



Ain Shams University
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Department of Architecture

Functional structuring of shape as an economical approach to forming the elements of low income houses

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By Architect

Ayman Mohammed Assem

B.Sc. Architecture - Ain Shams University, 2001

M.Sc. Architecture - Ain Shams University, 2007

Prof. Dr.

Mohammed Ayman Ashour

Professor of Architecture

Faculty of Engineering
Ain Shams University

Prof. Dr.

Muhammad Ibrahim Gabr

Professor of Architecture

Faculty of Engineering
Ain Shams University

**Cairo, Egypt
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STATEMENT

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No Part of this thesis has been submitted for a degree of a qualification at any other university or institute.

Name: Ayman Mohamed Assem Ahmed

Signature:

Date:

BOARD OF EXAMINERS

| <u>Board</u> | <u>Signature</u> |
|--|--|
| <p>Prof. Dr. Robert Hewitt Professor of Landscape Architecture Department of Planning and Landscape Architecture Clemson University</p> |  |
| <p>Prof. Dr. Mohammed Abdel Baki Ibrahim Professor of planning and urban design Department of Planning and urban design Faculty of Engineering Ain Shams University</p> |  |
| <p>Prof. Dr. Mohammed Ayman Ashour Professor of Planning and Architecture Department of Architecture Faculty of Engineering Ain Shams University</p> |  |
| <p>Prof. Dr. Muhammad Ibrahim Gabr Professor of Architecture Department of Architecture Faculty of Engineering Ain Shams University</p> |  |

Date: / / 2011

To My Parents
To My Loving Wife Rania
To My Little Son Mohamed

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ABSTRACT

It is obvious that the housing problem in Egypt is still getting worse despite the abundance of a lot of different housing projects and of large numbers of housing units. Those projects are mostly limited to certain social groups and are usually difficult to reach to truly low-income groups, which makes it a necessity to re-study the economic assessment of housing in all aspects of design and spatial elements of the housing unit itself.

When talking about reducing the cost of housing construction one should note that all solutions have been running in one direction; to reduce the area of a housing unit and introduce the use of low-cost material in the construction. However, the spatial aspect of the house is often overlooked in the process. The relationship between the house and the user's functional and perceptual needs is seldom studied in efficacy.

The main goal of this thesis is to devise a functional evaluation expert system for small dwellings, which are designed for low-income groups in Egypt based on their socio-cultural characteristics.

This thesis investigates the lifestyle of low-income inhabitants in Egypt, in order to explore their socio-cultural characteristics, essential needs, the amount of satisfaction with existing housing and their aspirations for the future housing. Furthermore, it illustrates the points of divergence and convergence between the ways of thinking for the two major participants in creating a residential environment for low-income groups in Egypt: The architect and the user. Thereafter, the functional performance in the internal spaces of low-income houses has been analyzed in order to infer an evaluation criterion for low-income houses based on dwellers' lifestyles and their socio-cultural characteristics. Finally, a functional evaluation expert system has been devised.

By applying this expert system the overall cost of the construction of low-income houses could be controlled through the re-formulation of the house spaces and its elements and reducing the surface area of houses without any negative effects on functional and perceptual properties.

The Research focuses on the spatial elements and the functional use of internal spaces of low-income housing units in Cairo. All external relations are out of the scope of this research such as environmental, contextual aspects, building materials, construction methods and all other economic aspects.

The Research as a whole is divided in three parts; first is the theoretical section which uses the analytical methodology, through carrying out a social survey and studying three real case studies in order to induce the characteristics of low-income dwellers in Cairo. The second part studies the functional analysis of the elements of low-income dwellings. The third part is performed by experimentation, applying a computer system to devise the targeted evaluation system.

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INTRODUCTION

A lot of changes in housing policy in Egypt are currently taking place in order to meet with the needs of different social groups for suitable houses. However we can see a clear inefficacy in these projects that have been implemented, despite the clarity of their objectives and their target group. There are many negative aspects that can be observed in those projects, starting from management and how to select the target groups, all the way to the design of low-income houses and the formulation of their spaces.

Thus it is obvious that the housing problem in Egypt is still getting worse despite the abundance of a lot of different housing projects and of large numbers of housing units. Those projects are mostly limited to certain social groups and are usually difficult to reach to truly low-income groups, which makes it a necessity to re-study the economic assessment of housing in all aspects of design and spatial elements of the housing unit itself.

When discussing how to reduce the cost of housing construction it should be noted that all solutions have been running in one direction; to reduce the area of a housing unit and to use low-cost material in construction. However, the spatial aspect of the house is often overlooked in the process. The relationship between house and the user's functional and perceptual needs is seldom studied in efficacy.

This research studies the low-income house and its spatial properties to determine the possibility of reducing the size of houses in general without causing negative effects on functional and perceptual properties, by studying the lifestyle of the low-income dwellers and how they coexist with the dwelling spaces.

Problem Definition

Specialists in the field of housing have been trying to reduce the cost of houses by reducing the surface area of houses, but they usually ignore many of the spatial relations, which can be summarized as follows:

- The relation between the area of the house and the vital functional areas in its spaces.
- The reciprocal relationship between the physical elements of the house and the socio-cultural characteristics of the dwellers.

Goal of Research

The main goal of this thesis is to devise a functional evaluation expert system for small dwellings which are designed for low-income groups in Egypt based on their socio-cultural characteristics. This expert system is highly recommended to be used in the Design Phase.

Objectives

The research aims to control the overall cost of the construction of low-income houses through the re-formulation of the house spaces and its elements without any negative effects on functional and perceptual properties

Objective 1: Investigate the lifestyle of low-income inhabitants in Egypt, in order to explore their socio-cultural characteristics, essential needs, the amount of satisfaction with existing housing and their aspirations for the future housing.

Objective 2: Illustrate the points of divergence and convergence between the ways of thinking for the two major participants in creating a residential environment for low-income groups in Egypt: The architect and the user.

Objective 3: Analyze functional performance in the internal spaces of low-income houses based on dwellers' lifestyle.

Objective 4: Infer an evaluation criterion for low-income houses based on dwellers' lifestyles and their socio-cultural characteristics.

Objective 5: Devise a functional evaluation expert system based on dwellers' socio-cultural characteristics

Research Hypothesis

There is a deficiency in the understanding of the nature of design elements of low-income houses and their vocabulary as applied in previous housing projects: A more efficient approach is to control the cost of house construction based on the lifestyle of low-income families and their socio-cultural characteristics.

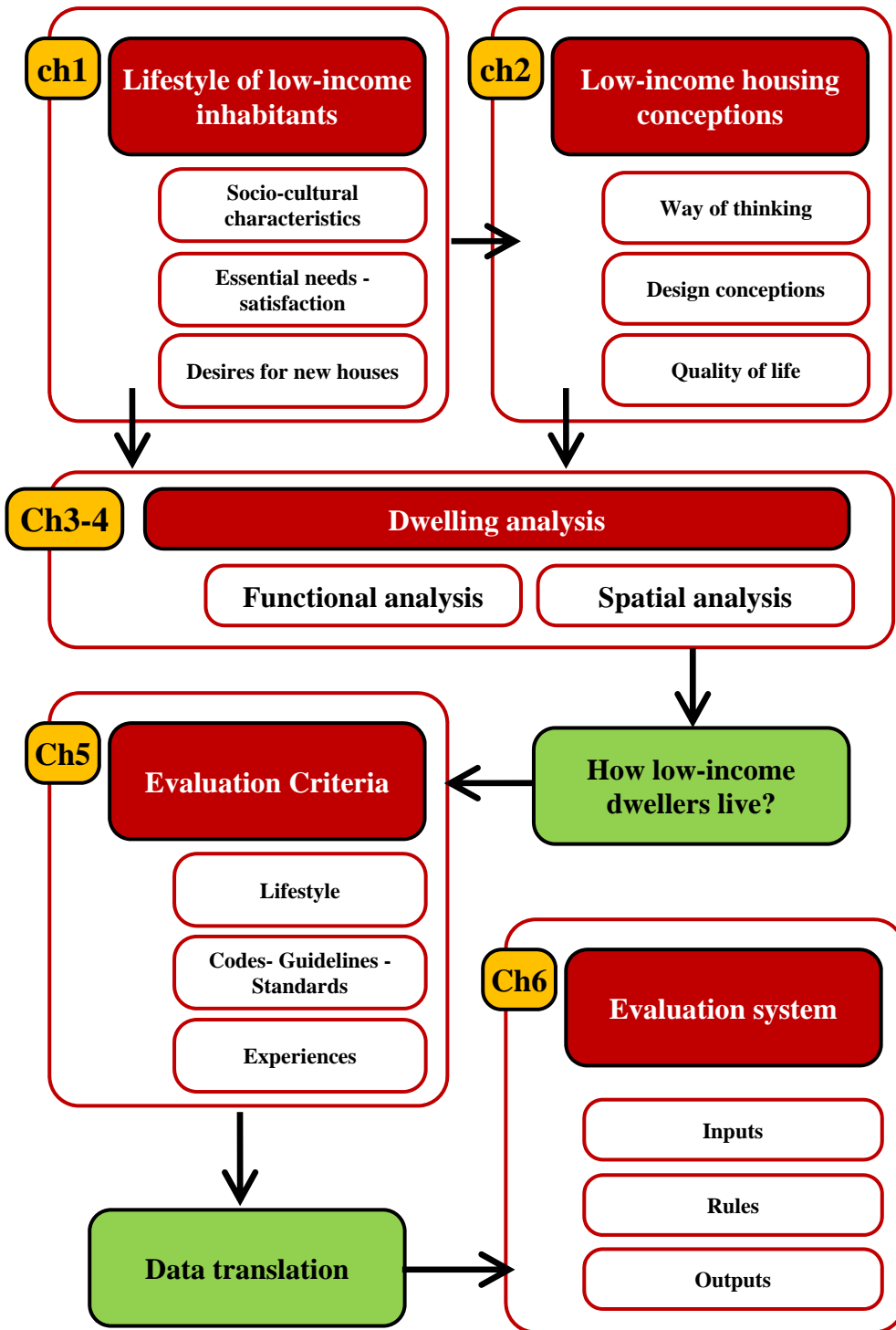
Scope & Limitations of Research

The research will focus on the spatial elements and the functional use of internal spaces of low-income housing units in urban communities in Cairo. All external relations are out of the scope of this research such as environmental, contextual aspects, building materials, construction methods and all other economic aspects.

Furthermore, the research focuses on the organized mass housing built by the governmental and cooperative organizations.

Methodology

The Research as a whole is divided in three parts; first is the theoretical section which uses the analytical methodology, through carrying out a social survey and studying three real case studies in order to induce the characteristics of low-income dwellers in Cairo. The second part studies the functional analysis of the elements of low-income dwellings. The third part is performed by experimentation, applying a computer system to devise the targeted evaluation system.



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Part 1: Low income housing between local and foreign conceptions

This Part consists of two chapters. The first chapter concerns the socio-cultural characteristics of low-income dwellers in urban communities in Cairo. The second chapter demonstrates the relation between housing design and dwellers' needs

Chapter 1: Low-income housing characteristics according to local aspects

Preface

This chapter is concerned with the main characteristics of low-income houses in Cairo and how the residents deal with house spaces. It also describes the lifestyle of low-income groups and how they live in their small houses and how they meet their needs.

To incorporate how low-income families live with the process, it is necessary to perform a field study, to know in detail how they perform the basic activities, and what is essential and what is not. For this reason, this chapter centers around a field study questionnaire, interviews with case studies and observation, in addition to previous researches which had described the middle class in Egypt and its lifestyle.

1.1 Social stratification

In the majority of residential communities, there is a clear caste of discrimination among individuals depending on the social role that each one of them plays. This role is evaluated according to their importance to society, which leads to discrimination of some groups that play an important role among the others.

There are great debates among sociologists on stratification theories. Some theorists stratify the community in two major social classes, the rich class and the poor class. Earlier sociologists however stratify the community into three classes, the upper class, the middle class and the lower class. More recent theorists go up to as many as nine classes (with sub-classes included). Yet the approach by sociologist Lloyd Warner may have been the most realistic, since his social stratification was based more upon social attitudes than upon the actual amount of money owned by individuals of different class.¹

1.1.1 Warner's Stratification

Based on the works of social anthropologists, Warner stratifies the community into three classes (upper, middle, and lower), then further subdivided each of these into an "upper" and "lower" segment, with the following postulates:

- **Upper-Upper Class.** This class includes the people who have been born into and raised with wealth; it mostly consists of prestigious families. This class is also known as "Old money."

¹ د.حسين عبد الحميد أحمد رشوان. الطبقات الاجتماعية والمجتمع - دراسة في علم الاجتماع. الإسكندرية: مؤسسة شباب الجامعة، 2008

- **Lower-Upper Class.** This class includes the Individuals who have become rich within their own lifetimes (e.g., entrepreneurs, movie stars, top athletes, as well as some prominent professionals). This class is also known as "New money."
- **Upper-Middle Class.** This class includes the professionals with a college education, and more often with postgraduate degrees like Ph.D.s, MSs, etc. (e.g., doctors, engineers, dentists, lawyers, bankers, etc.).
- **Lower-Middle Class.** This class includes workers, but not manual laborers. They often hold Associates or Bachelor degrees. (e.g., primary and high school teachers, accountants, nurses, office workers and low to mid-level civil servants, technicians, small business owners).
- **Upper-Lower Class.** This class includes the workers and manual laborers. It is also known as the "working class."
- **Lower-Lower Class.** This class includes the homeless and permanently unemployed. It is also known as "working poor."²

1.1.2 Stratification in Egypt

In the fourteenth century, the Egyptian society was stratified by the famous historian El-Maqrizi into seven classes, with the following postulates:

- **First class:** includes the statesmen and government workers.
- **Second class:** includes the renowned traders.
- **Third class:** includes the majority of small traders.
- **Fourth class:** includes farmers and villagers.
- **Fifth class:** includes scientists, scholars and learners.
- **Sixth class:** includes all other workers and craftsmen.
- **Seventh class:** includes poor people and destitute.

This stratification depended on the actual income and possession of money of each class. Therefore, each class had its distinctive properties.

² Ibid.

In the nineteenth century, “Klut bay” stratified the Egyptian society into four classes based on social role and the impact of this role. The first class of this stratification included the scientists and scholars, because they work on the progress and elevation of their nation. The second class included the big traders and wealth owners. The third class included the workers, manual laborers, craftsmen and servants, and the fourth class included farmers and villagers. This class represents most of the public.³

After the 1952 revolution, stratification of the Egyptian society went through a significant change, as the emergence of what is now known as the middle class began. In this context, sociologist Dr. Abelazim Ramadan re-stratified the society into five classes, with the following postulates:

- First class includes prominent cultivated land owners.
- Second class includes the prominent capitalists.
- Third class represents the middle class.
- Fourth class includes farmers.
- Fifth class includes agricultural workers.⁴

1.1.3 Middle class in Egypt

The middle class in Egypt is a very complex and sophisticated class. It includes different and incoherent social groups. This class is characterized by flexibility where individuals can easily move up and down within it.

This class consists of two main sectors, an urban sector and another rural sector. This confirms the complexity of this class, which includes mixed and inhomogeneous groups, working in disproportionate work fields. The individuals that belong to this class generally have different socio-cultural properties and have relatively less commitment to prevailing traditions and customs.⁵

1.1.3.1 Middle class in Egypt before 1952 revolution:

Before the 1952 revolution, the middle class in the Egyptian society was very limited in size. According to the income

³ Ibid

⁴ Ibid

⁵ Ibid

distribution study performed by the British government in 1955, the middle class formed no more than 19% of the whole society.

The majority of the population at the time though was stratified in the lower class, which had been estimated at 80% as a percentage to the whole society. The upper class, on the other hand, was very limited, which was estimated at 1% of the whole society.

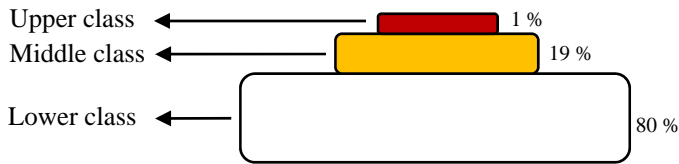


Figure 1: Stratification in Egypt before 1952 revolution

This inequality between classes was explained by the concentration of the income for the upper class. According to social theorists, this led to antithesis between the society classes in wealth and size percentage.

1.1.3.2 Middle class in Egypt after 1952 revolution:

After the 1952 revolution, the middle class in the Egyptian society expanded. Thus, according to the income survey done by the Egyptian government 1986, the middle class was found to constitute about 45% of the whole society.⁶

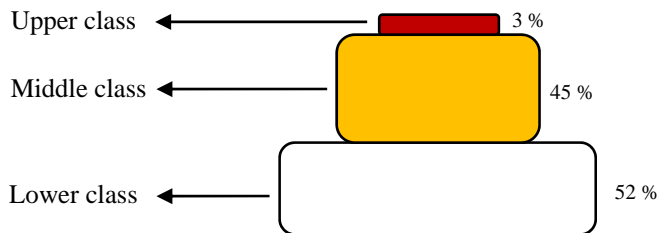


Figure 2: Stratification in Egypt after 1952 revolution

This growth was a result of the transformation in the Egyptian economic policy and the adoption of the 'opening-up' policy.

Despite the considerable increase in the income of individuals, this rapid social mobility motivated individuals that belong to the

⁶ د. جلال أمين. ماذا حدث للمصريين؟ تطور المجتمع المصري في نصف قرن. القاهرة: دار الشروق، 2005.

lower and the middle classes, grow an excessive desire to move-up to the upper class with no regard to legitimate sources of wealth, or how to earn it legally.⁷

1.1.4 Low income groups in Egypt

There are two main criteria that explain the properties of a low-income group.

The first criterion is the actual family income. Most of the low-income people fall below the poverty line or occasionally fall a little above the poverty line.

The second criterion is based on the social and cultural properties of the groups and includes marginal workers and non-regular employees as well as a wide sector of government staff.⁸

The low-income group in Egypt often belongs to both the lower middle class and the upper lower class. Even so, the majority of low-income families in the current time belong to the middle class which appears to be moving toward the lower class.

Demographers reckon that at least three-quarters of Egyptians actually live in urban areas. Census figures show that four in five people inhabit flats rather than houses. Those flats tend to be tiny. The 2007 census shows that there are fewer rooms than people. Families often share beds in shifts.⁹

Hence, the low-income group clearly needs support and assistance in finding a suitable housing environment.

1.2 The Egyptian family

In general, the family is considered the primary social institution in the society. It has a very important role in achieving personal satisfaction to each member of the family.

The family has a pivotal role in the socialization of its members in terms of observing and maintaining customs and traditions and adherence to religious beliefs among its members. Furthermore, the family is the first bulwark in preventing delinquency and deviation of its members,

⁷ Ibid

⁸ (12 3, 2005). تحقيقات: 40 مليون مواطن من محدودوي الدخل. Retrieved 11 22, 2010, from <http://www.ahram.org.eg/Archive/2005/3/12/INVE3.HTM>

⁹ "The Economist." A special report on Egypt, No paradise, Most Egyptians put up with a lot. 07 15, 2010. <http://www.economist.com/node/16564152/print> (accessed 07 20, 2010).

and has a great role in evaluating delinquents, and guiding them to the right way. Therefore, giving a special attention to the family is very essential to maintaining the cohesion of society.¹⁰

1.2.1 Family types according to social role

The main objective of any family is the production, enculturation and socialization of children. Thus, the family plays a primary social role in growth and continuation of the community. In this sense, there are two consecutive type of the family according to the social role it plays.

- **Family of orientation:** Producing a person, both physically and socially is one of the primary functions of the family. So from the perspective of socializing children, the family is a family of orientation.
- **Family of procreation:** This family includes only the husband, the wife, and unmarried children who are not of age. The most common form of this family is regularly referred to in sociology as a nuclear family.¹¹

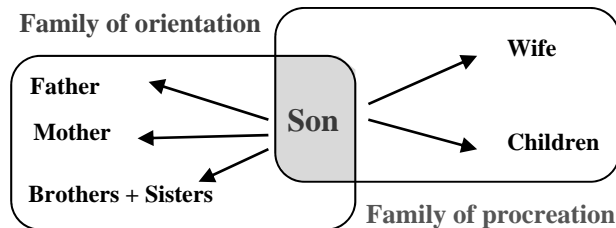


Figure 3: The relation between family of procreation and family of orientation

1.2.2 Family types according to family size

There are two family types, classified according to their relationship to other social institutions. The first type is the nuclear family or the conjugal family, where there is a slight difference between those two terms. The other type is the extended family.

Those types are explained as follows.

- **Conjugal Family:** This family consists of the husband, the wife and their children. This family is considered the primary unit, and

¹⁰ د. سناء الخولي. الأسرة والحياة العائلية. الاسكندرية: دار المعرفة الجامعية, 2009

¹¹ Ibid

it is financially independent where the husband usually is responsible for meeting all family needs.

- **Nuclear Family:** The term "nuclear family" is commonly used. This family is similar to the conjugal family. The only difference is in the probability of living for any of family relatives with the nuclear family.
- **Extended family:** This family was the common family type in the past decades in Egypt. It consists of many nuclear families. It is also known as joint family or consanguine family; however, this type is very limited in current days, because of the transformation of the mainstream social activity of economic production from agriculture to industry.¹²

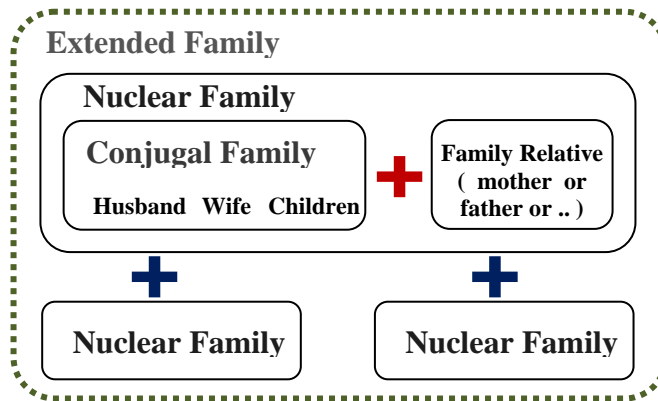


Figure 4: Family types according to its size

The evidence from most of the social field studies emphasizes that the nuclear family type is widespread among the low-income families in urban communities.¹³

According to the results of the social survey of the governmental (social) housing in Zinhom district which had been accomplished in 1999, 84.2% of the district families were found to belong to nuclear family type. On the contrary, the extended family is not a common type, and it was estimated at 10.2%¹⁴

¹² Ibid

¹³ د محمد احمد بيومي - د عفاف عبد العليم ناصر. علم الاجتماع العائلي. الإسكندرية: دار المعرفة الجامعية, 2009

¹⁴ د سهير لطفي - د محمود الكردي - آخرون. المسح الاجتماعي الاقتصادي لمنطقة إيواء زينهم. القاهرة: المركز القومي للبحوث الاجتماعية والجنائية - برنامج بحوث العشوائيات في المجتمع المصري, 1999

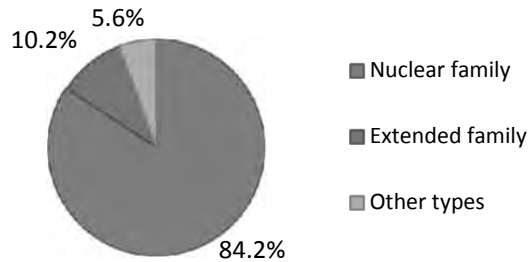


Figure 5: Pie chart showing the distribution of family types in Zinhom district.

Hence, the nuclear family type is the regular and widespread type in urban communities in Egypt. On the other hand, it is recommended to study the family type in the other distinct communities in Egypt, which have different and various socio-cultural characteristics that dependency influence the type of the proposed housing.

1.2.3 Rule of residence

In social anthropology, starting a new life and creating a nuclear family requires people to select a new adequate house. In Egypt, there are four residence types as classified according to location and distance between the new house and the original family house. This concept of house location is known as the 'rule of residence'.

This rule classifies the new residence into four types as follows:

- a- **Patrilocal:** This type was the most common in the Egyptian society, during the past decades especially in the rural sector, where the wife moves to live with the husband family house.
- b- **Matrilocal:** This type is very special and not common in the Egyptian society, where the husband moves to live in the wife family house. This special type might take place if the wife family is wealthy and has a distinguished status.
- c- **Biocal:** In this type, the new nuclear family moves to live in a new house but it must be as close as possible to the family of orientation (the original family).
- d- **Neocal:** In this type the new nuclear family moves to live in a new house and it is not obligatory to be close to the family of orientation (the original family). This type of residence is the common type in the present time in both sectors, the rural and

urban sectors, which confirms the independence of the new nuclear family from the original orientation family.

In some cases, one of the family relatives would live with the nuclear family, it is often to be one of the husband relatives, because the husband is usually responsible for his parents in our Egyptian society.¹⁵

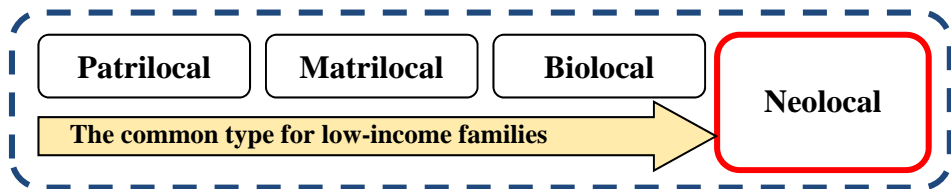


Figure 6: Rule of residence and the common type for low-income families

Hence through what is mentioned in the preceding paragraphs, it is obvious that the majority of low-income families in Egypt belong to the Neolocal type, especially in urban communities.

1.2.4 Structure and size of low-income family

The size of low-income families depends on the socio-cultural properties of the nurturing environment of family members.

The evidence from most social field studies emphasizes the variation in family size between rural and urban communities. Thus, the average size of low-income families in urban communities is about five persons.¹⁶

The family size has changed throughout the last two decades, specifically in the urban sector. The transformation of the family types from extended to nuclear is considered the main reason for this change in family size.

Hence, it is quite necessary to have an expectation of the new nuclear families' desire for their family size. Therefore, many field studies have been performed to establish the expected family size and the desired number of kids.

The evidence from most social field studies indicates that the majority of the new nuclear families prefer to have two or three kids.¹⁷

¹⁵ د. سناء الخولي. الأسرة والحياة العائلية. الإسكندرية: دار المعرفة الجامعية, 2009.

¹⁶ د. محمد أحمد بيومي - د. عفاف عبد العليم ناصر. علم الاجتماع العائلي. الإسكندرية: دار المعرفة الجامعية, 2009.

¹⁷ Ibid

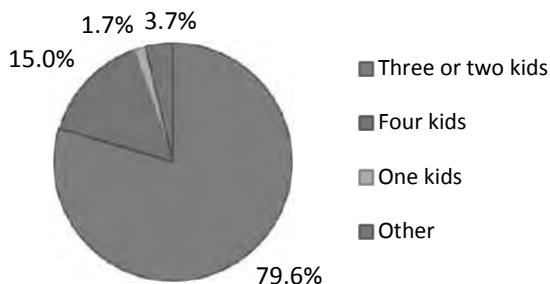


Figure 7: Pie chart showing the preferred number of kids for new families in urban communities.

