overall strategy for preventing overheating in hot-humid climates. Of these, some also present results which suggest that shading opaque areas, such as walls and roofs, is probably of no less importance than shading glass areas. Effective shading can be provided by various means, including dedicated shading devices, nearby structures, vegetation and special glasses. Generally, external shading devices are considered the most effective, since they intercept solar radiation before it passes through the building envelope into the interior space. An appropriately orientated high-pitched roof which affords self shading and allows only one side of it to receive direct solar radiation at a time is another possible shading technique. A key matter which should be considered in shading design is its tendency to conflict with daylighting. Reduced daylight penetration due to shading design can increase the need for artificial lighting, which

then offsets the energy savings from reduced heat gains. Such a conflict can be lessened, for example, by using inner surfaces of high reflectance values, such as wall surfaces with light colors, or using light shelves to reflect daylight into the deeper part of the interior. Movable shading devices, like louvres, which allow the inhabitants to adjust their local lighting and thermal environment, are additional solution. When shading is provided by a special glass, appropriate choice of glass is essential for balancing the advantage of heat gain reduction with that of daylighting (Chenvidyakarn, 2007).

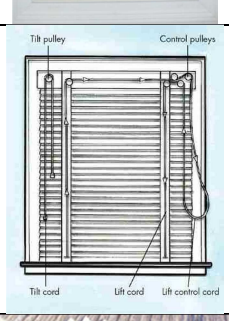
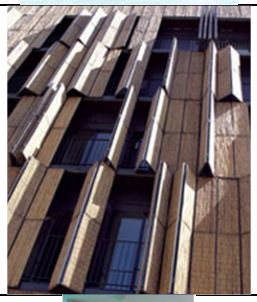
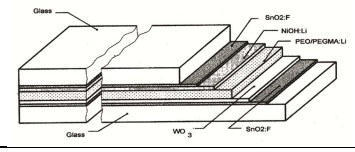
The essential issue that should be considered in design of shading devices is its tendency to conflict with daylighting. The shading device design may result in the decline of daylight penetration and increase the demand for artificial lighting that then help reduce the energy use and heat gains.

**2.1.1.5 Anti-glare System**

The function of anti-glare system is to control the intensity of sun. This issue is the most effective way of providing visual comfort, which is the difference between the anti-glare and sun protection system. The disadvantage of anti-glare system is that it increases the dependency on artificial light. Anti-glare system has different types that help reduce light intensity:

- ‘Curtain
- Horizontal blinds – Figure 8
- Vertical blinds – Figure 9
- Venetian blinds – Figure 10
- Screens – Figure 11

- Translucent glazing – Figure 12
- Electrochromic glazing (Schittich, 2001)' – Figure 13

| | |
|---|---|
|  | Figure 8: Horizontal blind.<br>Source: (URL5, 2013) |
|  | Figure 9: Vertical blinds.<br>Source: (URL6, 2006) |
|  | Figure 10: Venetian blind.<br>Source: (URL7, 2013) |
|  | Figure 11: Screen.<br>Source: (URL8, 2009) |
|  | Figure 12: Translucent glazing.<br>Source: (URL9, 2013) |
|  | Figure 13: Electrochromic window.<br>Source: (Pennesi, Simone, Barletta, Di Marco, & Lanza, 1999) |

#### 2.1.1.6 Daylighting and Residence Satisfaction

When considering the selection of windows in building design, climate, orientation, glazing area, window area to floor area ratio, window (frame and glazing) types and shading devices should carefully be considered. Although, it is not always easy for the designer to decide on the best option, it is possible to follow some guidelines for the optimum solution. In the window design of buildings in hot-humid climate, sunlight allowance in winter; and its blockage in summer stand out as important functional requirements of windows and their careful consideration will help increase the comfort level of users and their overall satisfaction from the building.

In terms of increasing the level of residences satisfaction, it is important to consider orientation of windows in hot-humid climates where most of the windows should be located on southern facade of the residential buildings. However, shading devices should also be integrated in order to increase residences' satisfaction.

When considering the daylight issues in summer, it should be noted that the use of daylight shows variations depending on the function of building. Furthermore, size of interior spaces and their ratio to the overall window area is important for gaining proper daylight. The other issues that have an influence on daylighting are size, orientation, and opening types and shape of windows (Santamouris, 2013). In figure 14, for example, daylight income in vertical window is more than horizontal one. These issues have influence on the residences satisfaction in terms of providing proper daylighting in the residential buildings.

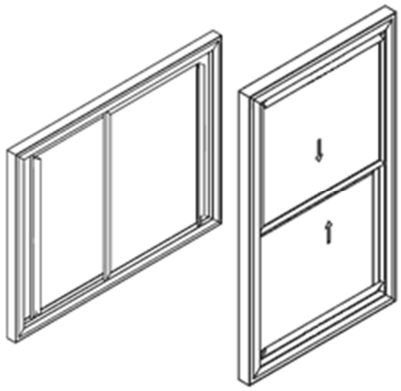


Figure 14: Difference of daylight income between horizontal and vertical windows with same area. Source: (URL10, 2014)

The other important factor in the design of windows is ratio of windows to floor area. Most of the time a certain ratio of window to floor area should be kept which is 1 to 4 or 1 to 5. Furthermore, this ratio for lower and upper floors should be different for gaining proper daylight or shape of room should be considered (Marks & Woodwell, 2010).

All these criteria discussed also have an impact on building codes of countries and building codes are there to make sure that users have an end product which is highest quality. The higher the standards of buildings and in this case windows, the more satisfied the residences feel in the spaces that they use often during their daily lives. However, in some cases, depending on the priorities, not all of these requirements can be achieved. For example, some measures are essential in terms of choosing a material with highest standards such as durability or maintenance of the material. It is indictable that quality of UPVC is better than wooden frame due to its long lifecycle and need of less maintenance but the other issue to consider is the user satisfaction such as user-base quality and the price. In this case, user may be interested to use the wood material for the building construction and durability of the

wood material is 20 years, however, the construction company may choose UPVC windows due to its durability or availability in the market.

### 2.1.2 Ventilation

Ventilation is an important issue in terms of both providing comfortable and healthy indoor environment for the occupants and saving energy in the buildings. Natural ventilation does not only help reduce cooling costs in hot climates but provides people with a feeling of comfort in relation to the supply of oxygen and release of carbon dioxide to outdoor space. Furthermore, natural ventilation reduces the feeling of tiredness due to natural speed of air movement in buildings. Therefore, natural ventilation is better than air conditioners, which can lead to various types of illnesses (Su, Zhang, & Gao, 2009). Many aspects should be considered when providing suitable natural ventilation such as the difference of air pressure between inside and outside of the building and local wind direction. While natural ventilation may not completely replace air conditioning and mechanical ventilation in hot-humid climates, it may reduce the need for air conditioner during in between seasons. In winter, the challenge is to block the cold air as it is brought into the building. In the summer, the control of humidity is a challenge especially in hot humid climates.

As it is clear windows have essential role to provide natural ventilation in residential buildings in many climates and especially hot-humid climates. Furthermore, as any significant number of operable windows are using in building, in design of windows should be careful about reducing heat gain and glare from the sunlight as well as increasing secure facility meanwhile allowing for income air and escape.

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Furthermore, as any significant number of operable windows are using in building, in design of windows should be careful about reducing heat gain and glare from the sunlight as well as increasing secure facility meanwhile allowing for air income and escape.

In hot-humid climate, one of the essential problems is the control of humidity in indoor environments in summer as it can affect the pattern of energy use if mechanical ventilation has to be used for removal of moisture.

Ventilation is shape of the building, and the occupants distance from the wall where windows are located. For instance, for a person who is living in a room with large area, providing proper ventilation and cooling through natural ventilation to this interior space may cause discomfort or inconvenience and it is significant to consider natural ventilation types that must flow according to interior space perimeter. Then, it is important to provide appropriate natural ventilation in interior spaces that result in residences happiness. Furthermore, if windows are designed properly in a building, this directly affects the use of air condition units in hot days. Consequently, in order to have good natural ventilation, size, location, number, orientation, and size of windows (Givoni, 1998) have to be taken into account in window design in buildings.

Ventilation in spaces takes place through the provision of fresh air, which is realized either by direct comfort ventilation that is through convection to cool and heat the residences, and indirect comfort ventilation (Roaf, Fuentes, & Thomas, 2010).

However, in modern apartment buildings, windows as passive cooling elements are mostly neglected. Generally, it is often observed that primary prevailing winds are not considered in design of apartment buildings (Ayata & Yıldız, 2006).

According to The Chartered Institution of Building Services Engineers (CIBSE), natural ventilation can be categorized under titles such as cross ventilation, single-sided, stack, and mechanically assisted ventilation. Natural ventilation can be investigated under three headings which are cross, two-sided, and single-sided ventilation (Tantasavasdi, Jareemit, Suwanchaiskul, & Naklada, 2007). Cross ventilation occurs when openings are located opposite to each other and airflows between openings due to difference of air pressure built up by wind. The other ventilation type is single-sided ventilation with just one opening(s) on one side of the space. Another ventilation type is stack ventilation that makes use of density differences as a result of buoyancy in encouraging an outflow from part of a building like roof and creating fresh and cool air from another part of the building like windows and doors.

In general, mechanical systems should be added with other natural ventilation systems described above to increase the airflow in buildings and also, a building might have more than one type of natural ventilation in buildings (Chen, 2004).

#### 2.1.2.1 Cooling techniques

Ventilation is the simplest way of cooling inside of a building and probably the most common passive cooling system. Ventilation has three main functions such as; control of indoor air quality (IAQ), cooling of human body and structural mass. Every function has different requirement for providing cooling and ventilation. However, solar radiation is an essential factor that declines the performance of

cooling system. The cooling system performance increases depending on the size and position of windows (Ayata & Yıldız, 2006).

- **Ventilation for hot-humid climate**

In hot-humid climates, ventilation is one of the best methods to decrease the heat gain in the building. Some techniques are needed and one of them is natural ventilation (La Roche & Milne, 2004). For example, natural ventilation is used for cooling the interior environments in hot-humid climate in New Orleans, LA. US Department of Energy states that exhaust fans may additionally be used for providing ventilation to remove moisture and pollutants in the building (Baechler & Love, 2004). Nighttime ventilation is one of the low-cost passive cooling systems in hot-humid regions. In order to have proper nocturnal ventilation (Nighttime ventilation) some issues are important like ambient climatic conditions such as air exchange rate. Furthermore, cool air obtained during night can decrease the indoor air temperature (Kubota, Toe Hooi Chyee, & Ahmad, 2009).

As an example, Givoni (1998) investigated influence of nighttime cooling in Israel and Pala, California. According to the results, in California nocturnal ventilation (Nighttime ventilation) is more effective by the use of exhaust fans. However, in comparison where both daytime and nighttime is hot, none of these can be adopted to Shanghai due to small daily air temperature rang and high humidity and air temperature. Therefore, nocturnal (Nighttime ventilation) ventilation is proper to use where high daily air temperature and nighttime air temperature is not much cold to cause discomfort (Kubota, Toe Hooi Chyee, & Ahmad, 2009).

#### 2.1.2.1.1 Ventilative Cooling

Interior spaces can be cooled with ventilation by enabling convective heat transfer from a hot indoor area to a cool exterior. The other method is the sufficiently high indoor air velocity that gives to user direct physical cooling. Furthermore, higher air change among night (cooling period) has influence on decreasing indoor air temperature. This mainly depends on user decision to open window or not (La Roche & Milne, 2004). Ventilation takes place either by wind, buoyancy or a combination of wind and buoyancy in a natural system (Chenvidyakarn, 2007).

#### 2.1.2.1.2 Ventilative Cooling by Wind

This issue takes place when there is enough wind force to produce pressure difference between inside and outside of the building that result in internal air movement and therefore heat removal from the interior. Furthermore, high indoor air velocities increase the convective heat transfer from occupants' skins and clothing and rate of the skin evaporation so, it increases cooling.

There are different ways for providing proper ventilation and this requires the location of at least two openings on opposite sides of a space in order to benefit from the wind - figure 16a. If orientation of the building is not proper to catch wind, wind deflectors as partitions in the building can help to channel air through the occupied zone – figure 16b. Internal spaces should also be designed accordingly to allow maximum amount of air entry - figure 16c (Chenvidyakarn, 2007).

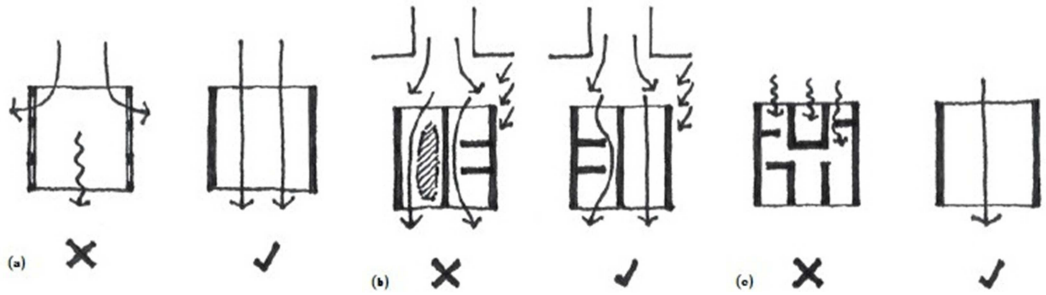


Figure 15: some sample for opening design to provide proper air movement inside buildings. Source: (Chenvidyakarn, 2007)

#### 2.1.2.2 Orientation

Orientation of a building affects the amount of solar radiation received and will help ventilation. Furthermore, the ventilation conditions and the window's shading condition have an influence on the cooling of indoor environment (Givoni, 1998). It is significant to minimize solar gain and maximize ventilation in the building design. By orientating the longer sides of the building to intercept prevailing winds and shorter sides of building to face the direction of the strongest solar radiation, proper ventilation can be gained, while the solar gain is minimized. These issues should be applied to design of apartment buildings (Chenvidyakarn, 2007).

#### 2.1.2.3 Windows Opening Types

There are different types of windows opening such as awing, casement, sliding, hopper, double hung, and sliding. In addition, types of window opening influence the amount of natural ventilation gained in the buildings. It is essential to consider window opening types and their features in the design of windows in residential buildings. However, while selecting windows opening types, it should be remembered that some of them have more air leakage than the others and this may cause problems for residences in cold days. Air leakage of casement window is lower than sliding ones as a result of the sash closing by pressing against the frame. Air leakage in sliding one is more than in awing window types. The sash closes by

pressing against the frame in hopper opening types. In addition, function of this opening type is same as awning and casement types. Sliding window has higher air leakage rates than projecting or hinged windows. Double hung window performance is similar to the projecting or hinged windows. Window opening types according to their good performance are categorized below (U.S. Department of Energy, 2012) - figure 17. In Famagusta, most of the buildings have casement opening types that are one of the best opening window types. Natural air ventilation through casement open windows provides cooling at nighttime during hot days (Broniek, 2008).

Awing < Casement < Sliding < Hopper < Double hung < Sliding

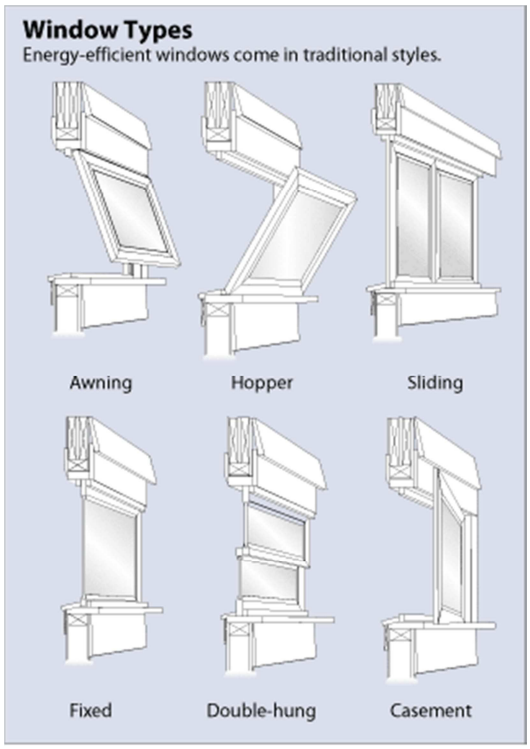



Figure 16: Types of energy efficient windows. Source: (URL11, 2012)

### 2.1.2.4 Control of Air leakage and Condensation

There are many issues to decrease the defects in windows such as control of air leakage so that windows can be airtight. Moreover, it has influence on the heat loss

and gain, condensation, comfort and sound insulation. The other issue that needs to be considered in the air leakage of windows is draught excluders which should be placed between the sashes and frame. In order to decline the moisture transport, strip should be placed on the inner side of the window. Otherwise, humidity can have an effect on the layer of double glazed window and cause condensation on the cold pane. To control the dirt accumulation, a dust-absorbing strip can be located between the windows layer but it allows the ventilation in cold days. The other issue is when the condensation appeared on the outer layer of the extremely insulated windows. During the days, that humidity influences formation of condensation, it starts from the coldest part of the window and spreads over the whole window.

**2.1.2.5 Dehumidification strategies**

Range of relative humidity for human factor is around 20 – 60%. The moisture inside of air is called the wet-bulb temperature, humidity ratio, or dewpoint temperature. Perspiration accumulates on the body skin; when the human body is overheated, then the moisture evaporates and the body is cooled. If the relative humidity is more than 60%, it slows down the evaporation from the skin and this result in both less cooling and more discomfort, particularly at high metabolic rates and higher temperatures. Human is more comfortable, when relative humidity levels are low and temperature is high. Relative humidity levels below 50% provide comfort in activities with higher metabolic rates than deskwork.

In hot-humid regions, most of the time these humidity requirements may be satisfied all or part of the time using natural ventilation, but sometimes to decline relative humidity in humid climates, air conditioning is needed. If relative humidity level is more than 70%, this can cause in growth of mold and mildew spores. This can happen even after reducing humidity to less than 70% that mold and mildew can be

subsided in proportion. However, removal of mold and mildew would not happen until relative humidity is reduced less than 30% for a long time, or the growth should be treated with biocide. Fans and operable windows can also provide air circulation and increase the higher temperature limit of comfort by about two degrees. In every place, if air speed is higher than 200 ft/minute, it creates problem for users as explained in figure 18. In hot-humid climate, if relative humidity is high, it can cause evaporation; and this can increase air speed and cause discomfort for users (Design, 1992); (Lstiburek, 2002).

| **Air Velocity** | **Probable Impact** |
|---|---|
| Up to 50 ft/minute | Unnoticed. |
| 50 to 100 ft/minute | Pleasant. |
| 100 to 200 ft/minute | Generally pleasant, but causes a constant awareness of air movement. |
| 200 to 300 ft/minute | From slightly drafty to annoyingly drafty. |
| Above 300 ft/minute | Requires corrective measures if work and health are to be kept in high efficiency. |

Figure 17: Influence of Air circulation on users. Source: (Design, 1992)

Consequently, most researchers claim that users prefer naturally ventilated spaces to air-conditioned ones due to feeling more comfortable in them.

In hot-humid climates, humidity should be controlled by dehumidification strategies both during the day and night (Kubota, Toe Hooi Chyee, & Ahmad, 2009). One approach is using air conditioning units to decline humidity in buildings. However, it is an expensive way of declining humidity due to the demand of energy required to operate it. The other strategy is desiccant louvers between glass panes during night to help absorb humidity and absorbed humidity can be dried by solar heating during the day.

#### 2.1.2.6 Ventilation and Residence Satisfaction

During the design of windows, consideration should be given to supplying the occupants with natural ventilation and finding solutions for the removal of humidity so that they can feel comfortable in hot days of the year. For instance, climatic indicators should carefully be considered such as air movement, air speed, and direction. However, in this study, only direction of the wind has been discussed.

Consequently, designing windows for an apartment building with rooms at various directions that all require ventilation is surely a difficult task. Windows should be designed in such a manner that they function properly during winter and summer months. This requires the adoption of strategies for winter and summer periods such as cross ventilation in hot humid climate. However, natural ventilation on its own may not be enough where the need for mechanical ventilation may be required for supplementary cooling in summer. The other important issues that should be considered carefully are the opening types of windows, control of air leakage and condensation in order to remove humidity.

If the building has many of these qualities; they enhance the interior environment and keep the occupants satisfied. Research proves that many of the residents are aware of these qualities and how much they contribute to the saving of energy in their buildings. Therefore, residents of buildings of which windows are more appropriately designed have higher satisfaction than others. However, some of the tenants have problem with ventilation system and space heating. Consequently, through the consideration of some criteria - which has been discussed previously - at the design stage, the level of residence satisfaction can increase considerably.

**Summary of Chapter 2**

Many aspects have influence on the building performance in terms of providing residences satisfaction in the building and one of them is windows. Two essential features of the windows are providing daylight and connection between inside and outside of the building. In hot humid-climate, windows have the other essential issue to consider the design windows properly in the building such as daylight and natural ventilation. As mentioned before, functional features of windows have effective role on increasing residences satisfaction such as daylighting and natural ventilation in order to provide suitable environment for residences in residential buildings in hot-humid climate. In daylight part, some basic information discussed and accordingly, orientation, glazing area and placement, windows and glazing, sun protection, and anti glare system criteria should be considered in the design. In ventilation part, as mentioned in this chapter have proper natural ventilation in design of windows some issues are important such as cooling techniques (cross or single-sided ventilation), orientation, windows opening types, control of the air leakage, dehumidification system. In the next chapter or in case study part, the functional features of windows are examined in selected residential buildings such as daylighting (e.g. size of windows, ratio of windows area to floor area, placement, and orientation, and shading devices and windows materials), and in ventilation (e.g. natural ventilation type, opening type, and so on) in order to remove humidity and cooling indoor environment to understand criteria of windows design according to residences satisfaction.

# Chapter 3

# 3 AN EVALUATION OF WINDOWS IN SELECTED RESIDENTIAL BUILDINGS IN FAMAGUSTA, NORTH CYPRUS

This part of the thesis discusses the individual cases selected from the city of Famagusta in North Cyprus with a hot-humid climate and presents them in a structured manner. Within this scope, use of windows in mass housing, background of windows, and window design in hot-humid climate is looked at through the collection and analysis of data where the results are discussed at the end of the chapter.

Climate of Famagusta, and significant features that should be considered in the design of windows in apartment buildings are explained. After that use of windows in North Cyprus is elucidated to understand how windows have been used in the history.

In data collection part, case studies are introduced from Uzun, Noyanlar, and Dovec companies and analysis are presented through inventories structured upon the criteria clarified in the second chapter. In data analysis, observations and questionnaires are utilized to arrive at the results. Observation part indicates the information about the windows of selected case studies and residences' conditions. In this part, satisfaction of residences in six apartment buildings (second and third floor) will be investigated in need to understand the level of satisfaction in relation to the design of windows; and the findings will be indicated by varieties of charts and analysis. After that, the whole of this information will be discussed in the discussion part.

## 3.1 North Cyprus and Famagusta Climate

Cyprus is an island in the Mediterranean Sea and located 65 km from Turkey, 100 km from Syria, 400 km from Egypt and 750 km from Greece. The island is physically divided into two administrative areas; Northern and Southern Cyprus. Northern part of the island has two other major cities - Girne and Famagusta- apart from the capital city Nicosia. Famagusta as the second largest city with the highest international student population has been selected as the case of this study (Darke, 2008) - Figure 19.

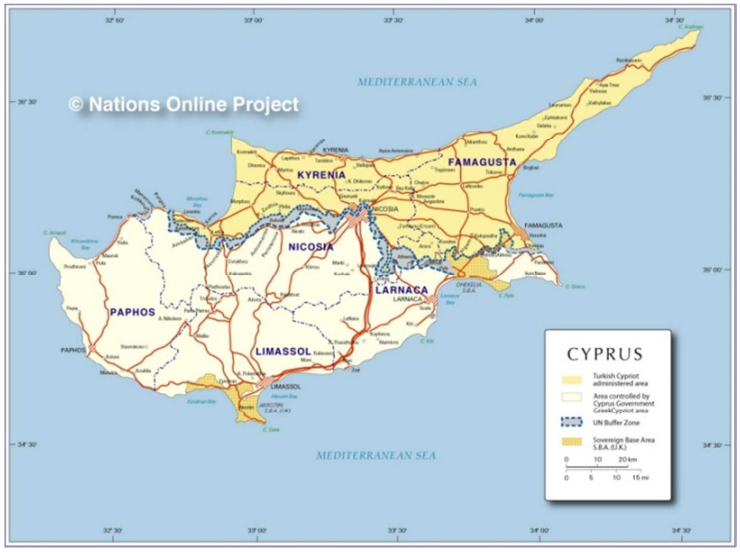



Figure 18: Map of North Cyprus. Source: (blogdog, 2013)

Although North Cyprus enjoys the features of Mediterranean climate and has hot, dry summers and cold winters, in coastal cities like Famagusta the climate is hot-humid due to high relative humidity. In this study, April – November is considered as hot months of the year and November – April as cold months of the year.

The climatic data of Famagusta which has been measured in 2001- 2002 is presented (Hançer, 2005). Figure 20, shows information of Famagusta climate during a year.

GAZIMAGUSA
Location: 35 º N Latitude 34 º E Longitude
Height Above Sea Level: 7 m

| Months | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sunshine Period (Hour/day) | 5.5 | 6.2 | 7.0 | 8.4 | 10.1 | 11.8 | 12.4 | 11.6 | 10.2 | 8.3 | 6.6 | 5.1 | |
| Cloud Cover | 6 | 5 | 5 | 4.5 | 4 | 2.5 | 2 | 1.5 | 2 | 3 | 4 | 5.5 | |
| Solar Radiation Intensity W/m² | | | | | | | | | | | | | |
| Total Solar Radiation (MJ/m² day) | 7 | 10 | 14 | 18 | 23 | 24 | 24 | 23 | 18 | 14 | 9 | 6.5 | |
| Mean Max Air Temperature (ºC) | 16.4 | 16.4 | 18.4 | 22.2 | 26.5 | 30.6 | 33.1 | 33.3 | 31.1 | 27.2 | 22.0 | 17.6 | |
| Mean Min Air Temperature (ºC) | 6.9 | 6.5 | 7.8 | 10.5 | 14.2 | 18.4 | 21.1 | 21.4 | 16.4 | 15.3 | 11.0 | 7.5 | |
| 14.00 Hours Relative Humidity (%) | 60 | 60 | 57 | 52 | 48 | 47 | 45 | 46 | 48 | 52 | 55 | 60 | |
| Mean Relative Humidity (%) | 72.8 | 71.7 | 72.8 | 70.7 | 67.3 | 64.3 | 65.0 | 67.3 | 66.6 | 67.5 | 70.0 | 73.2 | |
| 7.00 Hours Relative Humidity (%) | 88 | 89 | 84 | 89 | 90 | 88 | 85 | 88 | 86 | 86 | 88 | 87 | |
| Precipitation (Mm/month) | 57.2 | 54.5 | 40.9 | 17.9 | 10.2 | 4.1 | 0.8 | 0.6 | 1.1 | 17.8 | 45.4 | 81.9 | 332 |
| Predominant Wind Direction | W | W | W | W | W | SW | SW | SW | W | W | W | W | |

Figure 19: Climate data on Famagusta, North Cyprus. Source: (Özdeniz, 2011)

Due to the climatic features of the island, appropriate types of openings (windows and shading elements) have been used in buildings in order to maximize the amount of daylight; increase ventilation and eliminate humidity as well as protecting the buildings from unwanted solar gains. The following section will investigate types of windows used throughout various periods of island's history.

## 3.2 Use of Windows in North Cyprus

There are different architectural periods in North Cyprus such as; Ottoman (1571–1878), British (1878–1960) and Modern (1960-present) that imposed their own distinctive styles to everyday life. During the Ottoman period (1571–1878), master builders used to give a great importance to climatic issues in the design of public buildings and houses. For example, when designing houses rooms located around the courtyard with just one side of the building and windows opening to the garden to respond to the features of hot climate. Similarly, British period (1878–1960) was another essential era in Cyprus that has introduced the islanders with new techniques and materials as well as environmentally sensitive design. This period can be categorized in two parts; the first one in between 1878 - 1930 years and the second one in between 1930 - 1960 years. In the second period, right after the World War I, sitting rooms with large openings were popular and they were known as

‘‘Camlik’’. These spaces were usually positioned at the front facade of houses. Direction of the sun was carefully considered in the design of houses. In the modern period which coincides with the first decade of 1960, houses were built with one or two levels with respect to orientation where sunshades, size of windows and landscape elements were utilized. After 1970s, apartment type residential units became popular, however, the interest in climatic issues in design decreased to a great extend. After 1980s, together with the increase in temporary student population, demand for apartment type housing increased, lowering the quality of design & construction in buildings. Together with the rising need for budget housing especially for renting to students, there were more apartment type housing getting built with mas housing type plans without considering orientation, window size, type and location. From 1990s onwards, mass housing has spread in all major cities of Northern Cyprus including Famagusta. During recent years, we see buildings with larger openings located at randomly selected directions that help increase the heat gain in buildings. It is observed that most of these buildings now use aluminum shutters that absorb high amount of sunlight in summer. Features of windows which responded to the local climate changed drastically after the Ottoman and British period, where less consideration is now given to comfort, natural ventilation and climatic issues in building design (Ozay N. , 2005) – Figure 21.

Figure 21 indicates that most of the windows used previously in buildings were vertical but in the modern period until present, shape of the windows have changed to horizontal type. This may be the necessity deriving from more daylight need to keep warm in cold days and have enough natural ventilation in summer.

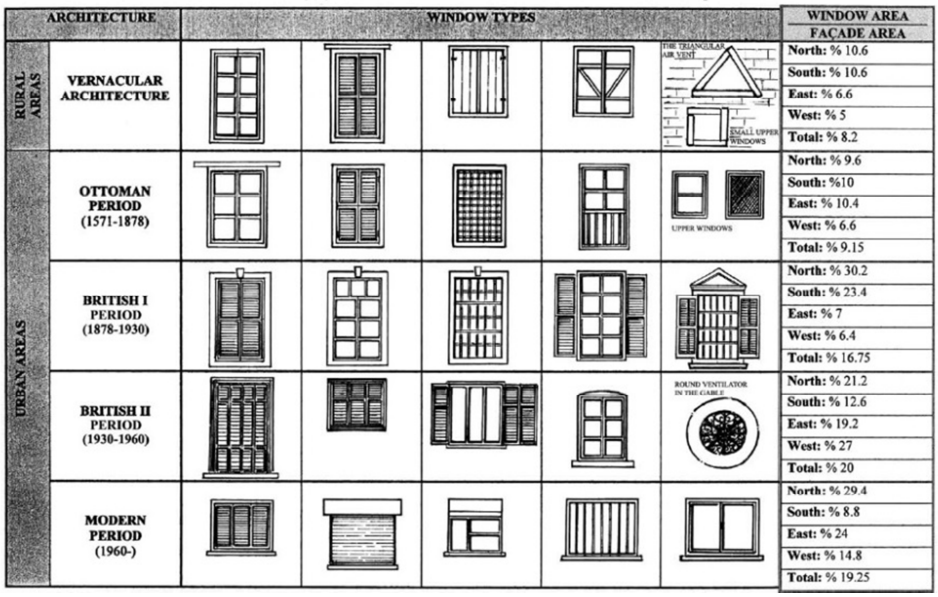



Figure 20: Different types of windows in different architectural period and every side of the building skin. Source: (Ozay N. , 2005)

## 3.3 Background to Current Window Design

As discussed previously, most of the apartment type buildings located in cities suffer from similar problems that come from standardization of housing design that do not consider the local climate. This is also applicable for current apartments designed and constructed in Famagusta where the characteristics of hot-humid climate are not taken into consideration. This has also been pinpointed by many of the residences questioned in the selected apartment buildings, which are taken as the case of this study.

It is well known that one of the most important components of any building is its skin as it protects the residences from extreme conditions of environment. The components of the building skin like windows and its parts play a significant role in the maintenance of optimum comfort levels, as they are the major contributors to heat gain and loss in buildings.

In order to achieve required comfort levels in buildings, criteria such as location of the building, orientation, daylight factor, ventilation, and building components such as windows should be carefully considered during the design stage. If these issues are not well thought out, this will create discomfort for the users and decrease their level of satisfaction.

Most of the residential buildings investigated in Famagusta have proved that major spaces like living rooms and bedrooms lack enough daylight and natural ventilation during the year.

The fact that there is a lack of standards in Northern Cyprus is surely another reason explaining the inconsideration of issues such daylight factor, ventilation, thermal property of materials, etc. Furthermore, the age and function of the building is also a determinant in the selection of windows.

## 3.4 Window Design in Hot-humid Climates

Climate in Famagusta is a combination of hot dry and warm-humid climate. The hot climate can create challenges for the design of buildings and can cause many failures if appropriate strategies are not used in buildings. The hot-humid climate necessitates the use of natural ventilation to provide air circulation for the elimination of humidity. Therefore, position of the building and openings are important to gain high amount of wind. Moreover, types of the windows are equally significant such as operable windows to provide cross ventilation. The necessary components should be included in order to direct air into the buildings.

It is necessary in hot dry and mixed climates to control the heat transfer into the building using thermal insulation, smaller windows, and bright high reflective external surfaces. Furthermore, in the climate of Famagusta in the east-west side

shorter facade has to be considered due to the high influence of the sun on this side. Therefore, shading devices should be considered in these faces or shadow casting of every building on each other.

## 3.5 Data Collection

In this study, six apartment buildings were selected from three construction companies, which are Uzun, Noyanlar and Dovec in Famagusta, North Cyprus. Furthermore, from every company two apartment buildings were chosen of which one is an apartment building with single glazed and the other apartment building with double glazed windows. Apartment buildings have four floors and the same building orientation; their location is not far from each other – figure 22 and Table 1, and all of them have similar window sizes. Furthermore, only second and third level of every apartment building is investigated as the ground and top floors may suffer more from heat loss and gain, which can affect the satisfaction of the residents negatively. Totally, 100 residences are questioned to understand the level of satisfaction relating to window as a building component.

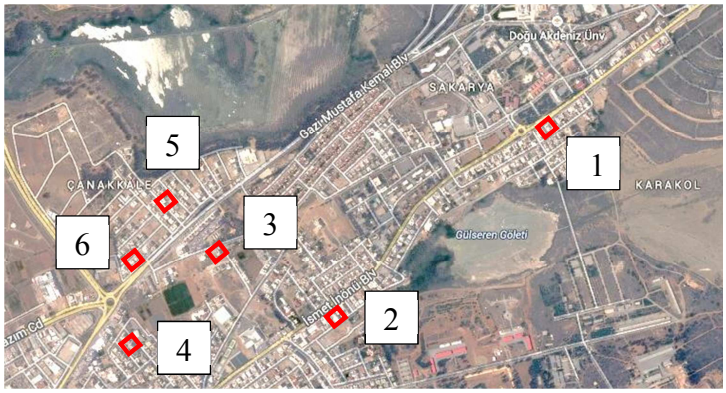


Figure 21: Map of North Cyprus. Source: (URL12, 2014)

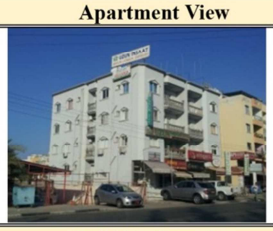
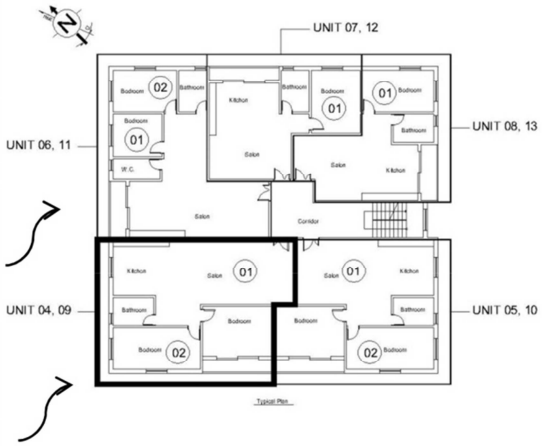
Table 1: Case studies from three different construction companies like Uzun, Noyanlar, and Dovec

| Construction Companies | Apartment building | Location | Table | Inventory Code | Page Number |
|---|---|---|---|---|---|
| **Uzun** | 1 (M.Oltan Apt.) | Salamis Yolu | 2 | (UZ.M.02.UN.04) | 45 |
| | | | | (UZ.M.02.UN.05) | 46 |
| | | | | (UZ.M.02.UN.06) | 47 |
| | | | | (UZ.M.02.UN.07) | 48 |
| | | | | (UZ.M.02.UN.08) | 49 |
| | | | | (UZ.M.03.UN.09) | 50 |
| | | | | (UZ.M.03.UN.10) | 51 |
| | | | | (UZ.M.03.UN.11) | 52 |
| | | | | (UZ.M.03.UN.12) | 53 |
| | | | | (UZ.M.03.UN.13) | 54 |
| | 2 (Emine Apt.) | Faiz Kaymak SK, Gülseren (Karakol) | 3 | (UZ.E.02.UN.03) | 55 |
| | | | | (UZ.E.02.UN.03) | 56 |
| | | | | (UZ.E.02.UN.04) | 57 |
| | | | | (UZ.E.02.UN.04) | 58 |
| | | | | (UZ.E.03.UN.05) | 59 |
| | | | | (UZ.E.03.UN.05) | 60 |
| | | | | (UZ.E.03.UN.06) | 61 |
| | | | | (UZ.E.03.UN.06) | 62 |
| **Noyanlar** | 3 (Arken 14) | Ulucam Yolu SK, Sakarya | 4 | (NOY.A14.02.UN.04) | 63 |
| | | | | (NOY.A14.02.UN.04) | 64 |
| | | | | (NOY.A14.02.UN.05) | 65 |
| | | | | (NOY.A14.02.UN.06) | 66 |
| | | | | (NOY.A14.03.UN.07) | 67 |
| | | | | (NOY.A14.03.UN.08) | 68 |
| | | | | (NOY.A14.03.UN.09) | 69 |
| | 4 (Arken 12 ) | Zafer SK, Sakarya | 5 | (NOY.A12.02.UN.03) | 70 |
| | | | | (NOY.A12.02.UN.03) | 71 |
| | | | | (NOY.A12.02.UN.04) | 72 |
| | | | | (NOY.A12.02.UN.04) | 73 |
| | | | | (NOY.A12.03.UN.05) | 74 |
| | | | | (NOY.A12.03.UN.05) | 75 |
| | | | | (NOY.A12.03.UN.06) | 76 |
| | | | | (NOY.A12.03.UN.06) | 77 |
| **Dovec** | 5 (No. 18) | Akhisar SK, Kaliland (Tuzla) | 6 | (DOV.18.02.UN.03) | 78 |
| | | | | (DOV.18.02.UN.03) | 79 |
| | | | | (DOV.18.02.UN.04) | 80 |
| | | | | (DOV.18.03.UN.05) | 81 |
| | | | | (DOV.18.03.UN.06) | 82 |
| | 6 (Celebi Apt.) | Ilgin SK, Kaliland (Tuzla) | 7 | (DOV.CE.02.UN.03) | 83 |
| | | | | (DOV.CE.02.UN.04) | 84 |
| | | | | (DOV.CE.02.UN.05) | 85 |
| | | | | (DOV.CE.02.UN.06) | 86 |
| | | | | (DOV.CE.03.UN.07) | 87 |
| | | | | (DOV.CE.03.UN.08) | 88 |
| | | | | (DOV.CE.03.UN.09) | 89 |
| | | | | (DOV.CE.03.UN.10) | 90 |

The first and second case studies are built by Uzun Construction Company of which the first one is M. Oltan Apartment building with single glazed windows located along Salamis Yolu. Information in inventories is from observations, and

questionnaires. In addition, users' satisfaction level has been measured through questionnaires and orientation of windows has been noted through observations in regards to analysis of ventilation – Table 2. Further information is in appendix B.

Table 2: M. Oltan Apt., Salamis Yolu

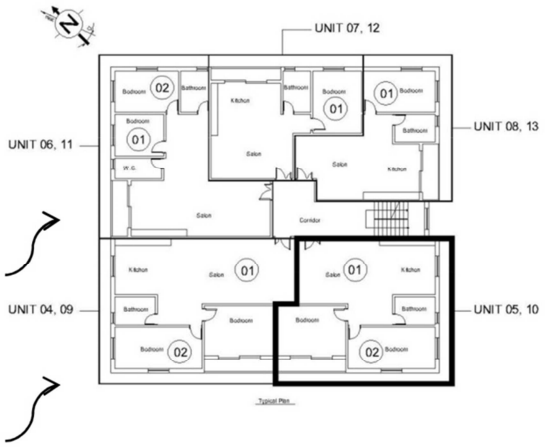
| Uzun: M. Oltan Apt., Salamis Yolu (Single Glaze windows) (UZ.M.02.UN.04) | | | | |
|---|---|---|---|---|
| **Apartment View** | | | **Schematic Plan** | |
|  | | |   | |
| **Building Location** | | | | |
|  | | | | |
| **Second floor – Unit 04 (UZ.M.02.UN.04)** | | | | |
| **Five units in each floor** | | | | |
| **The Functional Features of Windows** | | **01 (Living room)** | **Level of Satisfaction** | |
| **Daylighting :** | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | Dissatisfied | Dissatisfied |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/40=1/26 | Neutral | Neutral |
| **Placement** | | Salon | Northwest | Neutral | Dissatisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northwest | | Dissatisfied | Dissatisfied |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | **Level of Satisfaction** | |
| **Daylighting** | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Southwest | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/5 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest, and southwest | Neutral | Neutral |
| | | | | Dissatisfied | Satisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Southwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| Explanation: Orientation of unit 04 for daylight gain is from northwest, and southwest. Residences are less satisfied with these windows in winter (Windows size). Windows Size part in inventories just indicate size and number of windows. In addition, in this unit, daylighting and ventilation in bedroom is better than living room. This building does not have any shading devices. In bedroom, there is unwanted solar gain in summer. | | | | |

## Uzun: M. Oltan Apt., Salamis Yolu (Single Glaze windows) (UZ.M.02.UN.05)

**Apartment View**

**Building Location**

**Schematic Plan**

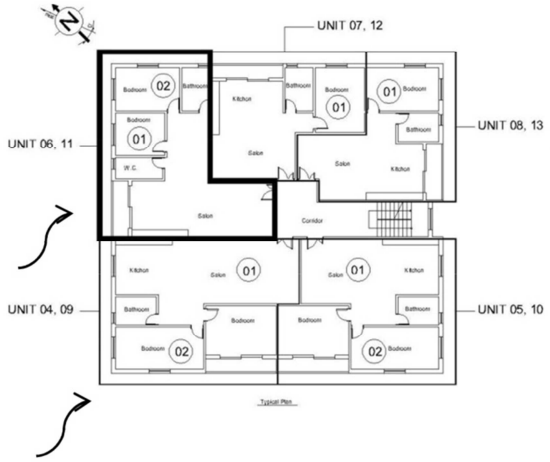


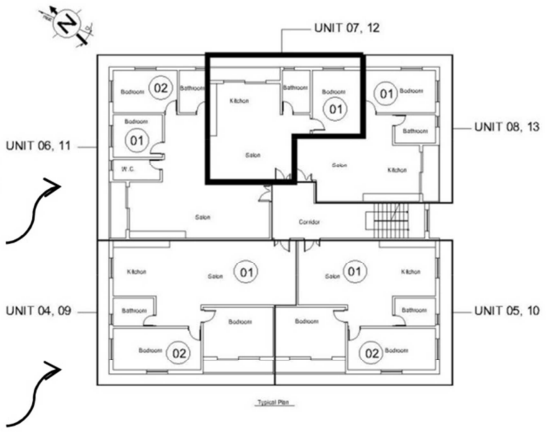

**Second floor – Unit 05 (UZ.M.02.UN.05)**

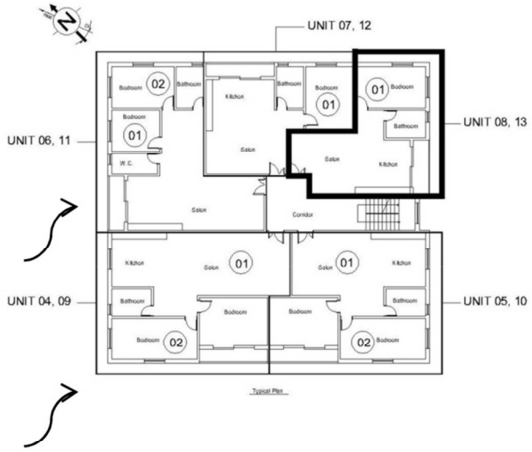
**Five units in each floor**

| The Functional Features of Windows | | 01 (Living room) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylighting** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/30=1/20 | Neutral | Neutral |
| **Placement** | | Salon | Southeast | Neutral | Dissatisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Southeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southwest | | Neutral | Neutral |
| | | Southeast | | Dissatisfied | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/5 | Neutral | Neutral |
| **Placement** | | Bedroom | Southeast, and southwest | Dissatisfied | Neutral |
| | | | | Dissatisfied | Satisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Southwest | | Neutral | Neutral |
| | | Southeast | | Dissatisfied | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

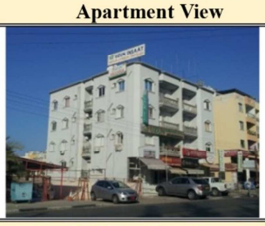
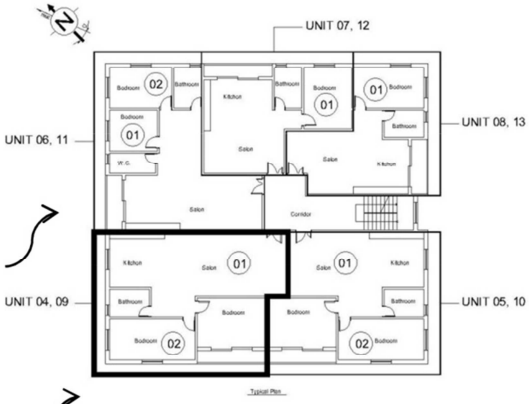
Explanation: Orientation of unit 05 for daylight gain is from southeast, and southwest. In this unit, living room does not have proper daylight and natural ventilation. In bedroom daylight and natural ventilation is suitable. This building does not have any shading devices. In this unit, there is glare and unwanted solar gain in summer. Windows Size part in inventories just indicate size and number of windows.

| Uzun: M. Oltan Apt., Salamis Yolu (Single Glaze windows) (UZ.M.02.UN.06) | | | | |
|---|---|---|---|---|
| **Apartment View** | | | **Schematic Plan** | |
|  | | |  | |
| **Building Location** | | | | |
|  | | | | |
| **Second floor – Unit 06 (UZ.M.02.UN.06)** | | | | |
| **Five units in each floor** | | | | |
| **The Functional Features of Windows** | | **01 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | Dissatisfied | Dissatisfied |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest | Neutral | Dissatisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northwest | | Dissatisfied | Dissatisfied |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/5 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest, and northeast | Neutral | Neutral |
| | | | | Dissatisfied | Satisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| Explanation: Orientation of unit 06 for daylight gain is from northwest, and northeast. In this unit, 01 (bedroom) does not have proper daylight and natural ventilation. In 02 (bedroom), daylight and natural ventilation is suitable. Windows Size part in inventories just indicate size and number of windows. | | | | | |

| Uzun: M. Oltan Apt., Salamis Yolu (Single Glaze windows) (UZ.M.02.UN.07) | | | | |
|---|---|---|---|---|
| **Apartment View** | | | **Schematic Plan** | |
|  | | |  | |
| **Building Location** | | | | |
|  | | | | |
| **Second floor – Unit 07 (UZ.M.02.UN.07)** | | | | |
| **Five units in each floor** | | | | |
| **The Functional Features of Windows** | | **01 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast | Neutral | Dissatisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | - |
| Explanation: Orientation of unit 07 for daylight gain is from northeast. In this unit, 01 (bedroom) does not have proper daylight and natural ventilation. Windows Size part in inventories just indicate size and number of windows. | | | | |

| Uzun: M. Oltan Apt., Salamis Yolu (Single Glaze windows) (UZ.M.02.UN.08) | |
|---|---|
| **Apartment View** | **Schematic Plan** |
|  |  |
| **Building Location** | |
|  | |

| **Second floor – Unit 08 (UZ.M.02.UN.08)** | | | | |
|---|---|---|---|---|
| **Five units in each floor** | | | | |
| **The Functional Features of Windows** | | **01 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | Neutral | Neutral |
| | | Southeast | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast, and southeast | Neutral | Neutral |
| | | | | Dissatisfied | Satisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Neutral | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| | | Southeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| Explanation: Orientation of unit 08 for daylight gain is from northeast, and southeast. In 01 (bedroom), daylight in winter and natural ventilation summer is suitable. In bedroom, there is unwanted solar gain in summer. Windows Size part in inventories just indicate size and number of windows. | | | | | |

| Uzun: M. Oltan Apt., Salamis Yolu (Single Glaze windows) (UZ.M.03.UN.09) | |
|---|---|
| **Apartment View** | **Schematic Plan** |
|  |  |
| **Building Location** | |
|  | |

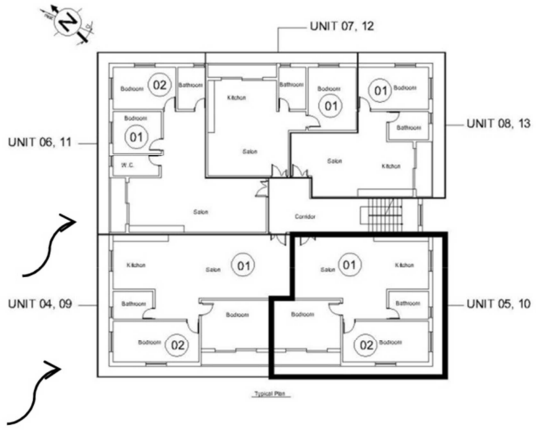
| **Third floor – Unit 09 (UZ.M.03.UN.09)** | | | | |
|---|---|---|---|---|
| **Five units in each floor** | | | | |
| **The Functional Features of Windows** | | **01 (Living room)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | Dissatisfied | Dissatisfied |
| **Windows Size** | **Ratio of windows area to Floor area** | 1.5x1 | 1.5/40=1/26 | Neutral | Neutral |
| **Placement** | | Salon | Northwest | Neutral | Dissatisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northwest | | Dissatisfied | Dissatisfied |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Southwest | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to Floor area** | (1.5x1)x2 | 3/15=1/5 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest, and southwest | Neutral | Neutral |
| | | | | Dissatisfied | Satisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Southwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| Explanation: Orientation of unit 09 for daylight gain is from northwest, and southwest. In this unit 01, (bedroom) does not have proper daylight and natural ventilation. In 02 (bedroom) daylight and natural ventilation are better than the other room. Windows Size part in inventories just indicate size and number of windows. | | | | |

Uzun: M. Oltan Apt., Salamis Yolu (Single Glaze windows) (UZ.M.03.UN.10)

**Apartment View**

**Building Location**

**Schematic Plan**

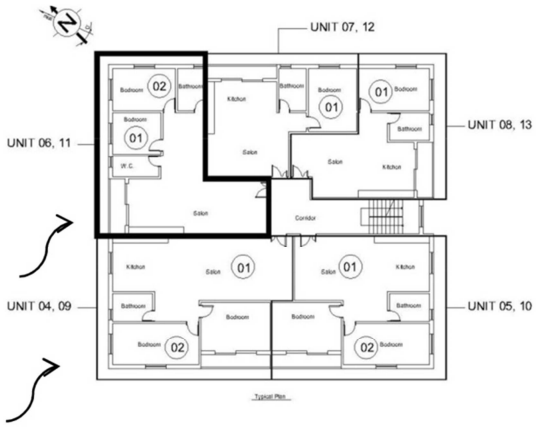



**Third floor – Unit 10 (UZ.M.03.UN.10)**

**Five units in each floor**

| The Functional Features of Windows | | 01 (Living room) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/30=1/20 | Neutral | Neutral |
| **`Placement** | | Salon | Southeast | Neutral | Satisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Southeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southwest | | Neutral | Neutral |
| | | Southeast | | Dissatisfied | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/5 | Neutral | Neutral |
| **Placement** | | Bedroom | Southeast, and southwest | Dissatisfied | Neutral |
| | | | | Dissatisfied | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Southwest | | Neutral | Neutral |
| | | Southeast | | Dissatisfied | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

Explanation: Orientation of unit 10 for daylight gain is from southeast, and southwest. In this unit, 01 (living room) has proper daylight in winter and natural ventilation in summer. In 02 (bedroom) daylight and natural ventilation is enough. In this unit, there is unwanted solar gain in summer. Windows Size part in inventories just indicate size and number of windows.

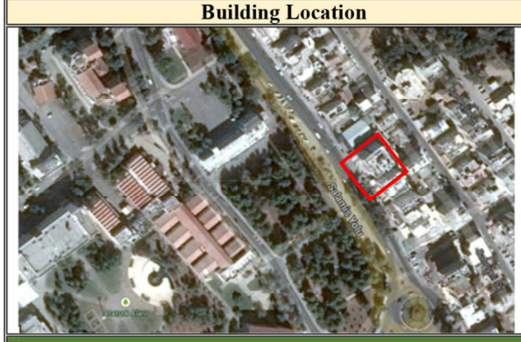
| Uzun: M. Oltan Apt., Salamis Yolu (Single Glaze windows) (UZ.M.03.UN.11) | |
|---|---|
| **Apartment View** | **Schematic Plan** |
|  |  |
| **Building Location** | |
|  | |

| **Third floor – Unit 11 (UZ.M.03.UN.11)** | | | | |
|---|---|---|---|---|
| **Five units in each floor** | | | | |
| **The Functional Features of Windows** | | **01 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | Dissatisfied | Dissatisfied |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.512=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest | Neutral | Dissatisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northwest | | Dissatisfied | Dissatisfied |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/5 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest, and northeast | Neutral | Neutral |
| | | | | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| Explanation: Orientation of unit 11 for daylight gain is from northwest, and northeast. In this unit, 01 (bedroom) does not have proper daylight and natural ventilation. In 02 (bedroom) daylight and natural ventilation is suitable. Windows Size part in inventories just indicate size and number of windows. | | | | |

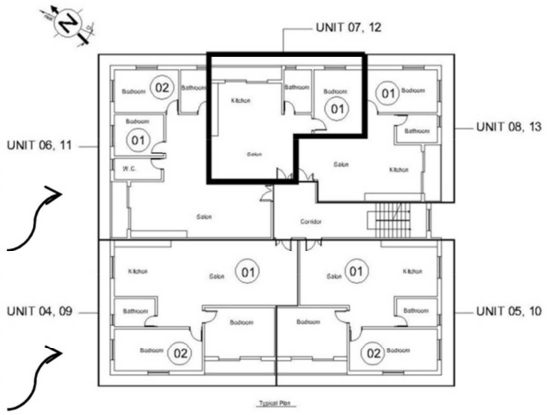
Uzun: M. Oltan Apt., Salamis Yolu (Single Glaze windows) (UZ.M.03.UN.12)

**Apartment View**

**Building Location**



**Schematic Plan**

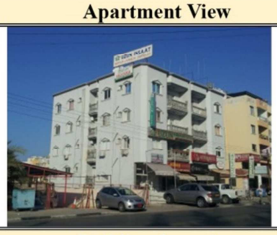
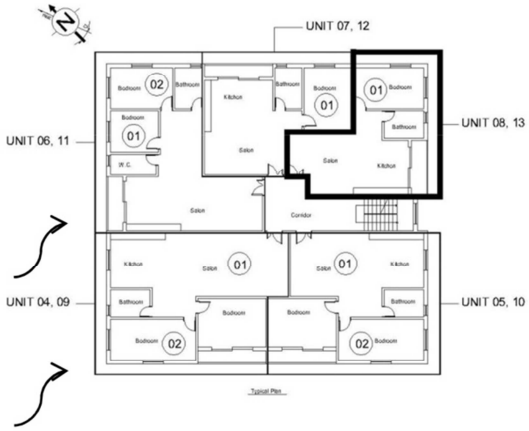



**Third floor – Unit 12 (UZ.M.03.UN.12)**

**Five units in each floor**

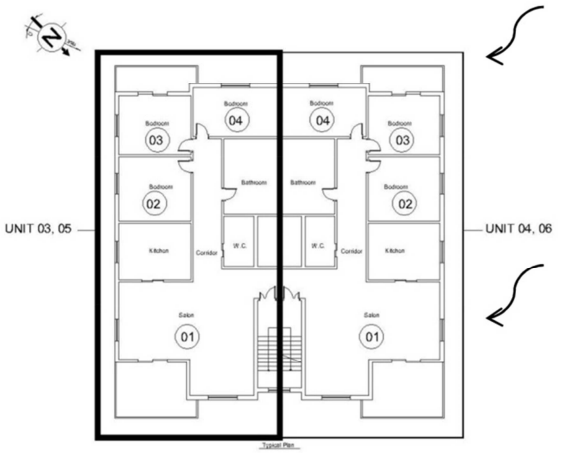
| The Functional Features of Windows | | 01 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast | Neutral | Dissatisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

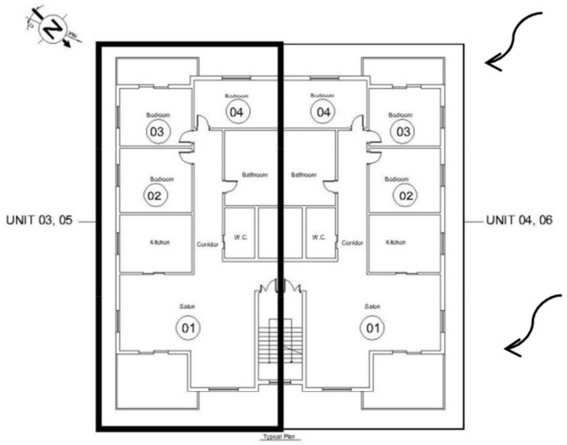
Explanation: Orientation of unit 12 for daylight gain is from northeast. In this unit, 01 (bedroom) does not have proper daylight and natural ventilation. Windows Size part in inventories just indicate size and number of windows.

| Uzun: M. Oltan Apt., Salamis Yolu (Single Glaze windows) (UZ.M.03.UN.13) | | | | |
|---|---|---|---|---|
| **Apartment View** | | | **Schematic Plan** | |
|  | | |   | |
| **Building Location** | | | | |
|  | | | | |
| **Third floor – Unit 13 (UZ.M.03.UN.13)** | | | | |
| **Five units in each floor** | | | | |
| **The Functional Features of Windows** | | **01 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | Northeast | | Neutral | Neutral |
| | Southeast | | Neutral | Neutral |
| **Windows Size** / **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | Bedroom | Northeast, and southeast | Neutral | Neutral |
| | | | Dissatisfied | Satisfied |
| **Shading Devices** | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | Cross and natural ventilation | | Neutral | - |
| **Windows Orientation** | Northeast | | Neutral | Neutral |
| | Southeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | Double casement opening | | Neutral | Neutral |
| Explanation: Orientation of unit 13 for daylight gain is from northeast, and southeast. In 01 (bedroom), daylight in winter and natural ventilation summer is suitable. In bedroom, there is unwanted solar gain in summer. Windows Size part in inventories just indicate size and number of windows. | | | | |

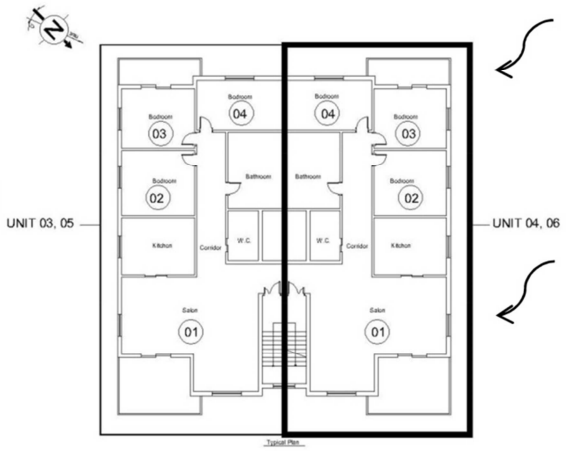
The second case study is from Uzun Construction Company, Emine Apartment located in Faiz Kaymak Street, Gülseren region of Famagusta with double glazed windows. Information in inventories is from observations, and questionnaires. In addition, users' satisfaction level is measured using questionnaires and orientation of windows has been noted through observations in regards to analysis of ventilation – Table 3. Further information is in appendix C.

Table 3: Emine Apt., Faiz Kaymak SK, Gülseren

| Uzun: Emine Apt., Gülseren, Faiz Kaymak SK (Double Glaze windows) (UZ.E.02.UN.03) | | | | | |
|---|---|---|---|---|---|
| **Apartment View** | | | **Schematic Plan** | | |
|  | | |  | | |
| **Building Location** | | | | | |
|  | | | | | |
| **Second floor – Unit 03 (UZ.E.02.UN.03)** | | | | | |
| **Two units in each floor** | | | | | |
| **The Functional Features of Windows** | | | **01 (Living room)** | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Satisfied |
| | | Southeast | | Dissatisfied | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/40=1/13 | Neutral | Neutral |
| **Placement** | | Salon (2 windows) | Northeast, and Southeast | Neutral | Neutral |
| | | | | Dissatisfied | Satisfied |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Cross ventilation | | Satisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| | | Southeast | | Dissatisfied | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | | **02 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southeast | | Dissatisfied | Satisfied |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1/10 | Neutral | Neutral |
| **Placement** | | Bedroom | Southeast | Dissatisfied | Satisfied |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Neutral |
| **Ventilation** | | Cross and natural ventilation | | Dissatisfied | - |
| **Windows Orientation** | | Southeast | | Dissatisfied | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

| Uzun: Emine Apt., Gülseren, Faiz Kaymak SK (Double Glaze windows) (UZ.E.02.UN.03) | |
|---|---|
| **Apartment View** | **Schematic Plan** |
|  |   |
| **Building Location** | |
|  | |

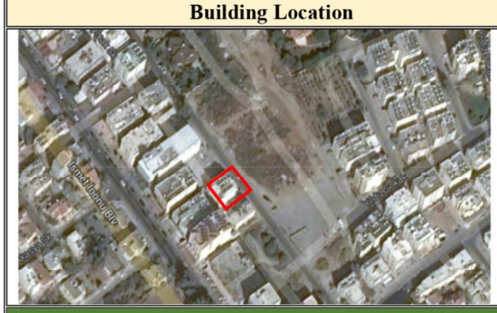
| **Second floor – Unit 03 (UZ.E.02.UN.03)** | | | | | |
|---|---|---|---|---|---|
| **Two units in each floor** | | | | | |
| **The Functional Features of Windows** | | **03 (Bedroom)** | | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southeast | | Dissatisfied | Satisfied |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1/10 | Neutral | Neutral |
| **Placement** | | Bedroom | Southeast | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Neutral |
| **Ventilation** | | Cross and natural ventilation | | Neutral | - |
| **Windows Orientation** | | Southeast | | Dissatisfied | Satisfied |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **04 (Bedroom)** | | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southwest | | Dissatisfied | Satisfied |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1/10 | Neutral | Neutral |
| **Placement** | | Bedroom | Southwest | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Single-sided | | Neutral | - |
| **Windows Orientation** | | Southwest | | Satisfied | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| Explanation: Unit three is on the left hand of Emine apartment building. Three orientation of this unit for daylight gain is from northeast, southeast, and southwest. This building has shutter shading devices however, on south side of the buildings shading devices that used in this building are not proper. Windows Size part in inventories just indicate size and number of windows. | | | | | |

| Uzun: Emine Apt., Gülseren, Faiz Kaymak SK (Double Glaze windows) (UZ.E.02.UN.04) | | | | |
|---|---|---|---|---|
| **Apartment View** | | | **Schematic Plan** | |
|  | | |  | |
| **Building Location** | | | | |
|  | | | | |
| **Second floor – Unit 04 (UZ.E.02.UN.04)** | | | | |
| **Two units in each floor** | | | | |
| **The Functional Features of Windows** | | **01 (Living room)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | Neutral | Neutral |
| | | Northwest | Dissatisfied | Dissatisfied |
| **Windows Size** | **Ratio of windows area to Floor area** | (1.5x1)x2 | 3/40=1/13 | Neutral | Neutral |
| **Placement** | | Salon (2 windows) | Northeast, and northwest | Neutral | Neutral |
| | | | | Neutral | Dissatisfied |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| | | Northwest | | Dissatisfied | Dissatisfied |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1/10 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Neutral |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

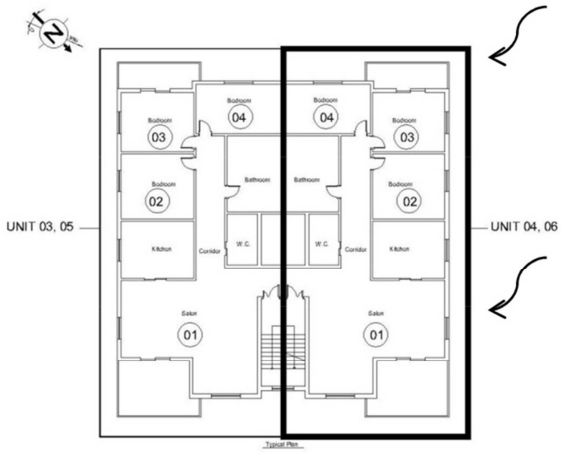
Uzun: Emine Apt., Gülseren, Faiz Kaymak SK (Double Glaze windows) (UZ.E.02.UN.04)

**Apartment View**

**Building Location**



**Schematic Plan**

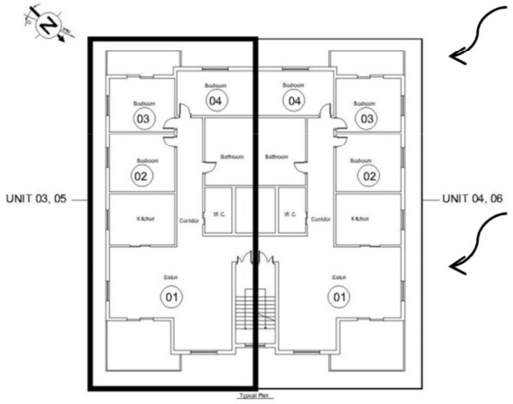


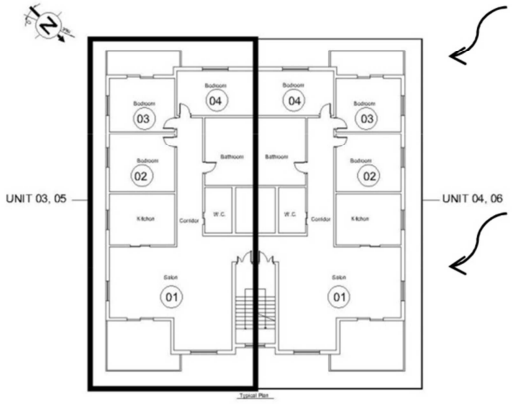

**Second floor – Unit 04 (UZ.E.02.UN.04)**

**Two units in each floor**

| The Functional Features of Windows | | 03 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1/10 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Neutral |
| **Ventilation** | | Cross and natural ventilation | | Dissatisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **04 (Bedroom)** | | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southwest | | Dissatisfied | Satisfied |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1/10 | Neutral | Neutral |
| **Placement** | | Bedroom | Southwest | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Single-sided | | Neutral | - |
| **Windows Orientation** | | Southwest | | Satisfied | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

Explanation: Unit four is on the right hand of Emine apartment building. Three orientation of this unit for daylight gain is from northeast, northwest, and southwest. This building has shutter shading devices however, on south side of the buildings shading devices that used in this building are not proper. Windows Size part in inventories just indicate size and number of windows.