Therefore, low-income families who live in urban communities consist of four or five members in average. However, according to probability theory, there are seven expected structures for the new families with the following postulates:

| | | | | | |
|---|--------|--------|------------|------------|------------|
| 1 | Father | Mother | Son 1 | Daughter 1 | |
| 2 | Father | Mother | Son 1 | Son 2 | |
| 3 | Father | Mother | Daughter 1 | Daughter 2 | |
| 4 | Father | Mother | Son 1 | Daughter 1 | Daughter 2 |
| 5 | Father | Mother | Son 1 | Son 2 | Daughter 1 |
| 6 | Father | Mother | Son 1 | Son 2 | Son 3 |
| 7 | Father | Mother | Daughter 1 | Daughter 2 | Daughter 3 |

Table 1: This table shows the seven expected structures for the new families

As a conclusion from the previous table (table 1), the family may find a greater problem in three particular cases from the seven probabilities. Where the default house designed for social housing (governmental housing – cooperative housing) consists of three habitable rooms (two bed rooms and living room)¹⁸.

However, the family may need another sleeping space, especially when they decide to separate between boys and girls according to their religious beliefs.

¹⁸ د سهير لطفى - د محمود الكردي - آخرون. المسح الاجتماعي الاقتصادي لمنطقة إيواء زينهم. القاهرة: المركز القومي للبحوث الاجتماعية والجنائية - برنامج بحوث العشوائيات في المجتمع المصري، 1999

1.3 Housing according to Islamic beliefs

This part illustrates the socio-cultural characteristics according to the Islamic customs and its influence in forming people lifestyle.

In Islamic culture, the debate of purchasing a small or a big house is argued according to the conception of extravagance. However, providing an appropriate and comfortable home for low-income people is considered the overriding goal.

1.3.1 Islamic rulings in housing design

Based on Islamic beliefs and what the Prophet Mohamad (peace and blessings of Allah be upon him) said in many occasions, a spacious house is considered a part of the Muslim's happiness. Thus, it says in the hadeeth narrated by Ahmad from Naafi' ibn 'Abd al-Haarith (may Allah be pleased with him) who said: The Messenger of Allah (peace and blessings of Allah be upon him) said: *"Part of a man's happiness includes a good neighbour, a comfortable mount, and a spacious abode."*

In other hadeeth the Prophet (peace and blessings of Allah be upon him) said: *"Four things are part of happiness: a righteous wife, a spacious abode, a good neighbour and a comfortable mount. And four things are part of misery: a bad wife, a bad neighbour, a bad mount and a small abode."*

Hence, a spacious house is a part of worldly happiness, not spiritual happiness. Thus, the one who is blessed with goodness in the things mentioned will have a good life, and may be happy in his life, because these are things which give comfort to the body and heart, and make life more comfortable.¹⁹

1.3.2 The debate of small and big house in Islamic culture

Accordingly, a small house is not a goal in itself but making an adequate home avoiding extravagance is the main objective.

Al-Manaawi (may Allah have mercy on him) said: "a spacious home" means: it is very comfortable for its inhabitants, in which case its spaciousness varies from one person to another, because what is spacious for one may be small for another, and vice versa.

Extravagance is that which oversteps the limit. Allah (praise be), has stated in His Book that He does not love the extravagant. Although,

¹⁹ Islam QA: <http://www.islam-qa.com/en/ref/120807> (accessed 01 20, 2011).

extravagance is overstepping the limit, it is not absolute in its definition, and its limits should be defined in each case separately.

Hence, purchasing a spacious house may be extravagance in the case of one person, but not in the case of another (according to their wealth and stature).²⁰

So while spaciousness of a house is basically a question of perception, extravagance is a question of relative estimates and it is different from one to another.

1.3.3 Separating between boys and girls in Islamic culture

Al-Daaraqutni and al-Haakim narrated from Sabrah ibn Ma'bad that the Prophet (peace and blessings of Allah be upon him) said: *“When your children reach the age of seven years, separate their beds and when they reach the age of ten, smack them if they do not pray.”* This hadeeth was classed as saheeh by al-Albaani in Saheeh al-Jaami’

Separating between siblings in their beds means two things: giving them each a separate bed, or letting them sleep in one bed, but apart from each other and not touching one another. In principle, the latter should be sufficient because there is no evidence to suggest that the hadeeth should be interpreted in the first way only.

When the siblings reach the age of ten years, whether they are male or female, or both male and female, their guardian should separate them in their beds and give each one of them a bed of his or her own, because the Prophet (peace and blessings of Allah be upon him) said: *“And separate them in their beds”*.

Another interpretation for the hadeeth was adopted by Ibn Muflih (may Allah have mercy on him) who said that A boy who reaches the age of ten should be prevented from sleeping naked with his sister or any other mahram. This was mentioned in al-Mustaw'ab and al-Ri'aayah.

Accordingly, siblings can sleep in the same room on a separate bed for each one; however, avoiding sleeping in the same room is better for one who can manage to do so.²¹

²⁰ Islam QA: <http://www.islam-qa.com/en/ref/101903> (accessed 01 20, 2011).

²¹ Islam QA: <http://www.islam-qa.com/en/ref/78833> (accessed 02 25, 2011).

1.4 Life style of low-income inhabitants

After the definition of low-income groups and their socio-cultural properties, this part of the chapter describes the lifestyle of low-income inhabitants.

The home is often imagined as a site for creating and displaying a lifestyle where people use their homes to construct and display a distinctive lifestyle and identity²²

To induce how Egyptian low-income families live, it is necessary to undertake a real social survey, and to study some family cases living in social housing. Therefore, a social survey was performed by the researcher for this end. Survey questions were asked to a sample of the low-income group who live in social housing (government housing – cooperative housing) and the results are displayed in the following sections.²³

1.4.1 Daily routine of the family members

Induction of the daily routine of the low-income family members, gives a clear vision of their basic needs in housing spaces. Furthermore, it reveals shortage of spaces and imbalance in home space uses.

According to the social survey, the daily routine can be described as follows:

1.4.1.1 Official working hours

Official working days in ministries, government facilities, public bodies, and local administrative units are five days a week (Sunday to Thursday).

Official working hours amount to thirty five hours per week. However, each competent authority is authorized to schedule attendance according to its needs.²⁴

1.4.1.2 Sleeping period

Low-income family members usually sleep for about seven or eight hours daily. Children may sleep more than eight hours, especially during

²² Joanne Hollows. *Domestic Culture*. New York: McGraw-Hill, 2008.

²³ For more details about the social survey and the statistical analysis, see (appendix 1)

²⁴ Egypt's information portal- Official Working Hours.

<http://www.eip.gov.eg/AboutEgypt/WorkingHours.aspx> (accessed 11 12, 2010).

the summer vacation. This sleeping period may increase on weekends and holidays.

1.4.1.3 Eating periods

Low-income families have three meals daily. Lunch is the main meal, where all family members gather to eat. And it lasts for about one hour daily. The other two meals, the breakfast and the dinner take about half an hour each one.

1.4.1.4 Cooking period

The mother spends about three hours in preparing daily meals, two hours in preparing the lunch and half an hour for each of the other meals.

1.4.1.5 Entertainment activities

Low-income family members spend about five hours daily in watching the television and using the telephone.

1.4.1.6 Studying period

The children usually study and do their homework for about four hours daily. This studying period may be increased at exam seasons

1.4.1.7 Playing period

The children usually play for about six hours daily. This playing period may be increased on weekends, holidays and summer vacation.

1.4.1.8 Laundering period

The mother spends about four hours weekly in laundering and washing clothes.

1.4.1.9 Praying period

Low-income family members spend about one hour daily in praying the five daily prayers.

1.4.1.10 Other activities

Other occasional activities like reading, cleaning home and ironing cannot be estimated

1.4.1.11 Regular daily routine schedule of low-income groups in Egypt

According to the previous description for the daily activities which are usually performed by all low-income family members, a common daily routine schedule can be plotted for each member. This schedule gives a clear indication about low-income lifestyle and how they perform their essential activities in the available spaces.

Table 2: A common daily routine schedule for low-income family members

| hr | Daily Routine / Member / Essential activities | | | | | | | | | | | | | | | | | | | | | | | |
|----|---|---|---|---------|---|---|--------|---|---|----------|---|---|------------|---|---|---------|---|---|--------------|---|---|----------|---|---|
| | F | M | S | F | M | S | F | M | S | F | M | S | F | M | S | F | M | S | F | M | S | F | M | S |
| | Working | | | Cooking | | | Eating | | | Studying | | | WatchingTV | | | Praying | | | Playing / pc | | | Sleeping | | |
| 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | | | | | | | | | | |
| 23 | | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | | | | | | | | | | | | | |

The table above demonstrates the common daily routine of low-income family members in urban communities; this table was inferred from the social questionnaire and the analysis of the case studies which were carried out by the researcher. The top row refers to the members of the family; (F-M) refers to the family parent (Father- Mother) and (S) refers to the children. The first column refers to the day hours.

1.4.2 Family members Coherence

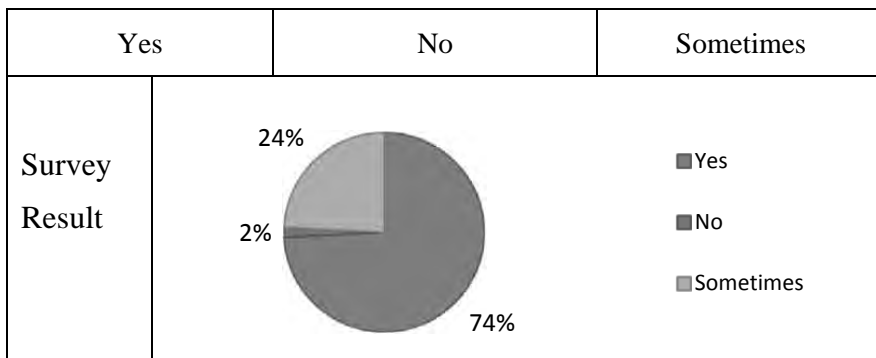
Family coherence is considered one of the main objectives for nurturing the family members. Thus, preserving the family coherence is the first step in preserving the community coherence at large.

1.4.2.1 Eating together

Gathering all family members for eating their daily meals is considered a clear social indicator for the coherence of the family. Therefore, the following question was asked to the members of low-income families.

Question objective: Evaluating family coherence

Question: Do all family members gather to eat?



Conclusion: most of low-income families still eat together; hence, the family is generally still coherent.



Figure 8: Eating together is one of the sacred traditions that cannot be dispensed with – Ref:
<http://goodbrain.maktoobblog.com/505/>

1.4.3 Hosting guests and strangers

There is a remarkable ongoing change in the relations between people in our nation. Hosting other relatives in Egyptian homes rarely occurs nowadays. Some families, though, may host their relatives once weekly.

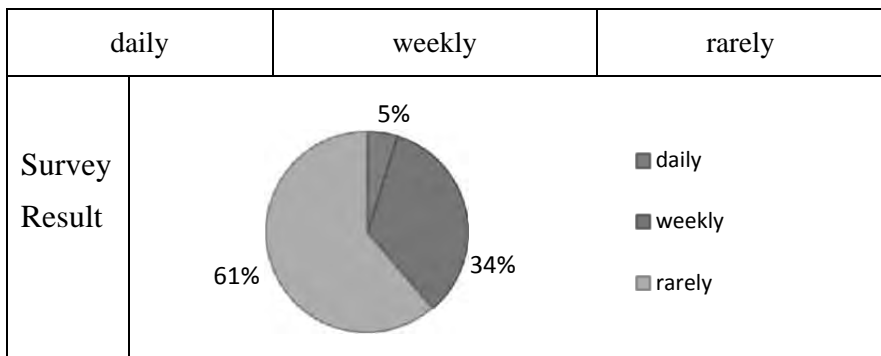
According to the social survey, the relation between the families and their relatives can be described as follows.

1.4.3.1 Rate of hosting guests

The following question investigates the rate of hosting guests per unit time.

Question objective: To determine the need for a specific space to host guests

Question: How often do you receive guests?



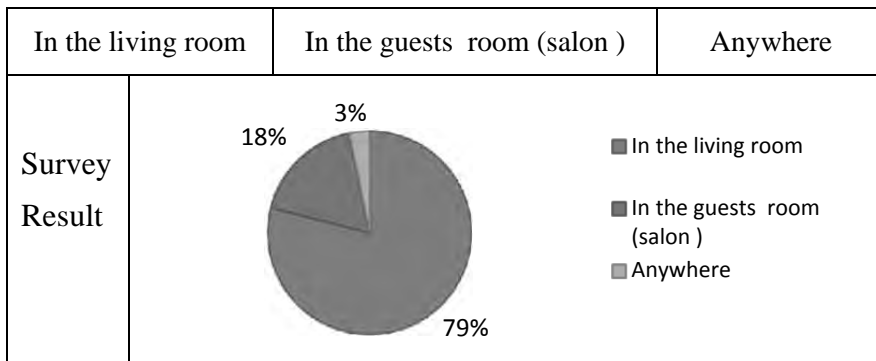
Conclusion: the majority of low-income families rarely host guests, and there is no need to have a specific place as a guest room.

1.4.3.2 Place of hosting guests

According to the social survey, the following question seeks to learn about the place (in the house) where the family usually receives their guests and if there is an inevitable need to provide a separate guest room.

Question objective: Identifying the place which is considered semi private where the family always receives guests.

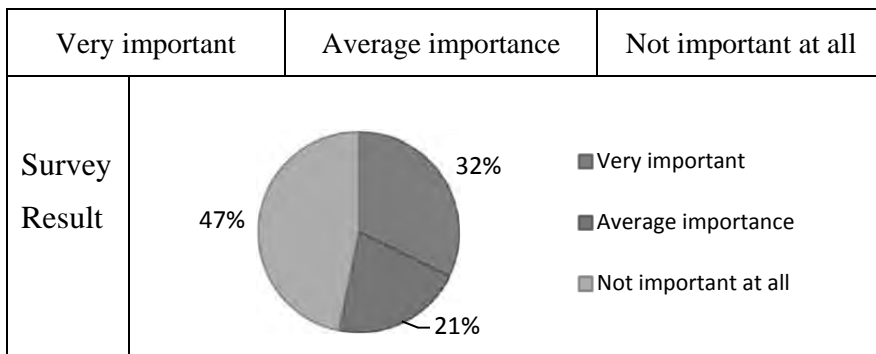
Question: Where do you host your guests?



Conclusion: most of the families receive their guests in the living room

Question objective: determining the importance of the guest room

Question: Do you find that the guest room (Salon) to be an important room in the new house?



Conclusion: most of the families think that having a separate guest room is not important at all.



Figure 9: Low-income families always host guests in the living room – a photo from Madinet Elmostakbal – New Cairo

It is concluded from the previous questions that the majority of low-income families rarely host guests, and there is no need to have a separate guest room and they usually receive their guests in the living room.

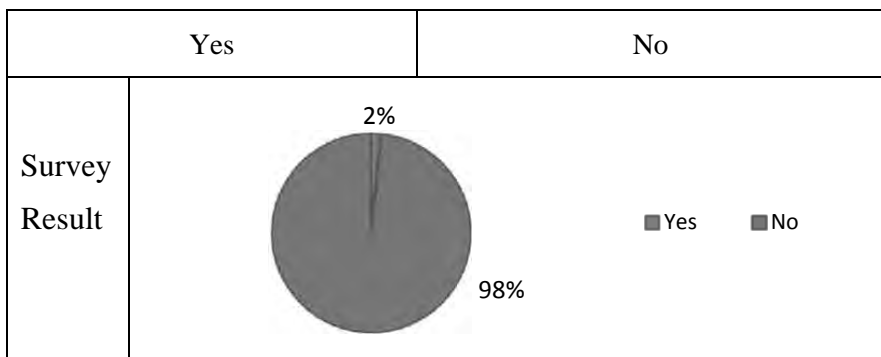
1.4.4 Performing external profitable works

The evidence from numerous social field studies shows that only 10% of low-income families use their home spaces in performing a profitable work. On the contrary, most of the low-income families never use their home spaces in performing other jobs besides their original occupations.²⁵

In the social survey undertaken by the researcher, some questions were asked to the selected sample of the low-income group to induce the use of home spaces for any external profitable work, and the following table shows the results.

Question objective: to determine the spaces in the house used for unexpected activity

Question: Do you perform any Profitable work in your home?



Conclusion: Low-income families use home spaces in performing only the ordinary activities and they do not need any specified spaces to perform any other external work.

²⁵ د سهير لطفى - د محمود الكردي - آخرون. المسح الاجتماعي الاقتصادي لمنطقة إيواء زينهم. القاهرة: المركز القومي للبحوث الاجتماعية والجنائية - برنامج بحوث العشوائيات في المجتمع المصري. 1999

In the current time, there is no profitable work being undertaken in the dwelling because of the lifestyle of low-income dwellers and their socio-cultural characteristics, however, there is an inevitable need to encourage carrying out small profitable works in the dwelling in order to improve their standard of living and encouraging small projects that help the prosperity of the national economy in general.

1.5 Coexistence with the existing housing spaces

Low-income family members usually perform their desired activities using the available furniture and equipments as follows.

1.5.1 Existing furniture and electrical appliances

The existing furniture and appliances are the primary method to perform all necessary activities, which usually occupy a huge space in the habitable room.

1.5.1.1 Existing electrical appliances:

According to the report published by the Egyptian cabinet – information and decision support center (The first year - Issue 1 - January 2007), there is a noticeable increase in owning electrical appliances by low-income families, thus, about 92.8% have a TV set. 94.4% of families who live on urban communities have a refrigerator. 59.2% have a water heater, and about 96.4% of families have a washing machine.²⁶

The social survey accomplished by the researcher results comply with the previous report that low-income families own various kinds of electrical appliances.

The following chart shows the distribution percentage of used electrical appliances in low-income houses.

26 تقارير معلوماتية - مستوى معيشة الأسرة المصرية هل تغير خلال السنوات العشر الماضية؟. القاهرة: مركز المعلومات ودعم اتخاذ القرار - مجلس الوزراء، يناير 2007

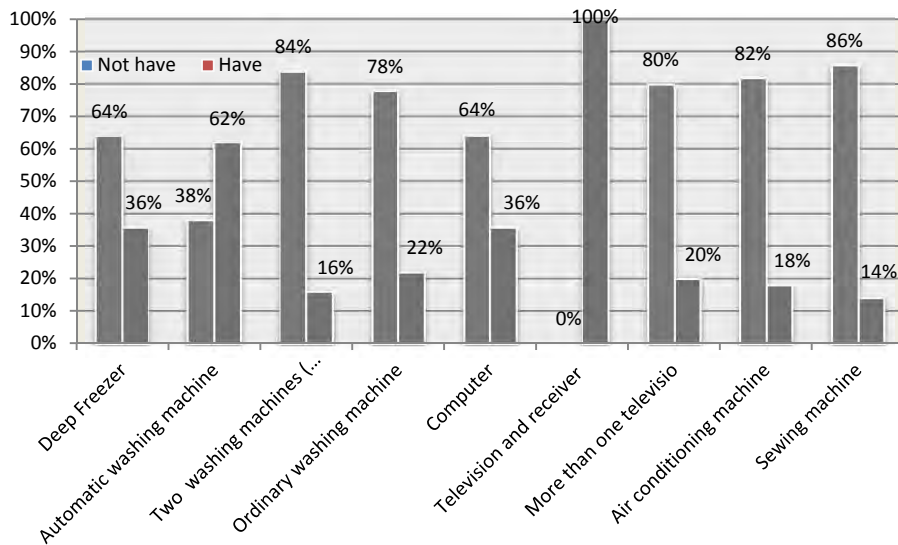


Figure 10: Column chart showing the distribution percentage of used electrical appliances

As a result from the previous chart, all low-income families have a TV set and a satellite receiver. 62% have an automatic washing machine, and about 36% of the families have a personal computer and a deep freezer. Therefore, the designer should take into account the spatial needs for those appliances in order to provide the optimum and ideal use of them avoiding waste of space.



Figure 11: 36% of the families have a computer and a deep freezer.



Figure 12: 100% of low-income families have a television

1.5.1.2 Existing furniture:

The majority of low-income families don't have a dining table or guest room (salon), and they usually eat their meals on a movable or folding table.

Living Room Furniture was found to be used in performing several activities like eating, reading, watching television, hosting guests and sometimes sleeping.



Figure 13: the main living room furniture



Figure 14: the folding table used for eating



Figure 15: the master bed room



Figure 16: the other bed room includes a bunk bed

1.5.1.3 Existing fixtures:

The majority of existing low-income houses have bathrooms equipped with toilet, hand-basin and shower. The following pictures demonstrate these fixtures.



Figure 17: example for bathroom fixtures



Figure 18: example for bathroom fixtures

1.5.2 Spatial relations between dwelling spaces

Low-income families think that not only the optimum use of space is the desired goal in furnishing their home, but also avoiding hurting the privacy of home space should be taken into account.

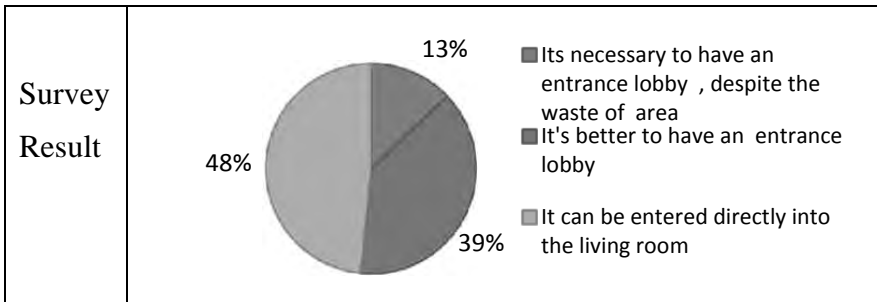
1.5.2.1 The transitional relation between the entrance and the dwelling:

According to the results of the social survey; low-income families have been asked the following question in order to clarify the importance of the entrance lobby, and if it is possible to dispense with it to increase the area of living spaces.

Question objective: determining the importance of the entrance lobby and explore the possibility of dispensing it

Question: Do you find it necessary to have an entrance lobby or you can be entering directly into the living room?

| | | |
|--|---------------------------------------|---|
| It is necessary to have an entrance lobby, despite the waste of area | It's better to have an entrance lobby | It can be entered directly into the living room |
|--|---------------------------------------|---|



Conclusion: few of low-income families think that It is necessary to have an entrance lobby, however, a considerable percentage of them find that it is better to have an entrance lobby in order to avoid hurting the privacy of the dwelling space.

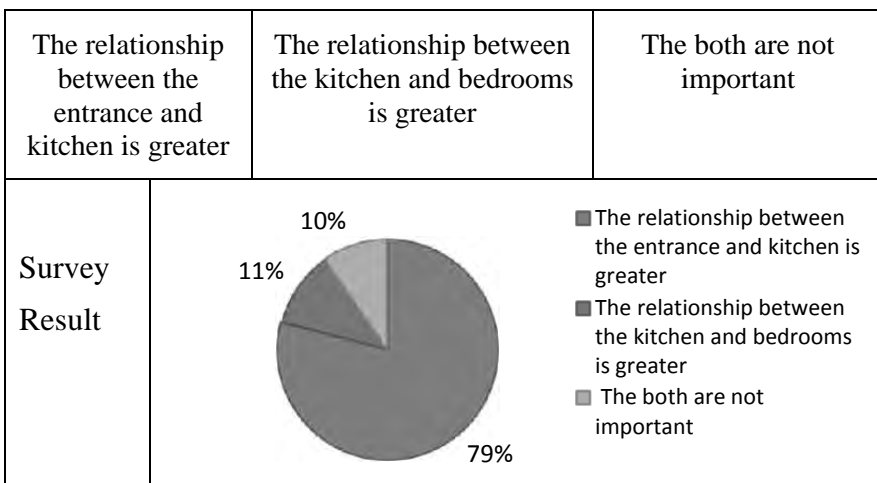
1.5.2.2 The correlation between dwelling spaces:

There are two spatial relations that low-income families may have dissimilar views in deciding them; first is the relation between the kitchen and other dwelling spaces, second is the relation between the balcony and other living spaces.

a. The relation between the kitchen and the other dwelling spaces:

Question objective: determining the desired relation between the kitchen and other dwelling spaces.

Question: Do you find that there is an important relationship between the entrance and kitchen? Or the relationship between the kitchen and bedrooms is greater?

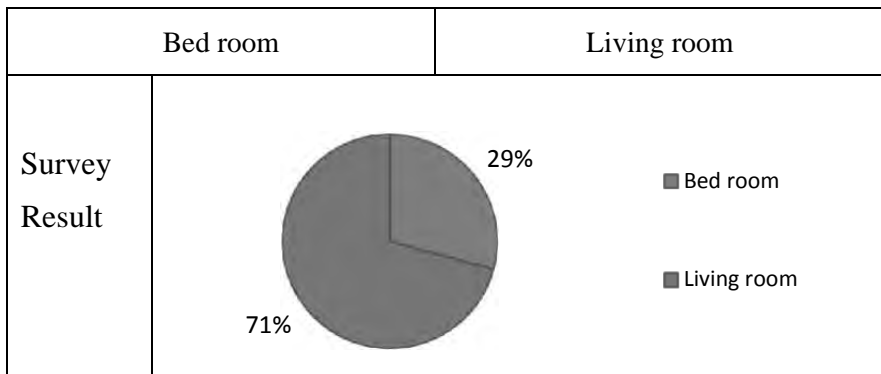


Conclusion: most of the families think that the relationship between the entrance and the kitchen is greater than one between the kitchen and bedrooms. This relation should be taken into account in the design of the new low-income dwelling.

b. The relation between the balcony and the other dwelling spaces:

Question objective: determining the relation between the balcony and the other living spaces

Question: Do you prefer the balcony to be connected to the bedroom or living room?



Conclusion: most of the low-income families prefer to connect the balcony to the living room in order to make it accessible to all members without hurting the zone of sleeping.

1.5.3 Usage of house spaces

Evaluating the quality of spaces in low income houses, it was found to depend on how family members use those spaces including the furniture, fixtures and appliances.

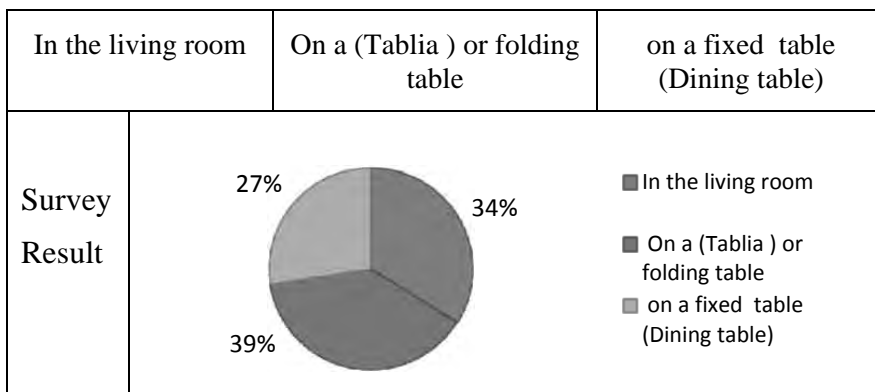
1.5.3.1 Living spaces:

The Living space is considered the main space in the low-income house. All family members spend long times performing various activities there.