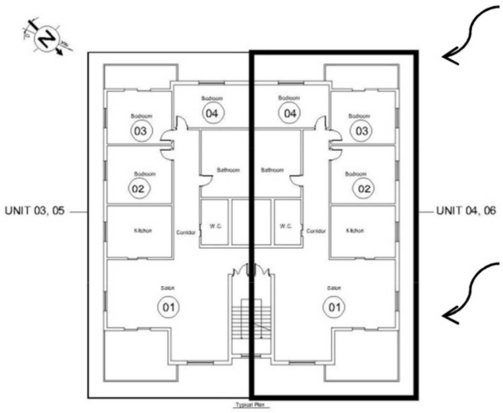
| Uzun: Emine Apt., Gülseren, Faiz Kaymak SK (Double Glaze windows) (UZ.E.03.UN.05) | | | | |
|---|---|---|---|---|
| **Apartment View** | | | **Schematic Plan** | |
|  | | |   | |
| **Building Location** | | | | |
|  | | | | |
| **Third floor – Unit 05 (UZ.E.03.UN.05)** | | | | |
| **Two units in each floor** | | | | |
| **The Functional Features of Windows** | | **01 (Living rooms)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | Northeast | | Neutral | Satisfied |
| | Southeast | | Dissatisfied | Neutral |
| **Windows Size** / **Ratio of windows area to floor area** | (1.5x1)x2 | 3/40=1/13 | Neutral | Neutral |
| **Placement** | Salon (2 windows) | Northeast, and Southeast | Neutral | Neutral |
| | | | Dissatisfied | Satisfied |
| **Shading Devices** | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | Northeast | | Neutral | Satisfied |
| | Southeast | | Dissatisfied | Neutral |
| **Control of the Air leakage and Condensation** | Yes | | Neutral | Neutral |
| **Windows Opening Types** | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | Southeast | | Dissatisfied | Satisfied |
| **Windows Size** / **Ratio of windows area to floor area** | 1.5x1 | 1/10 | Neutral | Neutral |
| **Placement** | Bedroom | Southeast | Dissatisfied | Satisfied |
| **Shading Devices** | Shutter (Aluminum with white color) | | Neutral | Neutral |
| **Ventilation** | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | Southeast | | Dissatisfied | Satisfied |
| **Control of the Air leakage and Condensation** | Yes | | Neutral | Neutral |
| **Windows Opening Types** | Double casement opening | | Neutral | Neutral |

| Uzun: Emine Apt., Gülseren, Faiz Kaymak SK (Double Glaze windows) (UZ.E.03.UN.05) | | | | |
|---|---|---|---|---|
| **Apartment View** | | | **Schematic Plan** | |
|  | | |   | |
| **Building Location** | | | | |
|  | | | | |
| **Third floor – Unit 05 (UZ.E.03.UN.05)** | | | | |
| **Two units in each floor** | | | | |
| **The Functional Features of Windows** | | **01 (Living rooms)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | Northeast | | Neutral | Satisfied |
| | Southeast | | Dissatisfied | Neutral |
| **Windows Size** / **Ratio of windows area to floor area** | (1.5x1)x2 | 3/40=1/13 | Neutral | Neutral |
| **Placement** | Salon (2 windows) | Northeast, and Southeast | Neutral | Neutral |
| | | | Dissatisfied | Satisfied |
| **Shading Devices** | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | Northeast | | Neutral | Satisfied |
| | Southeast | | Dissatisfied | Neutral |
| **Control of the Air leakage and Condensation** | Yes | | Neutral | Neutral |
| **Windows Opening Types** | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | Southeast | | Dissatisfied | Satisfied |
| **Windows Size** / **Ratio of windows area to floor area** | 1.5x1 | 1/10 | Neutral | Neutral |
| **Placement** | Bedroom | Southeast | Dissatisfied | Satisfied |
| **Shading Devices** | Shutter (Aluminum with white color) | | Neutral | Neutral |
| **Ventilation** | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | Southeast | | Dissatisfied | Satisfied |
| **Control of the Air leakage and Condensation** | Yes | | Neutral | Neutral |
| **Windows Opening Types** | Double casement opening | | Neutral | Neutral |

## Uzun: Emine Apt., Gülseren, Faiz Kaymak SK (Double Glaze windows) (UZ.E.03.UN.06)

**Apartment View**

**Schematic Plan**

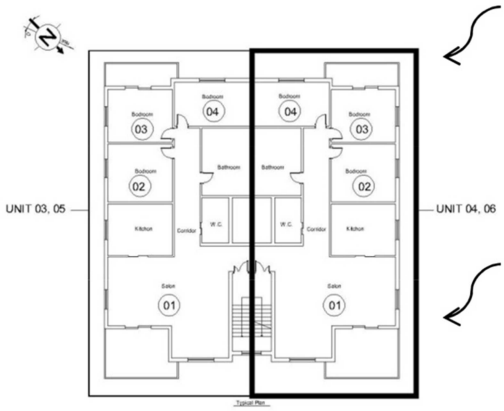



**Building Location**

**Third floor – Unit 06 (UZ.E.03.UN.06)**

**Two units in each floor**

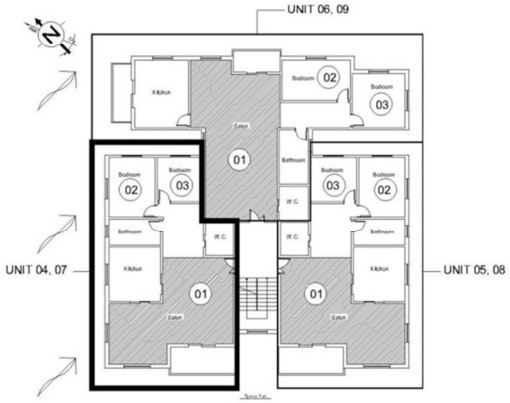
| The Functional Features of Windows | | 01 (Living rooms) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| | | Northwest | | Dissatisfied | Dissatisfied |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/40=1/13 | Neutral | Neutral |
| **Placement** | | Salon (2 windows) | Northeast, and northwest | Neutral | Neutral |
| | | | | Neutral | Dissatisfied |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| | | Northwest | | Dissatisfied | Dissatisfied |
| **Control of the Air leakage and Condensation** | | Yes | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1/10 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Neutral |
| **Ventilation** | | Single-sided | | Neutral | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

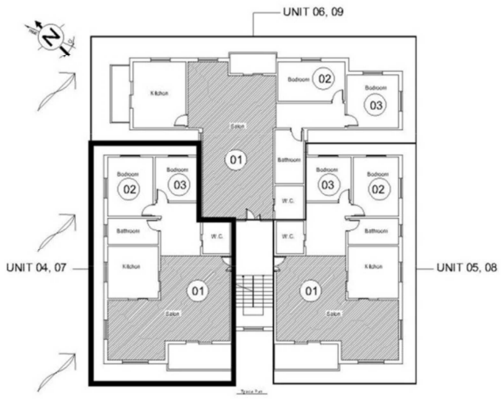
| Uzun: Emine Apt., Gülseren, Faiz Kaymak SK (Double Glaze windows) (UZ.E.03.UN.06) | | | | |
|---|---|---|---|---|
| **Apartment View** | | | **Schematic Plan** | |
|  | | |   | |
| **Building Location** | | | | |
|  | | | | |
| **Third floor – Unit 06 (UZ.E.03.UN.06)** | | | | |
| **Two units in each floor** | | | | |
| **The Functional Features of Windows** | | **03 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1/10 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Neutral |
| **Ventilation** | | Cross and natural ventilation | | Dissatisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **04 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Southwest | | Dissatisfied | Satisfied |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1/10 | Neutral | Neutral |
| **Placement** | | Bedroom | Southwest | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Single-sided | | Satisfied | - |
| **Windows Orientation** | | Southwest | | Dissatisfied | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| Explanation: Unit 06 is on the right hand of Emine apartment building. Three orientation of this unit for daylight gain is from northeast, northwest, and southwest. This building has shutter shading devices however, on south side of the buildings shading devices that used in this building are not proper. Windows Size part in inventories just indicate size and number of windows. | | | | |

The third and fourth case studies are constructed by Noyanlar Construction Company. The third one is Arken 14 Apartment building with single glazed windows which is located along Ulucam Street, Sakarya region of Famagusta. Information in inventories is from observations, and questionnaires. In addition, users' satisfaction level has been measured through questionnaires and orientation of windows has been

noted through observations in regards to analysis of ventilation – Table 4. Further information is in appendix D.

Table 4: Arken 14 Apt., Ulucam Yolu SK, Sakarya

| Noyanlar: Arken 14 Apt., Ulucam Yolu SK, Sakarya (Single Glaze windows) (NOY.A14.02.UN.04) | | | | | |
|---|---|---|---|---|---|
| **Apartment View** | | | **Schematic Plan** | | |
|  | | |  | | |
| **Building Location** | | | | | |
|  | | | | | |
| **Second floor – Unit 04 (NOY.A14.02.UN.04)** | | | | | |
| **Three units in each floor** | | | | | |
| **The Functional Features of Windows** | | | **01 (Living room)** | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Dissatisfied | Dissatisfied |
| | | Southwest | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/40=1/13 | Neutral | Neutral |
| **Placement** | | Salon (2 windows) | Northwest, and southwest | Neutral | Dissatisfied |
| | | | | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northwest | | Dissatisfied | Dissatisfied |
| | | Southwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | | **02 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Dissatisfied | Dissatisfied |
| | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/5 | Satisfied | Neutral |
| **Placement** | | Bedroom | Northwest, and northeast | Neutral | Dissatisfied |
| | | | | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northwest | | Dissatisfied | Dissatisfied |
| | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

| Noyanlar: Arken 14 Apt., Ulucam Yolu SK, Sakarya (Single Glaze windows) (NOY.A14.02.UN.04) | |
|---|---|
| **Apartment View** | **Schematic Plan** |
|  |  |
| **Building Location** | |
|  | |

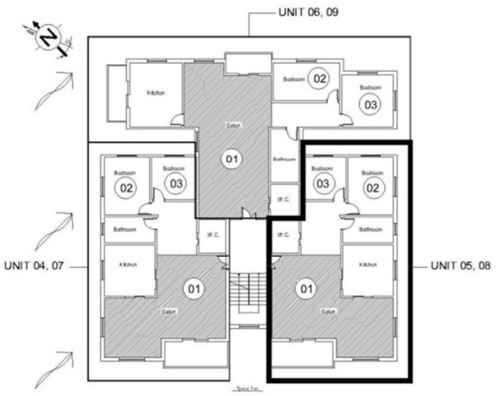
| **Second floor – Unit 04 (NOY.A14.02.UN.04)** | | | | |
|---|---|---|---|---|
| **Three units in each floor** | | | | |
| **The Functional Features of Windows** | | **03 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast | Neutral | Dissatisfied |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| Explanation: Orientation of this unit for daylight gain is from northwest, southwest, and northeast. This building has shutter shading devices however, on south side of the buildings these shading devices are not proper in this building in summer. Windows Size part in inventories just indicate size and number of windows. | | | | |

## Noyanlar: Arken 14 Apt., Ulucam Yolu SK, Sakarya (Single Glaze windows) (NOY.A14.02.UN.05)

**Apartment View**

**Building Location**

**Schematic Plan**




**Second floor – Unit 05 (NOY.A14.02.UN.05)**

**Three units in each floor**

| The Functional Features of Windows | | 01 (Living room) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southeast | | Dissatisfied | Satisfied |
| | | Southwest | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x 2 | 3/40=1/13 | Neutral | Neutral |
| **Placement** | | Salon (2 windows) | Southeast, and southwest | Neutral | Neutral |
| | | | | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Southeast | | Dissatisfied | Neutral |
| | | Southwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

| The Functional Features of Windows | | 02 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southeast | | Neutral | Neutral |
| | | Northeast | | Neutral | Dissatisfied |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x 2 | 3/15=1/5 | Satisfied | Neutral |
| **Placement** | | Bedroom | Southeast, and northeast | Dissatisfied | Satisfied |
| | | | | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| Windows Orientation | | Southeast | | Neutral | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

| The Functional Features of Windows | | 03 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast | Neutral | Dissatisfied |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

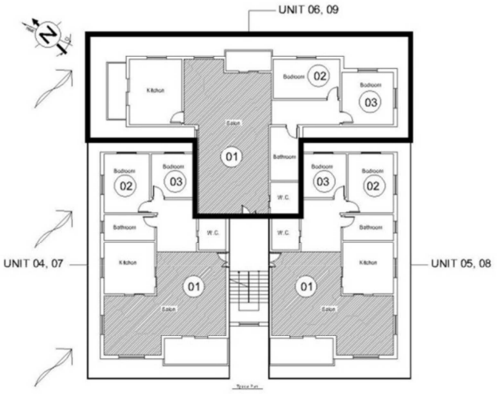
Explanation: Orientation of this unit for daylight gain is from northeast, southeast, and southwest. This building has shading devices (shutter) however; on south side of the buildings these shading devices are not proper in this building in summer. In living room and (02) bedroom, there is unwanted solar gain in summer. Windows Size part in inventories just indicate size and number of windows.

Noyanlar: Arken 14 Apt., Ulucam Yolu SK, Sakarya (Single Glaze windows) (NOY.A14.02.UN.06)

**Apartment View**

**Building Location**

**Schematic Plan**




**Second floor – Unit 06 (NOY.A14.02.UN.06)**

**Three units in each floor**

| The Functional Features of Windows | | 01 (Living room) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Dissatisfied |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 3/45=1/15 | Neutral | Neutral |
| **Placement** | | Salon | Northeast | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Single-sided | | Neutral | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Dissatisfied |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x2 | 3/15=1/5 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **03 (Bedroom)** | | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 3/15=1/5 | Neutral | Neutral |
| **Placement** | | Salon | Northeast | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

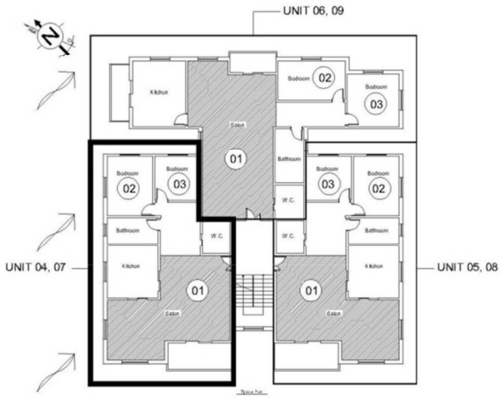
Explanation: Orientation of unit 06 for daylight gain is from northeast. This building has shutter shading devices although, on south side of the buildings these shading devices are not proper in this building in summer. Windows Size part in inventories just indicate size and number of windows.

## Noyanlar: Arken 14 Apt., Ulucam Yolu SK, Sakarya (Single Glaze windows) (NOY.A14.03.UN.07)

**Apartment View**

**Building Location**

**Schematic Plan**




**Third floor – Unit 07 (NOY.A14.03.UN.07)**

**Three units in each floor**

| The Functional Features of Windows | | 01 (Living room) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Dissatisfied | Dissatisfied |
| | | Southwest | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/40=1/13 | Neutral | Neutral |
| **Placement** | | Salon (2 windows) | Northwest, and southwest | Neutral | Dissatisfied |
| | | | | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northwest | | Dissatisfied | Neutral |
| | | Southwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

| The Functional Features of Windows | | 02 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Neutral | Dissatisfied |
| | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/5 | Satisfied | Neutral |
| **Placement** | | Bedroom | Northwest, and northeast | Neutral | Dissatisfied |
| | | | | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

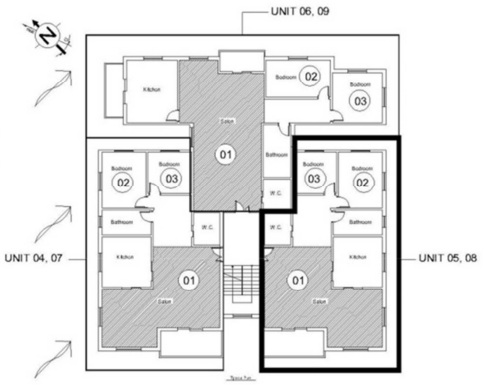
| The Functional Features of Windows | | 03 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast | Neutral | Dissatisfied |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Single-sided | | Neutral | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

Explanation: Orientation of this unit for daylight gain is from northwest, southwest, and northeast. This building has shutter shading devices however, on south side of the buildings these shading devices are not proper in this building in summer. Windows Size part in inventories just indicate size and number of windows.

Noyanlar: Arken 14 Apt., Ulucam Yolu SK, Sakarya (Single Glaze windows) (NOY.A14.03.UN.08)

**Apartment View**

**Schematic Plan**



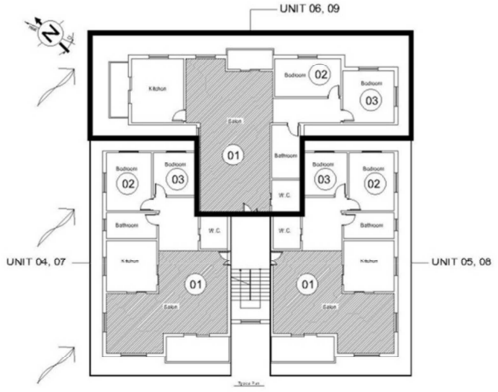

**Building Location**

**Third floor – Unit 08 (NOY.A14.03.UN.08)**

**Three units in each floor**

| The Functional Features of Windows | | 01 (Living room) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southeast | | Dissatisfied | Satisfied |
| | | Southwest | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/40=1/13 | Neutral | Neutral |
| **Placement** | | Salon (2 windows) | Southeast, and southwest | Neutral | Neutral |
| | | | | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Southeast | | Dissatisfied | Neutral |
| | | Southwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southeast | | Neutral | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/5 | Satisfied | Neutral |
| **Placement** | | Bedroom | Southeast, and northeast | Dissatisfied | Satisfied |
| | | | | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Southeast | | Neutral | Neutral |
| | | Northeast | | Neutral | Dissatisfied |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **03 (Bedroom)** | | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Dissatisfied |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast | Neutral | Dissatisfied |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

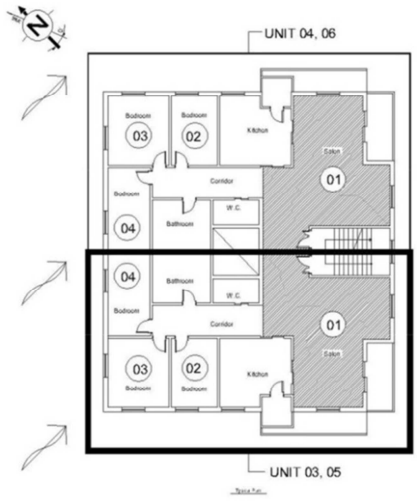
Explanation: Orientation of this unit for daylight gain is from northeast, southwest, and southeast. This building has shading devices (shutter) however; on south side of the buildings these shading devices are not proper in this building in summer. Windows Size part in inventories just indicate size and number of windows.

| Noyanlar: Arken 14 Apt., Ulucam Yolu SK, Sakarya (Single Glaze windows) (NOY.A14.03.UN.09) | | | | |
|---|---|---|---|---|
| **Apartment View** | | | **Schematic Plan** | |
|  | | |   | |
| **Building Location** | | | | |
|  | | | | |
| **Third floor – Unit 09 (NOY.A14.03.UN.09)** | | | | |
| **Three units in each floor** | | | | |
| **The Functional Features of Windows** | | **01 (Living room)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/45=1/15 | Neutral | Neutral |
| **Placement** | | Salon | Northeast | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Dissatisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Dissatisfied |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Dissatisfied |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/5 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Neutral | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **03 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/5 | Neutral | Neutral |
| **Placement** | | Salon | Northeast | Neutral | Dissatisfied |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Neutral | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| Explanation: Orientation of unit 09 for daylight gain is from northeast, and. This building has shutter shading devices although, on south side of the buildings these shading devices are not proper in this building in summer. Windows Size part in inventories just indicate size and number of windows. | | | | |

The fourth case is Arken 12 Apartment building with double glazed windows which is located in Zafer Street, Sakarya region of Famagusta. Information in inventories is

from observations, and questionnaires. In addition, users' satisfaction level has been measured through questionnaires and orientation of windows has been noted through observations in regards to analysis of ventilation – Table 5. Further information is in appendix E.

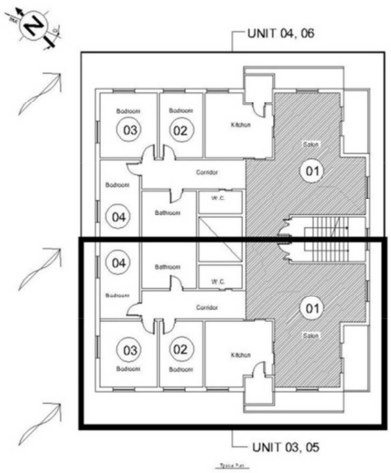
Table 5: Arken 12 Apt., Zafer SK, Sakarya

| Noyanlar: Arken 12 Apt., Zafer SK, Sakarya (Double Glaze windows) (NOY.A12.02.UN.03) | | | | |
|---|---|---|---|---|
| **Apartment View** | | | **Schematic Plan** | |
|  | | |   | |
| **Building Location** | | | | |
|  | | | | |
| **Second floor – Unit 03 (NOY.A12.02.UN.03)** | | | | |
| **Two units in each floor** | | | | |
| **The Functional Features of Windows** | | **01 (Living room)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | Northwest | | Dissatisfied | Dissatisfied |
| | Southwest | | Dissatisfied | Satisfied |
| **Windows Size** / **Ratio of windows area to floor area** | (1.5x1)x2 | 3/40=1/13 | Neutral | Neutral |
| **Placement** | Salon (2 windows) | Northwest, and southwest | Neutral | Neutral |
| | | | Neutral | Dissatisfied |
| **Shading Devices** | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | Northwest | | Dissatisfied | Neutral |
| | Southwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | Yes | | Neutral | Neutral |
| **Windows Opening Types** | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | Northwest | | Neutral | Neutral |
| **Windows Size** / **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | Bedroom | Northwest | Neutral | Neutral |
| **Shading Devices** | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | Northwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | Yes | | Neutral | Neutral |
| **Windows Opening Types** | Double casement opening | | Neutral | Neutral |

Noyanlar: Arken 12 Apt., Zafer SK, Sakarya (Double Glaze windows) (NOY.A12.02.UN.03)

**Apartment View**

**Schematic Plan**




**Building Location**

**Second floor – Unit 03 (NOY.A12.02.UN.03)**

**Two units in each floor**

| The Functional Features of Windows | | 03 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 1/5 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest, and northeast | Neutral | Neutral |
| | | | | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

| The Functional Features of Windows | | 04 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

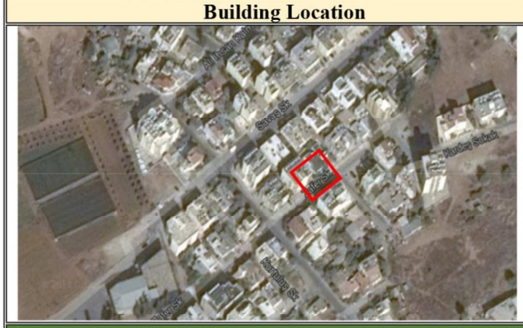
Explanation: Unit 03 is on the left hand of Arken 12 apartment building. Orientation of this unit for daylight gain is from northeast, northwest, and southwest. This Unit does have any shading devices. Windows Size part in inventories just indicate size and number of windows.

## Noyanlar: Arken 12 Apt., Zafer SK, Sakarya (Double Glaze windows) (NOY.A12.02.UN.04)

**Apartment View**

**Schematic Plan**


**Building Location**




**Second floor – Unit 04 (NOY.A12.02.UN.04)**

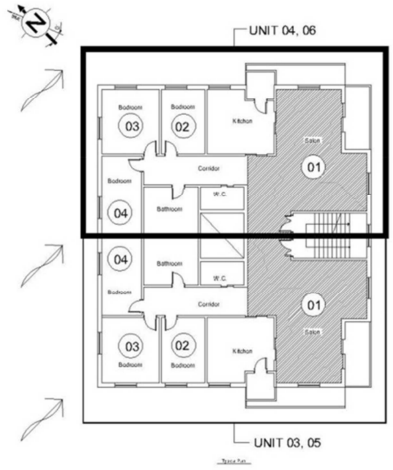
**Two units in each floor**

| The Functional Features of Windows | | 01 (Living room) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southwest | | Dissatisfied | Satisfied |
| | | Southeast | | Dissatisfied | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/40=1/13 | Neutral | Neutral |
| **Placement** | | Salon (2 windows) | Southwest, and Southeast | Neutral | Dissatisfied |
| | | | | Dissatisfied | Satisfied |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Southwest | | Satisfied | Neutral |
| | | Southeast | | Dissatisfied | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southeast | | Dissatisfied | Satisfied |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Southeast | Dissatisfied | Satisfied |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Neutral |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Southeast | | Dissatisfied | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

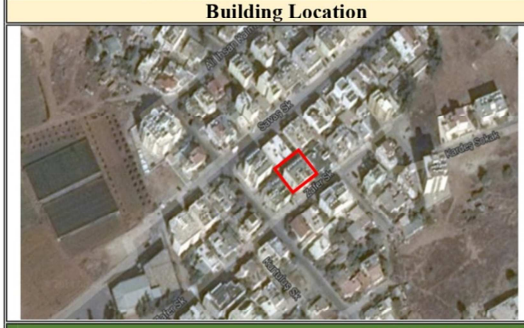
## Noyanlar: Arken 12 Apt., Zafer SK, Sakarya (Double Glaze windows) (NOY.A12.02.UN.04)

**Apartment View**

**Schematic Plan**




**Building Location**



**Second floor – Unit 04 (NOY.A12.02.UN.04)**

**Two units in each floor**

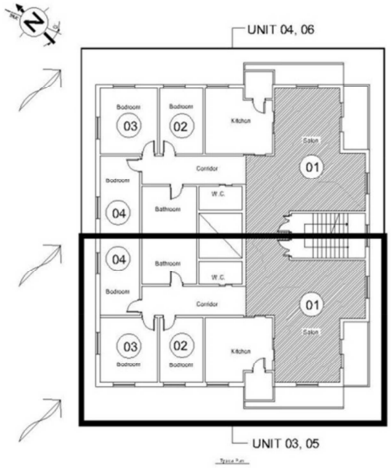
| The Functional Features of Windows | | 03 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southeast | | Dissatisfied | Satisfied |
| | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 1/5 | Neutral | Neutral |
| **Placement** | | Bedroom (2 windows) | Southeast, and northeast | Neutral | Neutral |
| | | | | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Neutral |
| **Ventilation** | | Cross and natural ventilation | | Neutral | - |
| **Windows Orientation** | | Southeast | | Dissatisfied | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **04 (Bedroom)** | | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

Explanation: Unit 04 is on the right hand of Arken 12 apartment building. Orientation of this unit for daylight gain is from northeast, southeast, and southwest. This Unit has shading devices (shutter) although, on south side of the buildings shading devices that used in this building are not proper. Windows Size part in inventories just indicate size and number of windows.

Noyanlar: Arken 12 Apt., Zafer SK, Sakarya (Double Glaze windows) (NOY.A12.03.UN.05)

**Apartment View**

**Schematic Plan**



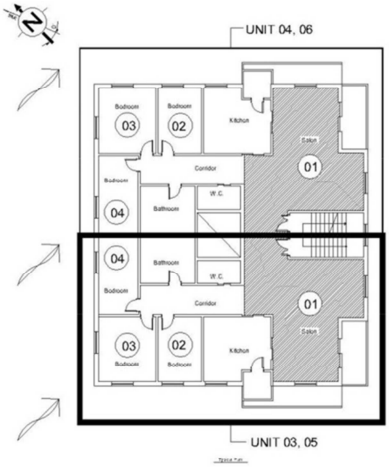
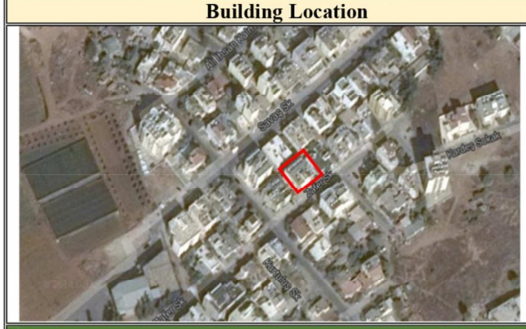

**Building Location**

**Third floor – Unit 05 (NOY.A12.03.UN.05)**

**Two units in each floor**

| The Functional Features of Windows | | 01 (Living room) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Dissatisfied | Dissatisfied |
| | | Southwest | | Dissatisfied | Satisfied |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/40=1/13 | Neutral | Neutral |
| **Placement** | | Salon (2 windows) | Northwest, and southwest | Neutral | Neutral |
| | | | | Neutral | Dissatisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northwest | | Dissatisfied | Dissatisfied |
| | | Southwest | | Satisfied | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

| The Functional Features of Windows | | 02 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

| Noyanlar: Arken 12 Apt., Zafer SK, Sakarya (Double Glaze windows) (NOY.A12.03.UN.05) | |
|---|---|
| **Apartment View** | **Schematic Plan** |
|  |   |
| **Building Location** | |
|  | |

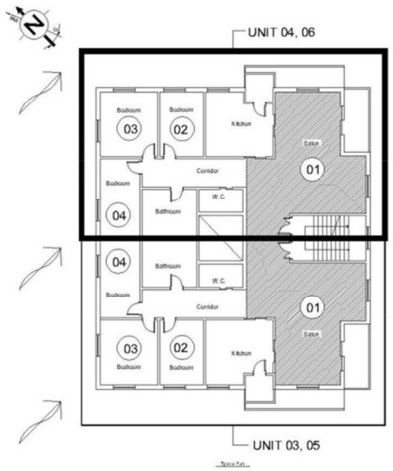
| Third floor – Unit 05 (NOY.A12.03.UN.05) | | | | |
|---|---|---|---|---|
| Two units in each floor | | | | |
| **The Functional Features of Windows** | | **03 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | Neutral | Neutral |
| | | Northeast | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 1/5 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest, and northeast | Neutral | Neutral |
| | | | | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **04 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| Explanation: Unit 05 is on the left hand of Arken 12 apartment building. Orientation of this unit for daylight gain is from northeast, northwest, and southwest. This Unit does have any shading devices. Windows Size part in inventories just indicate size and number of windows. | | | | |

## Noyanlar: Arken 12 Apt., Zafer SK, Sakarya (Double Glaze windows) (NOY.A12.03.UN.06)

**Apartment View**

**Building Location**

**Schematic Plan**




**Third floor – Unit 06 (NOY.A12.03.UN.06)**

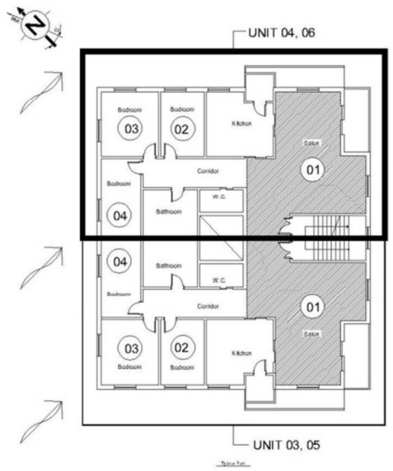
**Two units in each floor**

| The Functional Features of Windows | | 01 (Living room) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southwest | | Dissatisfied | Satisfied |
| | | Southeast | | Dissatisfied | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/40=1/13 | Neutral | Neutral |
| **Placement** | | Salon (2 windows) | Southwest, and Southeast | Neutral | Dissatisfied |
| | | | | Dissatisfied | Satisfied |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Southwest | | Satisfied | Neutral |
| | | Southeast | | Dissatisfied | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southeast | | Dissatisfied | Satisfied |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Southeast | Dissatisfied | Satisfied |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Neutral |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Southeast | | Dissatisfied | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

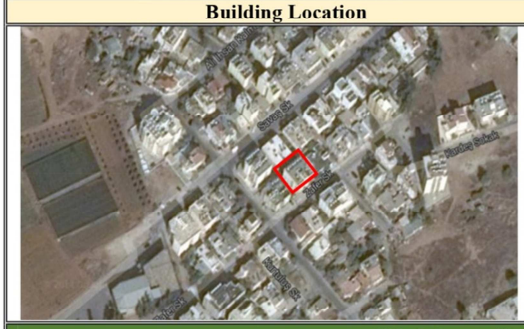
Noyanlar: Arken 12 Apt., Zafer SK, Sakarya (Double Glaze windows) (NOY.A12.03.UN.06)

**Apartment View**

**Schematic Plan**




**Building Location**



**Third floor – Unit 06 (NOY.A12.03.UN.06)**

**Two units in each floor**

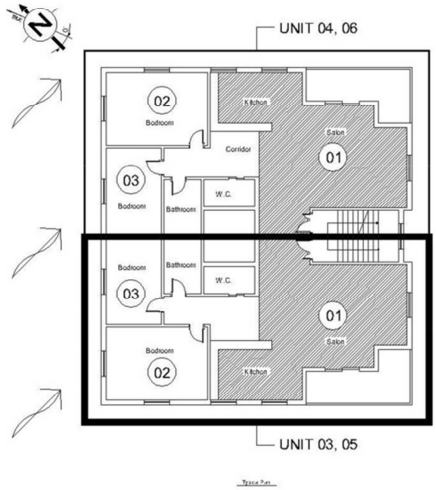
| The Functional Features of Windows | | 03 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southeast | | Dissatisfied | Satisfied |
| | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1/10 | Neutral | Neutral |
| **Placement** | | Bedroom (2 windows) | Southeast, and northeast | Neutral | Neutral |
| | | | | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Neutral |
| **Ventilation** | | Cross and natural ventilation | | Neutral | - |
| **Windows Orientation** | | Southeast | | Dissatisfied | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **04 (Bedroom)** | | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1/10 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast | Neutral | Neutral |
| **Shading Devices** | | Shutter (Aluminum with white color) | | Neutral | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Neutral | Neutral |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

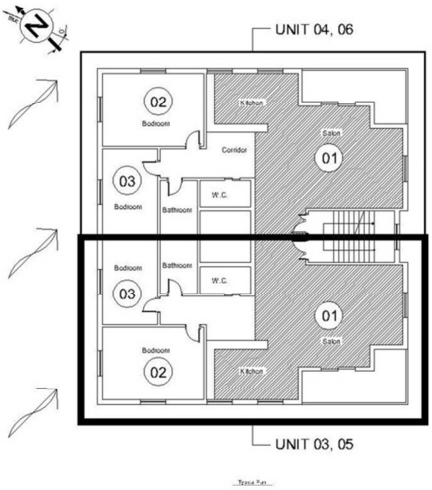
Explanation: Unit 06 is on the right hand of Arken 12 apartment building. Orientation of this unit for daylight gain is from northeast, southeast, and southwest. This Unit has shading devices (shutter) although, on south side of the buildings shading devices that used in this building are not proper. Windows Size part in inventories just indicate size and number of windows.

The fifth and sixth case studies are apartment buildings constructed by Dovec Company, of which the fifth one is Apartment building 18 with single glazed windows located in the Akhisar SK, Kaliland. Information in inventories is from observations, and questionnaires. In addition, satisfaction of users' level is from

questionnaires and just window orientation in ventilation part information is from observations – Table 6. Further information is in appendix F.

Table 6: 18 Apt., Akhisar SK, Kaliland

| Dovec: 18 Apt., Akhisar SK, Kaliland (Single Glaze windows) (DOV.18.02.UN.03) | | | | |
|---|---|---|---|---|
| **Apartment View** |  | | **Schematic Plan** |   |
| **Building Location** |  | | | |
| **Second floor – Unit 03 (DOV.18.02.UN.03)** | | | | |
| **Two units in each floor** | | | | |
| **The Functional Features of Windows** | | **01 (Living room)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | Northwest | | Neutral | Dissatisfied |
| | Southwest | | Neutral | Satisfied |
| **Windows Size** / **Ratio of windows area to floor area** | (1.5x1)x3 | 4.5/45=1/10 | Neutral | Neutral |
| **Placement** | Salon (3 windows) | Northwest, and southwest | Neutral | Neutral |
| | | | Neutral | Dissatisfied |
| **Shading Devices** | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | Northwest | | Neutral | Dissatisfied |
| | Southwest | | Neutral | Satisfied |
| **Control of the Air leakage and Condensation** | No | | Neutral | Dissatisfied |
| **Windows Opening Types** | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | Northwest | | Neutral | Dissatisfied |
| | Northeast | | Neutral | Neutral |
| **Windows Size** / **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/5 | Neutral | Neutral |
| **Placement** | Bedroom | Northwest, and northeast | Neutral | Neutral |
| | | | Neutral | Neutral |
| **Shading Devices** | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | Northwest | | Neutral | Dissatisfied |
| | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | No | | Neutral | Dissatisfied |
| **Windows Opening Types** | Double casement opening | | Neutral | Neutral |

| Dovec: 18 Apt., Akhisar SK, Kaliland (Single Glaze windows) (DOV.18.02.UN.03) | |
|---|---|
| **Apartment View** | **Schematic Plan** |
|  |  |
| **Building Location** | |
|  | |

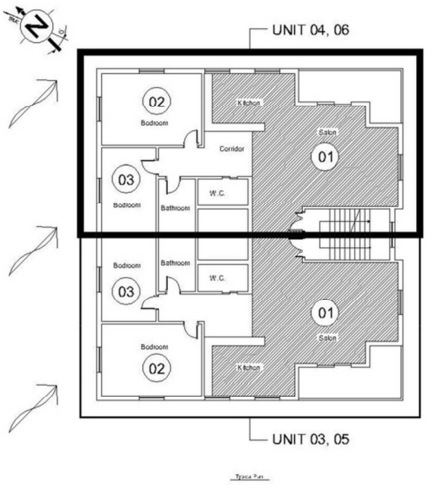
| **Second floor – Unit 03 (DOV.18.02.UN.03)** | | | | |
|---|---|---|---|---|
| **Two units in each floor** | | | | |
| **The Functional Features of Windows** | | **03 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Neutral | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| Explanation: Orientation of this unit for daylight gain is from northeast, northwest, and southwest. This building does not have any shading devices. In this unit, there is unwanted solar gain in summer. Windows Size part in inventories just indicate size and number of windows. | | | | |

## Dovec: 18 Apt., Akhisar SK, Kaliland (Single Glaze windows) (DOV.18.02.UN.04)

**Apartment View**

**Building Location**

**Schematic Plan**




**Second floor – Unit 04 (DOV.18.02.UN.04)**

**Two units in each floor**

| The Functional Features of Windows | | 01 (Living room) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southeast | | Dissatisfied | Neutral |
| | | Southwest | | Neutral | Satisfied |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x3 | 4.5/45=1/10 | Neutral | Neutral |
| **Placement** | | Salon (3 windows) | Southeast, and southwest | Neutral | Neutral |
| | | | | Neutral | Dissatisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Southeast | | Dissatisfied | Neutral |
| | | Southwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Neutral | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

| The Functional Features of Windows | | 02 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southeast | | Dissatisfied | Satisfied |
| | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 1/5 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast, and southeast | Neutral | Neutral |
| | | | | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Neutral |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Southeast | | Dissatisfied | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Neutral | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

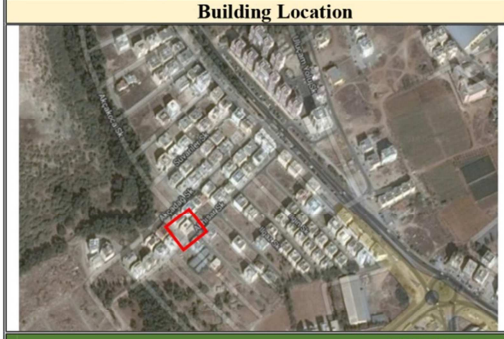
| The Functional Features of Windows | | 03 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Neutral | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

Explanation: Orientation of unit 04 for daylight gain is from northeast, northwest, and southeast. This building does not have any shading devices. In this unit, there is unwanted solar gain in summer. Windows Size part in inventories just indicate size and number of windows.

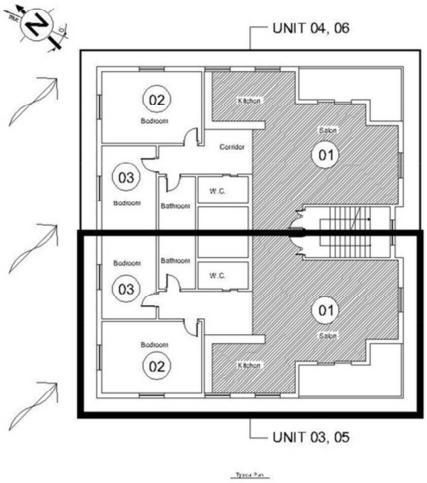
## Dovec: 18 Apt., Akhisar SK, Kaliland (Single Glaze windows) (DOV.18.03.UN.05)

**Apartment View**

**Building Location**



**Schematic Plan**




**Third floor – Unit 05 (DOV.18.03.UN.05)**

**Two units in each floor**

| The Functional Features of Windows | | 01 (Living room) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Neutral | Dissatisfied |
| | | Southwest | | Neutral | Satisfied |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x3 | 4.5/45=1/10 | Neutral | Neutral |
| **Placement** | | Salon (3 windows) | Northwest, and southwest | Neutral | Neutral |
| | | | | Neutral | Dissatisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northwest | | Dissatisfied | Neutral |
| | | Southwest | | Satisfied | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Neutral | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

| The Functional Features of Windows | | 02 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Neutral | Dissatisfied |
| | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/5 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest, and northeast | Neutral | Neutral |
| | | | | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Dissatisfied |
| | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Neutral | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

| The Functional Features of Windows | | 03 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Neutral | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

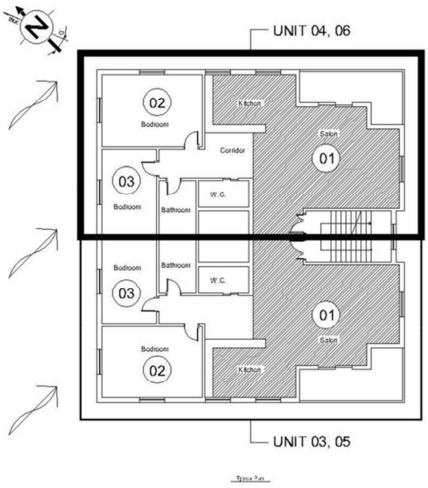
Explanation: Orientation of this unit for daylight gain is from northeast, northwest, and southwest. This building does not have any shading devices. Windows Size part in inventories just indicate size and number of windows. Windows Size part in inventories just indicate size and number of windows.

## Dovec: 18 Apt., Akhisar SK, Kaliland (Single Glaze windows) (DOV.18.03.UN.06)

**Apartment View**

**Building Location**

**Schematic Plan**




**Third floor – Unit 06 (DOV.18.03.UN.06)**

**Two units in each floor**

| The Functional Features of Windows | | 01 (Living room) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southeast | | Dissatisfied | Neutral |
| | | Southwest | | Neutral | Satisfied |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x3 | 4.5/45=1/10 | Neutral | Neutral |
| **Placement** | | Salon (3 windows) | Southeast, and southwest | Neutral | Neutral |
| | | | | Neutral | Dissatisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Southeast | | Dissatisfied | Neutral |
| | | Southwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

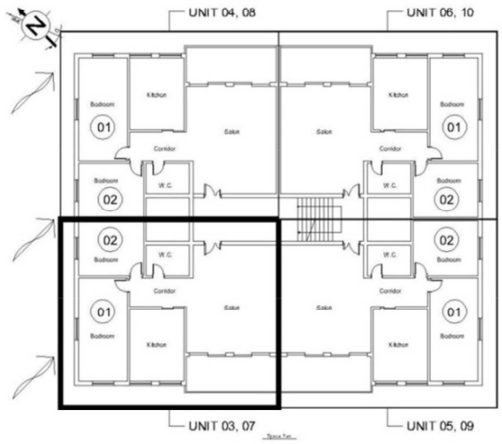
| The Functional Features of Windows | | 02 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southeast | | Dissatisfied | Satisfied |
| | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 1/5 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast, and southeast | Neutral | Neutral |
| | | | | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Neutral |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Southeast | | Dissatisfied | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Dissatisfied | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

| The Functional Features of Windows | | 03 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | No | | Neutral | Dissatisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

Explanation: Orientation of unit 04 for daylight gain is from northeast, northwest, and southeast. This building does not have any shading devices. In this unit, there is unwanted solar gain in summer. Windows Size part in inventories just indicate size and number of windows.

The sixth one is Celebi Apartment building with double glazed windows that is located in the Ilgin SK, Kaliland. Information in inventories is from observations, and questionnaires. In addition, satisfaction of users' level is from questionnaires and just window orientation in ventilation part information is from observations – Table 7. Further information is in appendix G.

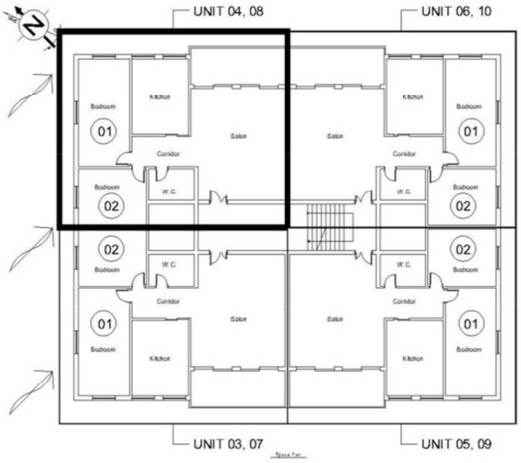
Table 7: Celebi Apt., Ilgin SK, Kaliland

| Dovec: Celebi Apt., Ilgin SK, Kaliland (Double Glaze windows) (DOV.CE.02.UN.03) | | | | |
|---|---|---|---|---|
| **Apartment View** |  | | **Schematic Plan** |   |
| **Building Location** |   | | | |
| **Second floor – Unit 03 (DOV.CE.02.UN.03)** | | | | |
| **Four units in each floor** | | | | |
| **The Functional Features of Windows** | | **01 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | Northwest | | Neutral | Neutral |
| | Southwest | | Neutral | Neutral |
| **Windows Size** / **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/5 | Neutral | Neutral |
| **Placement** | Bedroom | Northwest, and southwest | Neutral | Neutral |
| | | | Dissatisfied | Satisfied |
| **Shading Devices** | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | Northwest | | Neutral | Neutral |
| | Southwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | Yes | | Satisfied | Satisfied |
| **Windows Opening Types** | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | Northwest | | Neutral | Neutral |
| **Windows Size** / **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | Bedroom | Northwest | Neutral | Neutral |
| **Shading Devices** | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | Northwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | Yes | | Satisfied | Satisfied |
| **Windows Opening Types** | Double casement opening | | Neutral | Neutral |
| Explanation: Orientation of unit 03 for daylight gain is from northwest, and southwest. In this unit, 01 (bedroom) have proper daylight and natural ventilation. In 02 (bedroom) daylight and natural ventilation is less than the other room. Windows do not have any shading devices which makes problem for this flat due to increase the heat gain in summer. In this unit, there is unwanted solar gain in summer. Windows Size part in inventories just indicate size and number of windows. | | | | |

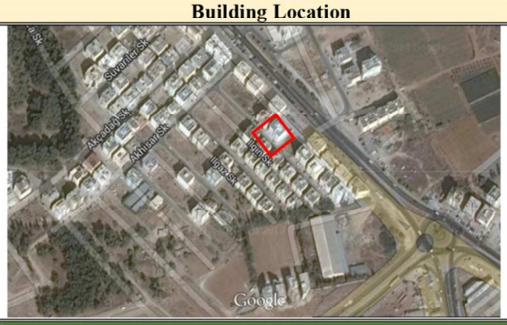
## Dovec: Celebi Apt., Ilgin SK, Kaliland (Double Glaze windows) (DOV.CE.02.UN.04)

**Apartment View**

**Schematic Plan**




**Building Location**




**Second floor – Unit 04 (DOV.CE.02.UN.04)**

**Four units in each floor**

| The Functional Features of Windows | | 01 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/10 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest, and northeast | Neutral | Neutral |
| | | | | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Satisfied | Satisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Neutral | Dissatisfied |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Satisfied | Satisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

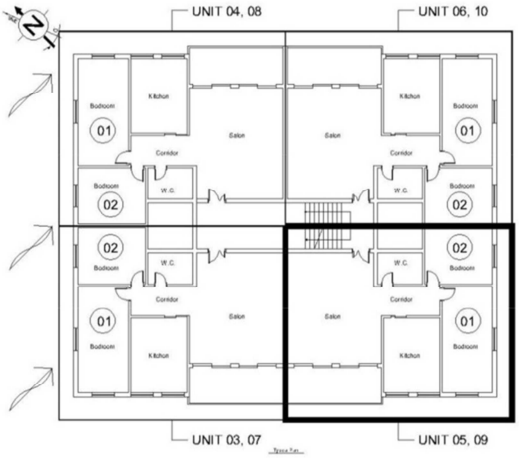
Explanation: Orientation of unit 04 for daylight gain is from northwest, and southwest. In bedroom 01, daylight and natural ventilation is a bit suitable. In 02 (bedroom), daylight and natural ventilation is less than the other room. This building does not have any shading devices. Windows Size part in inventories just indicate size and number of windows.

## Dovec: Celebi Apt., Ilgin SK, Kaliland (Double Glaze windows) (DOV.CE.02.UN.05)

**Apartment View**

**Building Location**


**Schematic Plan**



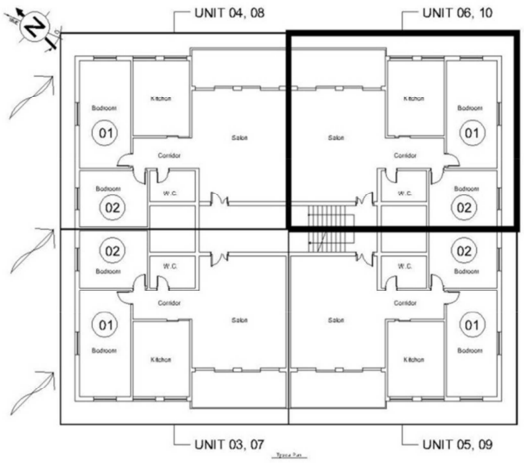

**Second floor – Unit 05 (DOV.CE.02.UN.05)**

**Four units in each floor**

| The Functional Features of Windows | | 01 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southwest | | Neutral | Neutral |
| | | Southeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/10 | Neutral | Neutral |
| **Placement** | | Bedroom | Southwest, and southeast | Neutral | Neutral |
| | | | | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Southwest | | Neutral | Neutral |
| | | Southeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Satisfied | Satisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

| The Functional Features of Windows | | 02 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southeast | | Dissatisfied | Satisfied |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Southeast | Neutral | Dissatisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Southeast | | Dissatisfied | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Satisfied | Satisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

Explanation: Orientation of unit 05 for daylight gain is from Southwest, and Southeast. . In 01 (bedroom), daylight and natural ventilation is suitable. In 02 (bedroom), daylight and natural ventilation is not as good as the other bedroom. In this unit, there is unwanted solar gain in summer. Windows Size part in inventories just indicate size and number of windows.

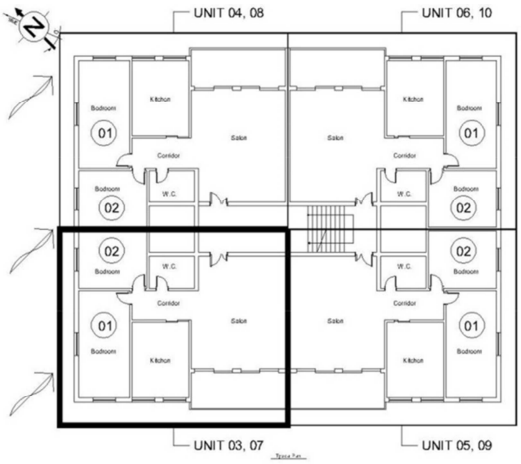
| Dovec: Celebi Apt., Ilgin SK, Kaliland (Double Glaze windows) (DOV.CE.02.UN.06) | |
|---|---|
| **Apartment View** | **Schematic Plan** |
|  |   |
| **Building Location** | |
|   | |

| **Second floor – Unit 06 (DOV.CE.02.UN.06)** | | | | |
|---|---|---|---|---|
| **Four units in each floor** | | | | |
| **The Functional Features of Windows** | | **01 (Bedroom)** | **Level of Satisfaction** | |
| **Daylightig** | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | Neutral | Dissatisfied |
| | | Southeast | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/5 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast, and southeast | Neutral | Neutral |
| | | | | Neutral | Satisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| | | Southeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Satisfied | Satisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southeast | | Satisfied | Satisfied |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Southeast | Neutral | Satisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Southeast | | Dissatisfied | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Satisfied | Satisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| Explanation: Orientation of unit 06 for daylight gain is from southeast, and northeast. In 01 (bedroom), daylight and natural ventilation is suitable. In 02 (bedroom), daylight and natural ventilation is not as good as the other bedroom. In this unit, there is unwanted solar gain in summer. Windows Size part in inventories just indicate size and number of windows. | | | | |

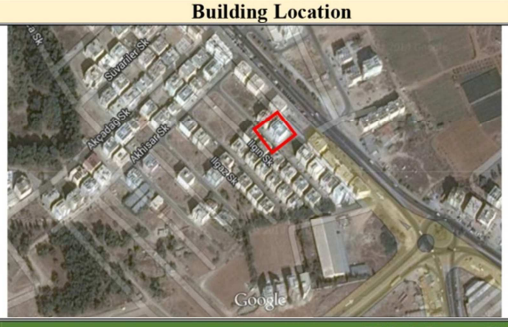
## Dovec: Celebi Apt., Ilgin SK, Kaliland (Double Glaze windows) (DOV.CE.03.UN.07)

**Apartment View**

**Schematic Plan**




**Building Location**




**Third floor – Unit 07 (DOV.CE.03.UN.07)**

**Four units in each floor**

| The Functional Features of Windows | | 01 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Southwest | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/5 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest, and southwest | Neutral | Neutral |
| | | | | Dissatisfied | Satisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Southwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Satisfied | Satisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

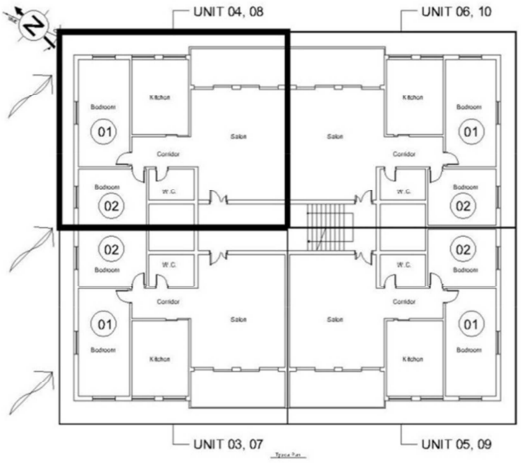
| The Functional Features of Windows | | 02 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Satisfied | Satisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

Explanation: Orientation of unit 07 for daylight gain is from northwest, and southwest. In this unit 01 (bedroom) have proper daylight and natural ventilation. In 02 (bedroom) daylight and natural ventilation is less than the other room. Windows do not have any shading devices which makes problem for this flat due to increase the heat gain in summer. In this unit, there is unwanted solar gain in summer. Windows Size part in inventories just indicate size and number of windows.

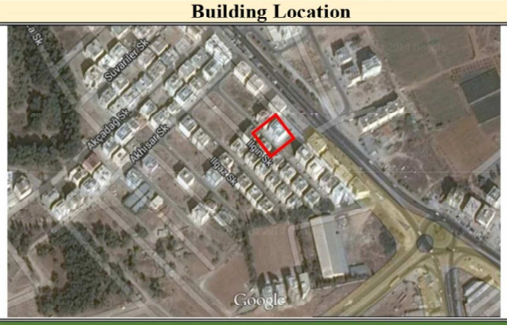
## Dovec: Celebi Apt., Ilgin SK, Kaliland (Double Glaze windows) (DOV.CE.03.UN.08)

**Apartment View**

**Schematic Plan**




**Building Location**




**Third floor – Unit 08 (DOV.CE.03.UN.08)**

**Four units in each floor**

| The Functional Features of Windows | | 01 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/5 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest, and northeast | Neutral | Neutral |
| | | | | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Satisfied | Satisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

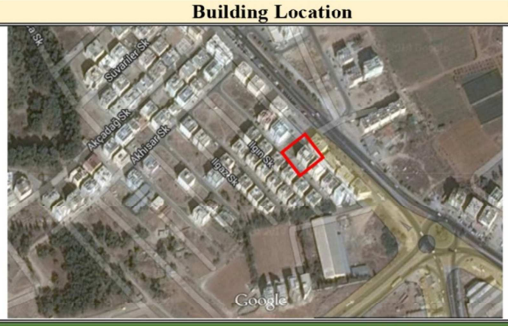
| The Functional Features of Windows | | 02 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northwest | | Neutral | Dissatisfied |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northwest | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northwest | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Satisfied | Satisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

Explanation: Orientation of unit 08 for daylight gain is from northwest, and northeast. In bedroom 01, daylight and natural ventilation is a bit suitable. In 02 (bedroom), daylight and natural ventilation is less than the other room. This building does not have any shading devices. Windows Size part in inventories just indicate size and number of windows.

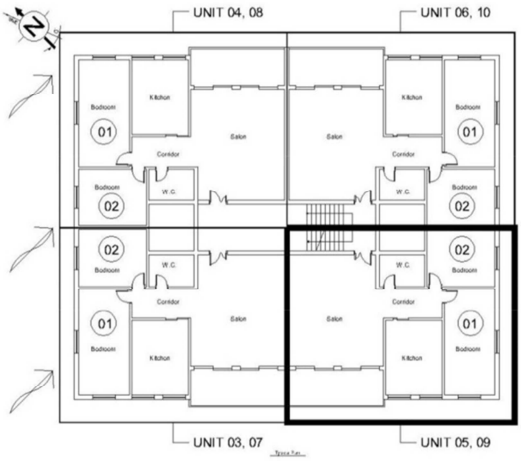
## Dovec: Celebi Apt., Ilgin SK, Kaliland (Double Glaze windows) (DOV.CE.03.UN.09)

**Apartment View**

**Building Location**




**Schematic Plan**




**Third floor – Unit 09 (DOV.CE.03.UN.09)**

**Four units in each floor**

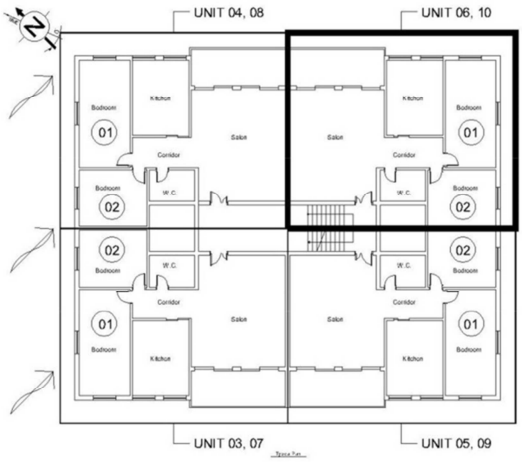
| The Functional Features of Windows | | 01 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Southwest | | Neutral | Neutral |
| | | Southeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | (1.5x1)x2 | 3/15=1/5 | Neutral | Neutral |
| **Placement** | | Bedroom | Southwest, and southeast | Neutral | Neutral |
| | | | | Neutral | Neutral |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Southwest | | Neutral | Neutral |
| | | Southeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Satisfied | Satisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |
| **The Functional Features of Windows** | | **02 (Bedroom)** | | **Level of Satisfaction** | |
| **Daylightig** | | | | Summer time | Winter time |
| **Placement** | | Southeast | | Dissatisfied | Satisfied |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Southeast | Neutral | Dissatisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Placement** | | Southeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Satisfied | Satisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

Explanation: Orientation of unit 09 for daylight gain is from Southwest, and Southeast. . In 01 (bedroom), daylight and natural ventilation is suitable. In 02 (bedroom), daylight and natural ventilation is not as good as the other bedroom. In this unit, there is unwanted solar gain in summer. Windows Size part in inventories just indicate size and number of windows.

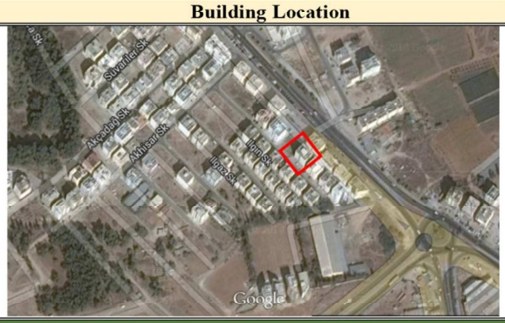
Dovec: Celebi Apt., Ilgin SK, Kaliland (Double Glaze windows) (DOV.CE.03.UN.10)

**Apartment View**

**Schematic Plan**




**Building Location**




**Third floor – Unit 10 (DOV.CE.03.UN.10)**

**Four units in each floor**

| The Functional Features of Windows | | 01 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Dissatisfied |
| | | Southeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 3/15=1/10 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast, and southeast | Neutral | Neutral |
| | | | | Neutral | Satisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Cross and natural ventilation | | Satisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Dissatisfied |
| | | Southeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Satisfied | Satisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

| The Functional Features of Windows | | 02 (Bedroom) | | Level of Satisfaction | |
|---|---|---|---|---|---|
| **Daylightig** | | | | Summer time | Winter time |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Windows Size** | **Ratio of windows area to floor area** | 1.5x1 | 1.5/12=1/8 | Neutral | Neutral |
| **Placement** | | Bedroom | Northeast | Neutral | Satisfied |
| **Shading Devices** | | - | | Dissatisfied | Dissatisfied |
| **Ventilation** | | Single-sided | | Dissatisfied | - |
| **Windows Orientation** | | Northeast | | Neutral | Neutral |
| **Control of the Air leakage and Condensation** | | Yes | | Satisfied | Satisfied |
| **Windows Opening Types** | | Double casement opening | | Neutral | Neutral |

Explanation: Orientation of unit 10 for daylight gain is from northwest, and northeast. In 01 (bedroom) daylight and natural ventilation is suitable. In 02 (bedroom) daylight and natural ventilation is not as good as the other bedroom. In this unit, there is unwanted solar gain in summer.

Appendix H indicates the information, which has been used for the analysis in the questionnaire part. This chart shows functional features of windows so residence satisfaction about ventilation and daylight can be understood.

## 3.6 Data Analysis

In this study, windows of selected apartment buildings were investigated with different techniques like observations, questionnaires with the residences (e.g. students and local residences; totally 100 persons). 36 flats from selected apartment buildings from three main construction companies - Uzun, Noyanlar, and Dovec- were chosen. Furthermore, from each company second and third levels from each of the two apartment buildings have been taken as the cases of this study due to more heat loss and gain on the ground and top floors. Accordingly, windows of the six apartment buildings in Famagusta have been investigated to understand the level of residence satisfaction relating to ventilation and daylighting issues. Finally, the results of the analysis will be indicated to understand the important role of daylighting and ventilation in window design.

### 3.6.1 Observations

It is a challenging task to design buildings that finally meet a variety of residences' satisfaction, decrease energy consumption and provide thermal comfort in hot-humid climates. According to observations, selected cases suffer from unventilated rooms that increase the possibility of condensation, and therefore mold in buildings.

Most of the residences have complained about the conditions of their indoor environment and the high electricity price they pay. Furthermore, they experience problems such as too much sunlight gain in hot days and most of the buildings do not have shading devices. Additionally, due to the design and location of their windows, users complain from the quality of natural ventilation, especially due to lack of windows located crossways that increase the possibility of ventilation.

Similarly, throughout the year residences experienced problems relating to passive cooling and heating the environment in their flat, which increased the use of electricity.

Apartment buildings with single glazed windows have more problems than the apartment buildings with double glazed windows due to the quality of the material of double glazed windows. The other essential issue that should not be forgotten is the installation of the windows and their material. Although, designers select the best type of windows and owner pay high amount of money to purchase the best type of energy efficient windows, if the construction companies do not implement the windows properly, it does not have any influence on decreasing of energy consumption. Another important aspect is the orientation of the building. If the building is not properly oriented in terms of gaining daylight in winter, this will again affect the energy use and physical and psychological health of users. The other essential issue is the windows size, which is important for allowing natural and cross ventilation in buildings. However, this issue is not well considered in buildings investigated. In addition, mold and mildew were observed especially on ground floor level floors where humidity was higher – Figure 23.

Figure 22: Case studies from three different construction companies - Uzun, Noyanlar, and Dovec

### 3.6.2 Questionnaire Relating to Windows' Functional Features

Aim of the questionnaire is to understand the level of the satisfaction of the residences in selected apartment buildings from Uzun, Noyanlar, and Dovec construction companies in Famagusta, Northern Cyprus. These information are from the evaluation of 100 questionnaire including 64 students (28 female, and 36 male), and citizen 36 (14 housewives, 22 men). Information has been categorized according to window features including daylighting and natural ventilation.

In chart 1, percentage of number of residences questioned from each construction company is given.

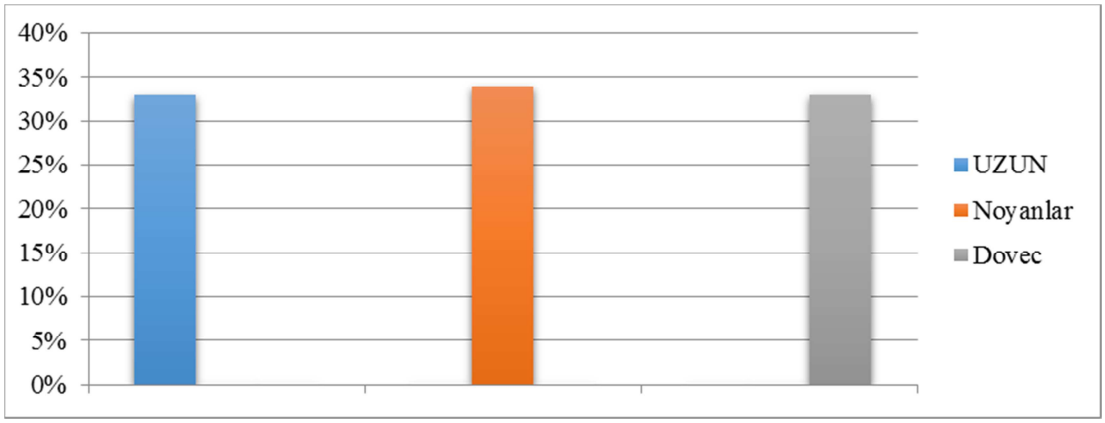



Chart 1: Percentage of the questionnaire of the different residences of different companies (Uzun, Noyanlar, Dovec)

### 3.6.2.1 Daylighting

In this part, the residences are questioned in relation to their satisfaction with daylighting and natural ventilation.

In the selected apartment buildings, residences are generally dissatisfied (61%) with shading devices due to not having any shading devices. However, some of the residential buildings have shutters with white color which result in absorption of heat in hot days. Consequently, residences are not generally satisfied even if some units possess have shading devices – Chart 2.

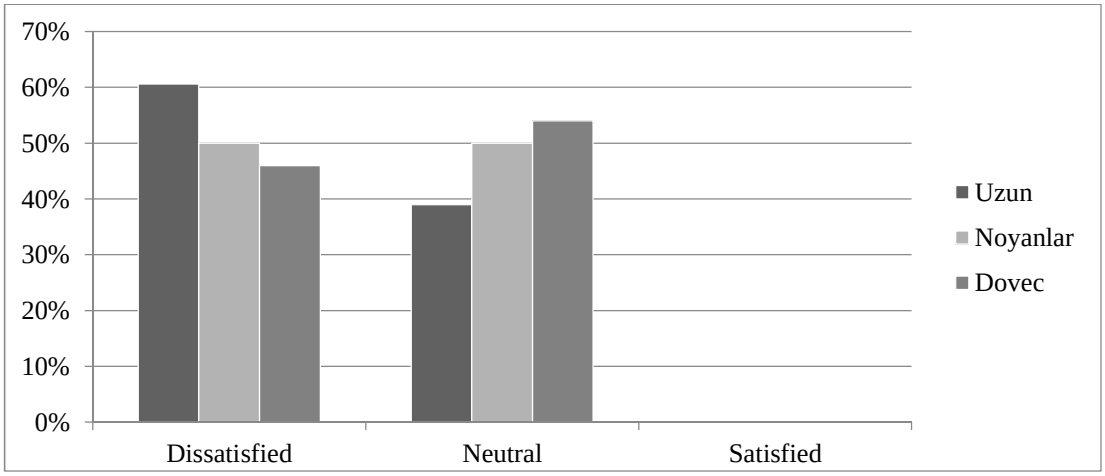



Chart 2: Satisfaction of residences with shading devices

In summer and winter time, residences' satisfaction relating to various orientation of windows are investigated in bedrooms with single glazed windows. Chart 04 indicates that residences are not satisfied with windows' orientation in summer time and only 5% are satisfied with windows located in southeast direction in bedrooms on the second and third floors during winter time. Approximately 5% of the residences are satisfied with windows looking to northwest and northeast on the second floor in summer, as well as northwest, northeast, and southeast on second floor in winter. On third floor, approximately 5% of the residences are not satisfied with windows located on northwest, and southeast in summer as well as northeast and northwest in winter – Chart 3.

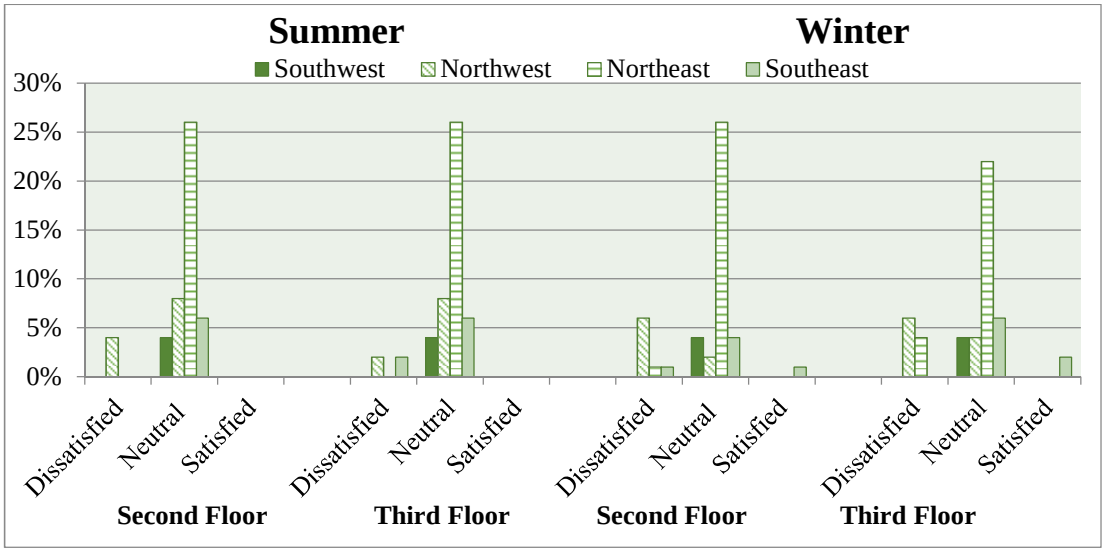



Chart 3: Satisfaction of residences with windows orientation in bedrooms with single glazed windows in summer and winter time

In summer and winter time, residences satisfaction in relation to different orientations is investigated in bedrooms with double glazed window. Chart 4 indicates that residences are more satisfied with windows' orientation in summer. Residences are more satisfied with double glazed windows in winter time. The residence satisfaction from southwestern windows is around 5% on third floor

(summer time), around 5% on the second floor (winter time), and less than 5% on the third floor on southeastern façade on the second floor. In third floor (winter time), residences are satisfied with windows located on southeast direction in bedrooms on second and third floors during the winter time.

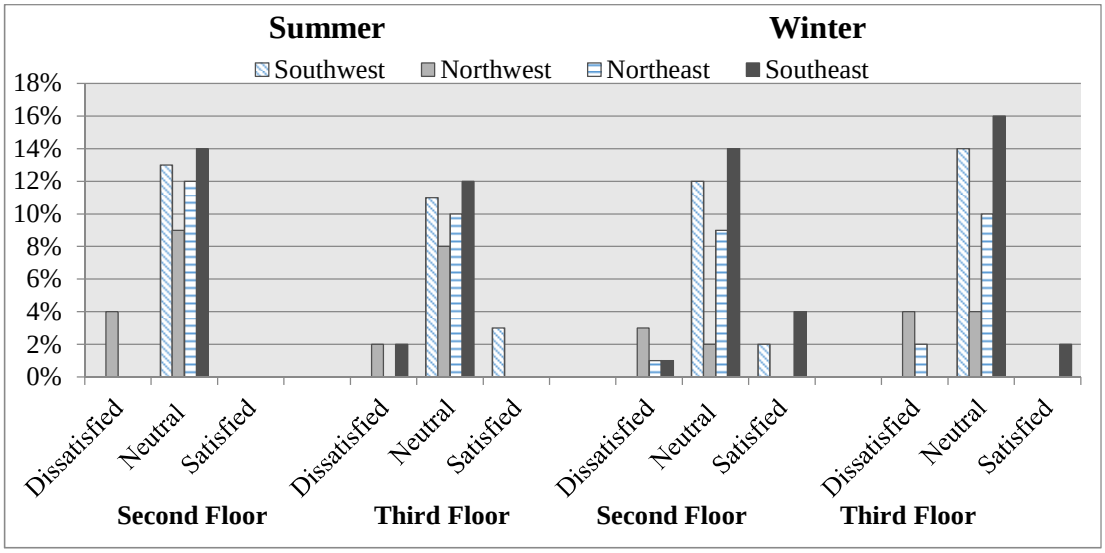



Chart 4: Satisfaction of residences with windows orientation in bedrooms with double glazed windows in summer and winter time

In summer and winter time, residences' satisfaction with different orientation of single glazed windows is investigated in living rooms. Chart 5 indicates that residences are not satisfied with windows orientation on northwest and southeast (8%) direction on the second floor in summer and winter time; southwest around 6%; northwest 10% and northeast 6% on the second floor. On the third floor, residences are not satisfied with windows located on southwest (2%) and northwest (8%) in summer, as well as southwest (2%), northwest (12%) and northeast (4%) in winter time. 20% of the residences are satisfied with windows located on southeast direction in living rooms on second and third floors during the winter time. Consequently, residences are not satisfied with windows located on the southern façade of their flats which is the most important facade of building in hot-humid climate for daylight gain

during cold days. Furthermore, in the design of windows this issue should carefully be considered.