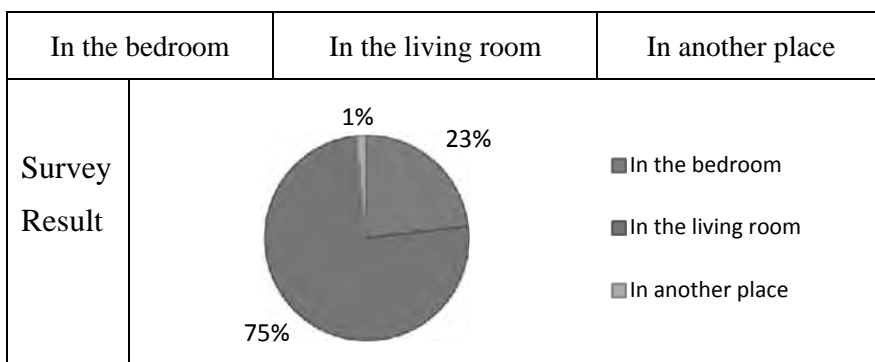
The following question seeks to define the activities that take place in the living space.

Questions objectives: to determine the performed activities in living space.

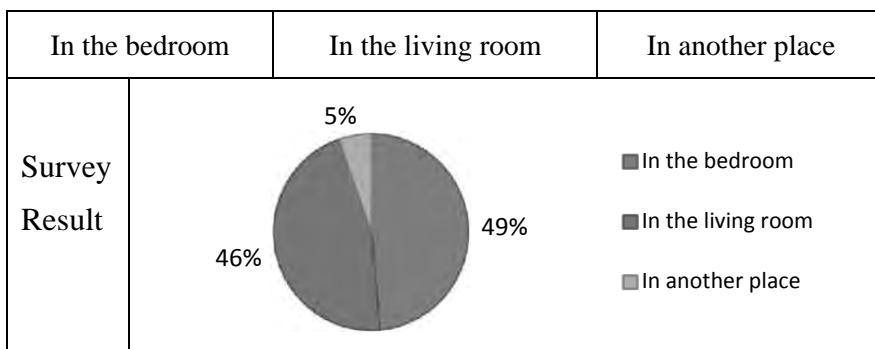
Question: Where does the family eat the daily meals?



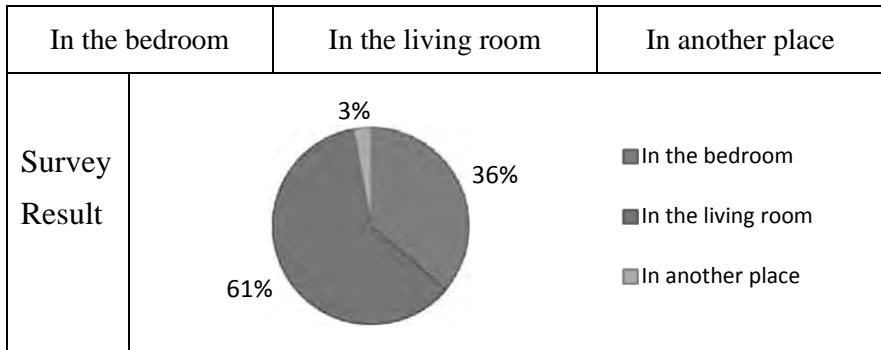
Question: In which room do your family watch the television?



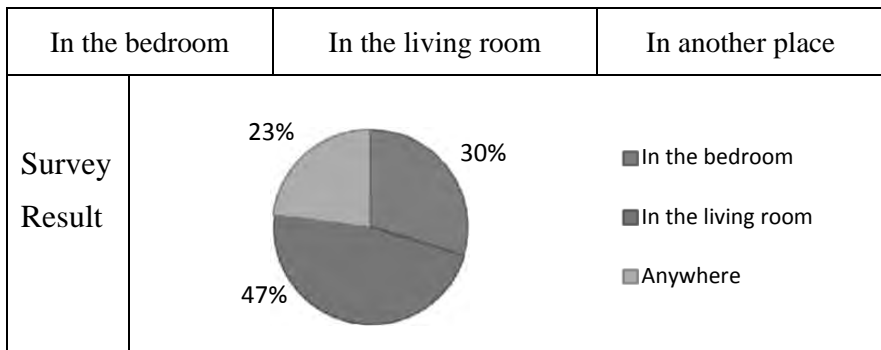
Question: Where do your children do their homework?



Question: Where do your children play (computer or something else)?



Question: Where do your family members pray?



Conclusion: As a result, the living space showed to be a multi-use space where family members perform various activities in different times such as eating, watching television, praying, playing and studying.

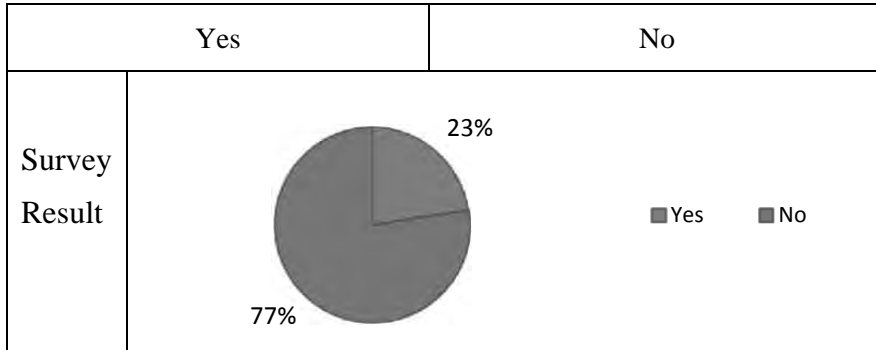
Accordingly, low-income families use the floor of the dwelling in performing various activities without using furniture, thus, sitting on the floor is a preferred eating position for a considerable percentage of low-income families.

1.5.3.2 Sleeping spaces:

Separating spaces for the exclusive function of sleep is essential, and most of the family members refuse to sleep on the floor or in the living room.

Question objective: determining the use of the bed rooms and how families solve the problem of separation between girls and boys.

Question: Does any member of the family sleep in the living room?



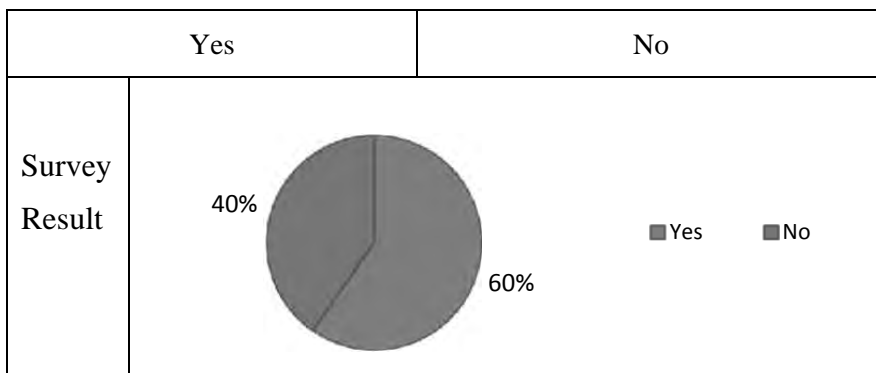
Conclusion: They believe it is a stigma that one sleeps in the lounge.

1.5.3.3 Balcony:

The balcony is considered one of the preferred spaces for low income spaces. However, they can dispense it if necessary.

Question objective: to find the priorities of spaces

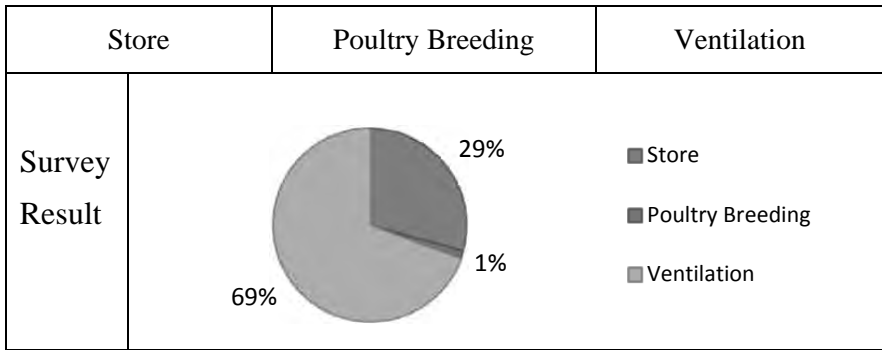
Question: Do you think it is better to dispense the terrace (balcony) in order to increase the area of the connected room?



Conclusion: low-income families can dispense the balcony in order to increase the area of the connected room or to create a new room.

Question objective: to determine the use importance of the balcony

Question: What is the importance of the balcony?



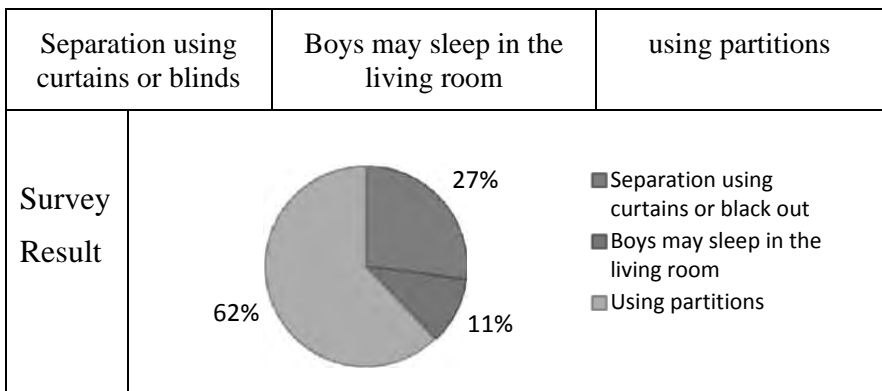
Conclusion: There is no specific function for the balcony. However, low-income families prefer to have a balcony as a port on the Street.

1.5.4 Re-division of spaces

Re-division of the designed space is a solution used by low-income families, especially in bed rooms to achieve the separation between boys and girls in sleeping areas.

Question objective: monitoring the solutions established by low-income families.

Question: If you believe that it is necessary to separate between boys and girls, what is the solution despite the lack of space?



Conclusion: the majority of low-income families seeks to establish the separation between boys and girls by dividing the sleeping space

1.5.5 Changing the use of spaces according to priorities

Changing the use of the designed space is a solution used by low-income families, especially when they need an additional sleeping space. They often create a sleeping space by closing the balcony. This solution is common when the family includes sons and daughters.

Closing the balcony is sometimes used to increase the area of the living room or to create storage.



Figure 19: Closing the balcony is commonplace in governmental housing
A photo from El-Zawia Elhamra- Cairo - Egypt

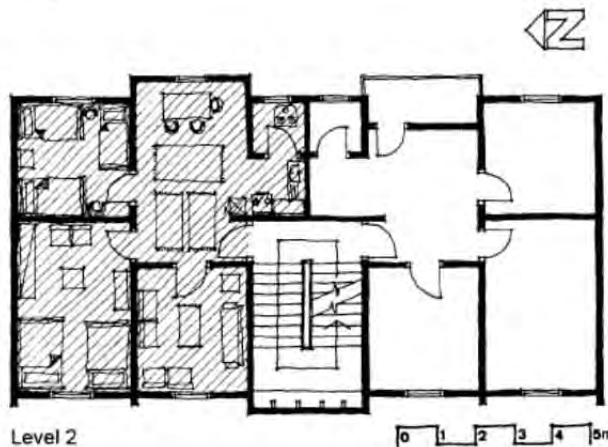


Figure 20: This three-roomed flat was extended only by including the balcony
space into a new larger central room- Ain Elsira-Cairo- Egypt
Ref: Graham Tipple, *Extending themselves*.

1.6 Existing house defects and desired house requirements

Looking to the future of low-income house design, it is necessary to achieve all habitants’ needs. Those needs come from two essential sources:

- The defects of the existing dwelling,
- And the requirement for the new desired dwelling.

1.6.1 Defects of the existing house

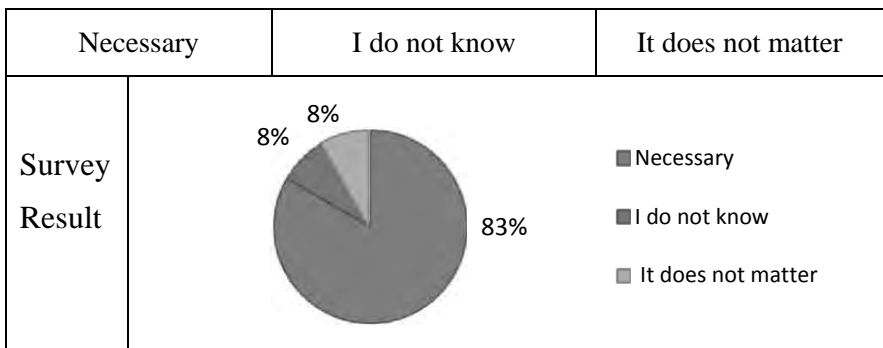
The defects of the existing low-income house come essentially from the lack in room areas and numbers of habitable rooms.

1.6.1.1 Number of bed rooms

The ordinary designs of low-income houses do not achieve the number of needed bed rooms.

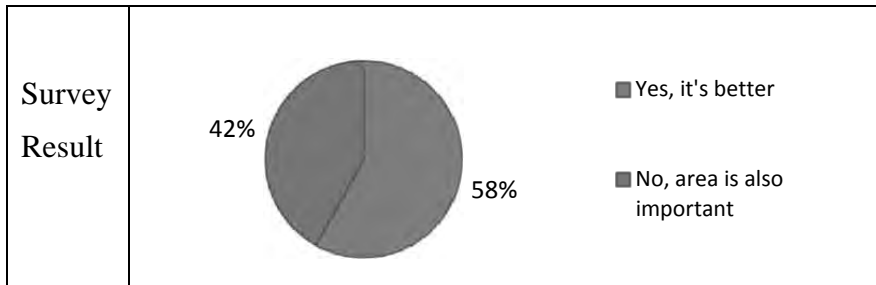
Question objective: to determine the need for more rooms or any other solution

Question: Do you think that it is necessary to separate between boys and girls in the bedroom?



Question: Is it better to reduce the areas of the bedrooms and to increase their number?

| | |
|------------------|----------------------------|
| Yes, it's better | No, area is also important |
|------------------|----------------------------|



Conclusion: a lot of low-income families need another bed room especially if the family includes boys and girls

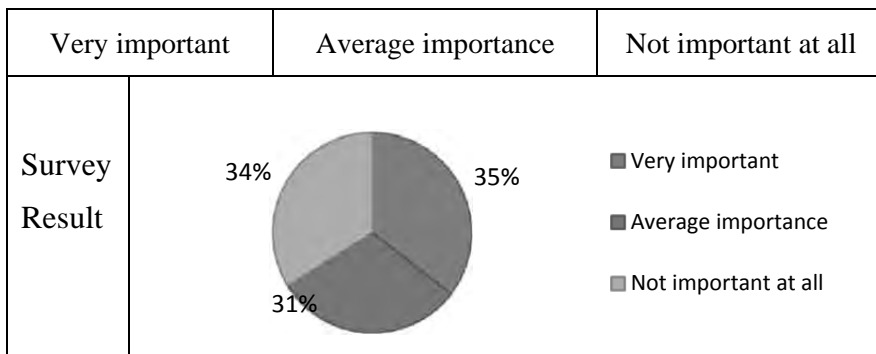
As an outcome from the prior questions which have been asked to the studied low income-families, most of them need another room in order to achieve their need for an additional sleeping space especially if the family includes boys and girls.

1.6.1.2 Utilities areas

According to the social survey, there is a clear lack of storage areas, although most low-income families refuse to specify a place for storage.

Question objective:

Question: Is it important to have a specific place used as storage (storage – attic (Sandara))?



Conclusion: There is no common answer for the previous question. However, there is a clear lack in the storage areas. The families who refused to have storage Justified that due to the spread of insects and rodents.



Figure 21: the lack of store areas

1.6.2 Satisfaction with the existing house

When dealing with satisfaction, there are three basic requirements for inhabitants determining the relation between them and the house.

- Security
- Identity
- Opportunity

According to social research, poor habitants assign the first priority to the proximity of the house to the workplace (opportunity), and then they give the second and third priorities to the house tenure (security) and the design of the house (identity) respectively.

On the contrary, middle class habitants give the first priority to the design of the house (identity), and then they give the second and third priorities to the house tenure (security) and the proximity of the house to the workplace (opportunity) respectively.²⁷

1.6.2.1 Priorities of activities:

According to the spatial needs of low-income families, the priorities of activities can be arranged as follows:

- Having a separate sleeping space is more important than having a wide balcony.
- Having a separate sleeping space is more important than having a guest room.

²⁷ د سهير لطفى - د محمود الكردي - آخرون. المسح الاجتماعي الاقتصادي لمنطقة إيواء زينهم. القاهرة: المركز القومي للبحوث الاجتماعية والجنائية - برنامج بحوث العشوائيات في المجتمع المصري. 1999

- Having a separate sleeping space is more important than having a dining room.
- Having a wide living area is more important than having a wide balcony.
- Having a wide bathroom is more important than having a wide balcony.
- Having a wide kitchen is more important than having a wide balcony.
- Having a wide balcony is more important than having a storage area.

1.6.3 Acceptance of non-traditional ideas

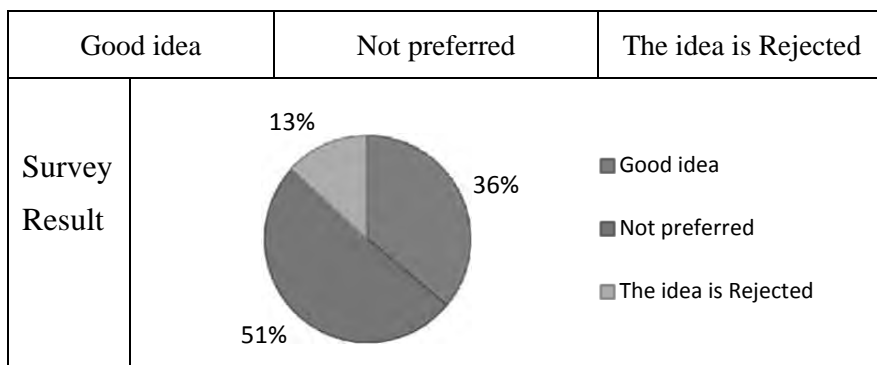
To perform a successful space-saving strategy, it is important to be sure about the acceptance of the user of these strategies.

1.6.3.1 Open Kitchen

The idea of the open kitchen had been used widely in local projects like the governmental housing project in Ain-Elsira- Cairo Egypt. The following question examines the preference of this idea.

Question objective: determine the preference of the open kitchen idea.

Question: Do you find that the idea of open kitchen helps to increase the use of space? Or is it rejected?



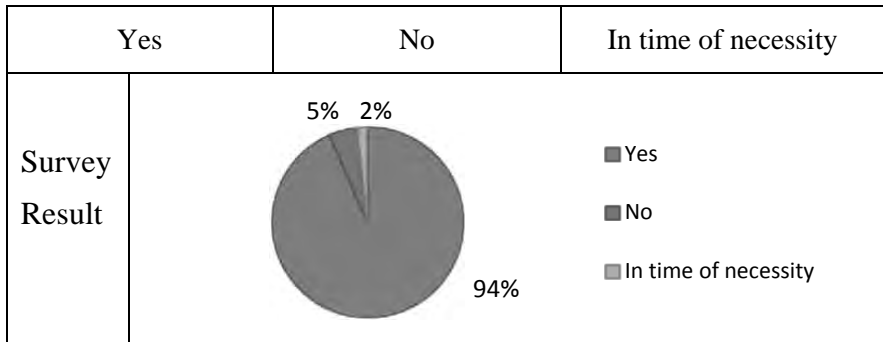
Conclusion: A large percentage of low-income families don't prefer the idea of the open kitchen. The reason for rejecting it is the lack in providing privacy to the woman when she is cooking.

1.6.3.2 Multi-use room:

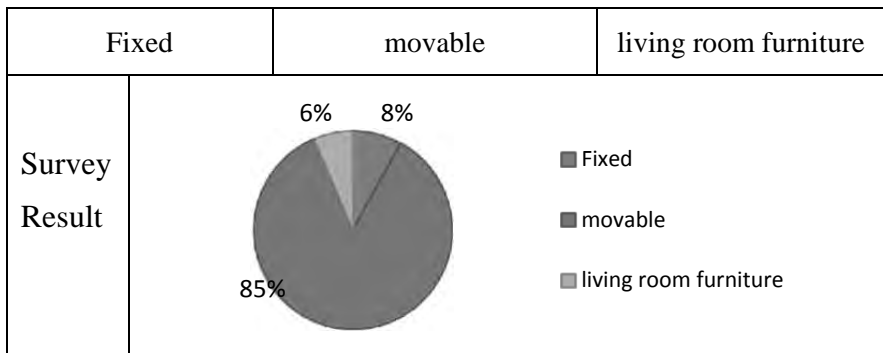
According to the social survey carried out by the researcher, low-income families were found to be used to performing more than one activity in the living space.

Question objective: determine the ability of having a multi use space in the new house

Question: Could your family eat their meals in the living room space?



Question: Do you prefer the dining furniture to be fixed or movable, or would you rather use the same living room furniture?



Conclusion: Low-income families accepted the idea of multi-use space, and they found there is no need to have a separate dining room.



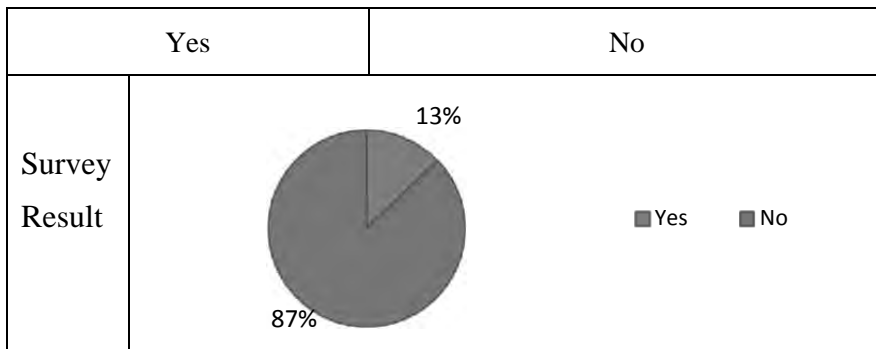
Figure 22: low-income families are used to performing more than one activity in the living space

1.6.3.3 Using bunk beds:

The idea of bunk beds has recently become a widespread idea, but the acceptance of this idea is largely dependent on socio-cultural properties of the dwellers.

Question objective: to determine the acceptance of the bunk bed idea.

Question: Do you have Bunk Beds?



Conclusion: most of the low-income families do not have a bunk bed, although, they do not refuse the idea.

They find this idea is suitable for boys only and not suitable for girls or small siblings because they fear they might fall off the higher bed when sleeping.



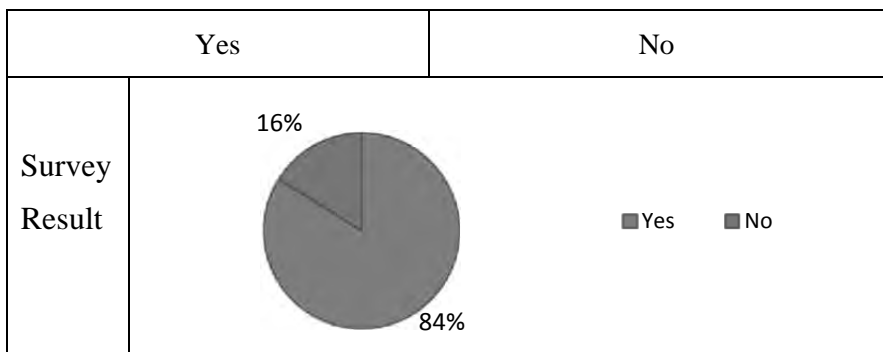
Figure 23: bunk bed used in low-income house

1.6.3.4 Using space-saving furniture:

In the meantime, there are many innovative ideas that achieve space-saving strategies based on the concept of space benefitting by performing many activities in one space and using space-saving furniture (small-movable-foldable)

Question objective: determining the acceptance of any unusual ideas

Question: Do you find that using movable or foldable furniture units saves the area of room space?



Conclusion: most low-income families are willing to accept any new ideas in order to achieve the new space saving strategies.

1.6.4 The requirements of the desired house

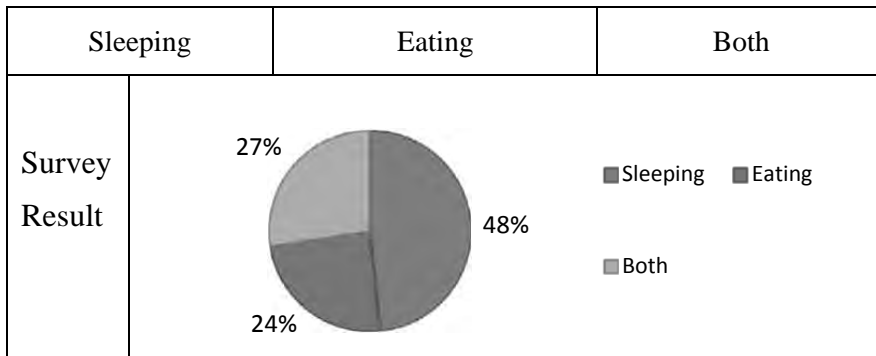
Looking to the future of low-income housing, there are numerous requirements to be taken into account, to meet with habitants need, and to confirm the provided quality.

1.6.4.1 Flexibility of spaces:

According to the social survey by the researcher, low-income families need flexible spaces that could be used to perform various activities.

Question objective: determining the availability of performing several activities in the same space

Question: What are the activities that can be performed through movable furniture?



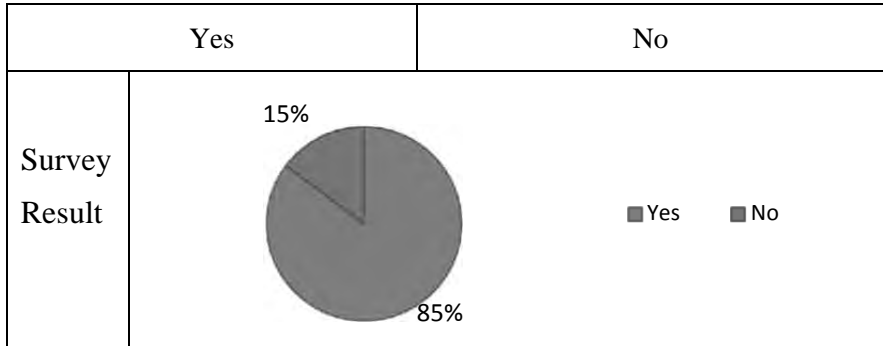
Conclusion: low-income families are used to performing more than one activity in the same place

1.6.4.2 Tendency to redesign spaces:

In some cases, low-income families would undertake a necessary alteration in house design to meet their needs, thus the following question was asked to the dwellers sample.

Question objective: determining the degree of participation of the user in designing his space.

Question: Do you think it is plausible that you and your family may redesign the spaces in your home?



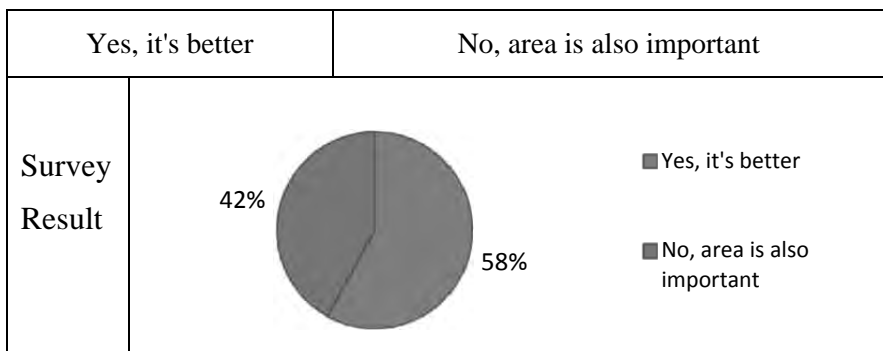
Conclusion: low-income families have the desire to redesign some spaces according to their needs.

1.6.4.3 Needed rooms and desired area for the dwelling:

Prevailing designs of low-income houses do not achieve the number of needed rooms. To induce the actual number of the needed rooms, the following question was asked.

Question objective: : to investigate the need for more rooms in the house

Question: Is it better to reduce the areas of the bedrooms and to increase their number?



Conclusion: most low-income families need another room especially if the family includes boys and girls

According to the results of the social survey of the governmental housing in Zinhom district which had been accomplished in 1999, 62% of the district families prefer to own a dwelling includes three habitable rooms (two bedrooms and a living room). On the other hand, the average area of the desired dwelling is between 60 m² to 70 m².²⁸

Summary

This chapter has demonstrated the main socio-cultural characteristics of low-income dwellers in Egypt and how they deal with house spaces. The general characteristics of low-income dwellers can be summarized as follows.

- In the current time, the majority of low-income families belong to the middle class which appears to be moving toward the lower class.
- The nuclear family type is widespread among the low-income families in urban communities which consist of the husband, the wife and their children and may include any of family relatives.
- Low-income families who live in urban communities consist of four or five members in average.

This chapter also has described the lifestyle of low-income groups and how they live in their small houses and how they meet their needs. The distinct characteristics of low-income dwellers can be summarized in the following points.

- They rarely host guests, and there is no need to have a separate guest room and they usually receive their guests in the living room.
- They often use their home spaces in performing only the ordinary home activities and they do not perform any other external profitable work.
- They are keen on acquiring new electrical appliances such as TV sets, satellite receivers and automatic washing machines.
- They think that it is not necessary to have an entrance lobby and there is an essential spatial relation between the entrance and the kitchen.

²⁸د سهير لطفى - د محمود الكردي - آخرون. المسح الاجتماعي الاقتصادي لمنطقة إيواء زينهم. القاهرة: المركز القومي للبحوث الاجتماعية والجنائية - برنامج بحوث العشوائيات في المجتمع المصري، 1999

- The living space showed to be a multi-use space where family members perform various activities in different times.
- Most of them refuse to sleep on the floor or in the living room and think that separating spaces for the exclusive function of sleep is essential and many families need another bedroom especially if the family includes boys and girls
- The balcony is considered one of the preferred spaces for low income families as a space viewing the Street. However, they can dispense it if necessary.
- Re-division of the designed space is a solution used by low-income families, especially in bed rooms to achieve the separation between boys and girls in sleeping areas.
- Changing the use of the designed space is a common solution, for example, they often create a habitable space by closing the balcony.
- Most of them need another room in order to achieve their need for an additional sleeping space especially if the family includes boys and girls.
- There is a clear lack in the storage areas.
- Low-income families accepted the idea of multi-use space, and they are willing to accept any new ideas in order to achieve the new space saving strategies.
- Most of low-income families have the desire to have the possibility to redesign some spaces according to their needs.

***Chapter 2: Points of convergence and divergence between
housing design and habitants needs***

Preface

After demonstrating the socio-cultural characteristics of low-income inhabitants in Egypt and how they deal with dwelling spaces in order to meet their basic needs and how they perform life activities in the available spaces, this chapter aims to illustrate the concepts proposed by designers in order to meet the dwellers needs.

Furthermore, it focuses on the design conception of low-income housing, and illustrates foreign concepts to better understand the low-income housing dilemma, and to demonstrate a variety of design approaches which are adopted to solve this problem.

To study the low-income housing problem from all sides, it is vital to induce the way of thinking for designers (architects) and users (residents) in order to monitor the gap between these two visions and thus attempt to reduce it, keeping in mind the distinctive socio-cultural characteristics of the inhabitants.

2.1 Relation between design conception and habitants' needs

This part discusses the relation between the ways of thinking for the two major participants in creating a healthy residential environment suitable for low-income groups in Egypt: The architect and the user.

To induce the architects' way of thinking, a practical experiment was designed in order to compare common visions among designers to those of users.

To infer the relation between design conception and habitants' needs, it is necessary to study the way some families live in social housing. Therefore, an interview with three low-income families was undertaken by the researcher for this end. All three families were low-income households living in social housing units (government housing) that had the same space design. Some questions were asked to the three cases in order to determine the life style of these families.

Afterwards, a comparison was carried out between the design solutions proposed for that same plan by professional designers and the way of living of the habitants, in order to induce the differences between the two visions.

2.1.1 Experiment Methodology

The methodology of this experiment proceeded through the following steps:

- a. Selecting three similar low-income families living in the same spatial condition (area – number of rooms – spatial relations)
- b. Carrying out an interview with each family to determine the lifestyle for its members and their essential needs.
- c. Carrying out an architectural survey to define the physical properties of the dwelling, and supporting it by illustrative images for all dwelling spaces.
- d. Drawing an accurate architectural plan for the selected dwelling with the three different furniture arrangements.
- e. Sending a draft of the unfurnished plan for the selected dwelling to a sample of professional Egyptian architects with medium experience (3:15 Years) asking them to redesign the interior space keeping in consideration the spatial and socio-cultural needs of low-income residents.
- f. Receiving design proposals from all participants and comparing the received proposals with the actual families' lifestyle, spatial needs and socio-cultural characteristics.

2.1.2 Monitoring residents' lifestyle

As mentioned in the previous part, there are predefined criteria in selection the three case studies which can be clarified as follows:

Dwelling area: 60-65 m²

Number of rooms: 3 habitable rooms (2 bedrooms)

Number of family members: 4 or 5 persons.

2.1.2.1: Selected case studies:

The following table displays the three selected case studies and the spatial properties for each case. All three cases have similar spatial conditions.²⁹

Table 3: The three selected case studies

| Case study (a): | | |
|-----------------|---------------------------|------------------------------|
| 1 | Dwelling area | 63 m² |
| 2 | No. of habitable rooms | 3 rooms |
| 3 | No. of bedrooms | 2 bedrooms |
| 4 | No. of family members | 5 persons |
| 5 | No. of children | 3 (2 boys + 1 girl) |
| 6 | Architectural plan | |

²⁹ For more details about the selected case studies, see (appendix 2)

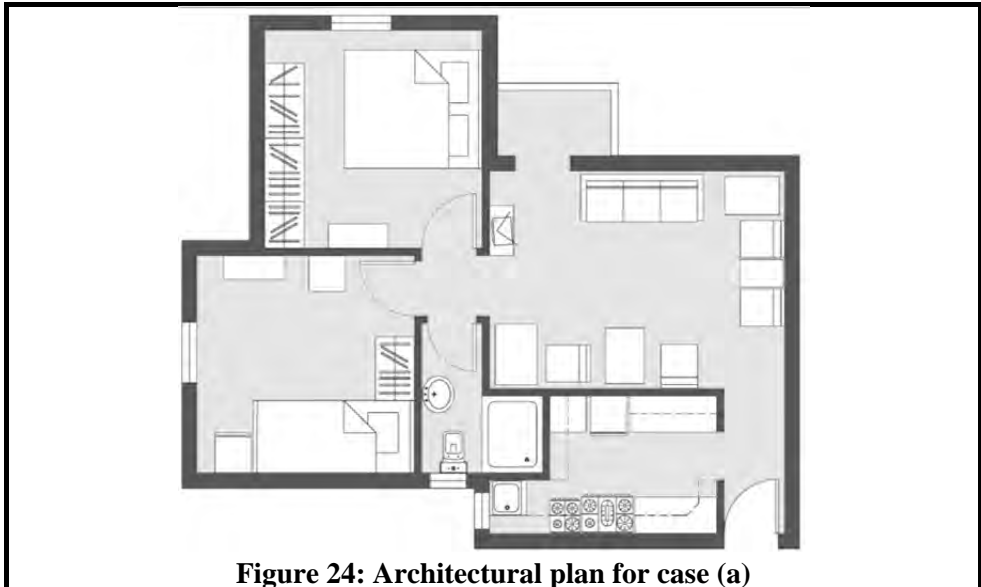


Figure 24: Architectural plan for case (a)

Case study (b):

| | | |
|----------|---------------------------|-------------------------|
| 1 | Dwelling area | 63 m² |
| 2 | No. of habitable rooms | 3 rooms |
| 3 | No. of bedrooms | 2 bedrooms |
| 4 | No. of family members | 4 persons |
| 5 | No. of children | 3 (3 girls) |
| 6 | Architectural plan | |

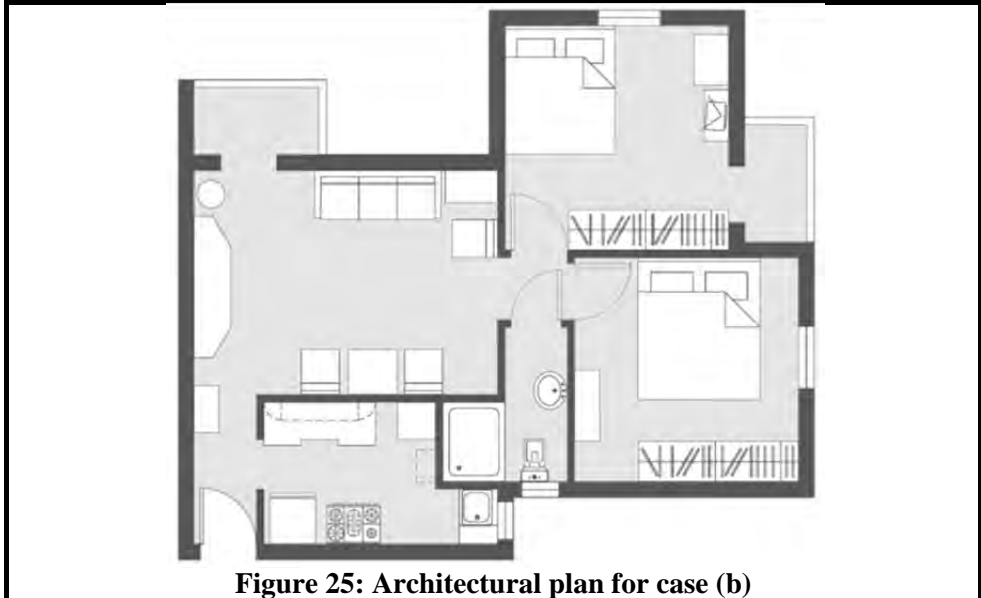


Figure 25: Architectural plan for case (b)

Case study (c):

| | | |
|----------|---------------------------|------------------------------|
| 1 | Dwelling area | 63 m² |
| 2 | No. of habitable rooms | 3 rooms |
| 3 | No. of bedrooms | 2 bedrooms |
| 4 | No. of family members | 5 persons |
| 5 | No. of children | 3 (2 boys + 1 girl) |
| 6 | Architectural plan | |



Figure 26: Architectural plan for case (c)

2.1.3 Designers' trials to solve the problem










After preparing a draft of the unfurnished plan for the selected dwelling (case a), a request for participation was sent via email with the draft attached, to a number of architects with different levels of experience (according to the number of years of practice).

The request included the following notes and constraints:








- The dwelling family consists of five members (father, mother and two sons and a daughter).
- The socio-cultural class of the family is moderate and the housing unit is one of a social housing project in Cairo.
- The area of the apartment and rooms should not be increased
- It is permissible to use any suitable furnishing units.
- The main objective of the study is to achieve the optimum use of the house spaces considering the essential needs for the habitants.

Sixteen different designs were proposed by the participants in attempt to furnish the plan, in order to achieve the essential functional needs for the habitants. The following table displays those design proposals as received from the architects.³⁰

Table 4: The furnishing proposals received from the participants architects

| | | |
|---|--|--|
|  <p>Figure 27: proposal from an architect with eight-year experience.</p> |  <p>Figure 28: proposal from an architect with eight-year experience.</p> |  <p>Figure 29: proposal from an architect with ten-year experience.</p> |
|  <p>Figure 30: proposal from an architect with two-year experience.</p> |  <p>Figure 31: proposal from an architect with ten-year experience.</p> |  <p>Figure 32: proposal from an architect with ten-year experience.</p> |
|  <p>Figure 33: proposal from an architect with eight-year experience.</p> |  <p>Figure 34: proposal from an architect with four-year experience.</p> |  <p>Figure 35: proposal from an architect with three-year experience.</p> |

³⁰ For more details about the experiment and the received proposals, see (appendix 3)

| | | |
|--|---|--|
|  <p>Figure 36: proposal from an architect with thirteen-year experience.</p> |  <p>Figure 37: proposal from an architect with four-year experience.</p> |  <p>Figure 38: proposal from an architect with three-year experience.</p> |
|  <p>Figure 39: proposal from an architect with fifteen-year experience.</p> |  <p>Figure 40: proposal from an architect with five-year experience.</p> |  <p>Figure 41: proposal from an architect with three-year experience.</p> |
| |  <p>Figure 42: proposal from an architect with two-year experience.</p> | |

2.1.4 Results of the experiment

To determine whether or not current habitants are likely to be satisfied with those design proposals if they were offered to them, it is very important to understand their way of thinking in dealing with home spaces.

2.1.4.1 Performing home activities

The target of achieving the essential needs is accomplished in all sixteen proposals using the ordinary way of thinking in furnishing such a small unit. Thus, there are particular places designated for each activity such as eating, sleeping, and seating. Each place is determined by its characteristic furnishing units.

2.1.4.2 Socio-cultural characteristics

a) Living spaces

In most of the proposals, the dining area is determined by using the usual dining furniture units in different shapes. Dwellers, on the other hand, used movable and folded furniture units as temporary dining furniture in all three selected case studies, in order to obtain a free living space where residents do not feel “cramped”.

Table 5: dining spaces in the received proposals.

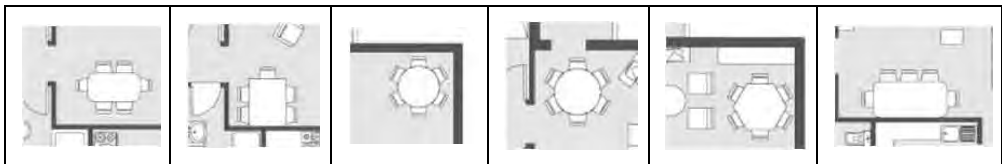


Figure 43: Using movable furniture as temporary dining furniture

b) Sleeping spaces

Segregation between boys and girls in sleeping spaces is a basic need for low –income families according to their religious beliefs.

Although, the family may need to come up with an additional sleeping space, especially when they decide to segregate boys from girls, only two participant designers tried to provide this additional space by dividing the second bedroom using a special piece of furniture or using partitions and adding the area of the balcony to the bedroom after enclosing it.

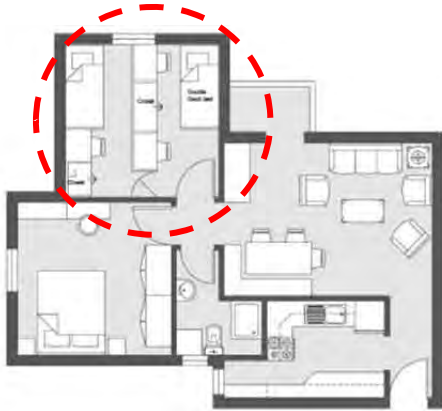


Figure 44: proposal from an architect with fifteen -year experience.



Figure 45: proposal from an architect with ten-year experience

2.1.4.3 Using non-traditional ideas to improve the functional performance

a) Using elevated furniture:

Using bunk beds is an easy method for the designer to provide more sleeping spaces without using more area from the dwelling.

There are ten proposals used bunk beds in order to achieve a maximum use of space in the bedroom and providing more sleeping spaces.

Even though this concept is commonly used by the designers in providing more sleeping spaces; it is not preferred by low-income habitants especially if the children are too young. Thus, when the three families were asked about this concept, only one family use bunk beds and the other two families do not prefer it.

Table 6: Using bunk bed as a space-saving strategy.**b) The concept of open kitchen:**

Only one proposal used the concept of the open kitchen in order to achieve a maximum use of space in the living room area and to keep a suitable free area to avoid feeling cramped.

**Figure 46: proposal from an architect with five-year experience.**

Although, the concept of open kitchen is considered a good space-saving strategy, most low-income habitants refuse this concept. Thus, when the three families were asked about this concept, they refused it because of the Egyptian lifestyle and the local customs of cooking. Furthermore, the need for privacy in the cooking area is very essential. This can be explained by the fact that it is always connected to the living area, which is considered the only available space in the house to receive guests.

As an overall conclusion from this experiment, it can be inferred that there is an obvious discordance in priorities in providing functional needs of space between low-income habitants' vision and designers' vision. This proves to be the case even with architects that enjoy over ten years of experience in practice. The researcher believes that this discordance is the result of a serious lack of knowledge on the part of the local architect concerning social and behavioral aspects of low-income dwellers, and a prevailing trend of (Cut-and-paste) use of standard furnishing units in every given housing prototype with no significant depth or attempt to study the way those units would impact the lives of targeted people in real life, or the way they would relate to their current lifestyles, socio-cultural characteristics and actual needs.

2.2 The dilemma of low-income housing in Egypt

There are obvious inequalities in housing provision in Egypt. While hi-income households may keep three and more flats (most of which were supposed to reach a different target group) empty for the day when their children reach maturity, others would crowd into very rudimentary accommodation in high density areas! Many such households are severely crowded and find alternative accommodation next to impossible to locate.

According to 1986 census data, the average occupancy rate in Cairo was 1.5 people per room with 15 m² of floor area per person. Thus, about 70 per cent of Cairo's population lived in poor quality housing that included the majority of public housing projects.

Most low-income habitants live in blocks of flats commonly referred to as 'Aimara' of three to seven storey. The flat would have two or three habitable rooms, a kitchen and a bathroom/toilet.



Figure 47: Public housing project – Abo Elreesh



Figure 48: Public housing project – Madinet Nasr



Figure 49: Public housing project – Elzawia Elhamraa

Lifestyle and behavior patterns are considered the truer indicators of class and status, however, classification of households by income, education or the neighborhood occupied is no longer suitable regarding the increasing complexity of the Egyptian society that arose in the 1990s.³¹

Though occupants of popular quarters might be expected to be homogeneously poor, this is not the case anymore, due to two major reasons. The first is the influx of remittances from Egyptians working in the oil-producing Middle Eastern states. The uncertainty about whether this income will continue prevents long-term movements out of the popular quarters into middleclass neighborhoods, to which the current annual income may suggest being more appropriate. The second reason is a shortage of rental housing for newly formed middle-income households.

Since the early 1960s, the Egyptian Government adopted a program of building low-cost housing in large numbers and mainly in four- and five-storey walk-up blocks of flats. During the 1980s, for example, the annual production of such housing exceeded 20,000 dwellings. At the same time, the private sector provided up to five times as many dwellings, also mostly in flats. Annual housing construction rates have been high historically, in 1983 the figure reached eight dwellings per 1000 people, in 1991 it was seven per 1000. The Cairo Governorate provided about half of the annual housing production, followed by the Building Cooperatives Authority (22 per cent) and the New Communities (18 per cent).³²

2.2.1 The existing condition of low-income housing in Egypt

As a result of overlooking the lifestyle of low-income habitants and their socio-cultural needs, extension in the dwelling has become a common phenomenon in Egypt in the last decades.

The most important reason for extending in Egyptian public houses is the need for more space to house additional members of the household especially to meet the need of separating growing children under the privacy tenets of Islam. For this end, many householders are driven to add an extra room.

³¹ Graham Tipple, *Extending themselves - user initiated transformations of government-built housing in developing countries* [Book]. - Oxford : LIVERPOOL UNIVERSITY PRESS, 2000.

³² Ibid



Figure 50: Two images for Ain Elsira district illustrate the extensions of dwellings

Motivations for extending rather than moving could be expected to center on affinity to the area and difficulty of finding an affordable alternative. The problem of finding suitable accommodation in urban Egypt is quite prevalent. Parents of grown-up children are particularly concerned about the difficulty of their married offspring's having a place to live not too far away so that inter-generational support can continue. It is not surprising, therefore, that, while affinity (or loyalty) to the neighborhood is very low as a motive to stay and extend, the unavailability of alternative accommodation at the right price or in suitable condition scores highly.³³

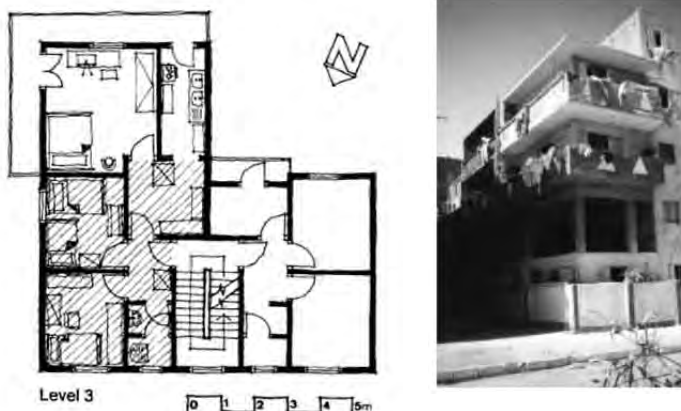


Figure 51: This flat occupied by seven people has been extended to provide a large kitchen and a third bedroom. -
Ref : Graham Tipple, *Extending themselves*

³³ Ibid

2.2.2 Considering the needs of low-income inhabitants

To determine the motives for extension in social housing projects in Egypt, it is a must to monitor the socio-cultural needs of dwellers and investigate the needs of a growing family.

It is to be noted from analyzing different cases of extending dwellings, that there is a vital demand on increasing the area of the dwelling in order to add more habitable areas and provide more habitable rooms.³⁴

2.2.2.1 The need for more habitable area

The need for adding more habitable areas is reflected in extensions of social housing projects which had been established in Egypt since 1960. Thus, total built area has been extended by over 20 m² in average from around 40 m² to 64 and 62 m² for established and recent transformers respectively. Most have added all the space in one phase, adding an area that amounts to about half the original flat, or two rooms in order to add more habitable area.

Throughout urban Egypt, the modification of balconies is commonplace in residents of all income levels. Many occupants enclose their balconies in glazing set in aluminum frames in order to increase the area of the connected room.³⁵

This evidence reveals that most of low-income dwellers attempt to increase the area of their habitable spaces such as living room and bedrooms in order to perform their essential living activities.

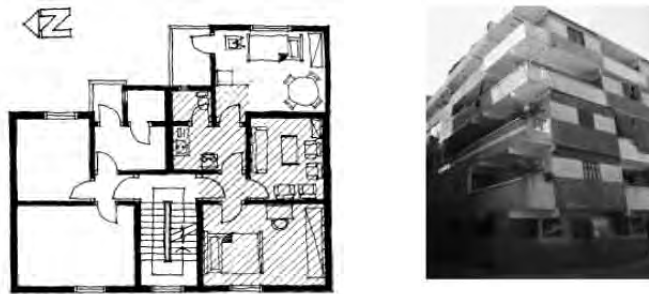


Figure 52: The extension of one room and a balcony provides a bedroom/dining area with a balcony at the side - Ref: Graham Tipple, Extending themselves.

³⁴ Ibid

³⁵ Ibid

2.2.2.2 The need for more habitable rooms

The original dwellings had two or three rooms intended as living rooms but transformers' dwellings now have three in average. The original three-roomed dwellings have almost all had their kitchens altered to serve as a living room without changes to internal walls. Thus, many of the non-transformers have four habitable rooms. While the average area of each phase was found to be equivalent to two rooms, the number of rooms added appears to vary more than might be expected from this data. This illustrates the ability of extenders to subdivide their new spaces in many different ways. The range of sizes of new rooms seems to be similar to the originals.

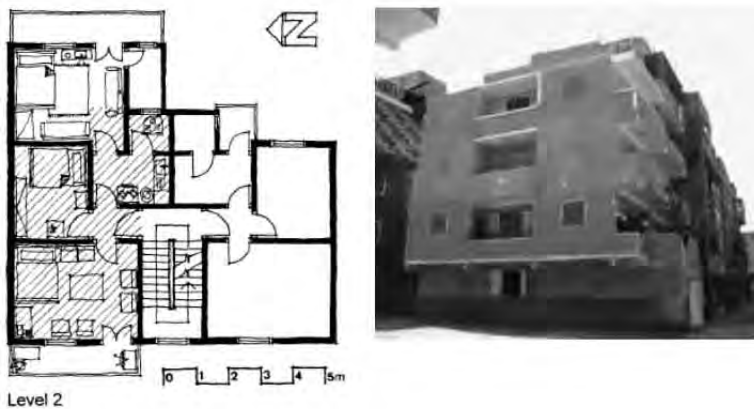


Figure 53: This two-roomed dwelling is occupied by 13 people (five men, four women, two boys and two girls) - Ref : Graham Tipple, Extending themselves.

2.2.2.3 The need for more flexible furniture

On the other hand, there is an obvious shortage in locally available small and space-saving furniture which could be suitable for small dwellings. And though locally manufactured furniture for low-income groups in Egypt is usually inexpensive; it is not really small. To demonstrate this problem, the researcher carried out a field visit to the economical furniture gallery which was held during the period from 28 October to 1 November 2010 under the sponsorship of the Egyptian ministry of social solidarity.



Figure 54: low-price furniture which manufactured for low-income groups in Egypt

So, obviously, there is no significant difference in size between low and high price furniture. Manufacturers usually reduce the price of the furniture by using Inexpensive raw materials, neglecting the real demand for small and compact furniture in order to achieve the optimal use of the available space.

2.3 Design conception for low-income housing

As mentioned in previous sections there is an obvious discrepancy in the relation between the two ways of thinking for the house designer and the habitants.

The next parts of this chapter examine the way of thinking of foreign designers and their conceptions of designing small and affordable dwellings.

2.3.1 Ways of Thinking

To achieve an effective design for any new low-income housing project, it is important to understand how people think and to take this

into consideration in the design process. Planning a large housing project naturally involves many people with naturally varied minds.

Before beginning with a new housing project, it is necessary to define the exact target group for this project and study their way of thinking. Each of these groups carries a different set of baggage with distinct needs, values, and objectives as well as, different ways of thinking. It is inevitable to not only recognize those differences but to also reconcile them.³⁶

These differences usually emerge in the first phase of any design process, which is architectural programming. This is why experts recognize analysis and synthesis as two different processes that call for two different ways of thinking.