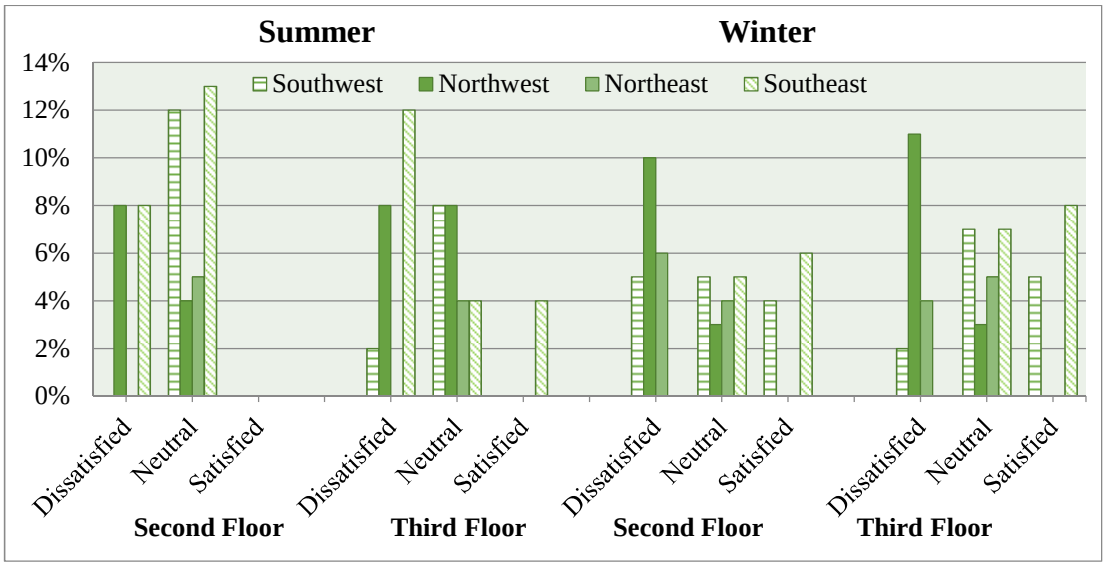



Chart 5: Satisfaction of residences with windows orientation in living rooms with single glazed windows in summer and winter time

In summer and winter time, residences' satisfaction with different orientation of double glazed windows has been investigated in living rooms. Chart 6 indicates that residences are more satisfied with windows' orientation in summer and winter time with double glazed windows than single glazed windows. This value is around 14% on the second floor in southeast (summer time), and around 10% on the third floor in southeast (summer time); 8% on the second floor in southeast (winter time), and more than 8% on the third floor in southeast (winter time) are satisfied with windows in southeast orientation in bedrooms on second and third floors in winter time.

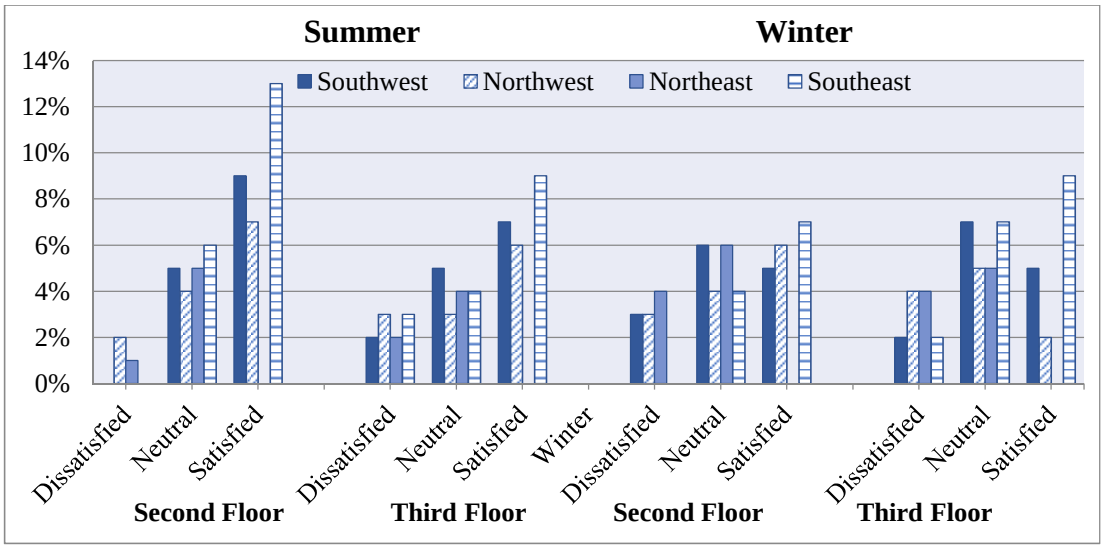



Chart 6: Satisfaction of residences with windows orientation in living rooms with double glazed windows in summer and winter time

In the selected apartments, 49% of the residences are satisfied with the size of their flat windows, 36% are not satisfied, and 15% wish to have a larger window than their current windows (single and double glaze) – Chart 7.

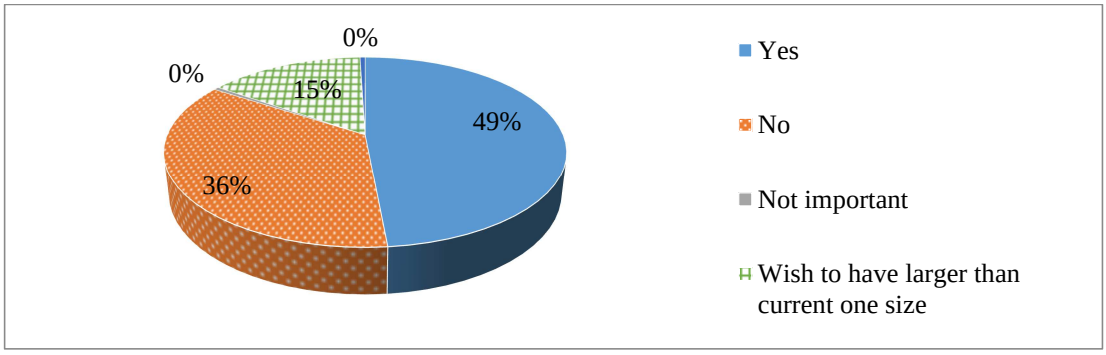



Chart 7: Satisfaction of residences with size of windows

In this chart, ratio of windows area to floor area is investigated so that ratio of windows area to floor area for bedrooms can be clarified and residences' are satisfactions from these conditions are investigated. In hot-humid climate, ratio of windows area to floor area should be in between 15 – 20% in order to have enough daylight. Bedrooms in the selected residential buildings have different ratio of

window area to floor area like 1/5, 1/8, and 1/10. Most of the residences did not have any idea about what should be the ideal ratio of windows area to floor in their bedrooms on second and third floors. Chart 8 shows that some of them wish to have larger windows than the existing one. In summer time, around 5% on second floor and third floor are satisfied with the ratio of 1/5 that is 20% in bedrooms. In addition, the other ratio of window area to floor area is less than 15 to 20 % – Chart 8.

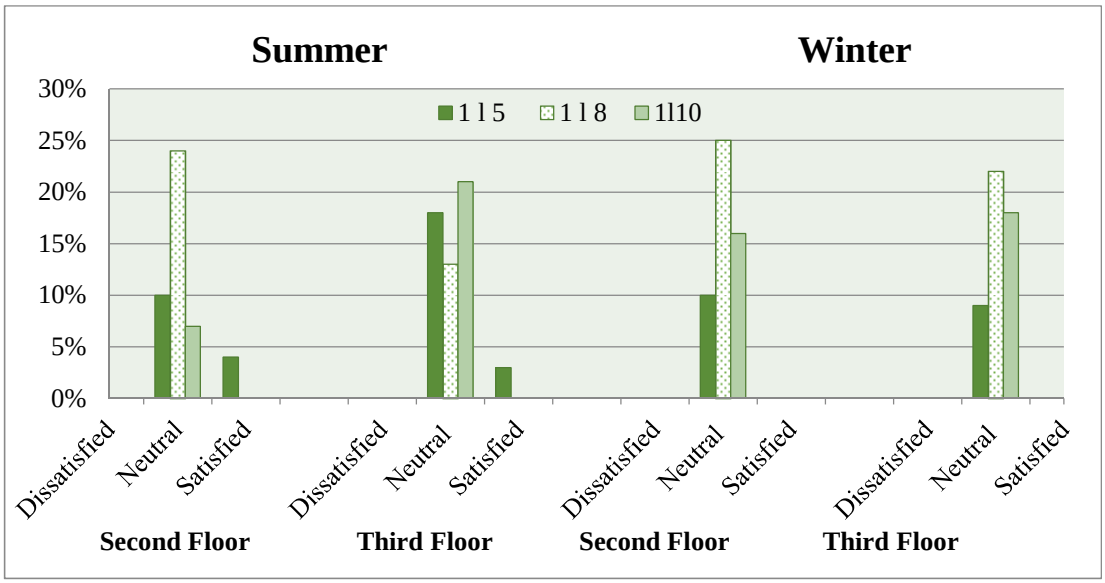



Chart 8: Satisfaction of residences about ratio of windows area to floor area in bedrooms in winter and summer time

In this chart, ratio of window area to floor area is investigated to understand user satisfaction and the proper ratio of window area to floor area for living rooms. Living rooms in the selected residential buildings have different ratio of windows area to floor area like 1/10, 1/13, 1/15, 1/20, and 1/26. In the living rooms, criteria for ratio of windows area to floor area did not consider. In summer and winter time, most of the residences do not have any idea about ratio of windows area to floor in their bedrooms in second and third floor – Chart 9.

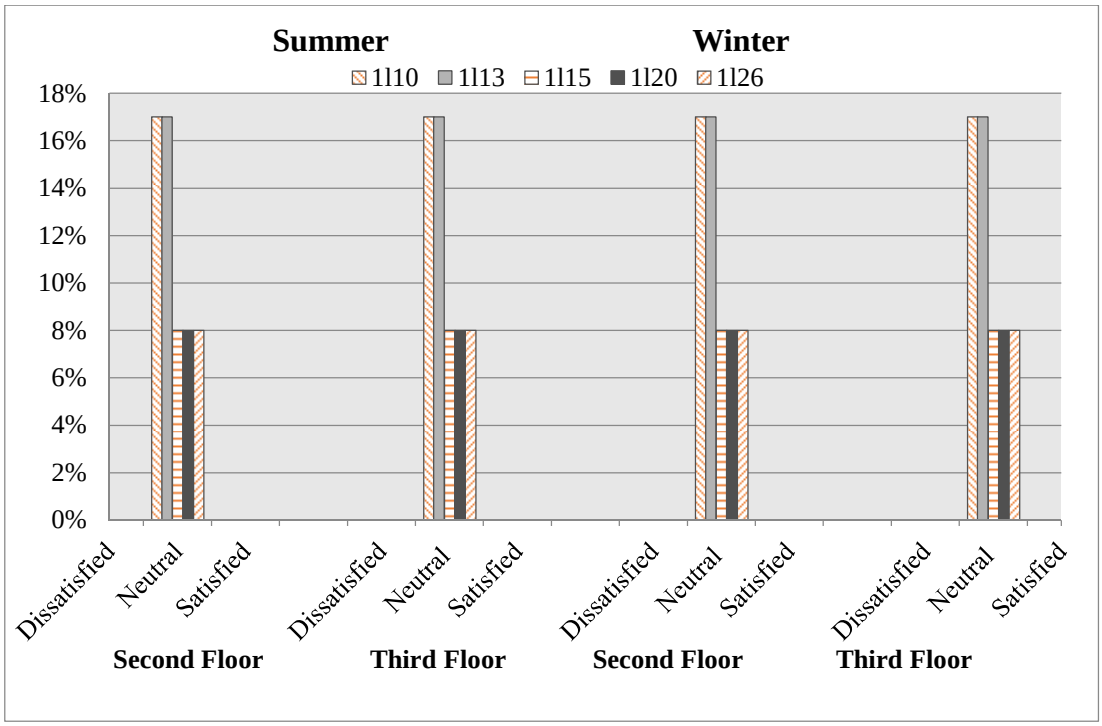



Chart 9: Satisfaction of residences about ratio of windows to floor area in living rooms in winter and summer time

Some of the residences do not have any idea about placement of windows in their bedrooms in residential buildings (Single glazed). Residences are not satisfied with southeast and northeast windows in summer on second and third floor – Chart 10. Further information (horizontal axis) relating to sampling is in Appendix I.

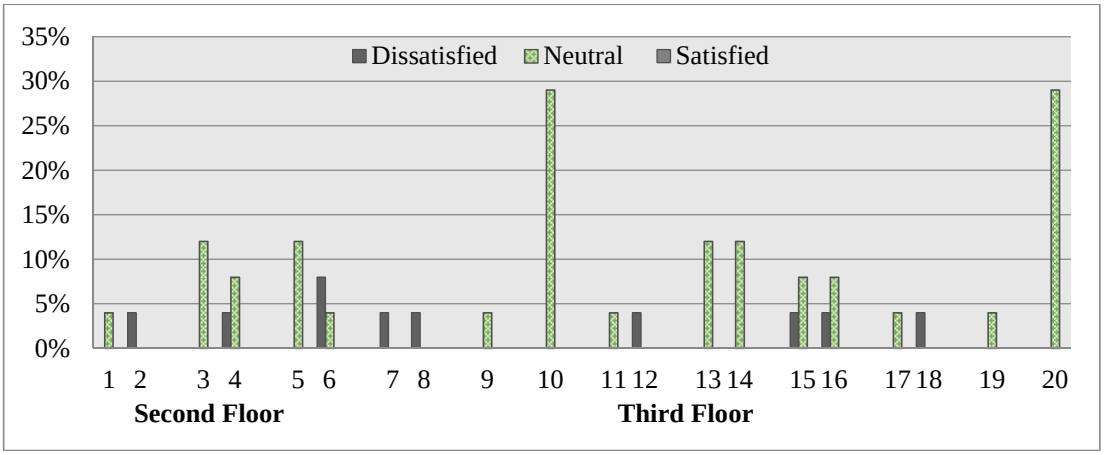



Chart 10: Satisfaction of residences about placement of windows in bedrooms with single glazed in summer time – Appendix I

Some of the residences do not have any idea about placement of windows in their bedrooms in residential buildings (double glazed). Residences are not satisfied with southwest and southeast windows in summer on second and third floor – Chart 11. Further information (horizontal axis) relating to sampling is in Appendix J.

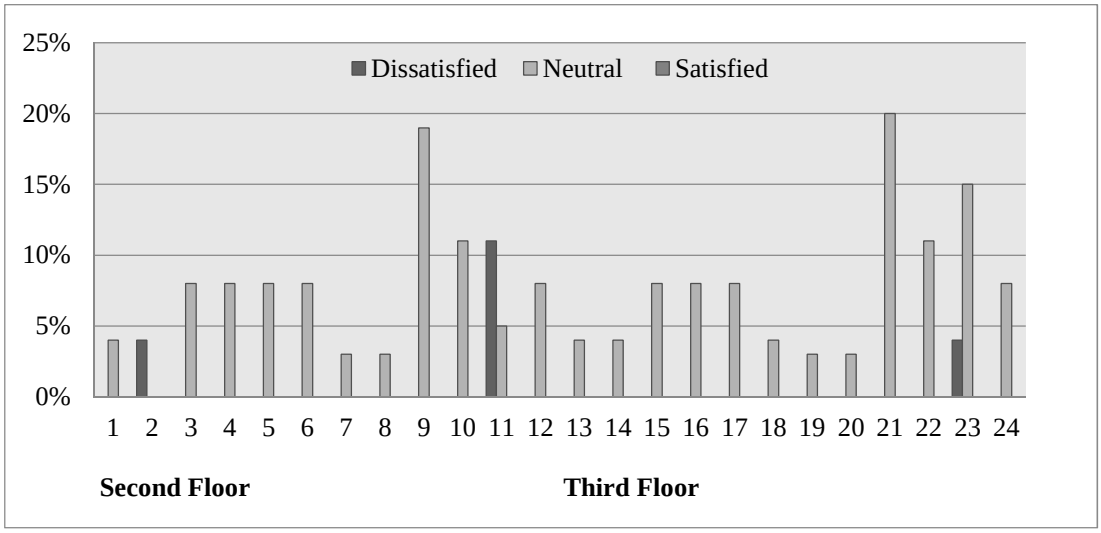



Chart 11: Satisfaction of residences about placement of windows in bedrooms with double glazed windows in summer time – Appendix J

Some of the residences do not have any idea about placement of windows in their bedrooms in residential buildings (single glazed). Residences are satisfied with southeast southwest and northeast windows in bedrooms more than other windows on other faces in winter on second and third floor – Chart 12. Further information (horizontal axis) relating to sampling is in Appendix I.

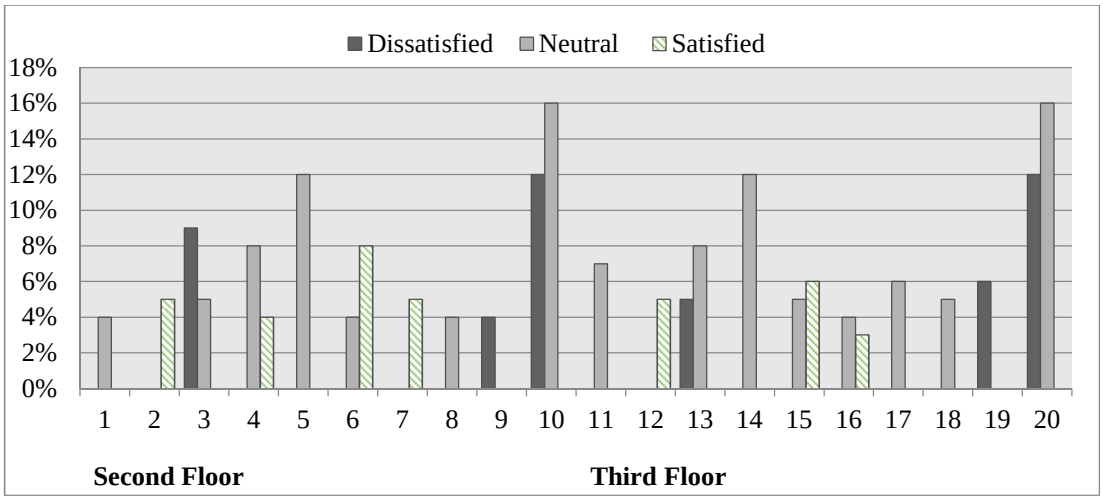



Chart 12: Satisfaction of residences about placement of windows in bedrooms with single glaze windows in winter time – Appendix I

Some of the residences do not have any idea about placement of windows in their bedrooms (double glazed). Residences are not satisfied with southeast and northeast windows in bedrooms more than other windows on other faces in winter on second and third floors – Chart 13. Further information (horizontal axis) relating to sampling is in Appendix J.

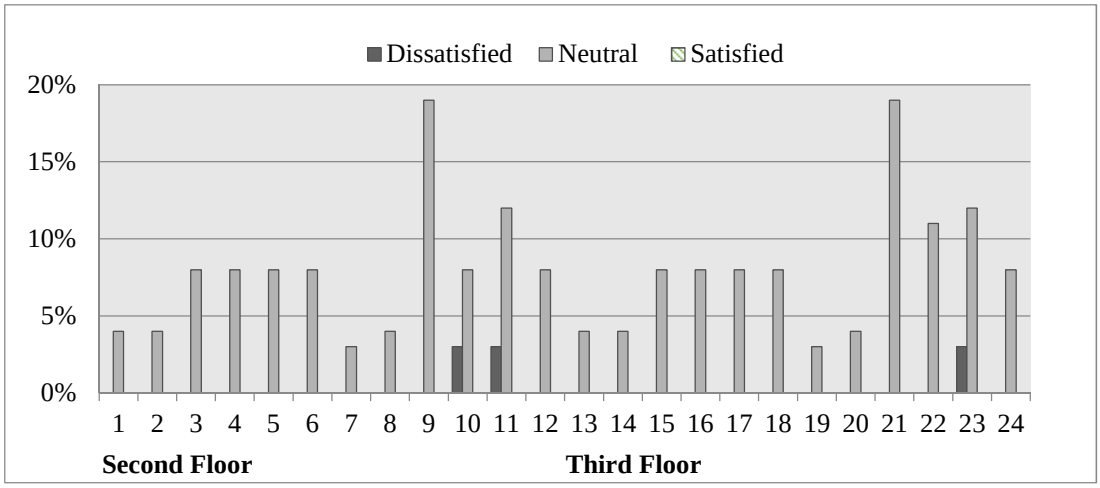



Chart 13: Satisfaction of residences about placement of windows in bedrooms with double glazed windows in winter time – Appendix J

Some of the residences do not have any idea about placement of windows in their living rooms in residential buildings in summer time (single glazed) – Chart 14.

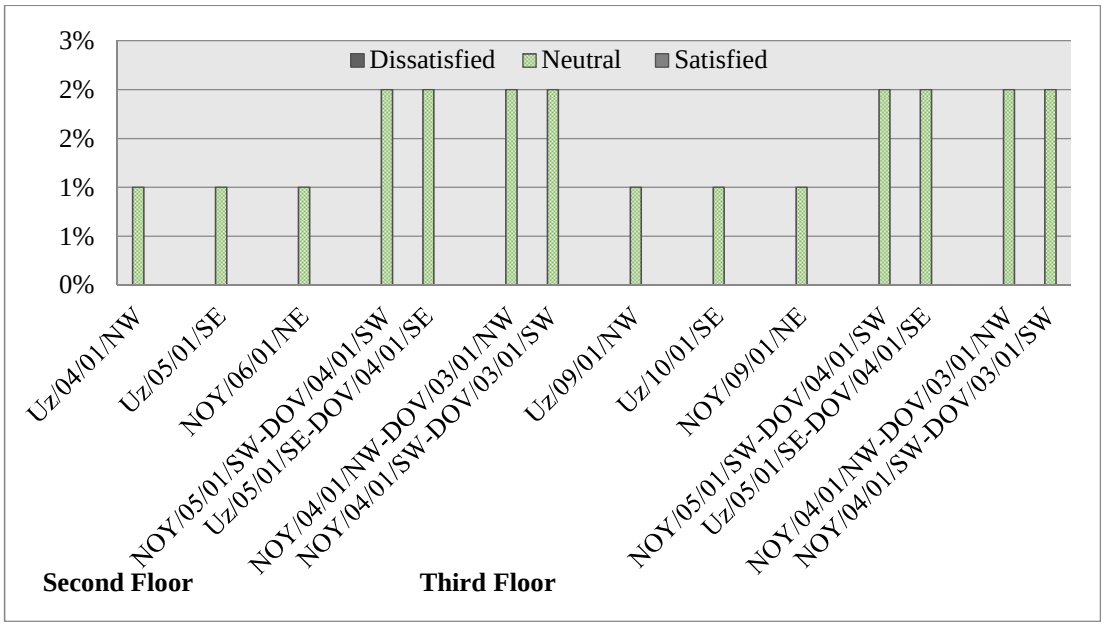



Chart 14: Satisfaction of residences about placement of windows in living rooms with single glazed windows in summer time

Some of the residences do not have any idea about placement of windows in their living rooms in residential buildings in summer time (double glazed). Residences are not satisfied with southeast and northwest windows in living rooms more than other windows on other faces in summer in second and third floor – Chart 15.

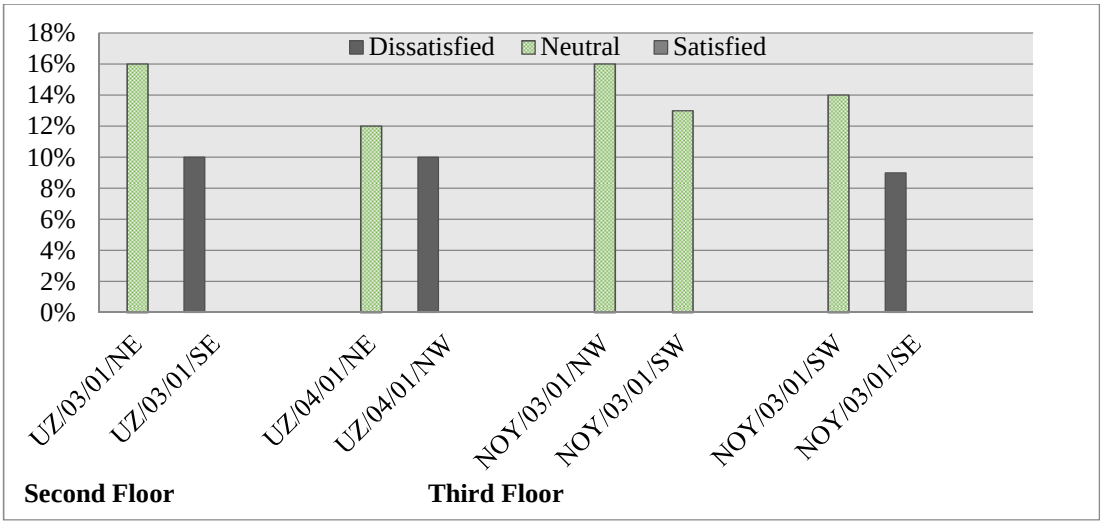



Chart 15: Satisfaction of residences about placement of windows in living rooms with double glazed windows in summer time

Some of the residences are not satisfied about placement of windows in northwest, northeast, and southwest in their living rooms in residential buildings in winter time (Single glazed) – Chart 16.

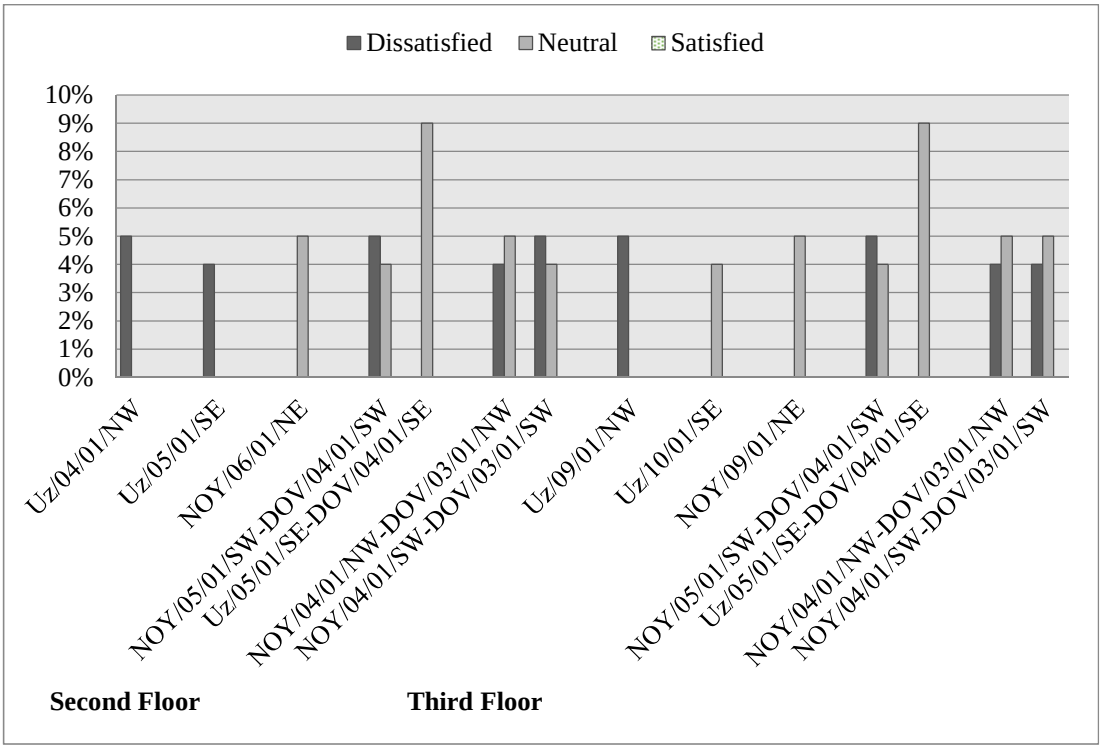



Chart 16: Satisfaction of residences about placement of windows in living rooms with single glazed windows in winter time

Some of the residences are not satisfied about placement of windows in northwest, northeast, and southwest in their living rooms in residential buildings in winter time (double glazed). Residences are not satisfied with southwest and northwest windows in living rooms more than other windows on other faces in winter in second and third floor – Chart 17.

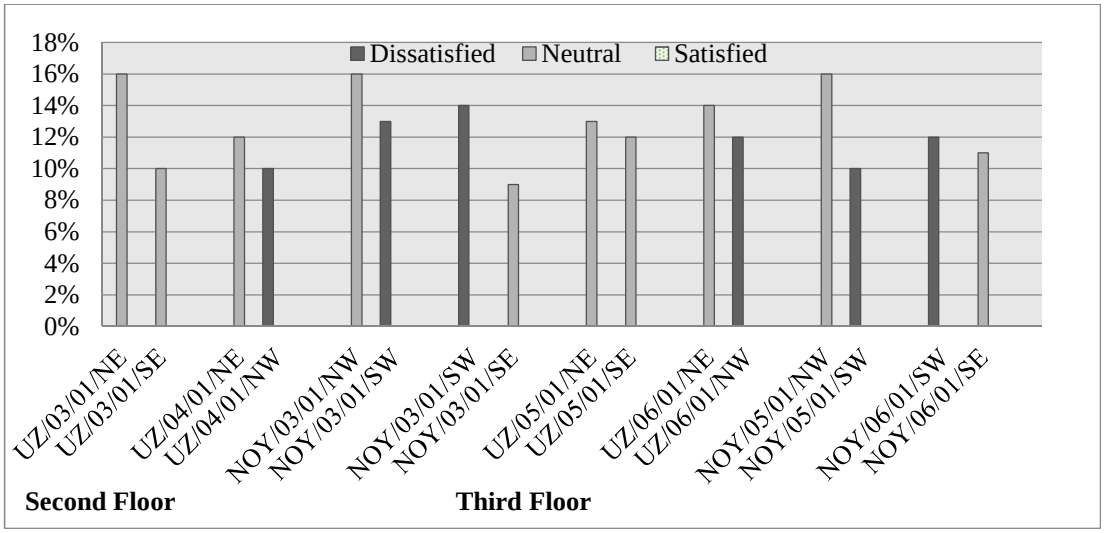



Chart 17: Satisfaction of residences about placement of windows in living rooms with double glazed windows in winter time

In next page (pine chart), 59% of the residences are satisfied with the placement of the windows in their flats. However, 41% of the residences are not satisfied with location of their windows, as they do not gain suitable daylight in cold days or do not provide ventilation in summer – Chart 18. Size of windows and location of the windows are mentioned before in data collection part.

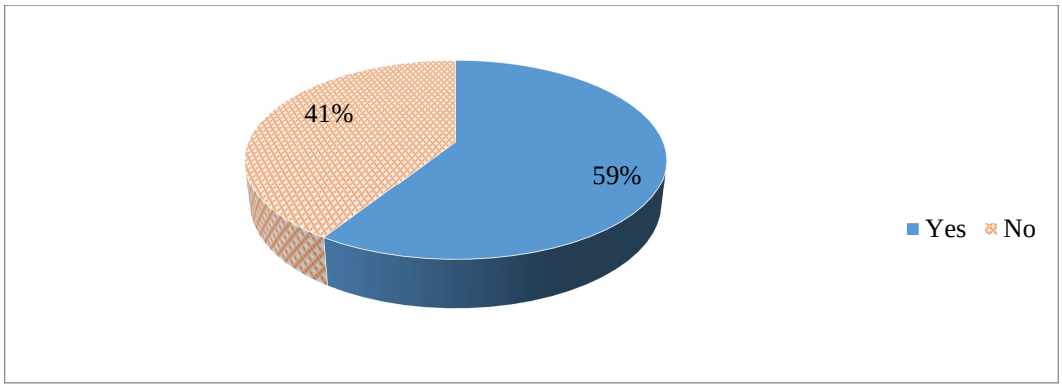



Chart 18: Satisfaction of residences with the placement of their windows

### 3.6.2.2 Natural Ventilation

Residences are more satisfied with cross ventilation of windows in southwest-northwest and northeast-southeast in their bedrooms in residential buildings in summer time. In single sided rooms, inhabitants are not satisfied with this type of natural ventilation. Moreover, this problem on the second floor is more than second floor – Chart 19. Further information (horizontal axis) relating to sampling is in Appendix K.

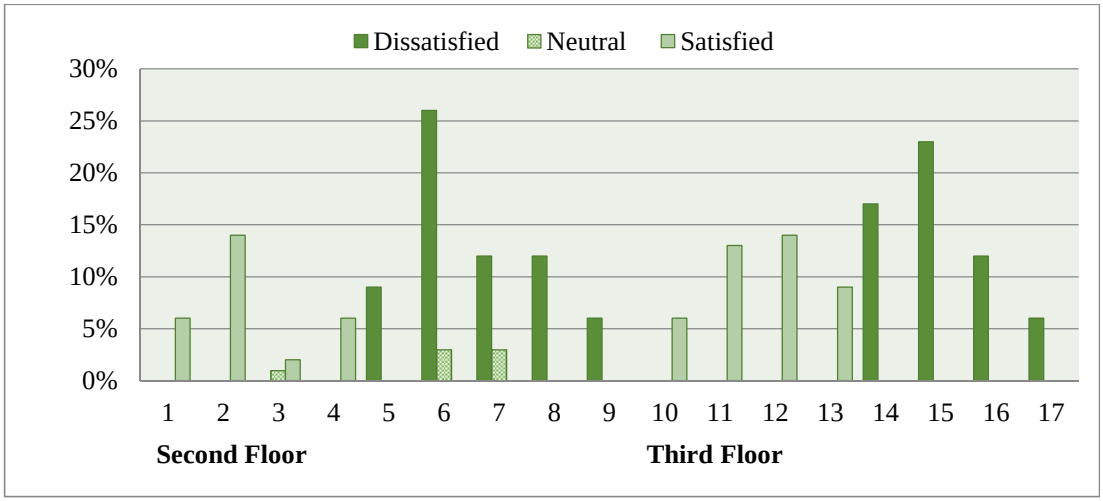



Chart 19: Satisfaction of residences about natural ventilation of windows in bedrooms in summer time – Appendix K

Residences are more satisfied with cross ventilation of windows in southwest-southeast, and northwest-southwest in second floor is same as second floor in summer time. In single sided rooms, residences are not satisfied with natural ventilation. Moreover, this problem on the third floor is more than second floor – Chart 20. Further information (horizontal axis) relating to sampling is in Appendix L.

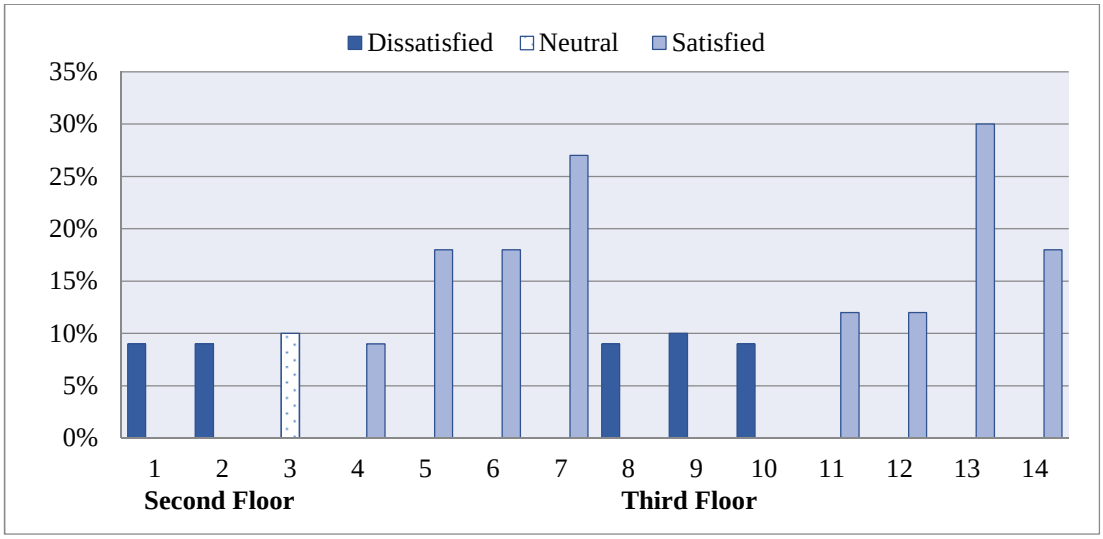



Chart 20: Satisfaction of residences about natural ventilation of windows in living rooms in summer time – Appendix L

In chart 21, generally 67% of the windows are not airtight that directly have an impact on energy consumption of the residential buildings in cold days.