To determine users' needs related to a proposed housing project, it is suggested that a selected group from the users be assigned to work with architectural programmers. This would effectively convey users' viewpoints and their ways of thinking to experts and planners, which should ensure their satisfaction with the final housing product.

2.3.2 Four Considerations

Four essential considerations should be observed at the beginning of any housing project. These considerations generally indicate the efficiency of the building, which is considered the predominant objective in all low-income housing projects.

- **Function:** It is what answers the question: “what’s going to happen in the building.” It defines activities, spatial interrelations, and people; their number, lifestyles and socio-cultural characteristics.
- **Form:** Generally relates to the site, the physical environment, psychological factors and the quality of space and construction.
- **Economy:** All Issues that have to do with the initial budget and quality of construction, in addition to considerations of running and lifecycle costs.

³⁶ William M. Peña, Steven A. Parshall Problem Seeking, An architectural Programming Primer [Book]. - New York. : John Wiley & Sons, Inc., 2001.

- **Time:** The study of the influences of history (the past), the inevitability of changes and the impact of events from the present, and projections into, and aspirations for the future.

Although, designers do not have to know everything about the users, they should know as much of the users' aspirations, needs, conditions, and lifestyle as should influence the design of the housing project.³⁷

2.4 Council Housing and mass housing projects

In the foreign countries, two models of council housing are usually established whenever the government attempts to find a realistic solution for the urgent demand of housing units.

At first tenements (as a pattern for council housing) was the only realistic choice for central sites, because of their higher densities. On the other hand, the model village was more compelling than the tenement as a pattern for council housing for various reasons. It lacked the unsavory image of tenements, and it matched with the suburban aspirations of the upwardly mobile stratum of society, thus attracting those who were most optimistic about reforming and improving low-class life.³⁸



Figure 55: A tenement block built by London County Council, under the Housing of the Working Classes Act 1890. - Ref: Alison Ravetz. . Council Housing and Culture.

³⁷ William M. Peña, Steven A. Parshall Problem Seeking, An architectural Programming Primer [Book]. - New York. : John Wiley & Sons, Inc., 2001.

³⁸ Alison Ravetz. (2001). Council Housing and Culture - The History of a Social Experiment. New York: Routledge.

For long times, Governments are considered to be responsible for providing housing for the population especially for the low-income group. In the developing countries, the governmental approach to provide the housing demand is expressed in quantitative. In most instances, living condition and quality of life are either overlooked or not expressly stated as priorities. The general policies embarked upon often seek to generate as many housing units in a short time as possible. Architectural design is therefore reduced to a rudimentary to reduce the cost as possible and to allow the possibility for repetition easily³⁹.



Figure 56: Public Housing in Hong Kong – 1967⁴⁰

Nowadays, generating mass housing projects in the developed countries have taken a different form taking into account the contemporary housing standards and achieving the principles of “quality of life”



Figure 57: U-shaped housing block- Lisbon Portugal 2003⁴¹

³⁹ Ozkan, Suha. "The architecture of mass housing." In *The architecture for housing*, by Robert Powell. Singapore: Concept media/ The Aga Khan Award of Architecture, 1990.

⁴⁰ Old Public Housing in Hong Kong – Lower Ngau Tau Kok (II) Estate.
<http://melonlam.wordpress.com/> (accessed 03 04, 2011).

⁴¹ Javier Mozas, Aurora Fernandez per. *Density - New collective housing*. 2006: a+t ediciones.

2.5 Minimum dwelling as a common International design approach

There is a real social and economic problem of housing for the subsistence minimum, and it can hardly be solved by means of ordinary ideal functional solutions. Therefore, the correct question to be asked is how to provide these increasing low-income families with a dwelling that would at least satisfy the basic minimal requirements for healthy living.

The appearance of the phrase “minimum dwelling” as the most pressing architectural problem can be traced to a number of causes;

- The important changes in the social structure of the population that have taken place during the past few decades and the worsening of the housing crisis after the war.
- The big demand for small and inexpensive houses.
- The increase in the number of small dwellings containing one to three rooms, which eloquently confirms the pauperization of the middle classes and the deepening of class differences.

Because of the high demand on the open market for small and inexpensive apartments, the private construction sector built more houses with smaller apartments, which had become an attractive speculative proposition.

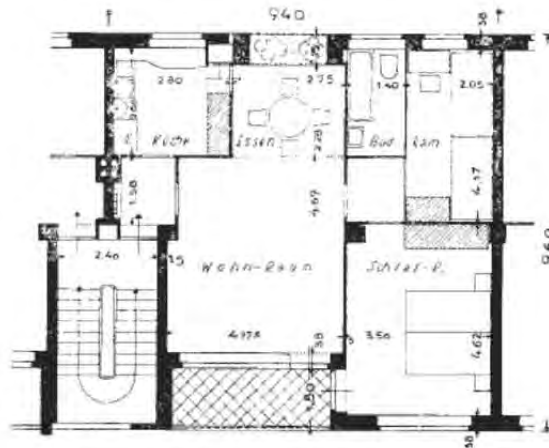


Figure 58: Floor plan of a small apartment in the Siemensstadt settlement Berlin, designed by Hans Scharoun – Ref: Karel Teige. The minimum dwelling

The problem of the minimum dwelling could not be solved by the reduction and simplification of the floor plan of the apartments of the

wealthy, whether traditional or modernized. Thus, it was not a question of simply reducing the number and size of rooms, or simplifying mechanical services and other amenities. It could be argued effectively that as long as we define the minimum dwelling as a traditional household type, its design will unquestionably involve the reduction of the size and number of rooms, apart from requiring a different organization of the floor plan with different appliances and furniture. The only possible strategy left is to attempt to reorganize the floor plan, along with opting for less expensive mechanical equipment and furniture.

Hence, the concept of minimum dwelling should build upon the following two principles:

- a) Formulate a functional program for the apartment that conforms to changes in the lifestyle, work schedule, and family condition of the classes of the subsistence minimum.
- b) Design the minimum dwelling not as a reduction of the size of the apartment, or as an emergency solution, but as an authentic, new type, with its own inherent dwelling standards that respond to the biological-hygienic as well as the socio-cultural needs of the habitants.⁴²

2.5.1 Types of small apartments

According to the western vision, the minimum apartment as a self-contained dwelling is considered the only basic housing option for all members of the society. It is essentially defined by its domestic housekeeping functions, with the housekeeping rooms the nerve center of both large and small apartments. In reformed versions of the minimum dwelling, all the housekeeping functions are now crammed into a single space - the kitchen, to the extent that the kitchen has been retained as the basic functional element of a small apartment, with several variations evolving thereof.⁴³

Basically, there are three types of small apartments:

- a. Apartments with a live-in kitchen, either as a single room (i.e., kitchen or so-called room with a stove) or as one room and a kitchen.

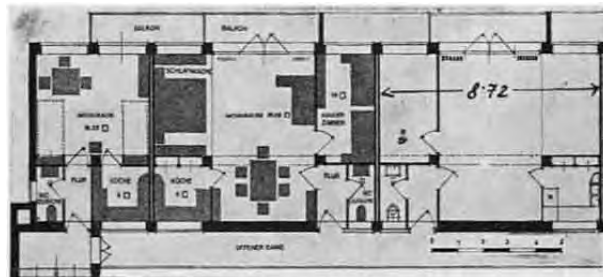
⁴² Karel Teige. *The minimum dwelling*. London: The MIT Press, 2002

⁴³ *Ibid*



**Figure 59: An example for the live-in Kitchen concept –
Ref: <http://www.homedit.com>**

- b. Apartments with small kitchen and one to three rooms. A special case is an apartment of minimal dimensions, whose kitchen is so reduced that it ceases to be a self-contained space and is reduced to a mere nook within the living room area. This type of minimal apartments may be regarded as either a throwback to the old live-in kitchen type or as a transition to a higher form of apartment (i.e., without a kitchen).



**Figure 60: Housing complex, Frankfurt by A. Brenner, 1928–1929
Ref: Karel Teige. The minimum dwelling.**

- c. Apartments without a kitchen, a dwelling that provides each adult with a separate room (in which only a single piece of furniture is provided for food preparation).



Figure 61: Furnishing of small apartments with folding beds (E. May & E.Kaufmann 1929) – Ref: Karel Teige. The minimum dwelling.

These three varieties of small apartments are not equivalent. Each corresponds to a different lifestyle and has a different social content.

The live-in kitchen is a suitable form for modern dwelling in the western culture, since people today spend most of their time outside the home.

In apartments that consist of a single room and a kitchen, the layout is organized in such a way as to retain the kitchen as the main living space in addition to its other functions, such as a place to eat and for children to play in.

2.5.2 The principle of dividing the apartment into day and night uses

The separation of sleeping from cooking areas was a consequence of the general drive to improve hygienic conditions in housing. Thus an apartment of one room and a kitchen may in effect be defined as a layout that is already functionally differentiated, at least as far as the separation of private functions from common dwelling is concerned.

One serious disadvantage of this solution is the unequal use of these spaces. Thus, if we assume that the inhabitants of such an apartment spend most of their time at home, the live-in kitchen becomes overused, while the sleeping room is used much less. For this reason, it proved more rational in apartments of a single room and kitchen to devise the layout so that the kitchen could also be used as a dining room, and the other room as a combined sleeping-living area.

With appropriately arranged furniture, better use could be made of the floor area in such apartments. Examples of such new furniture types are folding tables and, if need be, folding seats in the kitchen, which do not take up much space when not being used during meal time, as well as folding beds or sleeping sofas in the other room.

2.5.3 Space saving strategies used in minimum dwelling concept

The space saved by reducing the size of the live-in kitchen could be used to increase the size of the living room, sometimes even providing enough surpluses to add one or two small bedroom-sleeping cubicles to the floor plan. It was by such means that the floor plans for small apartments were arrived at: a small kitchen, a relatively large living room, and one to three sleeping cubicles. Given this new functional differentiation, such an apartment cannot be called minimal anymore; it is really just a miniature version of a large apartment. It is essentially a rationalized medium-size apartment, whose floor area has been squeezed down to 45 to 55 m².⁴⁴

Given the economic constraints imposed on the design of the minimum dwelling regardless of whether it has a live-in kitchen, a living room with a cooking nook, or two separate bedrooms, its equipment, space, and furnishings by definition still had to be reduced to their respective minima.

2.5.4 Small and Tiny House as a simple solution

Small and tiny house is often a result of a collaborative process between the architect and manufacturers. It is always constructed from wood, and it was designed to produce maximum quality at minimum cost.

The internal space of a tiny house is designed in order to minimize the space taken up for circulation, whereas the living space is maximized. Although the house is small, the open plan creates the feeling of living in a large space.⁴⁵

⁴⁴ Ibid

⁴⁵ Compact Houses [Online] // Habitares. - Bauart Architekten, 2009. - 10 10, 2010. - <http://www.habitares.co.cc/>.



Figure 62: An example for small prefabricated house

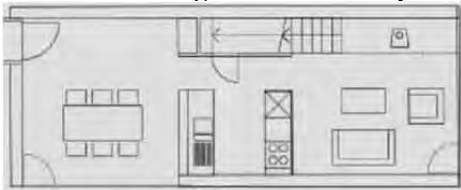


Figure 63: Ground floor for the house

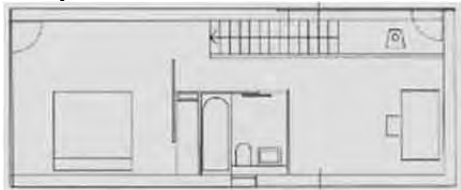


Figure 64: First floor for the house



Figure 65: Living area in the small prefabricated house



Figure 66: sleeping area in the small prefabricated house

This prefabricated house can be used in different ways: as a studio or private separated house or it can be adapted to be used as an extension to an existing house.

2.6 Residential Open Building

In Europe, Asia and North America, residential Open Building principles, variously known as OB, S/I (Support/Infill), Skeleton Housing, Supports and Detachable, Houses that Grow, etc, are now spearheading the reorganization of the design and construction of residential buildings in those countries in parallel ways.⁴⁶

⁴⁶ Stephen Kendall, Jonathan Teicher, Residential Open building. - London : Taylor & Francis, 2002.

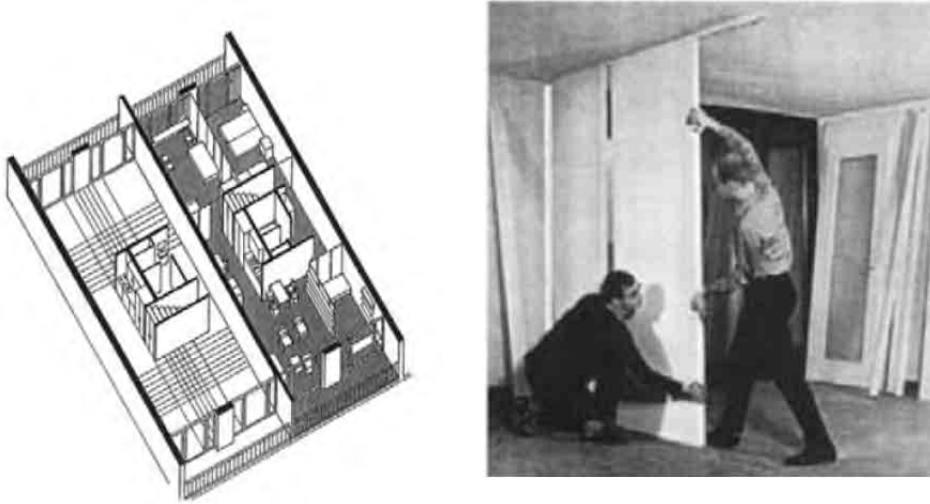


Figure 67 : Building with various dwelling layouts, drawing of M & A Architects, 1994, Pipe-Stairwell Adaptable Housing ,Cuiwei Residential Quarter, Beijing, China – Ref: Stephen Kendall, Residential Open building

Residential Open Building is a new multi-disciplinary approach to the design, financing, construction, fit-out and long-term management processes of residential buildings, including mixed-use structures. Its goals include creating varied, fine-grained and sustainable environment, and increasing individual choice and responsibility within it. In Open Building, responsibility for decision-making is distributed on various levels. New product interfaces and new permitting and inspection processes disentangle subsystems toward the ends of simplifying construction, reducing conflict, affording individual choice, and promoting overall environmental coherence. Residential OB thus combines a set of technical tools with a deliberate social stance toward environmental intervention.

Residential Open Building practices are rapidly evolving throughout the world. As new consumer-oriented infill systems appear and become more widely available, governments, housing and finance corporations and manufacturers are joining developers, sustainability advocates and academics in endorsing and advancing a new open architecture.⁴⁷

⁴⁷ Ibid



**Figure 68 : Optional dwelling unit wall positions and example of a dwelling unit ,Metron Architects. 1966 Neuwil Wohlen, Switzerland.
Ref: Stephen Kendall, Residential Open building**

New initiatives are needed to clarify the basic principles of the future of the (Open Building). Future methods must⁴⁸:

- More effectively organize and coordinate work by different parties on different levels;
- Reorder technical interfaces so as to reduce conflict and to ensure easy replacement and substitution of parts; and
- Lead to the realization of better, more adaptable, durable and sustainable buildings and neighborhoods.

Open Building may also flourish in situations where strong expectations for individual consumer choice collide with problems of social inequity and the procedural and physical limits of conventional construction. There are also attempts by people from all walks of life to realize personal preferences in the dwelling and in the work place that may find limits imposed by technical complexity, procedural barriers and demand for long-term value in the face of constant change. Such bottom up demand for variety, equity and responsibility will also bring methods such as Open Building to the fore.⁴⁹

⁴⁸ Ibid

⁴⁹ Ibid

2.7 Incremental house

The approaches of “incremental housing” were adopted between the periods of the 1970s-1980s as a more realistic approach to meet the housing needs of the urban poor. The concept of the incremental housing was that the cost of the house could be reduced by monitoring the low-income families as they build and extend their own dwellings incrementally in order to achieve their own social needs depends on the available resources.

This approach took two forms as follows:

- a- Upgrading the existing informal settlements with safe water, sanitation, drainage, electricity and access way.
- b- Affording new plots of serviced land (site and services) which allow households to build their own dwellings.



1976: Core services units with one room



1977: houses extensions in a disorganized way



2009: Fully urbanized settlement

Figure 69: Incremental housing project in Bogota, Colombia

The evaluation of many incremental housing projects after one or two years of their start, judged them to have failed. However, after about two decades, the success of these projects could be noticed. Thus it can be assumed that low-income families need more time to build better quality buildings.⁵⁰

2.7.1 The basic principles of (Sites-and-services)

The key components of the (site-and-services) scheme are the plot of land, infrastructure (roads, water supply, drainage, electricity and sanitary network), and the house itself. Various inputs that go into them include finance, building materials and technology. Thus, the sites-and-

⁵⁰ "CIVIS: All Issues." Cities Alliance.

http://www.citiesalliance.org/ca/sites/citiesalliance.org/files/CIVIS_3_English.pdf (accessed 01 22, 2011).

services approach emphasizes the role of government agencies in the preparation of land parcels or plots with certain basic infrastructure.

Afterward, the dwellers themselves have to use their own resources to build their house, such as informal finance or family labor and various other types of community participation modes.⁵¹

2.7.2 Typologies in sites-and-services schemes

Sites-and-services schemes were activated in a number of different ways depending on the resources available, and the implementation. This variation was a result of the attempt to strike a balance between minimum "acceptable" housing conditions and affordability of the inhabitants. While following the basic rule of a plot of land (sites) and essential infrastructure (services), the degree of participation and inputs of the implementing agency on one hand, and the inhabitants on the other, varied greatly. They ranged from an empty plot of land and some services (like water, electricity and sanitation connections) to the provision of a "core" house (consisting of a toilet and kitchen only) on the plot of land with attached services.

Some of the variations attempted in sites-and-services projects include:

- a) **Utility wall:** A "utility" wall is built on the plot which contains the connections for water, drainage, sewerage and electricity. The inhabitants have to build the house around this wall, and utilize the connections from it.
- b) **Latrine:** Many projects provide a basic latrine (bathroom and/or toilet) in each plot in order to avoid the critical waste disposal problems.
- c) **Roof frame/ shell house, core house:** Some projects provide the roof structure on posts, and the dwellers have to build the walls according to their requirements. Conversely, a plinth is sometimes built by the implementing agency, which forms a base over which the dwellers can build their house. Other variations to this are the shell house (which is an incomplete house consisting of a roof and

⁵¹ Hari Srinivas. "Sites and Services." Urban Squatters and Slums.
<http://www.gdrc.org/uem/squatters/s-and-s.html> (accessed 02 02, 2011).

two side walls, but without front or rear walls) and a core house (consisting of one complete room)



Figure 70: Basic latrine in each plot – incremental project, Visakhapatnum, India , 1988



Figure 71: Core house example - Core Housing project, Bangladesh 2009

This variety of approaches emphasizes the need for re-making the case for (incremental housing) projects based on the prior incremental housing experiments which demonstrate the ability of low-income people to house themselves depending on their own resources.⁵²

2.8 Space-saving strategies:

When dwellers attempt to perform all needed house activities in the small dwelling, they face many difficulties in the adaptation between performing these activities and the available spaces.

Accordingly, space-saving strategies aim to assist by providing some concepts for how low-income dwellers and designers can make the best use of the smallest possible spaces.⁵³

2.8.1 Space-saving strategies based on design conception

2.8.1.1 The Elevated Houses

An elevated house costs the same as a typical single-storey detached house; but it holds twice the amount of floor space. With slightly longer pillars, the entire ground floor space could be gained with little or no additional cost. Bathrooms could be situated on the ground floor so as to

⁵² Ibid.

⁵³ Jenny Pluknett, Peter Brooke-Ball. *Srotage & space-saving*. The Hamlyn Publishing Group Limited, 1990.

minimize the length of plumbing lines. The open space underneath the housing unit could then be used for a variety of activities.⁵⁴



Figure 72: Using the open spaces below the unit as public living rooms, Thailand

2.8.1.2 The Hidden Corridor

Several prototype dwellings are designed in which the corridor space is 'hidden' between the two floors. In this prototype, the living room is 3.25-3.50 meters high, and a 2.15-2.25 meters high sleeping nook with adjacent bathroom is also provided.



Figure 73: the concept of the hidden corridor

Another prototype is a temporary housing for new couples. In this housing plan, the sleeping space is placed right above the 2.0 meters high corridor. Like most dormitories, there are common bathroom and kitchen

⁵⁴ CODI, Baan Mankong Collective Housing. <http://www.codi.or.th/housing/SpaceSaving.html> (accessed 06 10, 2010).

facilities that are separated from the dwelling units. This idea could be used for multi-storey buildings as well as elevated single-storey housings.⁵⁵

2.8.1.3 Unstacked Stairs

Having unstacked stairs could actually save space. In most conventional designs however, the stairs are stacked one above the other. The rationale behind this approach is that building functions (stairs, bathrooms, storages, etc.) should be separated. It was the old Newtonian way of dealing with things, but it rendered the space underneath each flight of stairs useless.

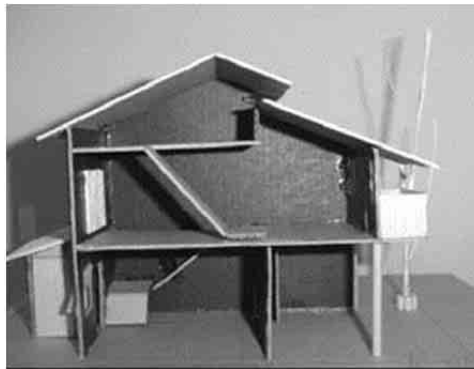


Figure 74: The concept of unstacked stairs

With the unstacked stairs - as shown above - the space underneath the stairs could be used as a bathroom (ground floor) and storage (upper floor).

2.8.1.4 Common Facilities

The building could be significantly shortened by having the common facilities such as bathrooms located outside the units. Shortening the building actually saves space and construction cost because as the building approaches the square shape, the length of its parameter will be shorter.

⁵⁵ Ibid

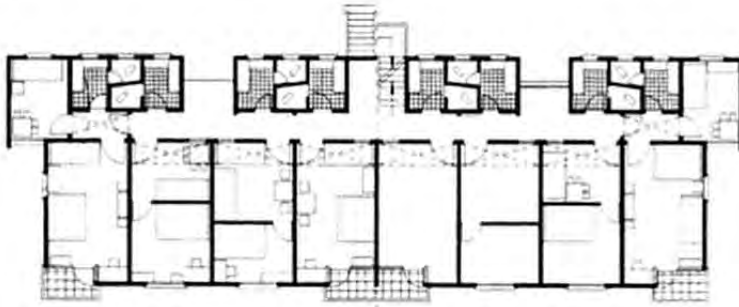


Figure 75: the common facilities located outside the dwelling

Although, this concept is used as a good space-saving strategy, it is not suitable for all inhabitants because of the need for privacy especially in Islamic communities.⁵⁶

2.8.2 Space-saving strategies based on use of dwellings' spaces

2.8.2.1 Overlapping Spaces

Overlapping area of different functions can save space. The kitchen, for example, requires a clear access space for cooking activities. The entry to the unit usually requires about the same amount of access space as shown in the following figure.⁵⁷

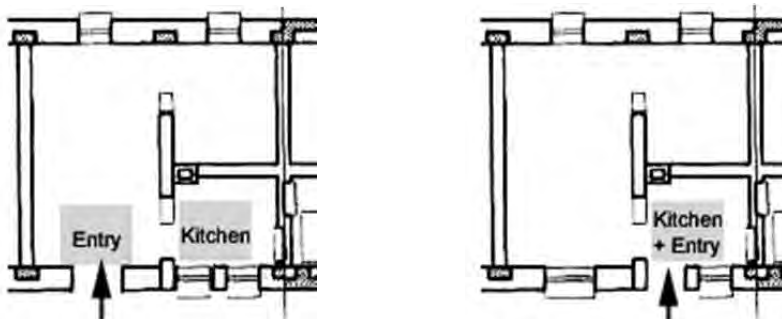


Figure 76: The concept of overlapping spaces

If the two spaces could be combined in one place, it could free up more living space for the unit. In this case, the kitchen is the place where

⁵⁶ CODI, Baan Mankong Collective Housing. <http://www.codi.or.th/housing/SpaceSaving.html> (accessed 06 10, 2010).

⁵⁷ Ibid

the overlapping occurs. In practices, however, architects often overlook this small but significant space saving potential.

This example with the kitchen used for entry lobby may however be subject to rejection due to privacy and tradition concerns.

2.8.2.2 Elevated and hidden Storages

Another often overlooked detail in space-saving design is the location of storage spaces. Storage area could take up valuable residential space if not properly placed. In the United States, many people have chosen to live their lives in solitude. They are artists, intellectuals, writers, musicians, film makers, travelers, and even architects.

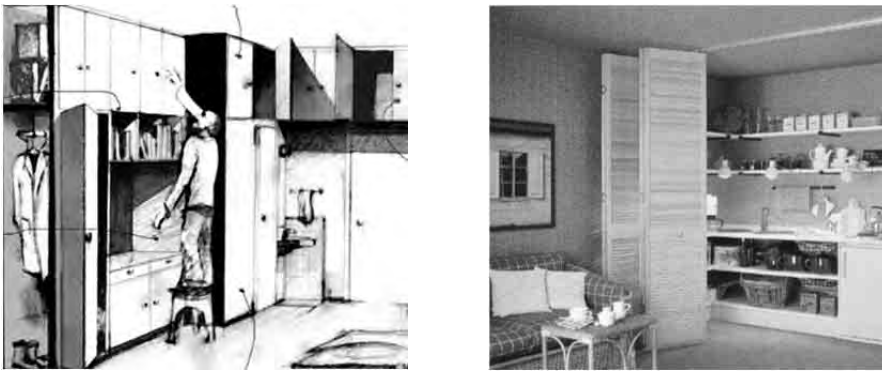


Figure 77: elevated and hidden storage as a good space saving strategy

Most often, they are poor; living in a large city with little space. Having elevated storage could help them recapture these valuable storage areas.⁵⁸

2.8.2.3 Flexible Space

There are no rules for how the space in a home should be used, thus, dwellers should utilize the space in the best way to suit their lifestyle.⁵⁹

Having a flexible space is indeed a space-saving strategy. Flexible space is considered a traditional Japanese modular home and it is usually used to demonstrate the multiple-use of one space and its conversion from a dining room to a bedroom.

⁵⁸ Ibid

⁵⁹ Jenny Pluknett, Peter Brooke-Ball. Storage & space-saving. The Hamlyn Publishing Group Limited, 1990.