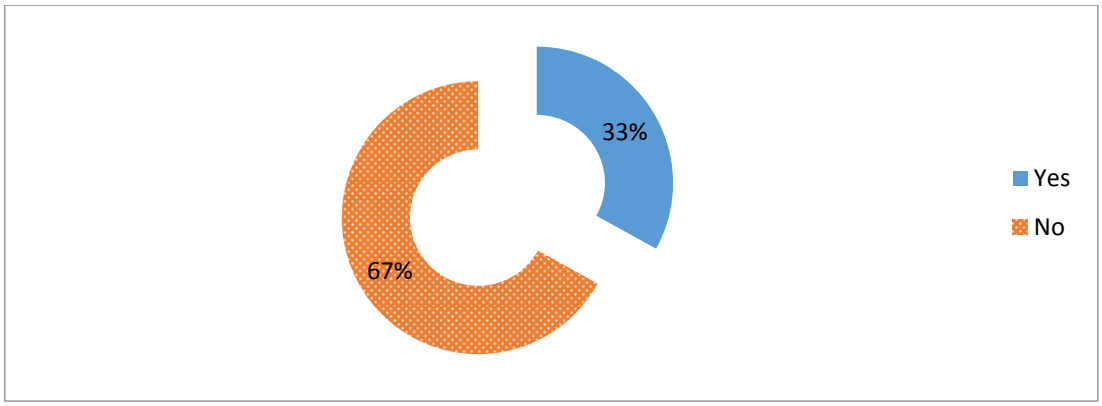



Chart 21: Airtight in windows

In this chart, user satisfaction about windows' opening types indicated that users do not have any idea about types of opening in their bedrooms in summer and winter time on the second and third floors – Chart 22 and 23. Further information (horizontal axis) relating to sampling is in Appendix I.

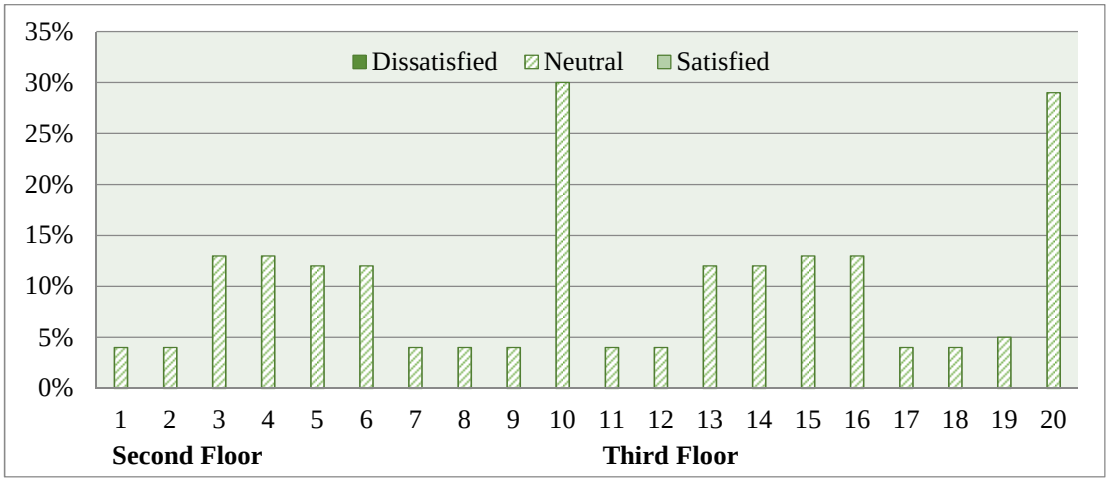



Chart 22: Satisfaction of residences windows opening type in bedrooms in summer time – Appendix I

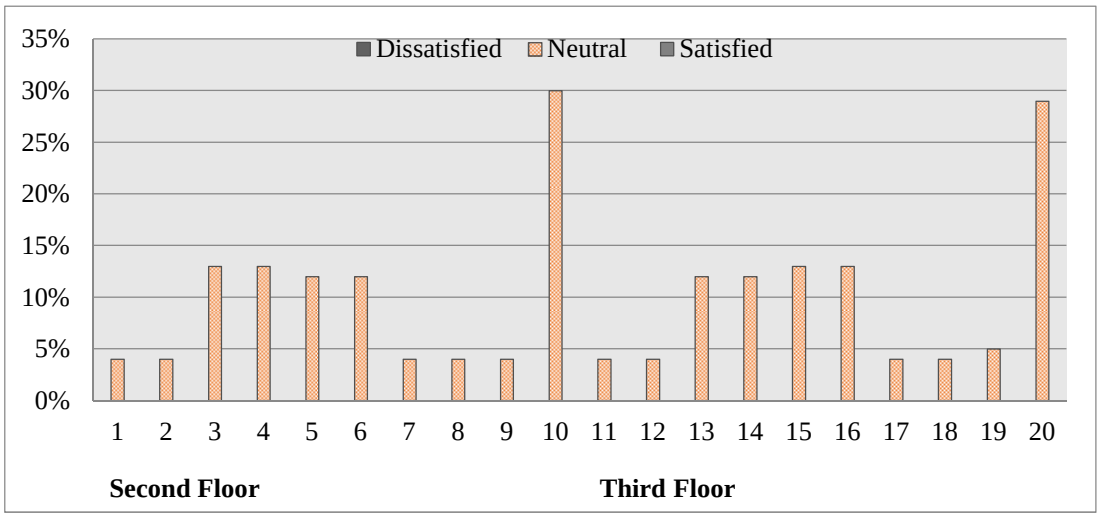



Chart 23: Satisfaction of residences windows opening type in bedrooms in winter time – Appendix I

In this chart, user satisfaction about windows' opening types indicated that users do not have any idea about types of opening in their living rooms in summer and winter time on the second and third floors – Chart 24 and 25.

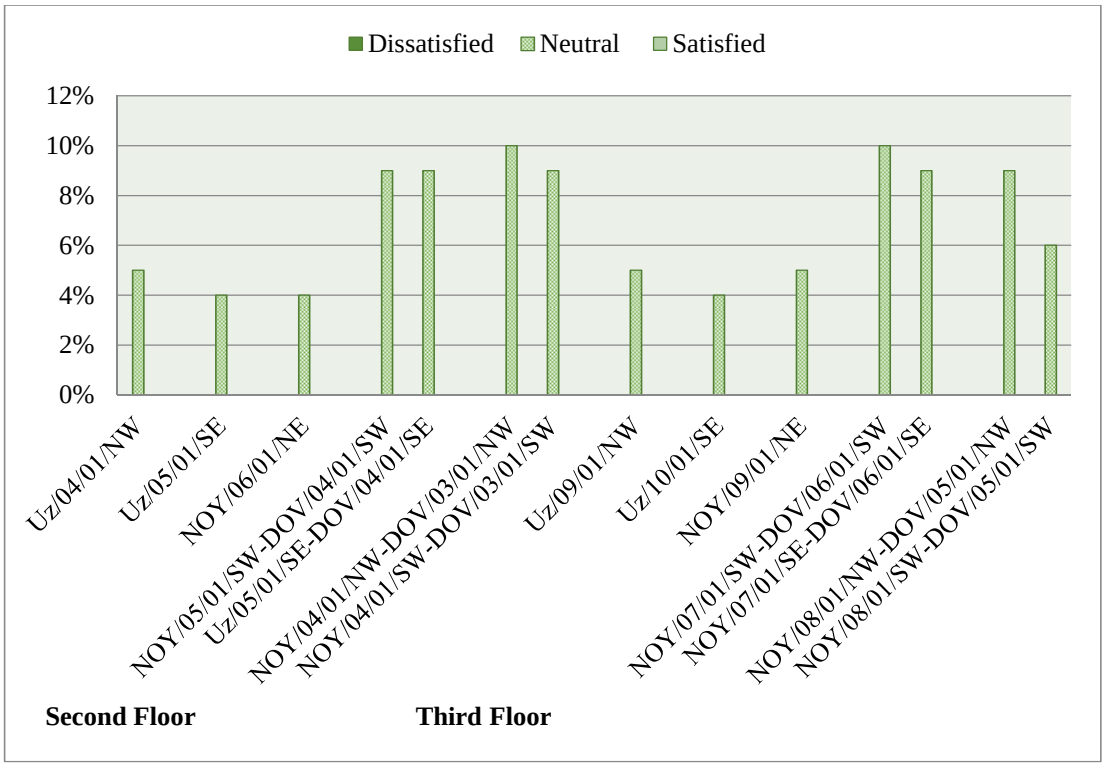



Chart 24: Satisfaction of residences windows opening type in living rooms in summer time

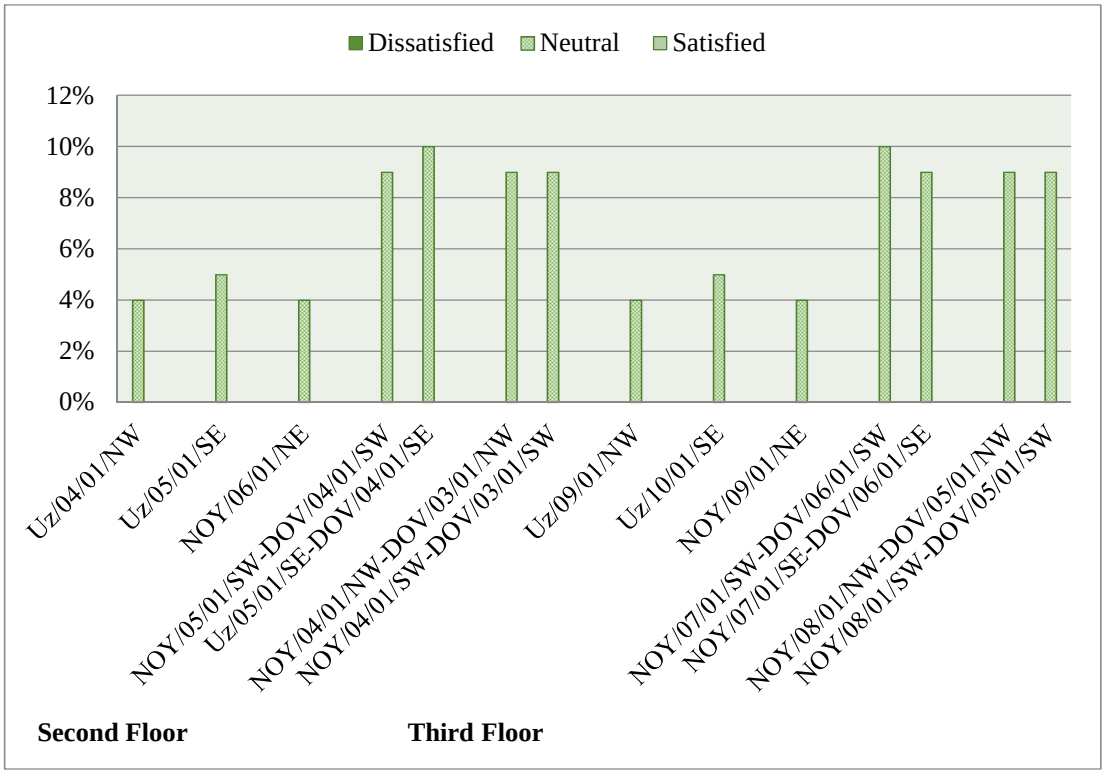
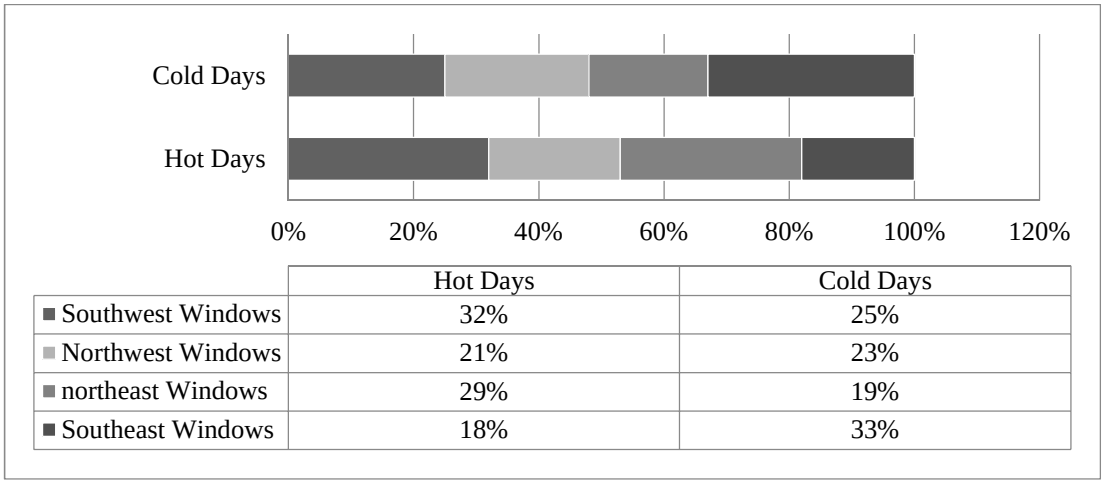



Chart 25: Satisfaction of residences windows opening type in living rooms in winter time

According to the opinion of the residences, performance to control (Daylight) heat gain and heat loss of single glazed windows in every side of their flats in summer and wintertime is indicated in Chart 26. Consequently, southern facade of residential buildings has an essential role in providing heat to buildings; accordingly 18% of the residences in hot days and 33% of the residences in cold days are satisfied from southern orientation.

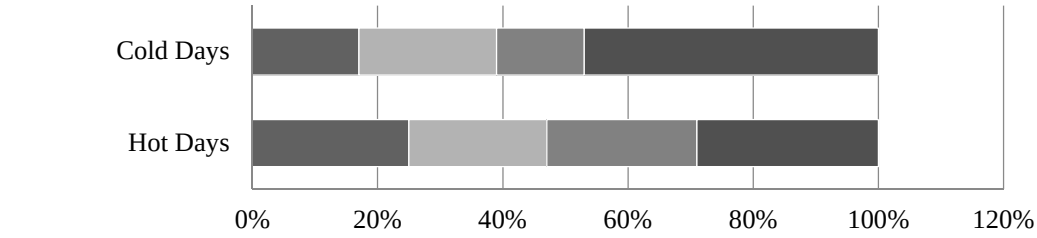
In Chart 27, satisfaction of the residences through double glazed windows in different sides of the apartment buildings is indicated. In comparison between satisfaction of residences in apartment buildings with single glazed windows and double glazed windows shows that residences are more satisfied with double glazed windows performance in summer and winter that is 29% in summer and 47% in winter.

Consequently, performance of the double glazed windows is better than single glazed windows in the south side of the selected residential buildings in summer and wintertime.




| | Hot Days | Cold Days |
|---|---|---|
| Southwest Windows | 32% | 25% |
| Northwest Windows | 21% | 23% |
| northeast Windows | 29% | 19% |
| Southeast Windows | 18% | 33% |

Chart 26: Satisfaction of the residences about different direction of the single glaze windows performance in hot and cold seasons




| | Hot Days | Cold Days |
|---|---|---|
| Southwest Windows | 25% | 17% |
| Northwest Windows | 22% | 22% |
| Northeast Windows | 24% | 14% |
| Southeast Windows | 29% | 47% |

Chart 27: Satisfaction of the residences about different direction of the double glaze windows performance in hot and cold seasons

Chart 28 indicates that performance of the single glazed windows is not good in terms of providing suitable indoor temperature, which has influence on the energy consumption in the residential building. On the other hand, in the residential building the situation is better than buildings with single glazed windows.

Solely, 33% of the residences who are living in the apartment buildings with single glazed windows are satisfied with performance of the windows in winter and similarly 55% for the summer.

Chart 29, indicate that in flats with double glazed windows 42% of the residences are satisfied with the performance of the windows in winter and 36% of the residences are satisfied with the energy performance of the windows in summer.

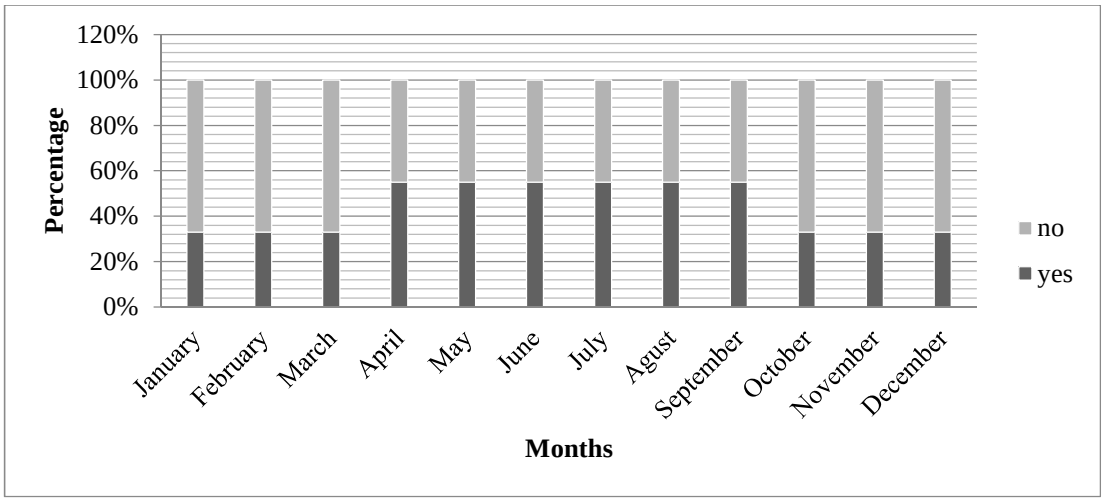



Chart 28: Satisfaction of the residences about single glaze windows performance in hot and cold seasons

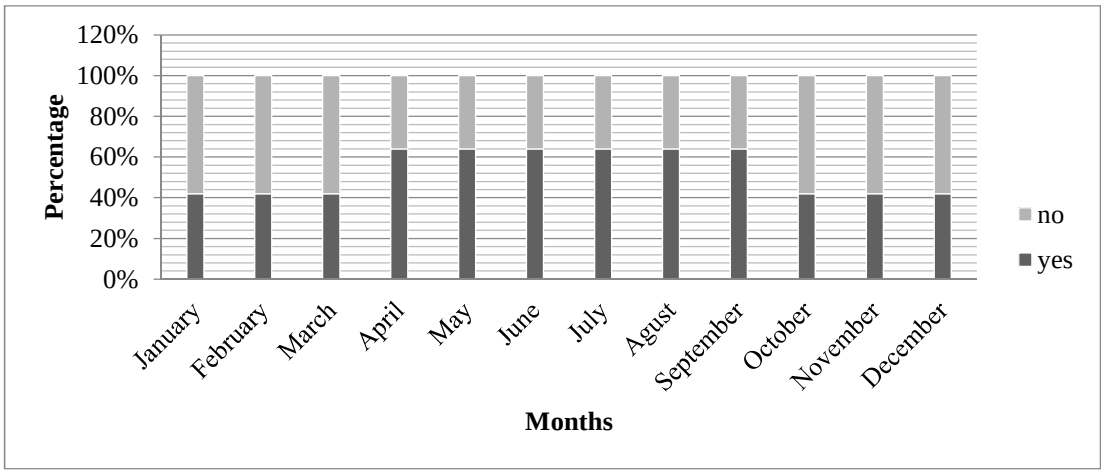



Chart 29: Satisfaction of the residences about double glaze windows performance in hot and cold seasons

In the selected residential building, most of the windows are single and double glazed. In addition, single glazed windows are around 50% where the remaining 50% of the windows are double glazed in the selected residential buildings, in Famagusta, North Cyprus – Chart 30.

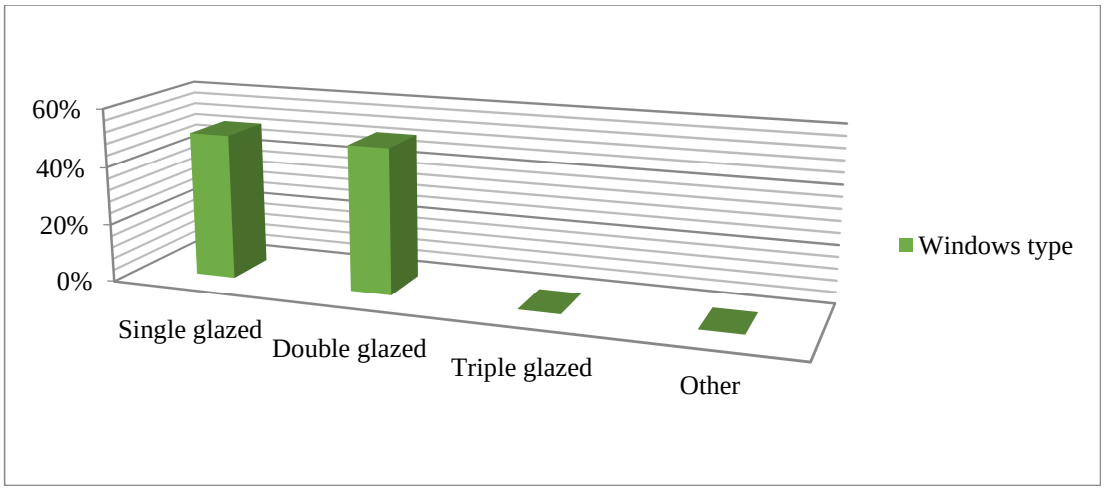



Chart 30: Windows types in selected residential buildings in Famagusta, North Cyprus

## 3.7 Discussion

Residential buildings are investigated according to daylighting issues which include window orientation, window size, ratio of window area to floor area, placement, window glazing and shading devices of windows; and ventilation which includes ventilation types, window orientation, control of the air leakage and condensation, and windows opening type in order to understand level of residences satisfaction for window design to provide proper daylight, and ventilation (heating in cold days and cooling in cold days) in the residential buildings to realize proper criteria for design of windows in hot-humid climate in selected residential buildings due to importance of creating appropriate place and indoor environment for human being by considering windows design.

At first, four orientations of windows with different windows types (e.g. single and double glazed) are investigated to realize the proper orientation of windows for residential buildings in Famagusta, North Cyprus. Most of the residences satisfaction level is neutral. Consequently, it indicates that orientation of window does not have

any influence on the single glazed windows. In general, it is essential to orient window towards south side of the buildings to have enough daylight especially in living rooms because most of the residences spend their time in living room during the day. Moreover, sunshades and sun breakers should be applied to windows on south side to block undesired daylight income in summer.

In Famagusta, size of the windows in each selected residential buildings are same as each other which is 1.5x1 and designers do not consider the area of the places in every flat to have proper daylight. However, most of the residences are satisfied with the size of windows. Another issue is window area to floor area, and results show that residences do not have enough information about ratio of window to floor area in their bedrooms and living rooms. Furthermore, some of them mentioned that they wish to have larger windows than the existing one. In addition, they were more satisfied with ratio of window area to floor area in bedrooms (second and third floor) in summer. Consequently, in the living room ratio of window area to floor area should be changed to gain proper daylight during cold days. It is preferable to consider 15 – 20% ratio in living rooms and bedrooms.

Window placement is another important issue that should be considered in window design of apartment buildings, because it has high influence on residences' satisfaction. Some of residences are not satisfied with window placement on southwest, southeast, and northeast in bedrooms in summer as well as southwest, southeast, and northeast in bedrooms in winter. Some of residences are not satisfied with window placement on southeast, northwest side in living rooms in summer as well as southwest, northeast, and northwest in living rooms in winter. These results indicate that in placement of windows it is important (e.g. southeast and southwest)

to consider the direction in winter and summer. It is important to locate windows to south in order to have proper daylight during cold days.

The other important issue is those designers just use available material of windows in market that are not much expensive such as single glazed and double glazed windows. They should know that installation of windows is important in terms of controlling heat and cool gain/loss. Influence on the double glaze windows is more than single glaze windows. If high-performance windows with low-solar-gain low-E coatings are used, the window orientation can decrease energy use in the building.

In this study, results indicate that shading devices type is also an important issue in especially in hot-humid climate during the summer time. However, important role of shading devices has not been considered in windows design of selected residential buildings in Famagusta, North Cyprus. Furthermore, some of the residential buildings have shading devices which is shutters. Residences are not satisfied with this type of shading devices due to it blocking daylight gain during cold days. The best type is the exterior shading devices and overhangs in south side. However, sunlight has impact on the quality of the exterior sunshades and somehow interior sunshades are appropriate for controlling solar gain. Shading devices have high influence on the decline of energy use in the buildings.

The other essential factor is providing proper natural ventilation in the residential buildings in hot-humid climates. The level of satisfaction of residences in rooms and living rooms that have cross ventilation is higher than single-sided ventilation no matter windows are in which direction. Most of the residences are interest to open windows during night. They operate air conditioner during noon in hot days in

bedrooms. Some investigation discussed that cooling effect of night ventilation is larger than those of the other ventilation strategies during the day and night in hot-humid regions.

In the design of windows, air leakage and condensation should be controlled and it is essential in design of windows in residential buildings especially in cold days. In this study, most of the residences are not satisfied with these issues in single glazed windows and just they are satisfied in one apartment building with double glazed windows. This issue is essential for residences during cold days so, this issue should be considered in window selection.

The other important issue is opening type that has influence on providing amount of natural ventilation in residential buildings. Most of the buildings have double casement opening type that is one of the appropriate opening types for Famagusta, North Cyprus. Residences do not have any idea about opening type or maybe it is not as important as it is for users. Further information that is summary of results in appendix M, N, O, and P.

It is important to consider these issues in order to have proper daylight in cold days such as locating most of windows on south side so that daylight can be gained in cold days; use vertical windows, have the ratio of window area to floor area in between 15 – 20%, place windows to have enough daylight during cold days, use double glazed windows, and apply shading devices in south, east and west side of the residential buildings.

In order to have enough natural ventilation, windows should be located on two sides of the rooms so that natural enough ventilation (cross ventilation) can be achieved during hot days. It is proper to locate windows on southwest and west side, control air leakage and condensation in window design, and opening type should be awing or double casement for the allowance of more air.

In the following chapter, results of Chapter 3 will be explained to clarify the importance of window design for residences' satisfaction in the selected residential buildings – Table 8. Further information is in appendix H.

Table 8: Summary of findings

| | |
|---|---|
| **DAYLIGHTING** | **Orientation** user satisfaction for living room (e.g. southwest, southeast and northeast in winter time) in buildings with double glazed windows is more than buildings with single glazed windows and they are not satisfied with northwest windows. User satisfaction for bedroom: southwest and southeast |
| | **Ratio of windows area to floor area** for living rooms are 1/10, 1/13, 1/15, 1/20, and 1/26 and for bedrooms are 1/5, 1/8, and 1/10. However, residences satisfaction level is neutral. |
| | **Placement** for living room and bedrooms: Users' satisfaction is neutral. Living room and bedrooms: southeast in winter |
| | **Shading devices or sun breaker** (type, material, color) are important in the design of windows in Famagusta in hot-humid climate and especially in summer. Exterior shading devices and overhangs in south side. Greenery in west side |
| **NATURAL VENTILATION** | **Ventilation** the level of satisfaction of residences in bedrooms and living rooms that have cross ventilation is higher than single-sided ventilation no matter windows are in which direction. |
| | **Orientation** southwest in summer for living room and for bedroom southwest and southeast. For living room northwest and southeast are not satisfied. Users are not satisfied with windows of bedrooms on southeast. |
| | **Control of air leakage** just in double glaze windows and residences are more satisfied. |
| | **Windows opening types** in all of the buildings is casement and residences do not have any opinion. The best choice is awing type and second one is double casement. |

# Chapter 4

# CONCLUSION AND FURTHER STUDY

This part includes an evaluation of the case study and gives out recommendations for the further study. Due to the restrictions related to the desire of the constructors to have maximum amount of flats in a minimum area, it is hard to end up with designs that satisfy the requirements of hot-humid climate. However, it may be possible to overcome these difficulties by the introduction of some standards that affect the design, selection and construction of windows. The study on the selected residential buildings in Famagusta most clearly proves that there is a lack of standards relating to window design in Northern Cyprus.

However, as an essential component of the building, window has two main functions like providing daylighting and ventilation in buildings as well as supplying a visual connection between inside and outside of the residential buildings. In this study, daylighting and ventilation issues and their constituents have been considered in the evaluation of windows in hot-humid climate. In terms of daylighting, orientation, window glazing, size of windows, placement and ratio of windows area to floor area, and shading devices have been looked at in more detail in order to understand the role of these issues in providing proper daylight and in the ventilation part, natural ventilation type, orientation, opening type and dehumidification strategies have been scrutinized in order to understand how windows satisfy the residences.

As far as the daylight issue is considered, several factors should be considered in the design of windows such as orientation, shading devices, placement, size and ratio of windows area to floor area, and window glazing. In the design of windows, the first effective factor for gaining suitable daylight is designing a building with proper orientation so that suitable solar radiation can be collected both in winter and summer. Most of the residences are not satisfied with windows orientation in south east side of their units in winter time due to lack of enough daylight in winter so, it is essential to design windows properly in this side in order to increase the level of residence satisfaction.

In Famagusta, windows with largest spans should be located on southeast and southwest side of buildings in order to gain enough daylight. In northwest, windows should be minimized.

Most of the residences are not satisfied with horizontal windows. Therefore, window size should be enlarged as well as including vertical openings for gaining more daylight during winter especially in living rooms because users spend most of their time in living rooms. In most of bedrooms and living rooms ratio of window area to floor area is less than 15 – 20% and in bed rooms 20%. It is advisable to have the ratio of window area to floor area in between 15 to 20% in bedrooms and living rooms, however, it has been discovered that the case is different in the selected residential buildings.

According to the questionnaires, around 49% of the residences are satisfied with the size of the windows in their flats especially with room sizes of 12m². However, 15% of the residences wish to have larger windows than the existing ones located in the

living rooms due to daylight and natural ventilation issues. Therefore, it is not only important to design the size of windows thinking daylight issues, but also consider the depth of space in the building so that there is enough opening to gain daylight in cold days. However, wide openings can also have an effect on the increase of heat loss and gain.

The other important aspect is the kind of window glazing used in selected residential buildings, so, it is preferable to use double, triple-glazed and other new types of materials in order to control solar radiation in summer in Famagusta, North Cyprus. In general, level of residence satisfaction with double glazed windows is a slightly higher than single glazed windows. Thermal insulation is an important issue to be considered in the selection of window material, because heat loss can occur through the windows when indoor temperature is more than outdoor temperature. Therefore, U-Value of windows (e.g. both sash and frame) should be selected properly in order to control the heat loss through windows. Therefore, apartment buildings and its components should be designed appropriately considering the environmental characteristics of the residential buildings that have been mentioned above.

Furthermore, in order to control sunlight penetration, shading devices and sun breakers should be integrated. According to the questionnaires carried out with the users, most of the residences are not satisfied with the shutters of their flat windows. In order to maximize the level of users' satisfaction, overhangs are suggested on the southern side of residential buildings in order to control the sun in summer and early fall. In west, east and north side of the building, moveable or stable sun shades can be integrated.

The other function in design of windows in hot-humid climate is providing appropriate natural ventilation during hot days in hot-humid climate in residential buildings. Some factors should be realized in design of windows to have appropriate natural ventilation such as cooling techniques, orientation, window opening type and control of humidity.

Most of the living rooms and bedrooms do not have cross ventilation and this creates problem for providing suitable air circulation in the building in order to remove heat and humidity. Therefore, air circulation has an important especially in residential buildings and it is important to provide cross ventilation in most of the flats in order to increase level of residences' satisfaction and decline electricity usage.

Residences are more satisfied if windows are located on southwest and west sides of their living room and bed rooms. According to Famagusta climate, wind direction is from southwest and west in summer. Therefore, most of windows should be located on mentioned sides. The other important issue is natural ventilation in design of windows in residential buildings.

Components of windows like glass and their proper installation are also important for designers. Types of openings are effective for providing proper daylight and natural ventilation in the apartment buildings. Almost all of the window opening types in selected residential buildings have double casement opening. The level of residence satisfaction is neutral. According to criteria and collected data the best possible choices can be awing, casement, sliding and casement type (Vertical one) as they help reduce heat loss and gain through the windows in residential buildings in Famagusta, North Cyprus. One of the problems in Famagusta is the humidity where

providing suitable indoor temperature during the year is difficult for residents in apartment buildings. Opening types of windows sometimes have an essential role in improving the function of windows in hot and cold days in Famagusta.

In cases where windows are double glazed residences are satisfied with the control of air leakage and condensation. Therefore, it is essential to consider these issues in window design. The other essential matter is to choose airtight windows as well as other components (e.g. moisture transport strip between glazing or proper insulation) to control condensation in humid climates.

For removing humidity, it is essential to provide cross ventilation in the residential buildings. As mentioned in most of the cases in bedroom and living room, this issue is very much underestimated. Therefore, residences are usually obliged to use air conditioning units in summer time. Therefore, it is important to provide cross ventilation in the residential buildings in order to increase residence satisfaction in hot-humid climates.

In this study, daylighting and natural ventilation issues were examined in selected residential buildings in Famagusta to understand the level of residence satisfaction. In further study, material of windows can be examined so that the role of material in controlling of daylight and decreasing of energy use in apartment buildings can be understood. This will help recommend new types of material which are both flexible under various environmental conditions and inexpensive to apply.

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# APPENDICES

# Appendix A: Questionnaire Relating to Windows' Functional Features

EASTERN MEDITERRANEAN UNIVERSITY
(DOĞU AKDENİZ ÜNİVERSİTESİ)

**SUBJECT:**
**An Evaluation of Residence Satisfaction on Window Design of Mass Housing in Hot-Humid Climates: The Case of Famagusta, North Cyprus**

**QUESTIONAIRE**

SOOLMAZ ABDALI HAJIABADI 125371

**Data collection**
**Questionnaire** for user satisfaction:

The aim of this questionnaire has been to identify the effect of openings on people's life in every unit of ..... apartment.

**A. Daylighting**

1. Are you satisfied with shading devices of you unit?

1

| Construction Companies | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|
| Uzun | | | |
| Noyanlar | | | |
| Dovec | | | |

2. Are you satisfied with windows orientation in bedrooms with single glazed in summer and winter time?

| Windows Orientation | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|
| Summer | Southwest | | | |
| | Northwest | | | |
| | Northeast | | | |
| | Southeast | | | |
| | Southwest | | | |
| | Northwest | | | |
| | Northeast | | | |
| | Southeast | | | |
| Winter | Southwest | | | |
| | Northwest | | | |
| | Northeast | | | |
| | Southeast | | | |
| | Southwest | | | |
| | Northwest | | | |
| | Northeast | | | |
| | Southeast | | | |

Why?.....

3. Are you satisfied with windows orientation in bedrooms with double glazed windows in summer and winter time?

| Windows Orientation | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|
| Summer | Southwest | | | |
| | Northwest | | | |
| | Northeast | | | |
| | Southeast | | | |
| | Southwest | | | |
| | Northwest | | | |
| | Northeast | | | |
| | Southeast | | | |
| Winter | Southwest | | | |
| | Northwest | | | |
| | Northeast | | | |
| | Southeast | | | |
| | Southwest | | | |
| | Northwest | | | |
| | Northeast | | | |
| | Southeast | | | |

Why?.....

.....

4. Are you satisfied with windows orientation in living rooms with single glazed in summer and winter time?

2

| Windows Orientation | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|
| Summer | Southwest | | | |
| | Northwest | | | |
| | Northeast | | | |
| | Southeast | | | |
| | Southwest | | | |
| | Northwest | | | |
| | Northeast | | | |
| | Southeast | | | |
| Winter | Southwest | | | |
| | Northwest | | | |
| | Northeast | | | |
| | Southeast | | | |
| | Southwest | | | |
| | Northwest | | | |
| | Northeast | | | |
| | Southeast | | | |

Why?.....

.....

5. Are you satisfied with windows orientation in living rooms with double glazed windows in summer and winter time?

| Windows Orientation | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|
| Summer | Southwest | | | |
| | Northwest | | | |
| | Northeast | | | |
| | Southeast | | | |
| | Southwest | | | |
| | Northwest | | | |
| | Northeast | | | |
| | Southeast | | | |
| Winter | Southwest | | | |
| | Northwest | | | |
| | Northeast | | | |
| | Southeast | | | |
| | Southwest | | | |
| | Northwest | | | |
| | Northeast | | | |
| | Southeast | | | |

Why?.....
.....