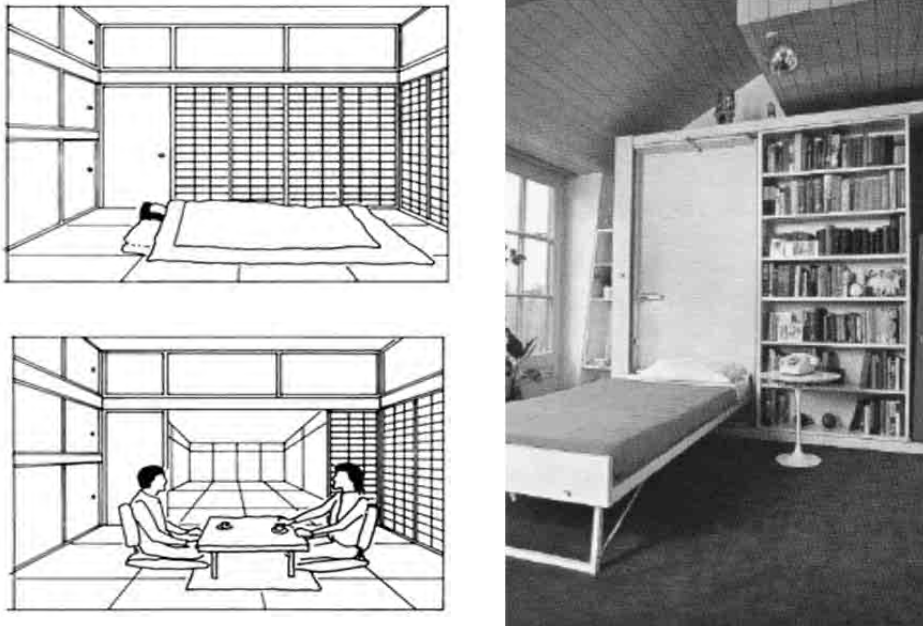


Figure 78: Using movable and folding furniture to create a flexible space

In the Eastern tradition, philosophical discourse tends to revolve around the concept of change, thus, the concept of flexibility is translated into architecture by creating a multi-functional space.⁶⁰

2.9 Quality of life as a principle in low-income housing design

This section discusses the principles which should be considered in creating healthier housing environments achieving 'quality of life' principles.

The residential environment is critical for all people. They spend most of their working time in buildings, and most of their leisure time at home. This fact alone justifies the need to study the role that housing and space play in the quality of life of individuals and communities.⁶¹

⁶⁰ CODI, Baan Mankong Collective Housing. <http://www.codi.or.th/housing/SpaceSaving.html> (accessed 06 10, 2010).

⁶¹ Ricardo García-Mira, David L. Uzzell, J. Eulogio Real and José Rom. Housing, space and quality of life. Ashgate publishing company, 2005.

The principle of quality of life is complex, because it includes a multitude of contributory facets such as housing, education, work and environment.

2.9.1 People have "the right to the city" and "the right to adequate housing"

The concept of the right to the city has become quite common in most countries over the world, significantly, low- and middle-income nations. This concept has been developed to counter this structural process of exclusion. Increasingly, legislation in low- and middle-income countries recognizes the consolidated rights of squatters and slum dwellers in settling urban land and creating communities.⁶²

It is argued that future migrant populations must be enabled to find adequate shelter in accordance with the principles and definition of adequate shelter enshrined in the Habitat Agenda.

The right to adequate housing, which is adopted by all UN member states in the Habitat agenda, is a major right for poor people. This right is an obligation by Governments to enable people to obtain shelter and to protect and improve dwellings and neighborhoods.

The "adequate shelter" is defined as "more than a roof over one's head. It also means adequate privacy; adequate space; physical accessibility; adequate security; security of tenure; structural stability and durability; adequate lighting, heating and ventilation; adequate basic infrastructure, such as water supply, sanitation and waste management, facilities; suitable environmental quality and health-related factors; and adequate and accessible location with regard to work and basic facilities, all of which should be available at an affordable cost."⁶³

Adequacy should be determined together with the people concerned, bearing in mind the prospect for gradual development. Adequacy often varies based on the socio-cultural characteristics of the dwellers and their countries.

⁶² Pietro Garau, Elliott D. Sclar, Gabriella Y. Carolini. A home in the city - UN millennium project - task force on improving the lives of slum dwellers. London: Earthscan - London - Sterling, Va., 2005.

⁶³ Ibid

2.9.2 The rule of regulations in the urban poor housing

Poor families were in fact never consulted about the kind of help that would be most useful to them and they were not given a chance to express their own lifestyle. Undoubtedly, reformers believed themselves to be sufficiently familiar with the lives of the poor to know what they wanted, but their reforms in effect imposed their own views, standards and priorities. Such certainty became a justification for state intervention, for in the words of an influential public figure, ‘a man ought not to be allowed to live in a bad home’.⁶⁴

Regulation can be regarded as a process or activity in which an authority requires certain activities or behavior on the part of individuals, communities, organizations or institutions through a continuing administrative process, generally involving specially designated regulatory agencies.

The right to adequate housing is recognized as an important component of the right to an adequate standard of living in the Universal Declaration on Human Rights of 1948. Most housing regulations and standards have been conceived with new housing development in mind, often of the type of a single house on its own plot. This, in itself, is unaffordable to many urban households. However, increasingly, rental housing has to be revised because it is often no more than a single room per household. Existing houses that have been built outside the rules could also be upgraded.

Previous research into housing standards has brought up a number of issues that ought to be considered in developing housing standards for low-income people. These are summarized as follows:⁶⁵

- Allowing incremental development both in terms of quality and of space, that growth could be horizontal or vertical.
- Involving communities in setting housing standards and regulations.
- Redefining the concept of a dwelling, the amount of floor space required and the permissible plot coverage.

⁶⁴ Alison Ravetz. (2001). *Council Housing and Culture - The History of a Social Experiment*. New York: Routledge.

⁶⁵ Alison Gray. (2001). *Definitions of Crowding and the Effects of Crowding on Health: a Literature Review*. Retrieved 02 01, 2011, from <http://www.msd.govt.nz/documents/about-msd-and-our-work/publications-resources/archive/2001-definitions-of-crowding.pdf>

- Paying more attention to the indoor environment, and particularly to smoke removal.
- Adopting performance standards for construction, to allow for a greater range of materials and components.
- Facilitating the adoption of innovative technologies in regulation.
- Mitigating the risk of disasters in affordable ways.

2.9.3 Public Health Aspects of Housing

The World Health Organization (WHO) Expert Committee on the Public Health Aspects of Housing refers to both occupancy standards and space requirements, which are included in most housing regulations. The Committee's statement has a health focus and acknowledges social and cultural differences.

The Committee states that: 'One of the fundamentals of a healthful residential environment should be a safe and structurally sound, adequately maintained, separate, self-contained dwelling unit for each household if so desired, with each dwelling unit providing at least the following:

- A sufficient number of rooms, usable floor area and volume of enclosed space to satisfy human requirements for health and for family life, consistent with the prevailing socio-cultural pattern of that region and so utilized that living or sleeping rooms are not overcrowded
- At least a minimum degree of desired privacy: for individual persons within the household and for members of the household against undue disturbance by external factors.
- Suitable separation of rooms as used for: sleeping by adolescent and adult members of the opposite sex except husband and wife.

These needs can be expressed in terms of space requirements to perform household activities and/or occupancy standards.'⁶⁶

⁶⁶ Ibid

2.9.4 Social requirements in residential environment

One of the primary objectives of balanced economic and social planning is to achieve high total production and a corresponding increase in the standard of living, while creating a condition in which the social values and culture of a society can be best expressed. The achievement of this dual objective, however, depends on the rational location of production, consumption and services in an efficient, healthful, comfortable and pleasing environment. The report of a WHO Scientific Group on the Development of Environmental Health Criteria for Urban Planning acknowledges that certain socio-physical factors in the environment of predominantly residential areas are essential to promoting and enhancing the physical wellbeing of the residents. This concerns the way individuals and communities form relationships either formally in clubs, associations, or civil, political and cultural groups or informally from day-to-day contact in shops, at work or when using transport. The role of these relationships for personal and social well-being and for reducing stress and anxiety cannot be overstated.⁶⁷

2.9.4.1 Provision of facilities for normal family life, hobbies, recreation, play and social activities

The shelter as a social setting has to accommodate individual and different interests and activities involving any or all of the family, with or without visitors. It must be designed to provide reasonable individual and group privacy as well as facilities for family life as part of a community of friends and relations. The shelter should therefore provide for children's play, homework, sewing and reading, hobbies, entertaining friends and callers, and the intimate physical relation between a man and his wife, in reasonable conditions of privacy from other family members. The adequacy and design of indoor space are two crucial factors in achieving this objective.⁶⁸

2.9.4.2 Provision of facilities for rest and recuperation from sickness or ill-health

The home is not just a place to sleep and eat; it is also a refuge from the rigors of work, school or other activities, and a place to recover from sickness or ill-health. Therefore, peaceful, pleasant surroundings with

⁶⁷ Ray Ranson. (2005). *Healthy Housing - a practical guide*. London: E & F N Spon

⁶⁸ Ibid

sufficient indoor space and provision of privacy are important considerations in healthy housing and personal enjoyment.⁶⁹

2.9.4.3 Provision of reasonable conditions of privacy

Privacy can be expressed by different factors including visual, aural and social criteria. People's reaction to privacy depends as much on their own attitudes as on physical facts. Intrusion relates mainly to being seen, noise, social contact and communication

Clearly, cultural and adaptive aspects need to be considered. In some cultures, all family members share the same room for sleeping whereas in other cultures, private sleeping quarters separated from the rest of the family are preferred. Similarly, in most cultures, people prefer privacy during personal toilet and washing activities while in others, this is not considered important or in some cases achievable. The need for privacy of the dwelling in relation to other dwellings and the wider community also varies significantly. Privacy must be considered in relation to a number of benefits, some of which may be incompatible with other housing hygiene requirements, e.g. large windows increase daylight, but could reduce privacy and security by making interiors visible from outside; rooms; low-rise, high-density development multiplies the chances of intrusions of all kinds. Design measures can only partly compensate for imbalances between opposing factors such as these.

A report by the UK Department of Environment noted that research is needed to analyze physical conditions and people's reactions to them to help establish privacy requirements. This would include such factors as distance and lighting to degrees of perception, the recognition of a person's physical attitude (standing, sitting) and his facial expression. It should relate the extent of view into rooms with the characteristics of the window, the position of the viewer and the angle of view. It also should study the effect of curtain meshes and the two-way loss of light and vision through the curtain, the movement of passersby in terms of angle and duration of the intrusive views and the effectiveness of screening by vegetation. Existing privacy standards are based mainly on spacing and visual standards, which may not always be relevant to sensible town planning.⁷⁰

⁶⁹ Ibid

⁷⁰ Ibid

2.9.4.4 Provision of opportunities for avoiding overcrowding

Overcrowding is still seen as a threat to health, and is defined by statute and controlled by law. Living densities have been important in the spread of infection of diseases, however, currently the threat is more often perceived as being mental rather than physical.

However, human behavior is complex, and problems associated with high density urban living can be greatly ameliorated by material factors such as good soundproofing between dwellings. With small crowded dwellings, the way they are used matters as well.

Many studies have been carried out to investigate the relationship between crowding and mental health. For instance, a study was carried out by Gabe and Williams in 1987 where 452 women were studied between 25 and 45 years of age in West London, finding a J-shaped relationship between crowding and General Health Questionnaire (GHQ) score. In other words, women who lived in households of less than one person per two rooms reported on average just under four psychological symptoms each; those living in rather more crowded households (up to one and a half persons per room) reported on average between two and three symptoms; and those in more crowded homes reported over six symptoms on average.⁷¹



Figure 79: Overcrowding is a threat to physical and mental health.
Ref: Bernard Ineichen, Homes and Health

⁷¹ Bernard Ineichen. (2003). *Homes and Health - How housing and health interact*. London: E & FN SPON.

2.9.4.5 Provision of opportunities for achieving aesthetic satisfaction in the home.

Many studies indicate that residents tend to judge the value of their home and housing environment largely by appearance and perceived visual impressions of various kinds. This may make a sizeable contribution to their moods, i.e. whether they feel contented or depressed. The matter though, is largely conceptual. Housing is often a status symbol, a sign of wealth, achievement or otherwise. In the surroundings of the house, view is an important factor, but the aesthetic nature of view means that it is somewhat difficult to measure or define. What is known is that the benefits of view can be assessed by examining the main components of the visual field and evaluating those factors which by common consent have a pleasing or unpleasing appearance. The total impression of view is affected by the magnitude of pleasant and unpleasant elements but also takes into account shape, size, lighting, movement, color, patterns, texture, detail and variety of the outside environment. Even small changes to one of these factors can influence satisfaction of view. These same factors apply equally to aesthetic satisfaction within the home. In these cases, provisions such as furnishings and consumer appliances are important and relevant to perceived satisfaction.⁷²

2.9.4.6 Provision of opportunities to enable work activities to be carried out at home

In some countries, one or more members of the family often use the home as a place of work. However, the adaptation of traditional housing for some work activities may not always be possible, although in many cases, a spare room can be easily converted into a suitable workroom.

Working from home is also a trend in developed, partly because of the increase in use of computer and information technology.

Accordingly, the suitability of housing for carrying out work activities must depend upon the nature of the work, which might be a source of additional home threats and may require additional natural and artificial lighting. Hence, possible work activities in the home should be

⁷² Ray Ranson. (2005). *Healthy Housing - a practical guide*. London: E & F N Spon.

monitored in order to advise on any necessary safety or health precautions or to regulate operations through other control procedures.⁷³

2.9.5 Green home as an international conception

The main reason for adapting green home conception is to create better homes that are healthier to live in, easier on the environment, more valuable over the long-term, and more delightful to come home to.⁷⁴

Some of the direct benefits of good green homes are summarized as follows:

2.9.5.1 Create more comfortable home:

A good green home is a more comfortable home. It's carefully built and well insulated so it doesn't overheat in the summer or feel chilly in the winter. Daylight, cross-ventilation, and other low-tech measures help keep spaces naturally and comfortably in tune with our bodies and the outdoors. Efficient lighting, heating, and cooling systems kick in when simpler solutions can't do the job on their own.⁷⁵

2.9.5.2 Create healthier home:

A good green home has fewer building products and furnishings made from materials that might undermine our health. Good ventilation, provided either by natural or mechanical means, helps keep the air fresh. Daylight brightens the rooms, providing an uplifting atmosphere.⁷⁶

2.9.5.3 Create greater value home:

Good green homes are built to last, with quality design and construction that hold up over time. They cost less to live in and maintain because they're built to be energy efficient and durable.

The deeper benefits may be less obvious. Using an energy-efficient light bulb, for example, saves money. It also results in less demand for electricity that, in turn, results in less pollution from power plants, which may help a child with asthma breathe a little easier. Choosing recycled plastic lumber for a deck will spare its owner from ever having to spend a

⁷³ Ibid

⁷⁴ Jennifer Roberts. (2003). Good green homes. Salt Lake: Gibbs Smith. Publisher.

⁷⁵ Ibid

⁷⁶ Ibid

Saturday afternoon staining it and in a broader context it means that somewhere a tree remains standing.⁷⁷

Summary

This chapter has discussed the way of thinking for designers and the dwellers in order to monitor the gap between these two visions. Thus, there is an obvious discordance in priorities in providing functional needs of space between low-income habitants' vision and designers' vision. , this discordance is the result of a serious lack of knowledge on the part of the local architect concerning social and behavioral aspects of low-income dwellers.

As a result of studying the housing dilemma for low-income inhabitants in Cairo, the evidence reveals that most of low-income dwellers attempt to increase the area of their habitable spaces such as living room and bedrooms in order to perform their essential living activities or adding more rooms.

On the other hand, there is no significant difference in size between low and high price furniture. Manufacturers usually reduce the price of the furniture by using Inexpensive raw materials, neglecting the real demand for small and compact furniture in order to achieve the optimal use of the available space.

This chapter also has illustrated foreign concepts to better understand the low-income housing dilemma, and to demonstrate a variety of design approaches which are adopted to solve this problem such as establishing small and Tiny House, using the concept of incremental house, the concept of residential open building and the commonly used space saving strategies.

In the end if this chapter, the principles which should be considered in creating healthier housing environments achieving 'quality of life' principles has been discussed.

⁷⁷ Ibid

Part 2: Functional structuring of shape as a new approach to recognizing the human considerations of low-income housing

This Part consists of two chapters. The first chapter explores how low-incomeers coexist in their dwellings. The second chapter discusses the correlation between dwelling spaces according to the social behavior of the dwellers

Chapter 3: Analytical functional study of spaces in low-income houses

Preface

House remodeling is a complex, expensive, and emotional process experienced by many dwellers. Major changes in home design may occur in response to changes in family lifestyle or to desired expansion.

This chapter will explore how low-incomers coexist in their dwellings based on their socio-cultural characteristics in order to meet their essential needs.

Our data sources on work and investments in the home include a short questionnaire; a digital photo archive of all interior spaces and household artifacts as surveyed, along with detailed floor plans that illustrate all family activities.

3.1 Anthropometrics and Ergonomic studies

Anthropometry is the branch of human sciences that deals with body measurements: particularly with measurements of body size, shape, strength and working capacity. Certainly there is no regional divergence in the main dimensions of the human body, regardless of many divergences in how they practice their human activities.⁷⁸

Ergonomics is the science of work; studying the human beings who do it and the ways it is done, the tools and equipment they use, the places they work in, and the psychosocial aspects of the working situation.

In the definition of Ergonomics, the word ‘work’ holds a number of meanings. In a narrow sense it is what we ‘do for a living’. However, the term ‘work’ may be applied to almost any planned or purposeful human activity, particularly if it involves a degree of skill or effort of some sort.

Hence, Work involves the use of tools. Ergonomics is concerned with the design of these tools, and by extension with the design of artifacts and environments for human use in general. Therefore ergonomics can be defined as a science concerned with work, and in the same time as a science concerned with design.⁷⁹

In short, Ergonomics is considered the science of fitting the job to the worker and the product to the user.

⁷⁸ STEPHEN PHEASANT Body Space, Anthropometry, Ergonomics and the Design of work [Book]. - London : Taylor & Francis Group, 2003.

⁷⁹ Ibid

3.1.1 The Social and Economic Value of Ergonomics

Ergonomics can contribute to human well-being in terms of safety, health, and comfort.

Many situations of everyday-life are risky to health. In many countries, diseases of psychological illnesses constitute the most important causes of absence due to illness, and of occupational disability. These conditions can be partly ascribed to poor design of equipment, technical systems and tasks. Thus, Ergonomics can help work-related health problems by improving working conditions.

Ergonomics can contribute to the realization of user-friendly products. Nowadays, a lot of consumer products are promoted as ergonomically, suggesting comfort and pleasure during the use of the product.⁸⁰

Finally, ergonomics can serve both social goals (well-being) and economic goals (performance). At society level, ergonomics can contribute to the reduction of costs due to preventable health problems such as work-related musculoskeletal disorders by improving working conditions. The societal costs include health care costs for the treatment of disorders and costs related to the loss of labor productivity due to absence from work.⁸¹

3.1.2 Ergonomics and design

Ergonomics has a strong influence on the design process of any product, and it will depend upon the circumstances. There are certain criteria that are commonly important and should be considered in the design process and include the following⁸²:

- Functional efficiency.
- Ease of use.
- Comfort.
- Health and safety,
- Quality of working life.

⁸⁰ Jan Dul, Bernard Weerdmeester Ergonomics for Beginners- A Quick Reference Guide [Book]. - London : Taylor & Francis Press, 2008.

⁸¹ Ibid

⁸² STEPHEN PHEASANT Body Space, Anthropometry, Ergonomics and the Design of work [Book]. - London : Taylor & Francis Group, 2003.

Nowadays, the term of ergonomic is widely used in advertising. An example to this is the marketing of furniture units that are supposed to be ‘good for you’ in terms of some theory concerning how to sit correctly. Thus, the main concept of using ergonomics in the design of any product is to better fit it for human use.

This concept of design is correspondent to the concept of functional design. The American architect Louis Sullivan is credited with originating the slogan ‘form follows function’ (c. 1895). He meant that functional considerations alone are sufficient to determine the form of an object, and that ornament is therefore superfluous. According to this philosophy, functional objects are, by definition, aesthetically pleasing. This is called ‘functionalism’. It was the dominant theory underlying the so-called ‘Modern Movement’ in design.

Around the middle of the eighteenth century, function started to play an increasingly accessory role as design was dominated by a succession of aesthetic theories or ‘styles’, the most recent of which at the time was the so-called ‘functionalism’. However, it should be seen as an aesthetic demand for absence of ornament, or ‘truth to materials’, rather than a particular concern with end use.⁸³

So, in reality, modernism did not really serve ergonomic concerns and purposes, as much as it sought to devalue ornamentation per se. And thus it may be said that whatever the artistic trend may be, ergonomic studies should – by definition - be included in functional considerations of design.

3.1.3 The user-centered approach

The Ergonomic approach to design may be described as a user-centered design approach.

In this design approach, every good project starts with a task analysis and ends with a user trial. A task analysis is attempted to define and state what the user is actually going to do with the product. This is stated in terms of the desired ends of the task, the physical operations the user will perform, the information-processing requirements it entails, the environmental constraints that might pertain, and so on. An effective task analysis will clarify the overall goals of the project, establish the criteria that need to be met, point out the most likely areas of mismatch, and so forth.

⁸³ Ibid

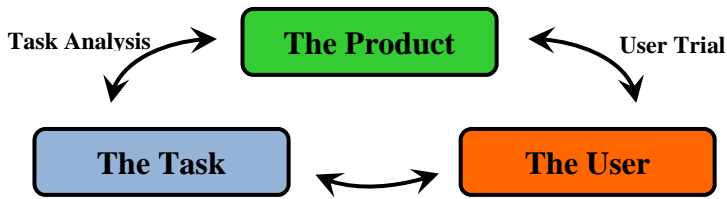


Figure 80: User-centered design

A user trial is an experimental investigation in which a sample of people tests a prototype version of the product under controlled conditions. Ideally they should be a representative sample of the population of users for whom the end product is ultimately intended. Likewise, it is very important to ensure that the circumstances under which the trial is conducted are a reasonably valid approximation to those of real-world use.⁸⁴

3.1.4 Ergonomics in performing home activities

In general, the home may be divided into a number of discrete spaces, each of which is specialized for the performance of a particular range of purposeful activities, which could be defined as ‘working tasks’. Most typically the boundaries of these spaces will coincide with the rooms of the house. The spaces may overlap physically to some extent, and tasks may intrude to some extent from one space to another.⁸⁵

These working tasks can be categorized and illustrated as follows.

3.1.4.1 Home activities

The purpose of any piece of furniture is to provide stable bodily support in a posture that is:

- a) Comfortable over a period of time.
- b) Physiologically satisfactory.
- c) Appropriate to the desired task or activity.

Seats as an example are uncomfortable in the long run, but some seats become uncomfortable more rapidly than others, and in any particular seat, some people will be more uncomfortable than others.

⁸⁴ Ibid

⁸⁵ Ibid

Comfort may also be influenced by the task or activity that the user is engaged in at the time. In other words, comfort will depend upon the interaction of seat characteristics, user characteristics, and task characteristics⁸⁶

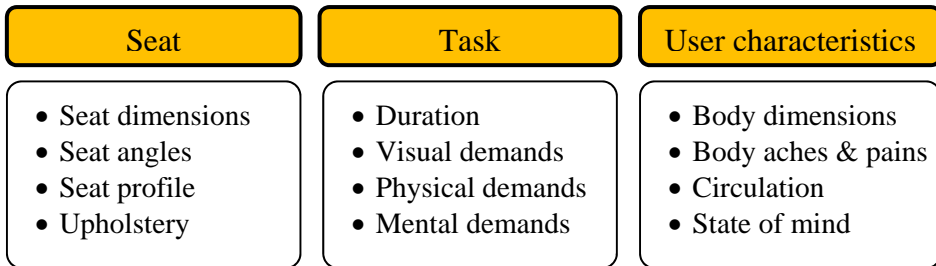


Figure 81: Determinants of sitting comfort

Sleeping spaces are another example for applying the results of the ergonomics study of home activities. Considering the amount of time, which is spent in bed and the importance of sound sleep to our overall well-being it seems remarkable how little formal scientific study has been devoted to the ergonomics of bed design.⁸⁷

The kitchen is one of the specialized spaces of the home that can most obviously be treated as a functional working area, it is perhaps because of this definitive fact that it has been discussed most extensively in ergonomics literature.

The bathroom should combine hedonistic luxury with functional efficiency. It is an environment in which to relax and unwind, soaking in a hot tub, but also a configuration of workstations for the practical activity of washing, grooming and excretion (assuming a special room is not set aside for the latter). The Bathroom by Alexander Kira (1976) is a classic of user-centered design research, which every interested person should endeavor to read.

The following table illustrates home ergonomics data in the analytical study of home activities in low-income houses based on inhabitants' lifestyle and socio-cultural characteristics.⁸⁸

⁸⁶ Ibid

⁸⁷ Ibid

⁸⁸ Julius Panero and Martin Zelnik. Human dimension & Interior spaces. New York: Whitney library of design an imprint of Watson-Guptill Publications, 1979.

Table 7: The used home ergonomics data in the analytical study of home activities⁸⁹

| |
|---|
| Seating in general : |
| Seating Width (in general) |
| Minimum dimension = 61cm - Maximum dimension = 76 |
| Sofa Seating (Minimum dimension) |
| Minimum width = 121.9 cm - Minimum depth (sofa + clearance) = 106.7 cm Minimum clearance = 31.6 cm |
| Eating : |
| Minimum dimension for eating space (one person) using dining table |
| Minimum dimension = 76.2 cm - Maximum dimension = 91.4 cm |
| Maximum dimension for eating space (one person) using dining table |
| Minimum dimension = 121.9 cm - Maximum dimension = 152.4 cm |
| Seating on the floor : |
| Using (Tablia) in eating on the floor |
| width dimension = 62.5:70 cm - depth dimension = 62.5:87.5 cm |
| Using Furniture : |
| Furniture accessibility (wall unit) - minimum space for a cabinet with door |
| Working zone = 45.7 cm Clearance zone for opening cabinet doors = 121.9 cm |
| Furniture accessibility (wall unit) - minimum space for a cabinet with drawers |
| Working zone = 45.7 cm Clearance zone for opening cabinet drawers = 121.9 cm |

⁸⁹ For more details about home ergonomics used in the analytical study of home activities, see (appendix 4)

| |
|---|
| Sleeping : |
| Sleeping spaces |
| <p>Single bed: Minimum dimension = 198.1*121.9 cm Optimum dimension = 213.4*137.2 cm Maximum dimension = 213.4*152.4 cm</p> <p>Double bed: Minimum dimension = 198.1* 91.4 cm Clearance between beds = 91.4 cm - Working zone beside the bed = 116.8 cm</p> |
| Dressing : |
| Dressing minimum space |
| Minimum width = 172.7 cm - Minimum depth = 116.8 cm |
| Kitchen activities : |
| Kitchen preparation center |
| <p>furniture dimension = 61 cm - Accessible area = 45.7 cm Working zone = 45.7 cm - Minimum width = 91.4 cm</p> |
| Sink center |
| <p>Sink dimension = 61 cm - Working zone = 101.6 cm Circulation clearance = 76.2 cm</p> |
| Bathroom activities : |
| Bathtub (hand basin) minimum space |
| <p>Bathtub dimension = 53:66 cm - Working zone = 45.7 cm Circulation clearance = 76.2 cm</p> |
| Showering space |
| Minimum working zone dimension = 106.7 cm |
| Closet minimum clearance |
| <p>Minimum clearance in the front of a closet = 106.7 cm Closet dimensions = various</p> |

3.2 Analysis methodology

One of the most critical issues in housing design is spatial functionality, an area seemingly overlooked by house builders.

Designers frequently furnish and decorate their show homes. Visits carried out as contextual research to design firms, have shown that some designers enhance their house designs by omitting items of furniture that cannot conveniently be removed.⁹⁰ They also resort to using smaller sizes than normal.

However, functionality has never been fully adopted by house builders. This may be due to the variety of furniture available, but may also reflect their unworkable designs. Where furniture is shown on the sales information it can be misleading. The fact that plans are not shown to a particular scale impedes potential buyers in their efforts to critically evaluate the designs.

The main goal of the studies in the coming sections is to present the low-income family lifestyle and the influence of their socio-cultural characteristics on their way of coexisting in all home spaces, and to effectively demonstrate how low-income dwellers live in their homes.

Furthermore, this analytical study is undertaken based on ergonomic data, which is matched with dwellers' lifestyle. These ergonomic data remain largely relevant today, despite changes in technology and habits. These changes are relatively minor and can safely be ignored in determining appropriate room sizes.

3.2.1 Space as configuration

It is clear that all social activities are not attributes of individuals, but patterns, or configurations, formed by groups or collections of people. They depend on an engineered pattern of co-presence, and indeed co-absence. Very few of the purposes for which buildings are built and environments are not 'people configurations' in this sense. Therefore, the relation between people and space will be found at the level of the configuration of space. However, in most reasonable spaces, most human activities can be carried out. In this sense, any habitable space is defined

⁹⁰ Beverley N. West, Stephen Emmitt. "An analysis of new speculative house plans in the UK." *Design Studies*, 05 2004: 275-299.

as configuration formed by performing several activities by group of users in a recognized space.⁹¹

3.2.2 Regular shapes as configurations

Clearly, any shape can be represented as a regularly constructed mesh of cellular elements, provided the mesh can be scaled as finely as needed.⁹²

Based on this method of presentation, the following studies are carried out using a square grid of five-centimeter cells. This five-centimeter grid was chosen because the multiples this value (five-centimeters) are used largely in determining the dimensions of the furniture and other appliances.

Every cell of the grid is connected to a database which contains all needed data for the analytical studies which will be illustrated in the following parts.

The main goal of using the grid analysis method is to reduce all space to small analytic cells, in order to present the lifestyle of the habitants in numerical data based on the way they actually use home spaces. Surely, this way of living (space-use) is reflected from the performing of different home activities using the available furniture and appliances and taking advantage of all home spaces.

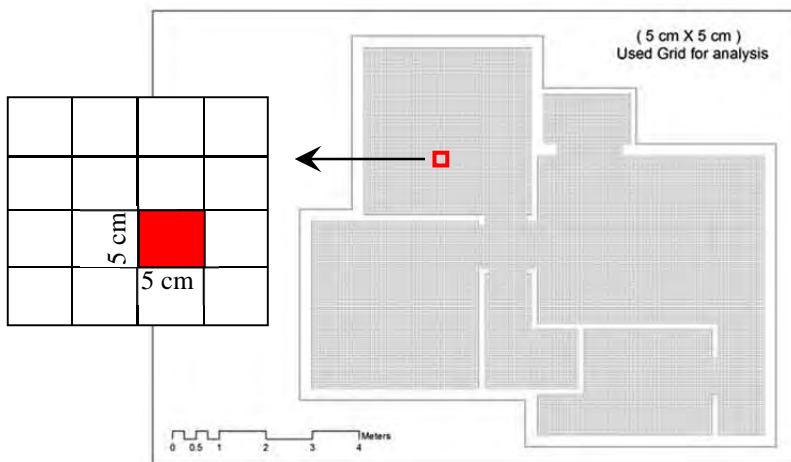


Figure 82: Transformation of spaces into analytical cells

⁹¹ Bill Hillier. (2007). *Space is the machine, A configurational theory of architecture*. London: Space Syntax.

⁹² Ibid.

The following figure illustrates how the analytical cells are used to express the performing of different home activities using the existing furniture and appliances. Furthermore, it displays the various kinds of data, which feeds the connected database. This means, that every cell of the grid has its distinct separated database.

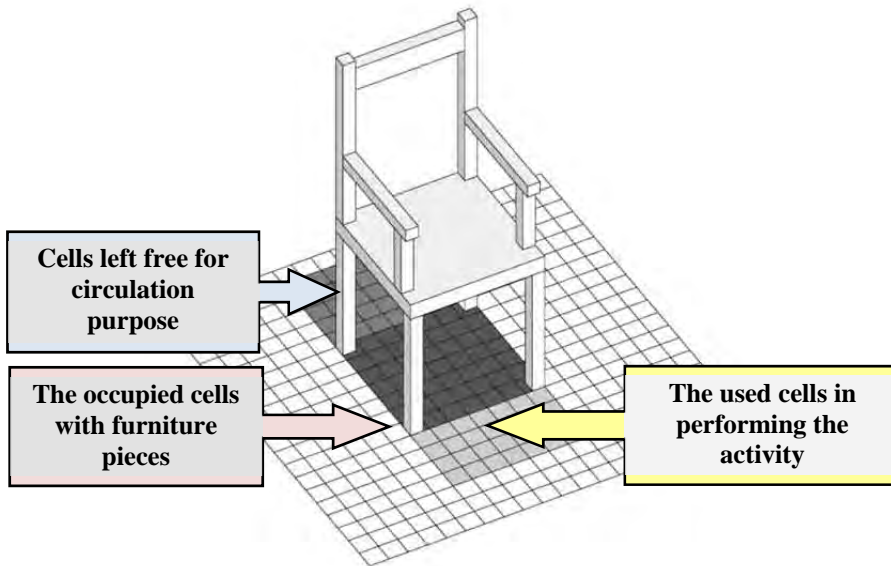


Figure 83: example of using the analytical cells in expressing the performing different home activities using the available furniture

3.2.3 Analysis sample

To perform the analytical study, the researcher had to apply it to a real dwelling sample inhabited by a low-income family.

The following table illustrates the family sample that consists of five members living in a small dwelling with 63 m² total area containing three habitable rooms (living room and two bedrooms).⁹³

Table 8: definition of the analysis family

| Case study (a): | | |
|-----------------|------------------------|-----------------------|
| 1 | Dwelling area | 63 m ² |
| 2 | No. of habitable rooms | 3 rooms |
| 3 | No. of bedrooms | 2 bedrooms |
| 4 | No. of family members | 5 persons |
| 5 | No. of children | 3 (2 boys + 1 girl) |

⁹³ For more details about the selected case study, see (appendix 2)



Figure 84: Architectural plan for the analysis sample.

The following figure illustrates the furniture which is located on the floor in the study sample, and shows the existing position for each piece.

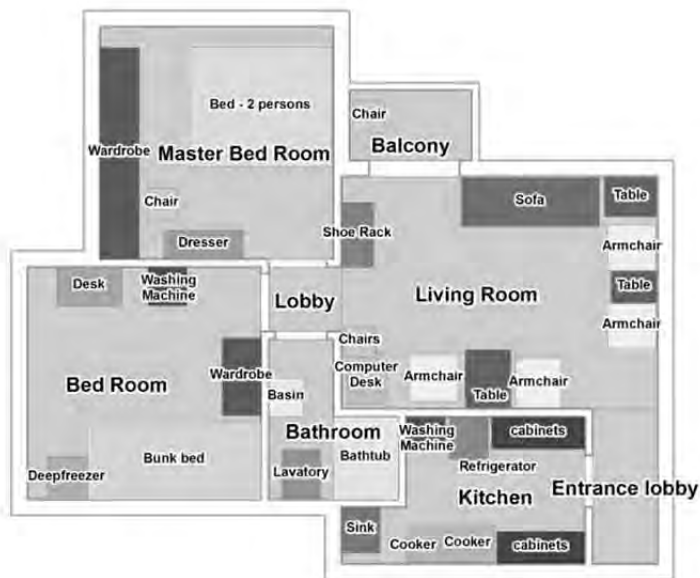


Figure 85: Locations of furnishing units on the floor

3.2.4 The tool used for analysis

To undertake the analytical studies, it is required to use a database tool that allows connecting the resulting data from the socio-cultural study which displays the lifestyle of low-income families, to the grid cells of the home spaces based on the way home activities are performed using the existing furniture.

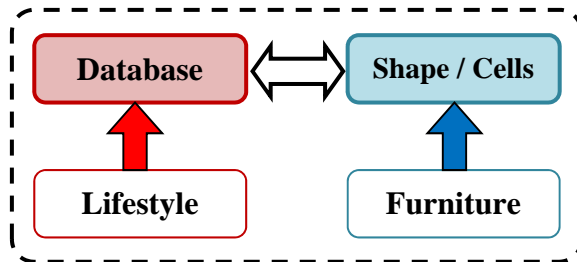


Figure 86: analysis process using the required tool

ArcInfo is the desktop GIS software application selected for the study. It includes all the desired functionality of spatial analysis, and extensive data manipulation.⁹⁴ This program is usually used for geographical and land spatial analysis. However, it can also be used to perform the required analytical studies for home spaces as it provides the connection between the spaces' grid cells and the data base tables, and then, producing this data in visual maps.

3.2.5 Analysis methodology

To analyze the efficiency of home spaces based in performing essential home activities, a set of analytical studies should be undertaken.

Using the selected analysis software, three sets of analysis should be performed, and can be illustrated as follows:

- a) Determining the effective area of home spaces according to low-income lifestyle.
- b) Identifying conflicting areas which hinder the performance of home activities.
- c) Determining the duration of use of home spaces in performing home activities.

⁹⁴ ArcInfo. <http://www.esri.com/software/arcgis/arcinfo/index.html> (accessed 2 25, 2011).

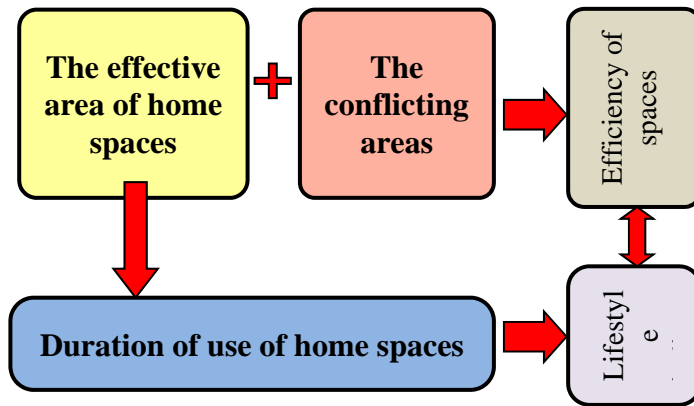


Figure 87: Analysis methodology

3.3 Determining the effective area of home spaces according to low-income life style

When one deals with the effective area in the dwelling, many studies should be carried out to determine the quality of home spaces according to the lifestyle of habitants.

These studies should represent all living activities performed in home spaces, reflecting the socio-culture properties of the habitants.

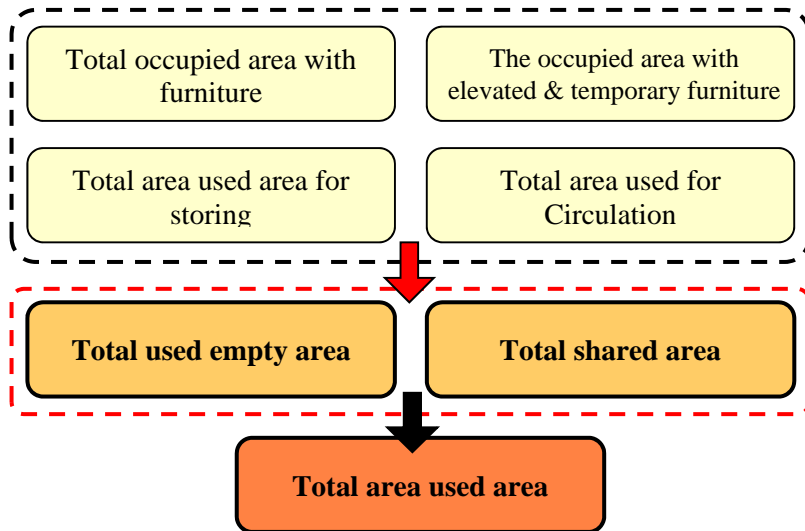


Figure 88: The analytical studies needed to determine the effective area of home spaces and the relation between these studies

The chart above explains the flow of analytical studies which should be carried out in order to determine the effective area of home spaces referring to the lifestyle of the habitants.

3.3.1 Determining the total occupied area with furniture

The main target of this study is to identify the use of furniture owned by a low-income family.

Two basic factors affect this analytical study. The first factor is how all home activities are performed using the available furniture. The second is how to avoid feeling (cramped) which is dependent on the free visible area left for avoiding this feeling.



Figure 89: Examples of the furniture owned by the case family

By applying the furniture occupancy on the analytical grid, the occupied area with furniture could be illustrated in the following analytical figure.

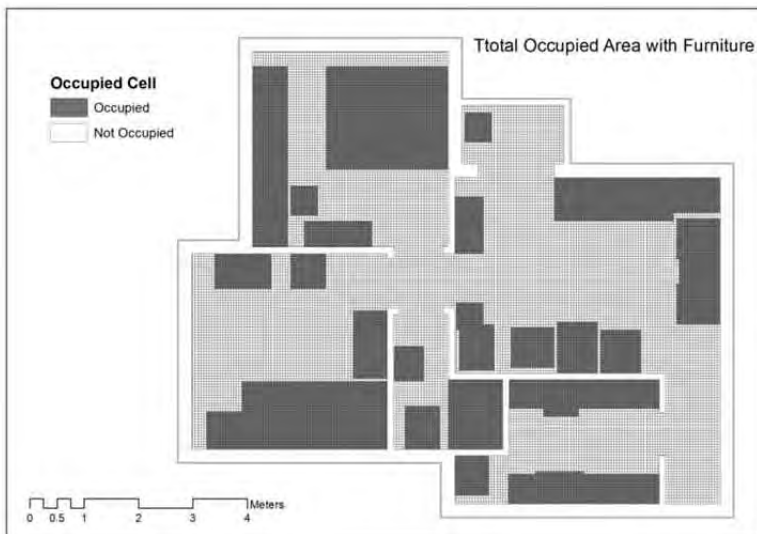


Figure 90: Total occupied area with furniture

The following table illustrates the conclusion from the previous study.

Table 9: Percentage of Total Occupied Area with Furniture:

| No.of used cells | No.of all cells | Used area in m2 | Percentage |
|------------------|-----------------|-----------------|------------|
| 10544 | 24538 | 26.1152 | 43% |

As an output from the mentioned table, the low-income family sample was found to have used about 43 percent from the total area in occupation by furniture. This percentage is considered an indicator of how much free space can be obtained by repositioning, omitting or manipulation, of furnishing units.

3.3.2 Determining the occupied area with elevated and temporary furniture

This study is divided in two parts. The first is to determine the occupied area with temporary furniture such as using movable or folded furniture in performing various activities like eating or studying.

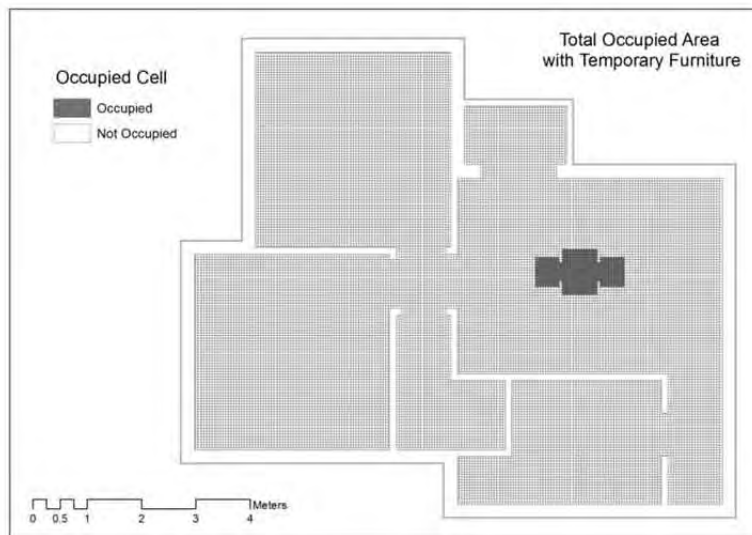


Figure 91: Total occupied area with temporary furniture

Table 10: Percentage of Total Occupied area with Temporary Furniture:

| No.of used cells | No.of all cells | Used area in m2 | Percentage |
|------------------|-----------------|-----------------|------------|
| 433 | 24538 | 1.0825 | 02% |

As output from the mentioned table, the low-income family sample occupied no more than 2 percent of the total area by temporary furniture.

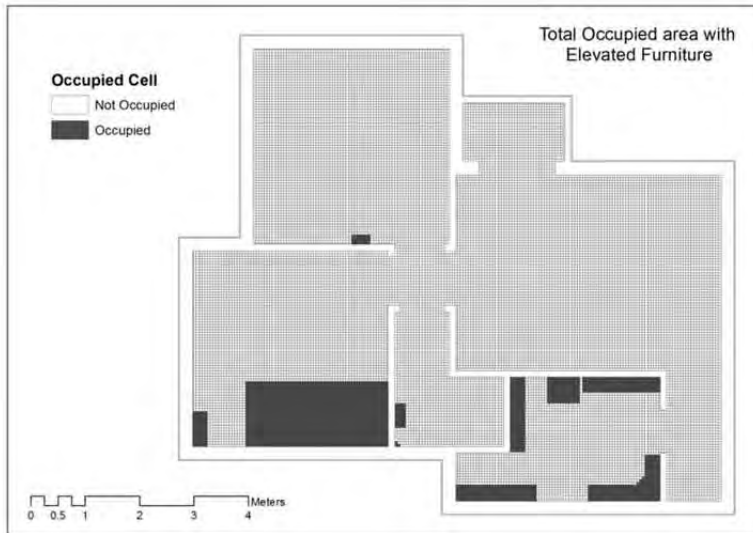


Figure 92: Total occupied area with elevated furniture

Table 11: Percentage of Total Occupied area with elevated furniture:

| No.of used cells | No.of all cells | Used area in m2 | Percentage |
|------------------|-----------------|-----------------|------------|
| 2293 | 24538 | 5.5788 | 09% |

As output from the previous table, the low income family sample used about 9 percent of the total area in elevated furniture.

3.3.3 Determining the total area used for storage

This study investigates the area used for storing home goods and things that are rarely used (like old furniture or appliances).



Figure 93: Area used for storing home goods and things that are rarely used

The calculated area can be used as an indicator for the area which may be specified for separated storage in future designs.



Figure 94: Total used area for storing

Table 12: Percentage of Total Used Area for storing:

| No.of used cells | No.of all cells | Used area in m2 | Percentage |
|------------------|-----------------|-----------------|------------|
| 883 | 24538 | 2.1535 | 04% |

As output from the previous table, the low-income family sample used about 4 percent from the total area for storage.

3.3.4 Determining the total area used for Circulation

According to anthropometric data, there is always a specified free area that is used in the house for circulation between spaces. Although this area does not get occupied by any furniture pieces, it could sometimes be used for any temporary activity.

The following table shows the minimum and maximum spaces which should be left free for circulation purpose.⁹⁵

⁹⁵ Julius Panero and Martin Zelnik. Human dimension & Interior spaces. New York: Whitney library of design an imprint of Watson-Guptill Publications, 1979.

Table 13: Circulation zone dimensions

| Circulation Zone for one person | |
|--|--|
| Minimum dimension = 76.2 Maximum dimension = 91.4 | |
| Circulation Zone for two persons | |
| Minimum dimension = 121.9 Maximum dimension = 152.4 | |

Based on the data in the previous table, the total area used for circulation in the case unit can be approximated in the following figure.

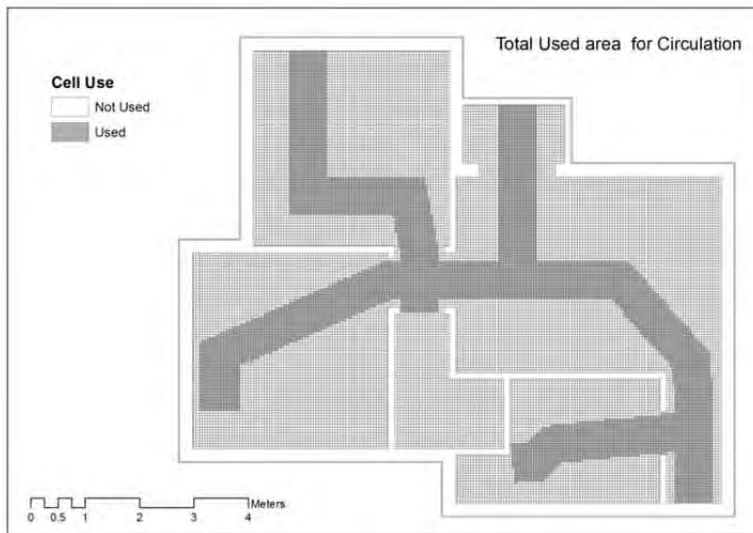
**Figure 95: Total area used for circulation in home spaces**

Table 14: Percentage of Total Area Used for Circulation:

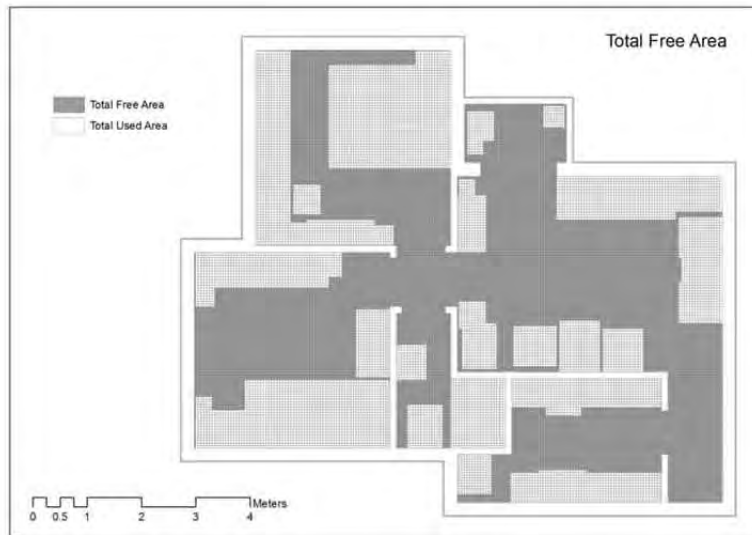
| No.of used cells | No.of all cells | Used area in m2 | Percentage |
|------------------|-----------------|-----------------|------------|
| 7123 | 24538 | 17.7715 | 29% |

As output from the table, the low income family sample shows to make use of about 29 percent from the total area for circulation purpose.

3.3.5 Determining the total empty (unoccupied) area

After determining the occupied area with furniture (settled-temporary-elevated) and the area used for storing things and circulation, this study calculates the extent of use of the free space in the dwelling in order to determine the extent of exploitation of this space in performing the daily home activities.

Initially, the following figure displays the total free (unoccupied) area. This area is usually free to be used for circulation between spaces and as a clearance used for performing various activities.

**Figure 96: Total free area****Table 15: Percentage of Total unoccupied area:**

| No.of used cells | No.of free cells | Used area in m2 | Percentage |
|------------------|------------------|-----------------|------------|
| 9138 | 24538 | 22.7396 | 57% |

As an output from the this table, about 57 percent of the total area is left free in order to be used for circulation purposes or as a clearance area.

The following figure illustrates the use of this free area, which is used to perform the following activities:

- Temporary activities such as (playing – praying – eating)
- The required clearance area to perform activities or to use furniture

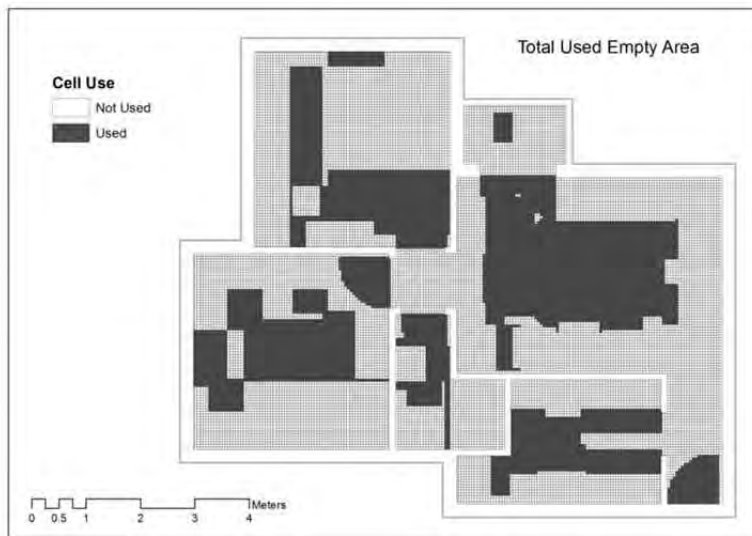


Figure 97: Total used free area

Table 16: Percentage of Total used empty area:

| No.of used cells | No.of free cells | Used area in m2 | Percentage |
|------------------|------------------|-----------------|------------|
| 9138 | 13994 | 22.7396 | 66% |

The table shows that the low income family sample used about 37 percent of the total area in performing various activities in the available free area.

3.3.6 Determining the shared area in multiple activities

Based on the performed activities in the free area from the dwelling, the shared area (used to perform more than one activity) can be determined. This percentage indicates how low-income families use the living room as a flexible space in order to perform more home activities in the same area.

The family sample often uses the area of the living room in performing many activities during the day such as eating on a movable low table (tablia), studying on a movable table, playing, praying, and sleeping on the sofa.

The area of the bedrooms is also used for performing many activities such as dressing and sleeping.

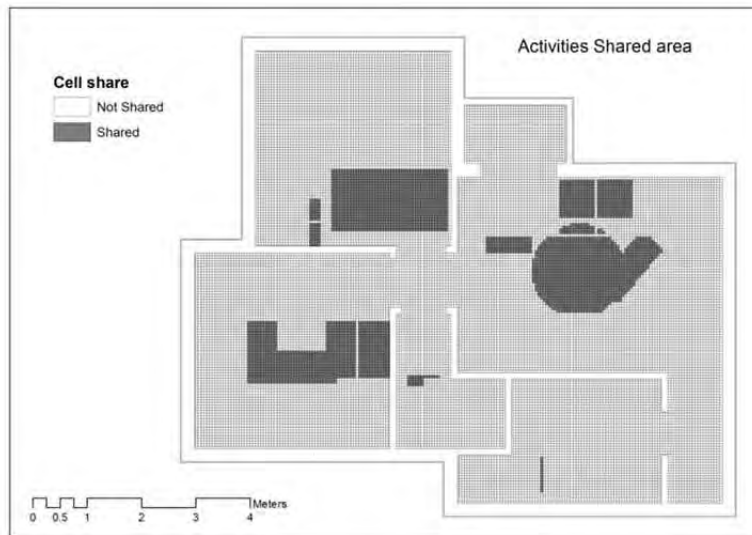


Figure 98: Total shared area

Table 17: Percentage of shared area used to perform various activities:

| No.of used cells | No.of all cells | Used area in m2 | Percentage |
|------------------|-----------------|-----------------|------------|
| 3591 | 24538 | 8.9525 | 15% |

The table indicates that the low-income family sample uses about 15 percent of the total area as a shared area for performing more than one activity.