6. Are you satisfied with the size of windows?

3

| | |
|---|---|
| Yes | |
| No | |
| Not important | |
| Wish to have larger than current one size | |
| Wish to have smaller than the current one size | |

7. Are you satisfied with ratio of windows area to floor area in bedrooms in winter and summer time?

| Ratio of Windows Area to Floor Area | | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|---|
| Summer | Second Floor | 1\5 | | | |
| | | 1\8 | | | |
| | | 1\10 | | | |
| | Third Floor | 1\5 | | | |
| | | 1\8 | | | |
| | | 1\10 | | | |
| Winter | Second Floor | 1\5 | | | |
| | | 1\8 | | | |
| | | 1\10 | | | |
| | Third Floor | 1\5 | | | |
| | | 1\8 | | | |
| | | 1\10 | | | |

Why?.....
.....

8. Are you satisfied with ratio of windows to floor area in living rooms in winter and summer time?

| Ratio of Windows Area to Floor Area | | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|---|
| Summer | Second Floor | 1\10 | | | |
| | | 1\13 | | | |
| | | 1\15 | | | |
| | | 1\20 | | | |
| | | 1\26 | | | |
| | Third Floor | 1\10 | | | |
| | | 1\13 | | | |
| | | 1\15 | | | |
| | | 1\20 | | | |
| | | 1\26 | | | |
| Winter | Second Floor | 1\10 | | | |
| | | 1\13 | | | |
| | | 1\15 | | | |
| | | 1\20 | | | |
| | | 1\26 | | | |
| | Third Floor | 1\10 | | | |
| | | 1\13 | | | |
| | | 1\15 | | | |
| | | 1\20 | | | |
| | | 1\26 | | | |

Why?.....
.....

4

9. Are you satisfied with placement of windows in bedrooms with single glazed in summer time?

| | |
|---|---|
| Dissatisfied | |
| Neutral | |
| Satisfied | |

Which place? Which floor? Why?.....
.....

10. Are you satisfied with placement of windows in bedrooms with double glazed windows in summer time?

| | |
|---|---|
| Dissatisfied | |
| Neutral | |
| Satisfied | |

Which place? Which floor? Why?.....
.....

11. Are you satisfied with placement of windows in bedrooms with single glaze windows in winter time?

| | |
|---|---|
| Dissatisfied | |
| Neutral | |
| Satisfied | |

Which place? Which floor? Why?.....
.....

12. Are you satisfied with placement of windows in bedrooms with double glazed windows in winter time?

| | |
|---|---|
| Dissatisfied | |
| Neutral | |
| Satisfied | |

Which place? Which floor? Why?.....
.....

13. Are you satisfied with placement of windows in living rooms with single glazed windows in summer time?

| | |
|---|---|
| Dissatisfied | |
| Neutral | |
| Satisfied | |

Which place? Which floor? Why?.....
.....

14. Are you satisfied with placement of windows in living rooms with double glazed windows in summer time?

| | |
|---|---|
| Dissatisfied | |
| Neutral | |
| Satisfied | |

5

Which place? Which floor? Why?.....
.....

15. Are you satisfied with placement of windows in living rooms with single glazed windows in winter time?

| | |
|---|---|
| Dissatisfied | |
| Neutral | |
| Satisfied | |

Which place? Which floor? Why?.....
.....

16. Are you satisfied with placement of windows in living rooms with double glazed windows in winter time?

| | |
|---|---|
| Dissatisfied | |
| Neutral | |
| Satisfied | |

Which place? Which floor? Why?.....
.....

17. Are you satisfied with placement of their windows?

| | |
|---|---|
| Yes | |
| No | |

**B. NATURAL VENTILATION**

18. Are you satisfied with natural ventilation of windows in bedrooms in summer time?

| | |
|---|---|
| Dissatisfied | |
| Neutral | |
| Satisfied | |

Which place? Which floor? Why?.....
.....

19. Are you satisfied with natural ventilation of windows in living rooms in summer time?

| | |
|---|---|
| Dissatisfied | |
| Neutral | |
| Satisfied | |

Which place? Which floor? Why?.....
.....

20. Do you have air tight from your windows?

| | |
|---|---|
| Yes | |
| No | |

21. Are you satisfied with windows opening type in bedrooms in summer time?

| | |
|---|---|
| Dissatisfied | |
| Neutral | |
| Satisfied | |

6

Which place? Which floor? Why?.....
.....

22. Are you satisfied with windows opening type in bedrooms in winter time?

| | |
|---|---|
| Dissatisfied | |
| Neutral | |
| Satisfied | |

Which place? Which floor? Why?.....

23. Are you satisfied with windows opening type in living rooms in summer time?

| | |
|---|---|
| Dissatisfied | |
| Neutral | |
| Satisfied | |

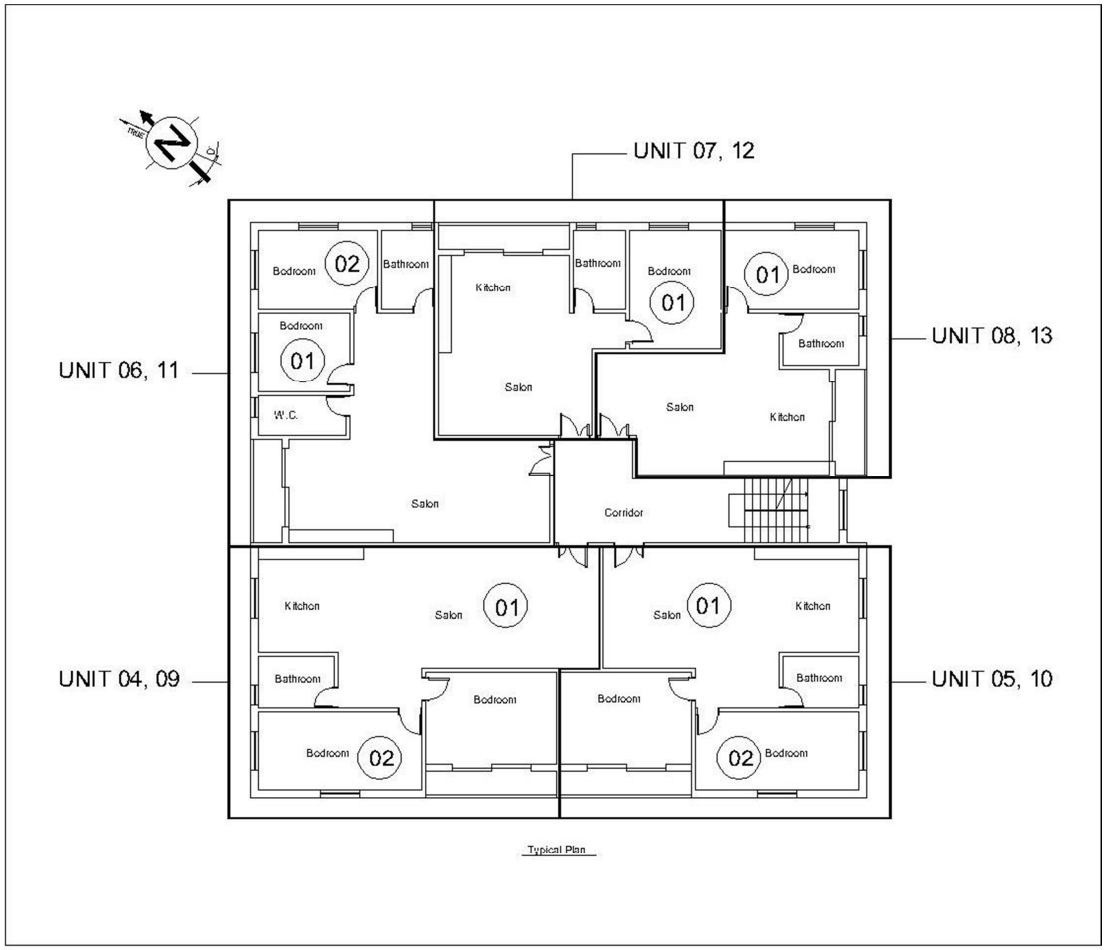
Which place? Which floor? Why?.....
.....

24. Are you satisfied with windows opening type in living rooms in winter time?

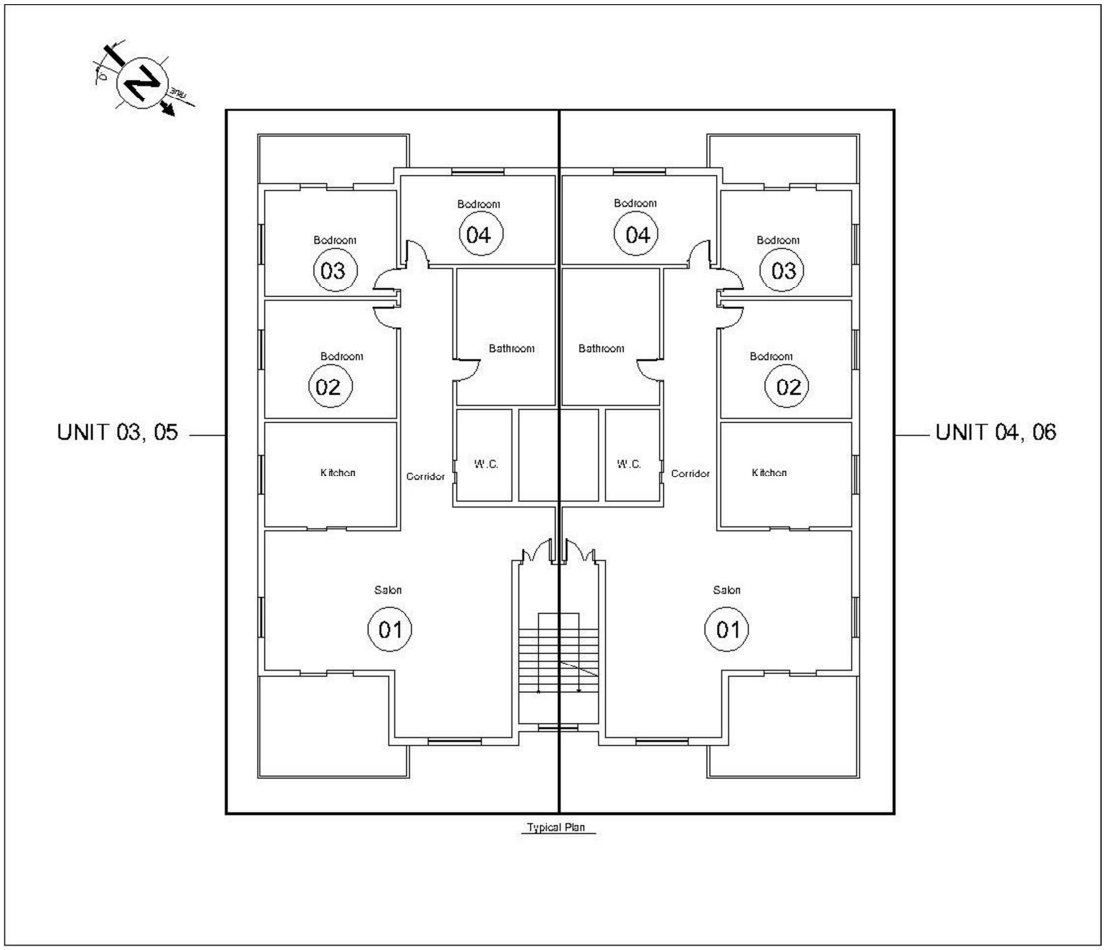
| | |
|---|---|
| Dissatisfied | |
| Neutral | |
| Satisfied | |

Which place? Which floor? Why?.....

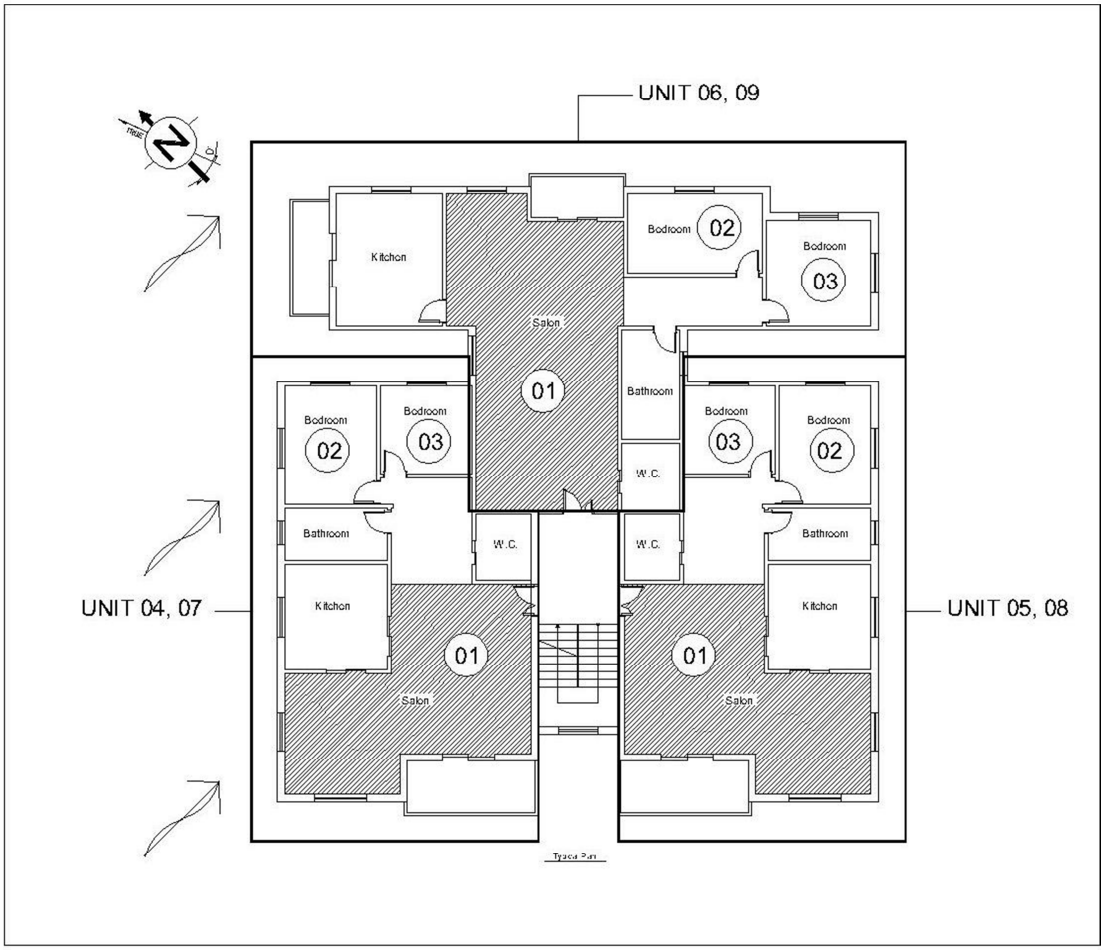
## Appendix B: M. Oltan Apt., Schematic Plan (Uzun)



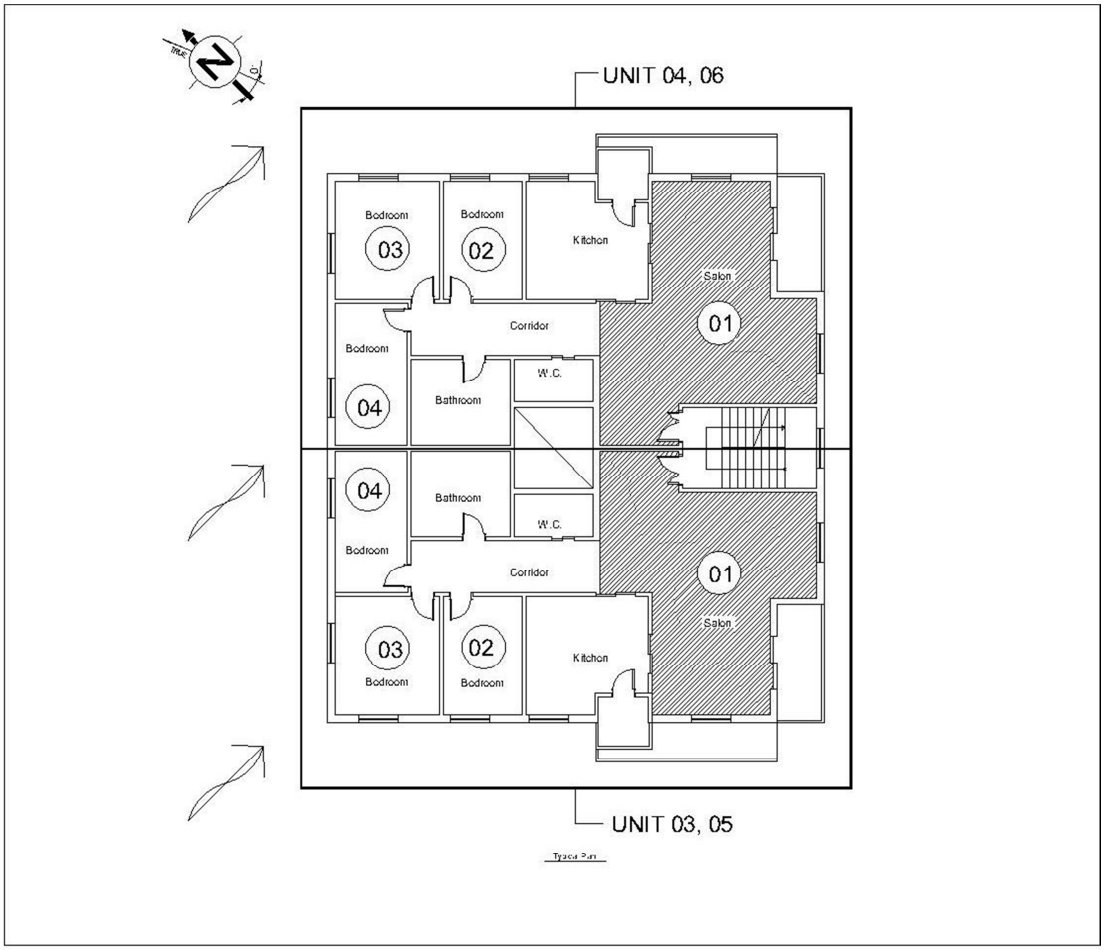
# Appendix C: Emine Apartment, Schematic Plan (Uzun)



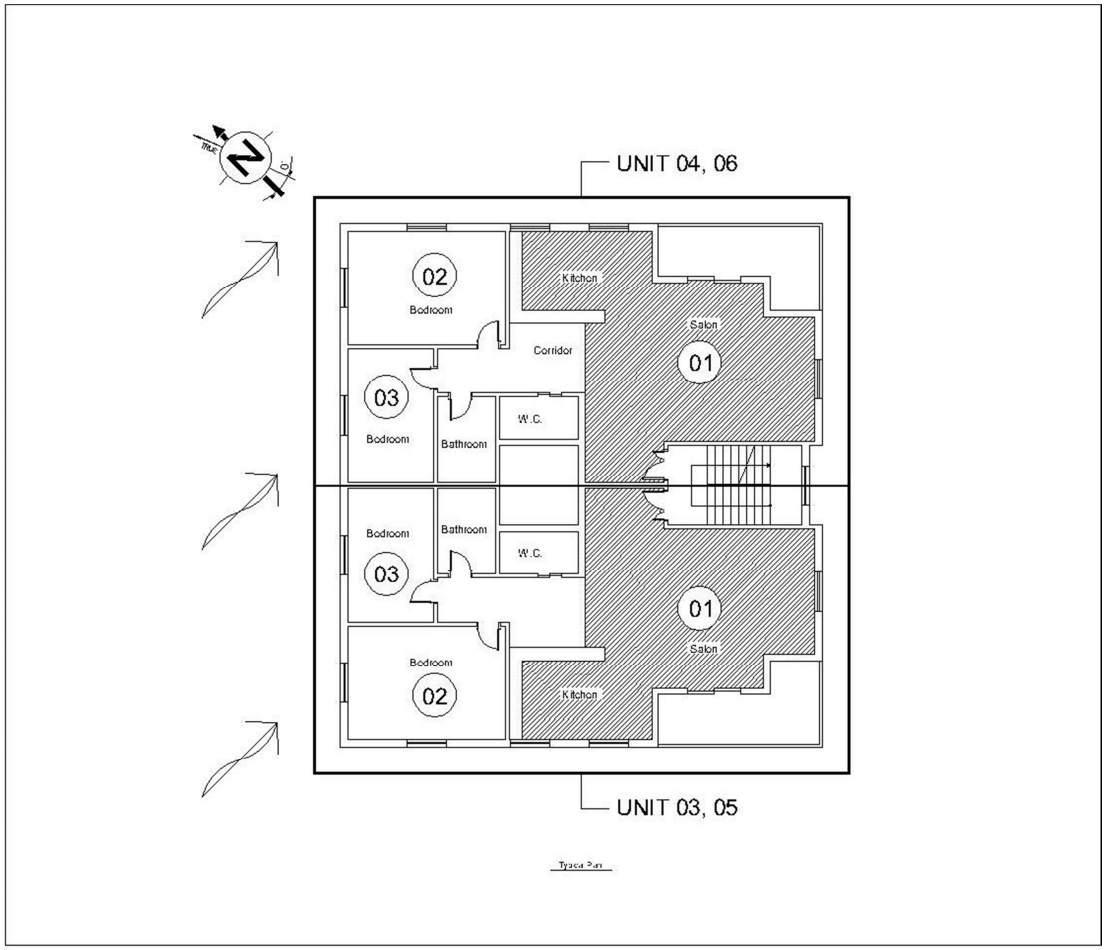
# Appendix D: Arken 14 Apartment, Schematic Plan (NOYANLAR)



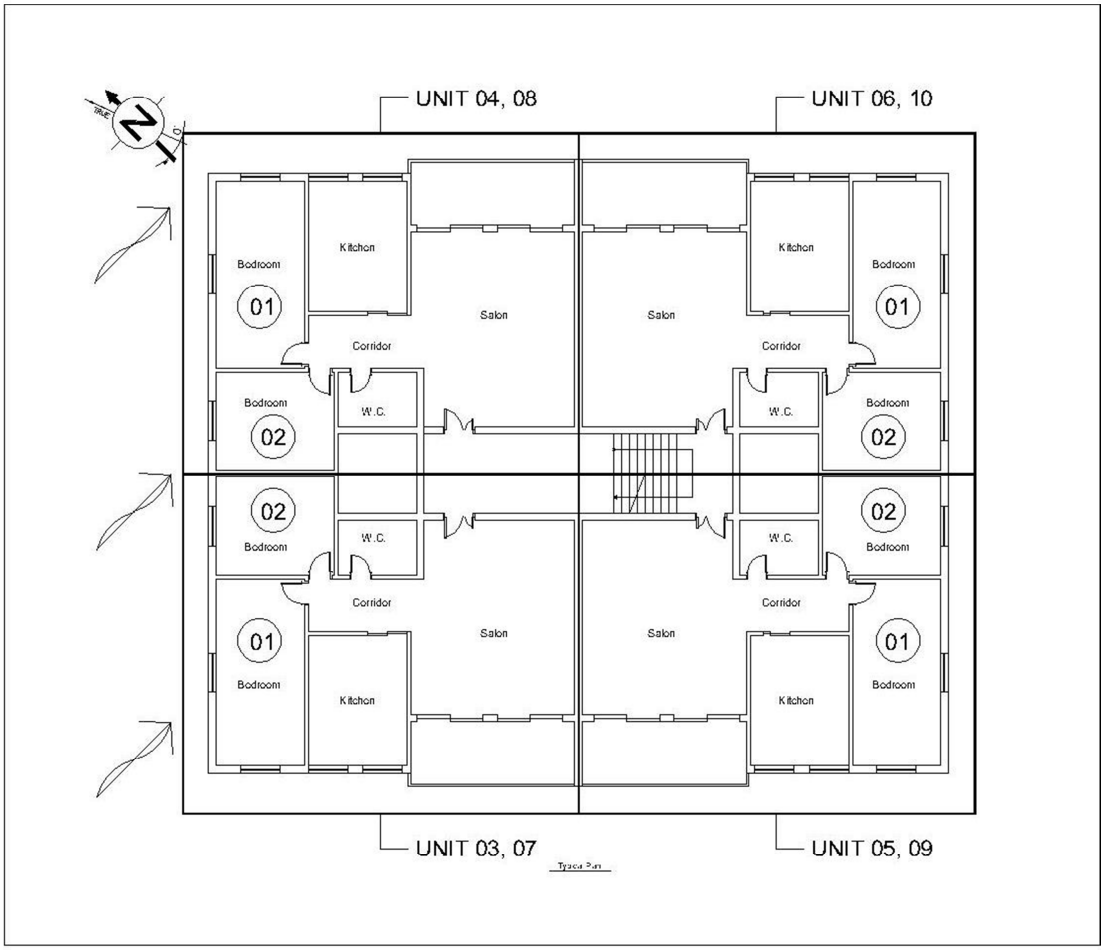
# Appendix E: Arken 12 Apartment, Schematic Plan (NOYANLAR)



# Appendix F: Apartment Number 18, Schematic Plan (DOVEC)



# Appendix G: Celebi Apartment, Schematic Plan (DOVEC)



# Appendix H: Questionnaires results

| **Windows Functional Features** | | | | |
|---|---|---|---|---|
| **Daylighting** | | | | |
| 1. Are you satisfied with shading devices? | | | | |
| Uzun | | 61% | 39% | - |
| Noyanlar | | 50% | 50% | - |
| Dovec | | 46% | 54% | - |
| 2. Are you satisfied with windows orientation in bedrooms with single glazed in summer and winter time? | | Dissatisfied | Neutral | Satisfied |
| Summer | Southwest | | 4% | |
| | Northwest | 4% | 8% | |
| | Northeast | | 26% | |
| | Southeast | | 6% | |
| | Southwest | | 4% | |
| | Northwest | 2% | 8% | |
| | Northeast | | 26% | |
| | Southeast | 2% | 6% | |
| Winter | Southwest | | 4% | |
| | Northwest | 6% | 2% | |
| | Northeast | 1% | 26% | |
| | Southeast | 1% | 4% | 1% |
| | Southwest | | 4% | |
| | Northwest | 6% | 4% | |
| | Northeast | 4% | 22% | |
| | Southeast | | 6% | 2% |
| 3. Are you satisfied with windows orientation in bedrooms with double glazed windows in summer and winter time? | | Dissatisfied | Neutral | Satisfied |
| Summer | Southwest | | 13% | |
| | Northwest | 4% | 9% | |
| | Northeast | | 12% | |
| | Southeast | | 14% | |
| | Southwest | | 11% | 3% |
| | Northwest | 2% | 8% | |
| | Northeast | | 10% | |
| | Southeast | 2% | 12% | |
| Winter | Southwest | | 12% | 2% |
| | Northwest | 3% | 2% | |
| | Northeast | 1% | 9% | |
| | Southeast | 1% | 14% | 4% |
| | Southwest | | 14% | |
| | Northwest | 4% | 4% | |
| | Northeast | 2% | 10% | |
| | Southeast | | 16% | 2% |

| 4. Are you satisfied with windows orientation in living rooms with single glazed in summer and winter time? | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|
| Summer | Southwest | | 12% | |
| | Northwest | 8% | 4% | |
| | Northeast | | 5% | |
| | Southeast | 8% | 13% | |
| | Southwest | 2% | 8% | |
| | Northwest | 8% | 8% | |
| | Northeast | | 4% | |
| | Southeast | 12% | 4% | 4% |
| Winter | Southwest | 5% | 5% | 4% |
| | Northwest | 10% | 3% | |
| | Northeast | 6% | 4% | |
| | Southeast | | 5% | 6% |
| | Southwest | 2% | 7% | 5% |
| | Northwest | 11% | 3% | |
| | Northeast | 4% | 5% | |
| | Southeast | | 7% | 8% |
| 5. Are you satisfied with windows orientation in living rooms with double glazed windows in summer and winter time? | | Dissatisfied | Neutral | Satisfied |
| Summer | Southwest | | 5% | 9% |
| | Northwest | 2% | 4% | 7% |
| | Northeast | 1% | 5% | |
| | Southeast | 13% | 6% | |
| | Southwest | 2% | 5% | 7% |
| | Northwest | 3% | 3% | 6% |
| | Northeast | 2% | 4% | |
| | Southeast | 3% | 4% | 9% |
| Winter | Southwest | 3% | 6% | 5% |
| | Northwest | 3% | 4% | 6% |
| | Northeast | 4% | 6% | |
| | Southeast | | 4% | 7% |
| | Southwest | 2% | 7% | 5% |
| | Northwest | 4% | 5% | 2% |
| | Northeast | 4% | 5% | |
| | Southeast | 2% | 7% | 9% |
| 6. Are you satisfied with the size of windows? | | | | |
| Yes | | 49% | | |
| No | | 36% | | |
| Not important | | - | | |
| Wish to have larger than current one size | | 15% | | |
| Wish to have smaller than the current one size | | - | | |

| 7. Are you satisfied with ratio of windows area to floor area in bedrooms in winter and summer time? | | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|---|
| Summer | Second Floor | 1/5 | | 10% | 4% |
| | | 1/8 | | 24% | |
| | | 1/10 | | 7% | |
| | Third Floor | 1/5 | | 18% | 3% |
| | | 1/8 | | 13% | |
| | | 1/10 | | 21% | |
| Winter | Second Floor | 1/5 | | 10% | |
| | | 1/8 | | 25% | |
| | | 1/10 | | 16% | |
| | Third Floor | 1/5 | | 9% | |
| | | 1/8 | | 22% | |
| | | 1/10 | | 18% | |
| 8. Are you satisfied with ratio of windows to floor area in living rooms in winter and summer time? | | | Dissatisfied | Neutral | Satisfied |
| Summer | Second Floor | 1/10 | | 17% | |
| | | 1/13 | | 17% | |
| | | 1/15 | | 8% | |
| | | 1/20 | | 8% | |
| | | 1/26 | | 8% | |
| | Third Floor | 1/10 | | 17% | |
| | | 1/13 | | 17% | |
| | | 1/15 | | 8% | |
| | | 1/20 | | 8% | |
| | | 1/26 | | 8% | |
| Winter | Second Floor | 1/10 | | 17% | |
| | | 1/13 | | 17% | |
| | | 1/15 | | 8% | |
| | | 1/20 | | 8% | |
| | | 1/26 | | 8% | |
| | Third Floor | 1/10 | | 17% | |
| | | 1/13 | | 17% | |
| | | 1/15 | | 8% | |
| | | 1/20 | | 8% | |
| | | 1/26 | | 8% | |

| 9. Are you satisfied with placement of windows in bedrooms with single glazed in summer time? | | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|---|
| Summer | Second Floor | Uz/04/02/NW | | 4% | |
| | | Uz/04/02/SW | 4% | | |
| | | Uz/04/02/NW-NOY/04/02/NW-DOV/03/02/NW | | 12% | |
| | | Uz/04/02/NE-NOY/04/02/NE-DOV/03/02/NE | 4% | 8% | |
| | | Uz/08/01/NE-NOY/05/02/NE-DOV/04/02/NE | | 12% | |
| | | Uz/08/01/SE-NOY/05/02/SE-DOV/04/02/SE | 8% | 4% | |
| | | Uz/05/02/SW | 4% | | |
| | | Uz/05/02/SE | 4% | | |
| | | Uz/06/01/NW | | 4% | |
| | | Uz/07/01/NE-NOY/04/03/NE-NOY/05/03/NE-NOY/06/02/NE-NOY/06/03/NE-DOV/03/03/NE-DOV/04/03/NE | | 29% | |
| | Third Floor | Uz/09/02/NW | | 4% | |
| | | Uz/09/02/SW | 4% | | |
| | | Uz/11/02/NW-NOY/07/02/NW-DOV/05/02/NW | | 12% | |
| | | Uz/11/02/NE-NOY/07/02/NE-DOV/05/02/NE | | 12% | |
| | | Uz/13/01/NE-NOY/08/02/NE-DOV/06/02/NE | 4% | 8% | |
| | | Uz/13/01/SE-NOY/08/02/SE-DOV/06/02/SE | 4% | 8% | |
| | | Uz/10/02/SW | | 4% | |
| | | Uz/10/02/SE | 4% | | |
| | | Uz/06/01/NW | | 4% | |
| | | Uz/07/01/NE-NOY/04/03/NE-NOY/05/03/NE-NOY/06/02/NE-NOY/06/03/NE-DOV/03/03/NE-DOV/04/03/NE | | 29% | |

| 10. Are you satisfied with placement of windows in bedrooms with double glazed windows in summer time? | | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|---|
| Summer | Second Floor | DOV/03/01/NW | | 4% | |
| | | DOV/03/01/SW | 4% | | |
| | | NOY/03/03/NW-DOV/04/01/NW | | 8% | |
| | | NOY/03/03/NE-DOV/04/01/NE | | 8% | |
| | | NOY/04/03/NE-DOV/06/01/NE | | 8% | |
| | | NOY/04/03/SE-DOV/06/01/SE | | 8% | |
| | | DOV/05/01/SW | | 3% | |
| | | DOV/05/01/SE | | 3% | |
| | | UZ/04/02/NW-UZ/04/03/NW-NOY/03/02/NW-DOV/03/02/NW-DOV/04/02/NW | | 19% | |
| | | NOY/03/04/NE-NOY/04/04/NE-DOV/06/02/NE | | 11% | |
| | | UZ/03/02/SE-UZ/03/03/SE-NOY/04/02/SE-DOV/05/02/SE | 11% | 5% | |
| | | Uz/03/04/SW-Uz/04/04/SW | | 8% | |
| | Third Floor | DOV/07/01/NW | | 4% | |
| | | DOV/07/01/SW | | 4% | |
| | | NOY/05/03/NW-DOV/08/01/NW | | 8% | |
| | | NOY/05/03/NE-DOV/08/01/NE | | 8% | |
| | | NOY/06/03/NE-DOV/10/01/NE | | 8% | |
| | | NOY/06/03/SE-DOV/10/01/SE | | 4% | |
| | | DOV/09/01/SW | | 3% | |
| | | DOV/09/01/SE | | 3% | |
| | | UZ/06/02/NW-UZ/06/03/NW-NOY/05/02/NW-DOV/07/02/NW-DOV/08/02/NW | | 20% | |
| | | NOY/05/04/NE-NOY/06/04/NE-DOV/10/02/NE | | 11% | |
| | | UZ/05/02/SE-UZ/05/03/SE-NOY/06/02/SE-DOV/09/02/SE | 4% | 15% | |
| | | Uz/05/04/SW-Uz/06/04/SW | | 8% | |

| 11. Are you satisfied with placement of windows in bedrooms with single glaze windows in winter time? | | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|---|
| Winter | Second Floor | Uz/04/02/NW | | 1% | |
| | | Uz/04/02/SW | | | 1% |
| | | Uz/04/02/NW-NOY/04/02/NW-DOV/03/02/NW | 2% | 1% | |
| | | Uz/04/02/NE-NOY/04/02/NE-DOV/03/02/NE | | 2% | 1% |
| | | Uz/08/01/NE-NOY/05/02/NE-DOV/04/02/NE | | 3% | |
| | | Uz/08/01/SE-NOY/05/02/SE-DOV/04/02/SE | | 1% | 2% |
| | | Uz/05/02/SW | | | 1% |
| | | Uz/05/02/SE | | 1% | |
| | | Uz/06/01/NW | 1% | | |
| | | Uz/07/01/NE-NOY/04/03/NE-NOY/05/03/NE-NOY/06/022/NE-NOY/06/03/NE-DOV/03/03/NE-DOV/04/03/NE | 3% | 4% | |
| | Third Floor | Uz/09/02/NW | | 1% | |
| | | Uz/09/02/SW | | | 1% |
| | | Uz/11/02/NW-NOY/07/02/NW-DOV/05/02/NW | 1% | 2% | |
| | | Uz/11/02/NE-NOY/07/02/NE-DOV/05/02/NE | | 3% | |
| | | Uz/13/01/NE-NOY/08/02/NE-DOV/06/02/NE | | 2% | 1% |
| | | Uz/13/01/SE-NOY/08/02/SE-DOV/06/02/SE | | 2% | 1% |
| | | Uz/10/02/SW | | 1% | |
| | | Uz/10/02/SE | | 1% | |
| | | Uz/06/01/NW | 1% | | |
| | | Uz/07/01/NE-NOY/04/03/NE-NOY/05/03/NE-NOY/06/022/NE-NOY/06/03/NE-DOV/03/03/NE-DOV/04/03/NE | 3% | 4% | |

| 12. Are you satisfied with placement of windows in bedrooms with double glazed windows in winter time? | | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|---|
| Winter | Second Floor | DOV/03/01/NW | | 4% | |
| | | DOV/03/01/SW | | 4% | |
| | | NOY/03/03/NW-DOV/04/01/NW | 8% | | |
| | | NOY/03/03/NE-DOV/04/01/NE | 8% | | |
| | | NOY/04/03/NE-DOV/06/01/NE | 8% | | |
| | | NOY/04/03/SE-DOV/06/01/SE | 8% | | |
| | | DOV/05/01/SW | | 3% | |
| | | DOV/05/01/SE | | 4% | |
| | | UZ/04/02/NW-UZ/04/03/NW-NOY/03/02/NW-DOV/03/02/NW-DOV/04/02/NW | 19% | | |
| | | NOY/03/04/NE-NOY/04/04/NE-DOV/06/02/NE | 3% | 8% | |
| | | UZ/03/02/SE-UZ/03/03/SE-NOY/04/02/SE-DOV/05/02/SE | 3% | 12% | |
| | | Uz/03/04/SW-Uz/04/04/SW | 8% | | |
| | Third Floor | DOV/07/01/NW | | 4% | |
| | | DOV/07/01/SW | | 4% | |
| | | NOY/05/03/NW-DOV/08/01/NW | 8% | | |
| | | NOY/05/03/NE-DOV/08/01/NE | 8% | | |
| | | NOY/06/03/NE-DOV/10/01/NE | 8% | | |
| | | NOY/06/03/SE-DOV/10/01/SE | 8% | | |
| | | DOV/09/01/SW | | 3% | |
| | | DOV/09/01/SE | | 4% | |
| | | UZ/06/02/NW-UZ/06/03/NW-NOY/05/02/NW-DOV/07/02/NW-DOV/08/02/NW | 19% | | |
| | | NOY/05/04/NE-NOY/06/04/NE-DOV/10/02/NE | 11% | | |
| | | UZ/05/02/SE-UZ/05/03/SE-NOY/06/02/SE-DOV/09/02/SE | 3% | 12% | |
| | | Uz/05/04/SW-Uz/06/04/SW | 8% | | |

| 13. Are you satisfied with placement of windows in living rooms with single glazed windows in summer time? | | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|---|
| Summer | Second Floor | Uz/04/01/NW | | 1% | |
| | | Uz/05/01/SE | | 1% | |
| | | NOY/06/01/NE | | 1% | |
| | | NOY/05/01/SW-DOV/04/01/SW | 2% | | |
| | | Uz/05/01/SE-DOV/04/01/SE | 2% | | |
| | | NOY/04/01/NW-DOV/03/01/NW | 2% | | |
| | | NOY/04/01/SW-DOV/03/01/SW | 2% | | |
| | Third Floor | Uz/09/01/NW | | 1% | |
| | | Uz/10/01/SE | | 1% | |
| | | NOY/09/01/NE | | 1% | |
| | | NOY/05/01/SW-DOV/04/01/SW | 2% | | |
| | | Uz/05/01/SE-DOV/04/01/SE | 2% | | |
| | | NOY/04/01/NW-DOV/03/01/NW | 2% | | |
| | | NOY/04/01/SW-DOV/03/01/SW | 2% | | |

| 14. Are you satisfied with placement of windows in living rooms with double glazed windows in summer time? | | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|---|
| Winter | Second Floor | UZ/03/01/NE | | 16% | |
| | | UZ/03/01/SE | 10% | | |
| | | UZ/04/01/NE | | 12% | |
| | | UZ/04/01/NW | 10% | | |
| | | NOY/03/01/NW | | 16% | |
| | | NOY/03/01/SW | | 13% | |
| | | NOY/03/01/SW | | 14% | |
| | | NOY/03/01/SE | 9% | | |
| | Third Floor | UZ/05/01/NE | | 13% | |
| | | UZ/05/01/SE | 12% | | |
| | | UZ/06/01/NE | | 14% | |
| | | UZ/06/01/NW | | 12% | |
| | | NOY/05/01/NW | | 16% | |
| | | NOY/05/01/SW | | 10% | |
| | | NOY/06/01/SW | | 11% | |
| | | NOY/06/01/SE | 12% | | |

| 15. Are you satisfied with placement of windows in living rooms with single glazed windows in winter time? | | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|---|
| Winter | Second Floor | Uz/04/01/NW | 5% | | |
| | | Uz/05/01/SE | 4% | | |
| | | NOY/06/01/NE | | 5% | |
| | | NOY/05/01/SW-DOV/04/01/SW | 5% | 4% | |
| | | Uz/05/01/SE-DOV/04/01/SE | | 9% | |
| | | NOY/04/01/NW-DOV/03/01/NW | 4% | 5% | |
| | | NOY/04/01/SW-DOV/03/01/SW | 5% | 4% | |
| | Third Floor | Uz/09/01/NW | 5% | | |
| | | Uz/10/01/SE | | 4% | |
| | | NOY/09/01/NE | | 5% | |
| | | NOY/05/01/SW-DOV/04/01/SW | 5% | 4% | |
| | | Uz/05/01/SE-DOV/04/01/SE | | 9% | |
| | | NOY/04/01/NW-DOV/03/01/NW | 4% | 5% | |
| | | NOY/04/01/SW-DOV/03/01/SW | 4% | 5% | |

| 16. Are you satisfied with placement of windows in living rooms with double glazed windows in winter time? | | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|---|
| Winter | Second Floor | UZ/03/01/NE | | 16% | |
| | | UZ/03/01/SE | | 10% | |
| | | UZ/04/01/NE | | 12% | |
| | | UZ/04/01/NW | 10% | | |
| | | NOY/03/01/NW | | 16% | |
| | | NOY/03/01/SW | 13% | | |
| | | NOY/03/01/SW | 14% | | |
| | | NOY/03/01/SE | | 9% | |
| | Third Floor | UZ/05/01/NE | | 13% | |
| | | UZ/05/01/SE | | 12% | |
| | | UZ/06/01/NE | | 14% | |
| | | UZ/06/01/NW | 12% | | |
| | | NOY/05/01/NW | | 16% | |
| | | NOY/05/01/SW | 10% | | |
| | | NOY/06/01/SW | 12% | | |
| | | NOY/06/01/SE | | 11% | |

| 17. Are you satisfied with placement of their windows? | Yes | No | |
|---|---|---|---|
| | 59% | 41% | |

| 17. Are you satisfied with placement of their windows? | | | Yes | No | |
|---|---|---|---|---|---|
| | | | 59% | 41% | |

| 18. Are you satisfied with natural ventilation of windows in bedrooms in summer time? | | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|---|
| | Second Floor | Uz/04/02/NW-DOV/03/01/NW + Uz/04/02/SW-DOV/03/01/SW | | | 6% |
| | | Uz/06/02/NW-NOY/04/02/NW-DOV/03/02/NW NOY/03/03/NW-DOV/04/01/NW+ Uz/0/02/NE-NOY/04/02/NE-DOV/03/02/NE-NOY/03/03/NE-DOV/04/01/NE | | | 14% |
| | | Uz/08/01/NE-NOY/05/02/NE-DOV/04/02/NE-NOY/04/03/NE-DOV/06/01/NE + Uz/08/01/SE-NOY/05/02/SE-DOV/04/02/SE-NOY/04/03/SE-DOV/06/01/SE | | 1% | 2% |
| | | Uz/05/02/SW-DOV/05/01/SW + Uz/05/02/SE-DOV/05/01/SE | | | 6% |
| | | Uz/06/01/NW | 9% | | |
| | | Uz/07/01/NE-NOY/04/03/NE-NOY/05/03/NE-NOY/06/02/NE-NOY/06/03/NE-DOV/03/03/NE-DOV/04/03/NE-NOY/03/04/NE-NOY/04/04/NE-DOV/06/02/NE | 26% | 3% | |
| | | UZ/04/02/NW-UZ/04/03/NW-NOY/03/02/NW-DOV/03/02/NW-DOV/04/02/NW | 12% | 3% | |
| | | UZ/03/02/SE-UZ/03/03/SE-NOY/04/02/SE-DOV/05/02/SE | 12% | | |

| | | | | | |
|---|---|---|---|---|---|
| Winter | | Uz/03/04/SW-Uz/04/04/SW | 6% | | |
| | Third Floor | Uz/09/02/NW-DOV/07/01/NW + Uz/09/02/SW-DOV/07/01/SW | | | 6% |
| | | Uz/11/02/NW-NOY/07/02/NW-DOV/05/02/NW-NOY/05/03/NW-DOV/08/01/NW + Uz/11/02/NE-NOY/07/02/NE-DOV/05/02/NE-NOY/05/03/NE-DOV/08/01/NE | | | 13% |
| | | Uz/13/01/NE-NOY/08/02/NE-DOV/06/02/NE-NOY/06/03/NE-DOV/10/01/NE + Uz/13/01/SE-NOY/08/02/SE-DOV/06/02/SE-NOY/06/03/SE-DOV/10/01/SE | | | 14% |
| | | Uz/10/02/SW-DOV/09/01/SW + Uz/10/02/SE-DOV/09/01/SE | | | 9% |
| | | Uz/11/01/NW-UZ/06/02/NW-UZ/06/03/NW-NOY/05/02/NW-DOV/07/02/NW-DOV/08/02/NW | 17% | | |
| | | Uz/12/01/NE-NOY/07/03/NE-NOY/08/03/NE-NOY/09/02/NE-NOY/09/03/NE-DOV/05/03/NE-DOV/06/03/NE-NOY/05/04/NE-NOY/06/04/NE-DOV/10/02/NE | 23% | | |
| | | UZ/05/02/SE-UZ/05/03/SE-NOY/06/02/SE-DOV/09/02/SE | 12% | | |
| | | Uz/05/04/SW-Uz/06/04/SW | 6% | | |

| 19. Are you satisfied with natural ventilation of windows in living rooms in summer time? | | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|---|
| Summer | Second Floor | Uz/04/01/NW | 9% | | |
| | | Uz/05/01/SE | 9% | | |
| | | NOY/06/01/NE | | 10% | |
| | | UZ/04/01/NE+UZ/04/01/NW | | | 9% |
| | | UZ/03/01/NE + UZ/03/01/SE | | | 18% |
| | | NOY/05/01/SW-DOV/04/01/SW-NOY/03/01/SW + NOY/05/01/SE-DOV/04/01/SE-NOY/03/01/SE | | | 18% |
| | | NOY/04/01/NW-DOV/03/01/NW-NOY/03/01/NW + NOY/04/01/SW-DOV/03/01/SW-NOY/03/01/SW | | | 27% |
| | Third Floor | Uz/09/01/NW | 9% | | |
| | | Uz/10/01/SE | 10% | | |
| | | NOY/09/01/NE | 9% | | |
| | | UZ/05/01/NE + UZ/05/01/SE | | | 12% |
| | | UZ/06/01/NE + UZ/06/01/NW | | | 12% |
| | | NOY/07/01/SW-DOV/06/01/SW-NOY/06/01/SW + NOY/07/01/SE-DOV/06/01/SE-NOY/06/01/SE | | | 30% |
| | | NOY/08/01/NW-DOV/05/01/NW-NOY/05/01/NW + NOY/08/01/SW-DOV/05/01/SW-NOY/05/01/SW | | | 18% |

| 20. Do you have air tight from your windows? | | Yes | No | |
|---|---|---|---|---|
| | | 33% | 67% | |

| 21. Are you satisfied with windows opening type in bedrooms in summer time? | | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|---|
| Summer | Second Floor | Uz/04/02/NW | | 4% | |
| | | Uz/04/02/SW | | 4% | |
| | | Uz/04/02/NW-NOY/04/02/NW-DOV/03/02/NW | | 13% | |
| | | Uz/04/02/NE-NOY/04/02/NE-DOV/03/02/NE | | 13% | |
| | | Uz/08/01/NE-NOY/05/02/NE-DOV/04/02/NE | | 12% | |
| | | Uz/08/01/SE-NOY/05/02/SE-DOV/04/02/SE | | 12% | |
| | | Uz/05/02/SW | | 4% | |
| | | Uz/05/02/SE | | 4% | |
| | | Uz/06/01/NW | | 4% | |
| | | Uz/07/01/NE-NOY/04/03/NE-NOY/05/03/NE-NOY/06/02/NE-NOY/06/03/NE-DOV/03/03/NE-DOV/04/03/NE | | 30% | |
| | Third Floor | Uz/09/02/NW | | 4% | |
| | | Uz/09/02/SW | | 4% | |
| | | Uz/11/02/NW-NOY/07/02/NW-DOV/05/02/NW | | 12% | |
| | | Uz/11/02/NE-NOY/07/02/NE-DOV/05/02/NE | | 12% | |
| | | Uz/13/01/NE-NOY/08/02/NE-DOV/06/02/NE | | 13% | |
| | | Uz/13/01/SE-NOY/08/02/SE-DOV/06/02/SE | | 13% | |
| | | Uz/10/02/SW | | 4% | |
| | | Uz/10/02/SE | | 4% | |
| | | Uz/06/01/NW | | 5% | |
| | | Uz/12/01/NE-NOY/07/03/NE-NOY/08/03/NE-NOY/09/02/NE-NOY/09/03/NE-DOV/05/03/NE-DOV/06/03/NE | | 29% | |

| 22. Are you satisfied with windows opening type in bedrooms in winter time? | | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|---|
| Winter | Second Floor | Uz/04/02/NW | | 4% | |
| | | Uz/04/02/SW | | 4% | |
| | | Uz/04/02/NW-NOY/04/02/NW-DOV/03/02/NW | | 13% | |
| | | Uz/04/02/NE-NOY/04/02/NE-DOV/03/02/NE | | 13% | |
| | | Uz/08/01/NE-NOY/05/02/NE-DOV/04/02/NE | | 12% | |
| | | Uz/08/01/SE-NOY/05/02/SE-DOV/04/02/SE | | 12% | |
| | | Uz/05/02/SW | | 4% | |
| | | Uz/05/02/SE | | 4% | |
| | | Uz/06/01/NW | | 4% | |
| | | Uz/07/01/NE-NOY/04/03/NE-NOY/05/03/NE-NOY/06/02/NE-NOY/06/03/NE-DOV/03/03/NE-DOV/04/03/NE | | 30% | |
| | Third Floor | Uz/09/02/NW | | 4% | |
| | | Uz/09/02/SW | | 4% | |
| | | Uz/11/02/NW-NOY/07/02/NW-DOV/05/02/NW | | 12% | |
| | | Uz/11/02/NE-NOY/07/02/NE-DOV/05/02/NE | | 12% | |
| | | Uz/13/01/NE-NOY/08/02/NE-DOV/06/02/NE | | 13% | |
| | | Uz/13/01/SE-NOY/08/02/SE-DOV/06/02/SE | | 13% | |
| | | Uz/10/02/SW | | 4% | |
| | | Uz/10/02/SE | | 4% | |
| | | Uz/06/01/NW | | 5% | |
| | | Uz/12/01/NE-NOY/07/03/NE-NOY/08/03/NE-NOY/09/02/NE-NOY/09/03/NE-DOV/05/03/NE-DOV/06/03/NE | | 29% | |

| 23. Are you satisfied with windows opening type in living rooms in summer time? | | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|---|
| Summer | Second Floor | Uz/04/01/NW | | 5% | |
| | | Uz/05/01/SE | | 4% | |
| | | NOY/06/01/NE | | 4% | |
| | | NOY/05/01/SW-DOV/04/01/SW | | 9% | |
| | | Uz/05/01/SE-DOV/04/01/SE | | 9% | |
| | | NOY/04/01/NW-DOV/03/01/NW | | 10% | |
| | | NOY/04/01/SW-DOV/03/01/SW | | 9% | |
| | Third Floor | Uz/09/01/NW | | 5% | |
| | | Uz/10/01/SE | | 4% | |
| | | NOY/09/01/NE | | 5% | |
| | | NOY/07/01/SW-DOV/06/01/SW | | 10% | |
| | | NOY/07/01/SE-DOV/06/01/SE | | 9% | |
| | | NOY/08/01/NW-DOV/05/01/NW | | 9% | |
| | | NOY/08/01/SW-DOV/05/01/SW | | 6% | |

| 24. Are you satisfied with windows opening type in living rooms in winter time? | | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|---|
| Winter | Second Floor | Uz/04/01/NW | | 5% | |
| | | Uz/05/01/SE | | 4% | |
| | | NOY/06/01/NE | | 4% | |
| | | NOY/05/01/SW-DOV/04/01/SW | | 9% | |
| | | Uz/05/01/SE-DOV/04/01/SE | | 9% | |
| | | NOY/04/01/NW-DOV/03/01/NW | | 10% | |
| | | NOY/04/01/SW-DOV/03/01/SW | | 9% | |
| | Third Floor | Uz/09/01/NW | | 5% | |
| | | Uz/10/01/SE | | 4% | |
| | | NOY/09/01/NE | | 5% | |
| | | NOY/07/01/SW-DOV/06/01/SW | | 10% | |
| | | NOY/07/01/SE-DOV/06/01/SE | | 9% | |
| | | NOY/08/01/NW-DOV/05/01/NW | | 9% | |
| | | NOY/08/01/SW-DOV/05/01/SW | | 6% | |

| 25. Are you satisfied with different direction of the single glaze windows performance in hot and cold seasons? | | Dissatisfied | Neutral | Satisfied |
|---|---|---|---|---|
| Hot days | Southwest | | | 32% |
| | Northwest | | | 21% |
| | Northeast | | | 29% |
| | Southeast | | | 18% |
| Cold days | Southwest | | | 25% |
| | Northwest | | | 23% |
| | Northeast | | | 19% |
| | Southeast | | | 33% |
| 26. Are you satisfied with different direction of the double glaze windows performance in hot and cold seasons? | | Dissatisfied | Neutral | Satisfied |
| Hot days | Southwest | | | 25% |
| | Northwest | | | 22% |
| | Northeast | | | 24% |
| | Southeast | | | 29% |
| Cold days | Southwest | | | 17% |
| | Northwest | | | 22% |
| | Northeast | | | 14% |
| | Southeast | | | 47% |
| 27. Are you satisfied with single glaze windows performance in hot and cold seasons? | | Yes | No | |
| | January | 33% | | |
| | February | 33% | | |
| | March | 33% | | |
| | April | 55% | | |
| | May | 55% | | |
| | June | 55% | | |
| | July | 55% | | |
| | Agust | 55% | | |
| | September | 55% | | |
| | October | 33% | | |
| | November | 33% | | |
| | December | 33% | | |

| 28. Are you satisfied with double glaze windows performance in hot and cold seasons? | | Yes | No | |
|---|---|---|---|---|
| | January | 42% | | |
| | February | 42% | | |
| | March | 42% | | |
| | April | 64% | | |
| | May | 64% | | |
| | June | 64% | | |
| | July | 64% | | |
| | Agust | 64% | | |
| | September | 64% | | |
| | October | 42% | | |
| | November | 42% | | |
| | December | 42% | | |
| 29. Are your windows | | Yes | NO | |
| Single glaze | | 50% | | |
| Double glaze | | 50% | | |
| Triple glazed | | | | |
| Other | | | | |

# Appendix I: Explanation of horizontal axis of chart 10, 12, 22, 23

| Number | Places |
|---|---|
| 1 | Uz/04/02/NW |
| 2 | Uz/04/02/SW |
| 3 | Uz/04/02/NW-NOY/04/02/NW-DOV/03/02/NW |
| 4 | Uz/04/02/NE-NOY/04/02/NE-DOV/03/02/NE |
| 5 | Uz/08/01/NE-NOY/05/02/NE-DOV/04/02/NE |
| 6 | Uz/08/01/SE-NOY/05/02/SE-DOV/04/02/SE |
| 7 | Uz/05/02/SW |
| 8 | Uz/05/02/SE |
| 9 | Uz/06/01/NW |
| 10 | Uz/07/01/NE-NOY/04/03/NE-NOY/05/03/NE-NOY/06/02/NE-NOY/06/03/NE-DOV/03/03/NE-DOV/04/03/NE |
| 11 | Uz/09/02/NW |
| 12 | Uz/09/02/SW |
| 13 | Uz/11/02/NW-NOY/07/02/NW-DOV/05/02/NW |
| 14 | Uz/11/02/NE-NOY/07/02/NE-DOV/05/02/NE |
| 15 | Uz/13/01/NE-NOY/08/02/NE-DOV/06/02/NE |
| 16 | Uz/13/01/SE-NOY/08/02/SE-DOV/06/02/SE |
| 17 | Uz/10/02/SW |
| 18 | Uz/10/02/SE |
| 19 | Uz/06/01/NW |
| 20 | Uz/07/01/NE-NOY/04/03/NE-NOY/05/03/NE-NOY/06/022/NE-NOY/06/03/NE-DOV/03/03/NE-DOV/04/03/NE |
| **Explanation:** Uz (Uzun construction Company), NOY (Noyanlar Construction Company), and DOV (Dovec Construction Company)<br>For example, **Uz/04/02/NW**: Uzun Co./ Unit number is 04/ Bedroom number is 02/ Northwest (window orientation) | |

# Appendix J: Explanation of horizontal axis of Chart 11, 13

| Number | Places |
|---|---|
| 1 | DOV/03/01/NW |
| 2 | DOV/03/01/SW |
| 3 | NOY/03/03/NW-DOV/04/01/NW |
| 4 | NOY/03/03/NE-DOV/04/01/NE |
| 5 | NOY/04/03/NE-DOV/06/01/NE |
| 6 | NOY/04/03/SE-DOV/06/01/SE |
| 7 | DOV/05/01/SW |
| 8 | DOV/05/01/SE |
| 9 | UZ/04/02/NW- UZ/04/03/NW-NOY/03/02/NW-DOV/03/02/NW-DOV/04/02/NW |
| 10 | NOY/03/04/NE-NOY/04/04/NE-DOV/06/02/NE |
| 11 | UZ/03/02/SE-UZ/03/03/SE-NOY/04/02/SE-DOV/05/02/SE |
| 12 | Uz/03/04/SW-Uz/04/04/SW |
| 13 | DOV/07/01/NW |
| 14 | DOV/07/01/SW |
| 15 | NOY/05/03/NW-DOV/08/01/NW |
| 16 | NOY/05/03/NE-DOV/08/01/NE |
| 17 | NOY/06/03/NE-DOV/10/01/NE |
| 18 | NOY/06/03/SE-DOV/10/01/SE |
| 19 | DOV/09/01/SW |
| 20 | DOV/09/01/SE |
| 21 | UZ/06/02/NW- UZ/06/03/NW-NOY/05/02/NW-DOV/07/02/NW-DOV/08/02/NW |
| 22 | NOY/05/04/NE-NOY/06/04/NE-DOV/10/02/NE |
| 23 | UZ/05/02/SE-UZ/05/03/SE-NOY/06/02/SE-DOV/09/02/SE |
| 24 | Uz/05/04/SW-Uz/06/04/SW |
| **Explanation:** Uz (Uzun construction Company), NOY (Noyanlar Construction Company), and DOV (Dovec Construction Company)<br>**DOV/03/01/NW**: Dovec Co./ Unit number is 03/ Bedroom number is 01/ Northwest (window orientation) | |

# Appendix K: Explanation of horizontal axis of Chart 19

| Number | Places |
|---|---|
| 1 | Uz/04/02/NW-DOV/03/01/NW + Uz/04/02/SW-DOV/03/01/SW |
| 2 | Uz/06/02/NW-NOY/04/02/NW-DOV/03/02/NW NOY/03/03/NW-DOV/04/01/NW+ Uz/0/02/NE-NOY/04/02/NE-DOV/03/02/NE-NOY/03/03/NE-DOV/04/01/NE |
| 3 | Uz/08/01/NE-NOY/05/02/NE-DOV/04/02/NE-NOY/04/03/NE-DOV/06/01/NE + Uz/08/01/SE-NOY/05/02/SE-DOV/04/02/SE-NOY/04/03/SE-DOV/06/01/SE |
| 4 | Uz/05/02/SW-DOV/05/01/SW + Uz/05/02/SE-DOV/05/01/SE |
| 5 | Uz/06/01/NW |
| 6 | Uz/07/01/NE-NOY/04/03/NE-NOY/05/03/NE-NOY/06/02/NE-NOY/06/03/NE-DOV/03/03/NE-DOV/04/03/NE-NOY/03/04/NE-NOY/04/04/NE-DOV/06/02/NE |
| 7 | UZ/04/02/NW- UZ/04/03/NW-NOY/03/02/NW-DOV/03/02/NW-DOV/04/02/NW |
| 8 | UZ/03/02/SE-UZ/03/03/SE-NOY/04/02/SE-DOV/05/02/SE |
| 9 | Uz/03/04/SW-Uz/04/04/SW |
| 10 | Uz/09/02/NW-DOV/07/01/NW + Uz/09/02/SW-DOV/07/01/SW |
| 11 | Uz/11/02/NW-NOY/07/02/NW-DOV/05/02/NW-NOY/05/03/NW-DOV/08/01/NW + Uz/11/02/NE-NOY/07/02/NE-DOV/05/02/NE-NOY/05/03/NE-DOV/08/01/NE |
| 12 | Uz/13/01/NE-NOY/08/02/NE-DOV/06/02/NE-NOY/06/03/NE-DOV/10/01/NE + Uz/13/01/SE-NOY/08/02/SE-DOV/06/02/SE-NOY/06/03/SE-DOV/10/01/SE |
| 13 | Uz/10/02/SW-DOV/09/01/SW + Uz/10/02/SE-DOV/09/01/SE |
| 14 | Uz/11/01/NW-UZ/06/02/NW- UZ/06/03/NW-NOY/05/02/NW-DOV/07/02/NW-DOV/08/02/NW |
| 15 | Uz/12/01/NE-NOY/07/03/NE-NOY/08/03/NE-NOY/09/02/NE-NOY/09/03/NE-DOV/05/03/NE-DOV/06/03/NE-NOY/05/04/NE-NOY/06/04/NE-DOV/10/02/NE |
| 16 | UZ/05/02/SE-UZ/05/03/SE-NOY/06/02/SE-DOV/09/02/SE |
| 17 | Uz/05/04/SW-Uz/06/04/SW |
| **Explanation:** Uz (Uzun construction Company), NOY (Noyanlar Construction Company), and DOV (Dovec Construction Company)<br>**Uz/04/02/NW**: Uzun Co./ Unit number is 04/ Bedroom number is 02/ Northwest (window orientation) | |

# Appendix L: Explanation of horizontal axis of Chart 20

| Number | Places |
|---|---|
| 1 | Uz/04/01/NW |
| 2 | Uz/05/01/SE |
| 3 | NOY/06/01/NE |
| 4 | UZ/04/01/NE+UZ/04/01/NW |
| 5 | UZ/03/01/NE+UZ/03/01/SE |
| 6 | NOY/05/01/SW-DOV/04/01/SW-NOY/03/01/SW + NOY/05/01/SE-DOV/04/01/SE-NOY/03/01/SE |
| 7 | NOY/04/01/NW-DOV/03/01/NW-NOY/03/01/NW + NOY/04/01/SW-DOV/03/01/SW-NOY/03/01/SW |
| 8 | Uz/09/01/NW |
| 9 | Uz/10/01/SE |
| 10 | NOY/09/01/NE |
| 11 | UZ/05/01/NE+UZ/05/01/SE |
| 12 | UZ/06/01/NE+UZ/06/01/NW |
| 13 | NOY/07/01/SW-DOV/06/01/SW-NOY/06/01/SW + NOY/07/01/SE-DOV/06/01/SE-NOY/06/01/SE |
| 14 | NOY/08/01/NW-DOV/05/01/NW-NOY/05/01/NW + NOY/08/01/SW-DOV/05/01/SW-NOY/05/01/SW |
| Explanation: Uz (Uzun construction Company), NOY (Noyanlar Construction Company), and DOV (Dovec Construction Company)<br>For example, Uz/04/01/NW: Uzun Co./ Unit number is 04/ Bedroom number is 01/ Northwest (window orientation) | |

# Appendix M: Summary of windows functional features (daylighting) in living room and bed room

## Living room

| Co. | Apartment building | Floor | Season | Windows Orientation | | | | Ratio of windows area to Floor area | | Placement | | | | Shading Devices | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Uzun | M.Oltan Apt. (single-glazed) | Second | Summer | SW | NW | NE | SE | 1/26 | 1/20 | SW | NW | NE | SE | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | 1/26 | 1/20 | SW | NW | NE | SE | NO | YES |
| | | Second | Summer | SW | NW | NE | SE | 1/26 | 1/20 | SW | NW | NE | SE | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | 1/26 | 1/20 | SW | NW | NE | SE | NO | YES |
| | Emine Apt. (double-glazed) | Second | Summer | SW | NW | NE | NE | SE | 1/13 | SW | NW | NE | SE | NO | YES |
| | | Third | Winter | SW | NW | NE | NE | SE | 1/13 | SW | NW | NE | SE | NO | YES |
| | | Second | Summer | SW | NW | NE | NE | SE | 1/13 | SW | NW | NE | SE | NO | YES |
| | | Third | Winter | SW | NW | NE | NE | SE | 1/13 | SW | NW | NE | SE | NO | YES |
| Noyanlar | Arken 14 (single-glazed) | Second | Summer | SW | NW | NE | SE | 1/13 | 1/15 | SW | NW | NE | SE | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | 1/13 | 1/15 | SW | NW | NE | SE | NO | YES |
| | | Second | Summer | SW | NW | NE | SE | 1/13 | 1/15 | SW | NW | NE | SE | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | 1/13 | 1/15 | SW | NW | NE | SE | NO | YES |
| | Arken 12 (double-glazed) | Second | Summer | SW | NW | NE | SE | 1/13 | | SW | NW | NE | SE | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | 1/13 | | SW | NW | NE | SE | NO | YES |
| | | Second | Summer | SW | NW | NE | SE | 1/13 | | SW | NW | NE | SE | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | 1/13 | | SW | NW | NE | SE | NO | YES |
| Dovec | No. 18 (single-glazed) | Second | Summer | SW | NW | NE | SE | 1/10 | | SW | NW | NE | SE | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | 1/10 | | SW | NW | NE | SE | NO | YES |
| | | Second | Summer | SW | NW | NE | SE | 1/10 | | SW | NW | NE | SE | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | 1/10 | | SW | NW | NE | SE | NO | YES |
| | Celebi Apt. (double-glazed) | Second | Summer | SW | NW | NE | SE | - | - | SW | NW | NE | SE | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | - | - | SW | NW | NE | SE | NO | YES |
| | | Second | Summer | SW | NW | NE | SE | - | - | SW | NW | NE | SE | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | - | - | SW | NW | NE | SE | NO | YES |

## Bed room

| Co. | Apartment building | Floor | Season | Windows Orientation | | | | | Ratio of windows area to Floor area | | Placement | | | | | Shading Devices | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Uzun | M.Oltan Apt. (single-glazed) | Second | Summer | SW | NW | NE | SE | | 1/5 | 1/8 | SW | NW | NE | SE | | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | | 1/5 | 1/8 | SW | NW | NE | SE | | NO | YES |
| | | Second | Summer | SW | NW | NW | NE | SE | 1/5 | 1/8 | SW | NW | NE | SE | | NO | YES |
| | | Third | Winter | SW | NW | NW | NE | SE | 1/5 | 1/8 | SW | NW | NE | SE | | NO | YES |
| | Emine Apt. (double-glazed) | Second | Summer | SW | NW | NE | SE | | 1/10 | | SW | NW | NE | SE | SE | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | | 1/10 | | SW | NW | NE | SE | SE | NO | YES |
| | | Second | Summer | SW | NW | NE | SE | | 1/10 | | SW | NW | NE | SE | SE | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | | 1/10 | | SW | NW | NE | SE | SE | NO | YES |
| Noyanlar | Arken 14 (single-glazed) | Second | Summer | SW | NW | NE | SE | | 1/5 | 1/8 | SW | NW | NE | SE | | NO | YES |
| | | Third | Winter | SW | NW | NE | NE | SE | 1/5 | 1/8 | SW | NW | NE | SE | | NO | YES |
| | | Second | Summer | SW | NW | NE | SE | | 1/5 | 1/8 | SW | NW | NE | SE | | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | | 1/5 | 1/8 | SW | NW | NE | NE | SE | NO | YES |
| | Arken 12 (double-glazed) | Second | Summer | SW | NW | NE | SE | | 1/5 | 1/8 | SW | NW | NE | SE | SE | NO | YES YES |
| | | Third | Winter | SW | NW | NE | SE | | 1/5 | 1/8 | SW | NW | NE | SE | SE | NO | YES |
| | | Second | Summer | SW | NW | NE | SE | | 1/5 | 1/8 | SW | NW | NE | SE | | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | | 1/5 | 1/8 | SW | NW | NE | SE | | NO | YES |
| Dovec | No. 18 (single-glazed) | Second | Summer | SW | NW | NE | SE | | 1/5 | 1/8 | SW | NW | NE | SE | SE | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | | 1/5 | 1/8 | SW | NW | NE | SE | SE | NO | YES |
| | | Second | Summer | SW | NW | NE | SE | | 1/5 | 1/8 | SW | NW | NE | SE | | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | | 1/5 | 1/8 | SW | NW | NE | SE | | NO | YES |
| | Celebi Apt. (double-glazed) | Second | Summer | SW | NW | NE | SE | | 1/5 | 1/8 | SW | NW | NE | SE | | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | | 1/5 | 1/8 | SW | NW | NE | SE | | NO | YES |
| | | Second | Summer | SW | NW | NE | SE | | 1/5 | 1/8 | SW | NW | NE | SE | | NO | YES |
| | | Third | Winter | SW | NW | NE | SE | SE | 1/5 | 1/8 | SW | NW | NE | SE | | NO | YES |

# Appendix N: Summary of windows functional features (ventilation) in living room and bed room

## Living room

| Co. | Apartment building | Floor | Season | Ventilation | | Windows Orientation | | | | Control of the Air leakage and Condensation | | Windows Opening Types |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Uzun | M.Oltan Apt. (single-glazed) | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| | | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| | Emine Apt. (double-glazed) | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| | | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | NE SE | NO | YES | DCO |
| Noyanlar | Arken 14 (single-glazed) | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| | | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| | Arken 12 (double-glazed) | Second | Summer | SS | CV | SW SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| | | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| Dovec | No. 18 (single-glazed) | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| | | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| | Celebi Apt. (double-glazed) | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| | | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |

## Bed room

| Co. | Apartment building | Floor | Season | Ventilation | | Windows Orientation | | | | Control of the Air leakage and Condensation | | Windows Opening Types |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Uzun | M.Oltan Apt. (single-glazed) | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| | | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| | Emine Apt. (double-glazed) | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE SE | NO | YES | DCO |
| | | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE SE | NO | YES | DCO |
| Noyanlar | Arken 14 (single-glazed) | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| | | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| | Arken 12 (double-glazed) | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| | | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| Dovec | No. 18 (single-glazed) | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| | | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| | Celebi Apt. (double-glazed) | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |
| | | Second | Summer | SS | CV | SW | NW | NE | SE | NO | YES | DCO |
| | | Third | Winter | - | - | SW | NW | NE | SE | NO | YES | DCO |