3.3.7 Determining the total area used in performing all home activities

The study is considered the apex of all previous studies. It calculates all performed activities and the total used cells, even if these cells are actually used in performing activities, or are left free as clearance in order to perform any temporary activities.

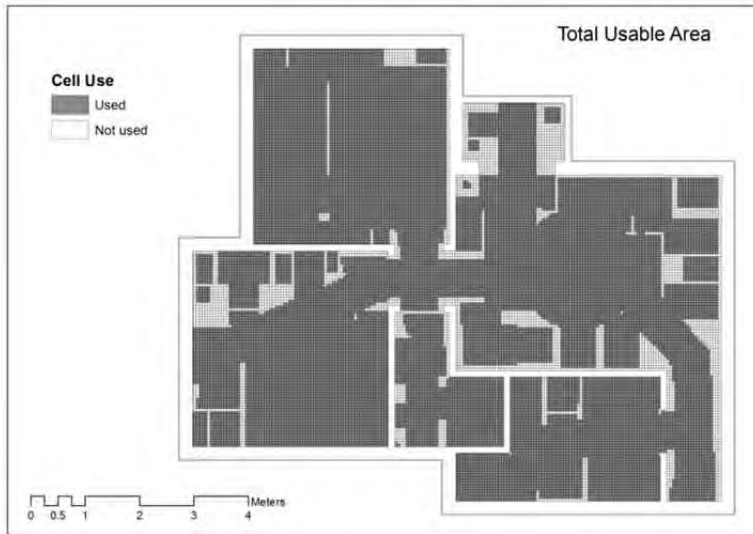


Figure 99: total used area

Table 18: Percentage of Total Used Area:

| No.of used cells | No.of all cells | Used area in m2 | Percentage |
|------------------|-----------------|-----------------|------------|
| 21495 | 24538 | 53.2997 | 88% |

The previous table tells us that the sample family uses about 88 percent of the total area of the dwelling in performing all household activities.

3.4 Determining conflicting areas which hinder the performance of home activities.

This study monitors the areas where the existing furniture intersects or (conflicts) with the area used in performing all home activities (circulation – clearance – daily activities). The researcher calls such areas (Conflicting Areas)

Determining conflicting areas can be used as an indicator of the efficacy of furnishing and the non-influential conflicting percentage.

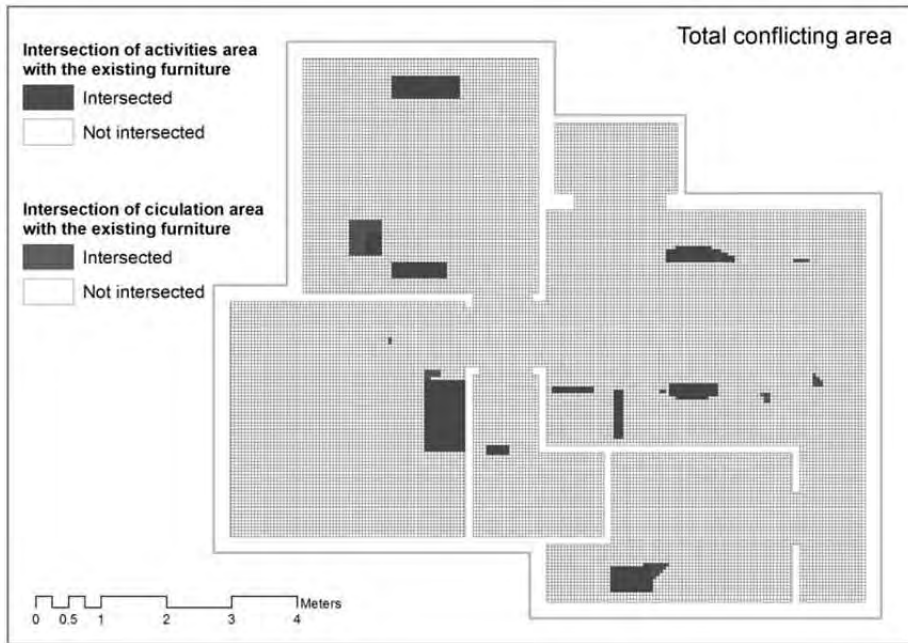


Figure 100: Total conflicting area

Table 19: Percentage of total conflicting Area

| Intersection of circulation area with the existing furniture | | | |
|---|-----------------|-----------------|------------|
| No.of used cells | No.of all cells | Used area in m2 | Percentage |
| 209 | 24538 | 0.5225 | 1% |
| Intersection of activities area with the existing furniture | | | |
| No.of used cells | No.of all cells | Used area in m2 | Percentage |
| 918 | 24538 | 2.273 | 4% |
| Total conflicting area | | | |
| No.of used cells | No.of all cells | Used area in m2 | Percentage |
| 1083 | 24538 | 2.573 | 4.5% |

As output from the previous table, about 4.5 percent of the total area may be considered as conflicting area which impedes the performing of home activities smoothly.

3.5 Duration of Use of home spaces in performing home activities

This analytical study is another theoretical application that could make use of the grid studies, highlighting the actual use of dwelling

spaces through time, applying what the researcher calls '*the space and time studies*' method.

This method makes use of a careful documentation of the dwelling's details, tracking the use of its spaces through time. Use of spaces can be observed such as the exclusive or restricted use of some spaces—what is referred to as spatial appropriation. Appropriation may reflect the intra-family hierarchy and/or special work demands.

In addition, specific functional areas within the home may be reserved for certain family members, marked by equipment that is simply asserted to be someone's personal property. This study provides a tool to investigate this dimension of home activities. It also identifies heavily shared spaces, where family interactions take places that are not restrictive.⁹⁶

3.5.1 Analysis sample

The following tables display the duration of use of each habitable space and the activities which are usually performed in it. They also determine the particular performer of these activities. These tables were inferred from the social questionnaire and the analysis of the case study which was carried out by the researcher.

These tables represent the usual daily scenario of dwelling spaces; however, there are many different scenarios that could occur on distinct occasions such as weekends or when the family receives guests.

Space 1 (Living Room):

The living room is considered a multi-use room, where many activities are performed such as eating, studying, watching television, hosting visitors, playing, praying, and sleeping.

The following table displays the activities which are performed on a daily basis. The top row refers to activities performed in the living room during all twenty four hours of the day. The lower part of the table illustrates the performer of the activity; all members of the household; (F-M) refers to the family parent (Father- Mother) and (S) refers to the children. The first column refers to the day hours.

⁹⁶ Jeanne E. Arnold, Anthony P. Graesch. "Space, Time, and Activities in the Everyday Lives of Working Families: An Ethnoarchaeological Approach." UCLA Center on Everyday Lives of Families (CELF). 2002. <http://www.celf.ucla.edu/pdf/celf02-arnoldgraesch.pdf> (accessed 11 16, 2010).

Table 20: Family sample- living room scenario:

| hr | Living Room Activities | | | | | | |
|-----------|------------------------|--------|----------|----|----|---------|---------|
| | Sleeping | Eating | Studying | TV | PC | Playing | Praying |
| 1 | ■ | | | | | | |
| 2 | ■ | | | | | | |
| 3 | ■ | | | | | | |
| 4 | ■ | | | | | | |
| 5 | ■ | | | | | | |
| 6 | ■ | | | | | | |
| 7 | ■ | | | | | | |
| 8 | ■ | | | | | | ■ |
| 9 | ■ | ■ | | | | | |
| 10 | ■ | | | | | ■ | |
| 11 | | | | | ■ | ■ | |
| 12 | | | | | ■ | ■ | ■ |
| 13 | | | | | ■ | ■ | ■ |
| 14 | | | | | ■ | ■ | |
| 15 | | | | | ■ | ■ | |
| 16 | | ■ | | | | | ■ |
| 17 | | | ■ | | ■ | ■ | ■ |
| 18 | | | ■ | | ■ | ■ | ■ |
| 19 | | | ■ | ■ | ■ | ■ | ■ |
| 20 | | ■ | ■ | ■ | | ■ | ■ |
| 21 | | | ■ | ■ | | ■ | |
| 22 | | | ■ | ■ | | ■ | |
| 23 | | | | ■ | | | |
| 24 | ■ | | | | | | |
| Performer | F | ■ | ■ | ■ | ■ | ■ | ■ |
| | M | | ■ | ■ | ■ | ■ | ■ |
| | S1 | ■ | | | | ■ | |
| | D | | | ■ | ■ | | ■ |
| | S2 | | ■ | ■ | ■ | ■ | ■ |

The previous table indicates the multi-use of the living room. All family members use the living room in order to perform many activities. Thus, the living room should be designed taking into account these activities which are performed in it.

Space 2 (Master bedroom):**Table 21: Family sample- Master bedroom scenario**

| hr | Master Bedroom Activities | | | | | | |
|-----------|---------------------------|--------|----------|----|----|---------|---------|
| | Sleeping | Eating | Studying | TV | PC | Playing | Praying |
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
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| 21 | | | | | | | |
| 22 | | | | | | | |
| 23 | | | | | | | |
| 24 | | | | | | | |
| Performer | S2 | | | | | | |
| | D | | | | | | |
| | S1 | | | | | | |
| | M | | | | | | |
| F | | | | | | | |

The table above reveals the sporadic use of the master bedroom whereas; only parents use the bedroom for sleeping. Accordingly, the bedroom should be designed as minimum area as it is used only for a specific set of activity.

Space 3 (bedroom):**Table 22: Family sample- bedroom scenario**

| hr | Bedroom Activities | | | | | | |
|-----------|--------------------|--------|----------|----|----|---------|---------|
| | Sleeping | Eating | Studying | TV | PC | Playing | Praying |
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
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| 21 | | | | | | | |
| 22 | | | | | | | |
| 23 | | | | | | | |
| 24 | | | | | | | |
| Performer | F | | | | | | |
| | M | | | | | | |
| | I | | | | | | |
| | S | | | | | | |
| S2 | D | | | | | | |
| | I | | | | | | |

The table above reveals the sporadic use of the bedroom. However, only siblings use the bedroom for sleeping and sometimes for playing. Therefore, the bedroom should be designed as a minimum area as it is used for specified activities.

3.5.2 Analysis map

Applying the previous scenario tables for dwelling spaces using the proposed grid analysis method, each used cell is fed with information about the duration of occupancy in performing home activities, resulting in the figure shown below.

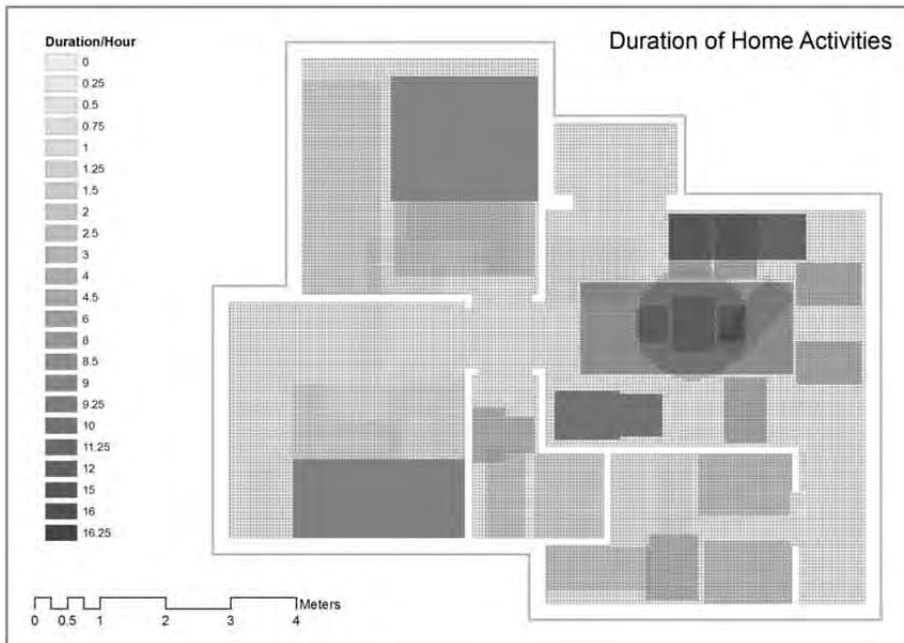


Figure 101: The duration of performing home activities

The figure above displays the actual use of dwelling spaces. The gradient colors of cells between yellow and red indicates the extent of use of each cell. The red cells are frequently used, and the yellow cells are rarely used.

This colored map indicates the use of dwelling spaces, and displays congested areas where many activities are being performed by many performers in the same space and time, and also indicates none-used or rarely used areas. Hence, this result clarifies to the designers the spaces which should be expanded in order to make it easy and comfortable to perform the needed activities by the actual number of family members, and the spaces which could be reduced due to the rarely-used areas.

Summary

This chapter has explored how low-incomers coexist in their dwellings based on their socio-cultural characteristics in order to meet their essential needs based on the ergonomics study in order to ensure the efficient performance of required activities.

To analyze the efficiency of home spaces based in performing essential home activities, a set of analytical studies have been undertaken using the selected analysis software, there are three sets of analysis have been performed on the selected sample, and can be summarized as follows:

- Determining the effective area of home spaces according to low-income lifestyle.
- Identifying conflicting areas which hinder the performance of home activities.
- Determining the duration of use of home spaces in performing home activities.

Chapter 4: Geometrical shape of spaces in low-income houses

Preface

This chapter discusses the correlation between dwelling spaces according to the social behavior of the dwellers. Furthermore, it demonstrates determinants of spaces geometry and shape parameters of dwelling spaces such as proportions of rooms.

There are many theories that deal with architectural spaces and space analysis. Some of these theories are based on social relations and the human behavior in the spaces. Other theories focus on the cognition and visual perception of spaces and the correlation between spaces through visual connections among them.

The main target of this chapter is to explain the correlation between dwelling spaces based on geometrical analysis of spaces. By identifying correlations between dwelling spaces, those could be used in devising the evaluation system of the dwelling spaces relaying the behavior of the dwellers.

4.1 The geometry created in space by social activities

The word geometry derives from two Greek words, for earth (ge) and measure (metron).⁹⁷

When one deals with the concept of geometry in house design, It is obvious that determining the geometry is the main goal for performing the activities to achieve the life essential needs.

4.1.1 The concept of place

The concept of place is what links architecture to life. The places people use are in direct relation to their lives. Living necessarily involves the conceptual organization of the built environment into places: places to work, places to rest; places to sleep, places to eat or places which are 'mine', places which are 'yours'; and so on. Like language, architecture is not stagnant. Architecture is perceived through use.

The identity of any place depends on the ability of the user to recognize it as such. A place might have many interpretations; a wall may be seen as a barrier, another may see it as a seat, another may see it as a path. Places can overlap. A bedroom has a place to sleep (the bed), but it also has places for getting out of bed, for sitting and reading, for dressing and undressing, for looking in a mirror, for standing looking out

⁹⁷ Simon Unwin. (2003). *Analysing Architecture*. New York: Routledge

of the window; these places are not distinct, but intermingle within the room, and perhaps change their identities from time to time.⁹⁸

4.1.2 The heart of the home

In many cultures, the hearth has had a traditional significance, as the heart of the home, a source of warmth, for cooking, around which life revolves.

The consequences of changing the location of the fireplace from a central position to a peripheral one is shown in following figure. The plans are similar, except for the position of the hearth.

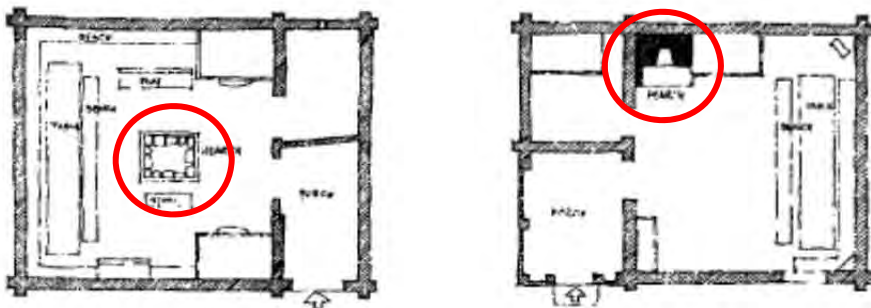


Figure 102: Two Norwegian traditional timber houses illustrate the location of the fireplace – Ref: Simon Unwin, *Analysing Architecture*

In the left plan the space of the living room is dominated by the central hearth. The other places for sitting and eating, for storage are arranged around this central focus. Moving around the room is a matter of moving around the fire. In the right plan the fireplace is situated in the corner of the room, and built as a small cell of stone, non-combustible to protect the timber of the outer walls. The consequence of this change is that, although the fire no longer occupies its central symbolically important position, movement within the room is less constrained. The floor becomes more open for human occupation a ‘multi-use floor’.⁹⁹

Thus the heart of the home becomes a free space left for performing many activities by many participants at many times.

⁹⁸ Ibid

⁹⁹ Ibid



Figure 103: living space the heart of low-income dwelling
 (The left image: formal housing – Elzawia Elhamrra
 -The right image: formal housing – Elsidia Zaynab)

In the Egyptian dwelling, especially in a small one, the centrality of the living space is clear and quite dominant due to the multiple uses of the space in performing many activities by all family members.

4.1.3 Togetherness defines the geometry of social activity

The geometry of social interaction between people appears when people congregate and then they identify their own places. Thus, they overlay a social geometry wherever they come together. Works of architecture can respond to social geometries, order them, and make their physical realization more permanent.



Figure 104: There is a social geometry to the space of togetherness
 Ref: <http://egyptiansabroad.org/vb/showthread.php>

People may sit in a rough circle around a table to eat together.

The radial arrangement of family members around a table, eating their daily meals, can architecturally be translated into a social geometry which could be identified according to family characteristics.

4.2 Geometry frames as architectural frames

Those ‘geometries’ could thus be identified by the activity performed in space, which defines the architectural frame needed to host these activities.

This part discusses the spatial determinants for low-income dwelling according to the social behavior of its dwellers which could be used as an approach for reducing the area of dwelling spaces, which should result in turn in a significant cut down on the overall cost of the construction.

4.2.1 Making an appropriate frame

It is obvious that architectural spaces include all three dimensions of space. But there is also the dimension of time, which accommodates movement and change and those more abstract dimensions which display patterns of life, of work, of ritual. The products of architecture can frame the lives of people.

Thinking about architecture as frame-making is part of conceiving it as identification of place. Frames define boundaries. Elements of architecture are frames: the rooms within which we work, the table where a family eats, the gardens in which we sit, the floors on which we pray...are all ‘frames’; and together they constitute a complex and extensive framework within which we live.

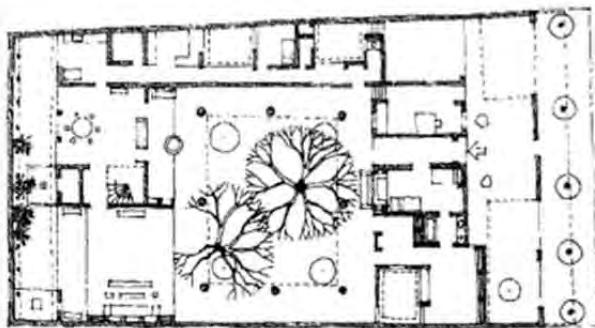


Figure 105: House in Colombo, Sri Lanka, designed by the architect Geoffrey Bawa, and built in 1962 - Ref: Simon Unwin, Analysing Architecture

The plan above, illustrates how architecture *frames* life. The house as a whole is framed by the outer fence, but it also contains many frames

within it: the living and bedrooms frame social activities and sleeping; the dining table frames the activity of eating daily meals; even the bath is a frame.

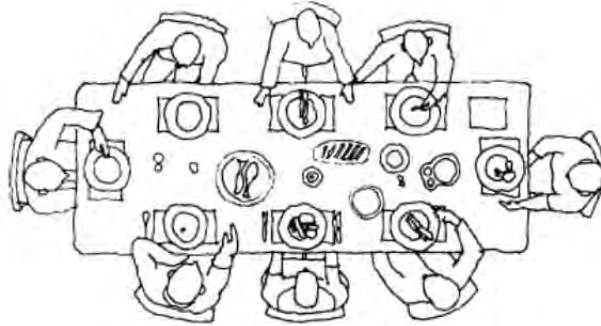


Figure 106: The frame of a meal - Ref: Simon Unwin, *Analysing Architecture*.

Frames need not only to be constructed of tangible material; even a spotlight can make a frame and can affect senses other than the visual; watching television might frame a group of people; gathering all family members to eat their daily meals can make a frame. Hence, togetherness to perform a social activity defines a social frame.¹⁰⁰

4.2.2 Determining the frame of life activities

A bed - as an essential space in the dwelling - is not just a piece of furniture; conceptually it is a place. It might be argued that the most fundamental purpose of a house is as a secure place for sleep. The bedroom is the innermost, most private, most protected part of a house. It is a place where one must feel safe enough to sleep. The earliest houses were, little more than bed rooms, with most other activities associated with dwelling taking place outside. The bedroom has become a room on the conceptual, and often also the physical, and often considered less important than the reception rooms. A bed can be a separate piece of furniture, with its own self-contained form, or it can be fixed into the architecture of its house. Like a hearth, a bed maybe no more than the patch of ground which a sleeping creature occupies.¹⁰¹

¹⁰⁰ Ibid

¹⁰¹ Ibid

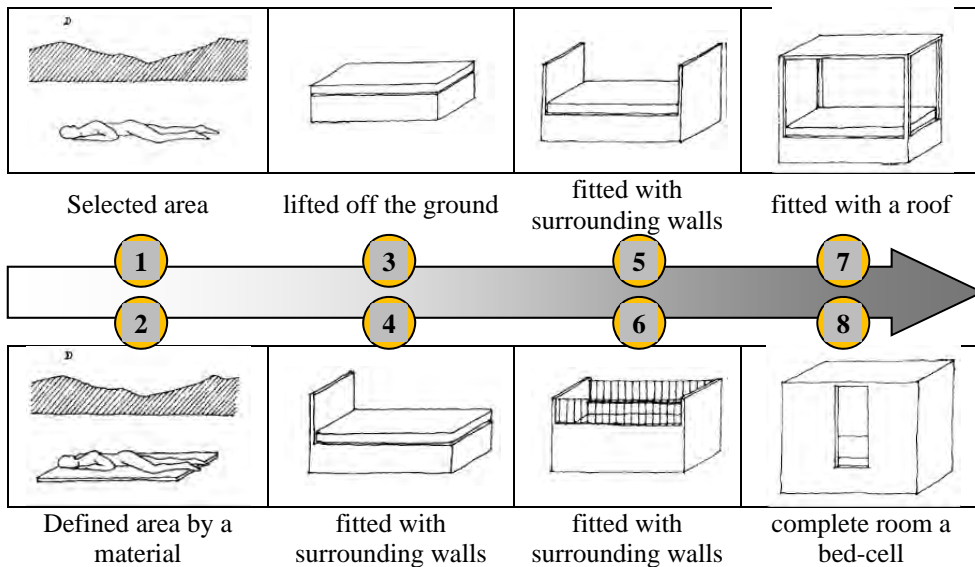


Figure 107: Bed room as a clear sample of creating space based on human needs

Ref: Simon Unwin, Analysing Architecture.

Not only do beds have architecture in themselves. They contribute to the composition of places in larger works of architecture; hence, the bedroom as a conception of making architectural physical frame is determined through the social behavior where the activity of sleeping is undertaken.

4.2.3 Circles of presence

People and objects introduce geometry into the world just by coming into being. Everybody has around it what might be called a 'circle of presence', which contributes to its own identification of place. When a body is in relationship with others, their circles of presence affect each other.¹⁰²

If one discounts electronic and radio presence, the broadest of these circles of presence is the visual, described by the distance at which the object is visible. This circle may stretch as far as the horizon, or it might be contained by a forest, or a wall.

¹⁰² Ibid



Figure 108: A lighthouse describes its circle of presence by the brightness of the light they emit.

Ref: <http://www.twelve2.org/2005/08>



Figure 109: The television describes its circle of presence by the viewing distance

Ref: <http://www.iso.bf/students/it11/it11tania/Untitled-1.html>

The smallest circle of presence, physically, is described by the distance within which one is able to touch the body. The most difficult circle of presence to determine rationally is the intermediate, the one within which one feels that one is ‘in the presence’ of the body.¹⁰³

Architecture uses all three: the extensive circle of visibility; the intimate circle of touch ability; and the intermediate circle of place. Much architecture, from prehistoric times to the present, has been concerned with asserting, defining, amplifying, molding, or controlling circles of presence. A candle, as well as a lighthouse, describes its circle of presence by the light that it emits.¹⁰⁴

4.2.4 Determining the area of habitable spaces

It follows from this notion that activities which are usually carried out in home spaces even by using the available furniture (fixed or movable) or those performed directly on the floor of the habitable room, such as playing, praying, and sometimes eating, are to be considered the key factor in determining the required area for any habitable room in the dwelling.

4.2.4.1 The living room:

The living room - as an example - is considered a multi-functional room, all family members use it and many activities are performed in it.

¹⁰³ Ibid

¹⁰⁴ Ibid

According to low-income dwellers and their socio-cultural characteristics, dwellers use all spatial elements therein.

The living room comprises many activities such as seating (hosting others), watching television, dining, studying, playing, praying and sometimes sleeping. Some of these activities require fixed furniture which could not be moved, and others may be performed directly on the floor or using movable and foldable furniture.

a) Area for seating:

The main purpose of the living room is gathering all family members; to talk together, pray together, play together and eat together. The minimum area required for seating together normally is specified with a diameter circle of (2.8-3) meter.¹⁰⁵

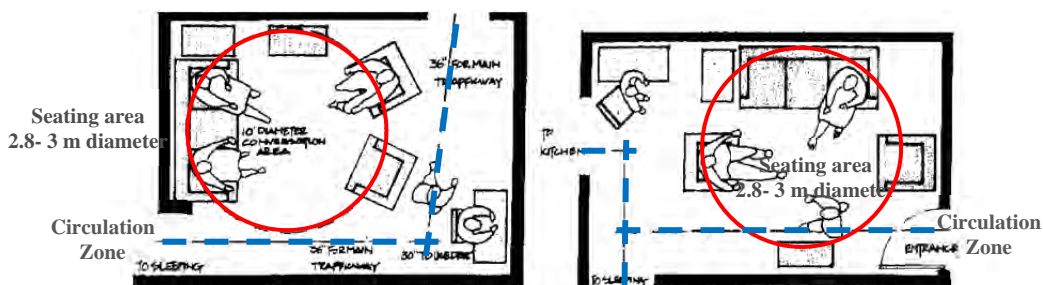


Figure 110: The required area for seating

Reference: Joseph De chiara, Julius Pareno, Morth Zelnik. Time saver standards for interior design and space planning: Mc Graw-Hill inc., 1992.

The circle of seating in the living room is determined by the surrounding furniture and contains a free space which could be used occasionally in performing other activities or sometimes for circulation purpose in case of not bothering the seating people.

b) Watching television:

Regardless of sociological debates concerning the impact of watching TV on societies as a whole, watching television has become one of a few major activities that gather all family members.

¹⁰⁵ Joseph De chiara, Julius Pareno, Morth Zelnik. Time saver standards for interior design and space planning: Mc Graw-Hill inc., 1992.

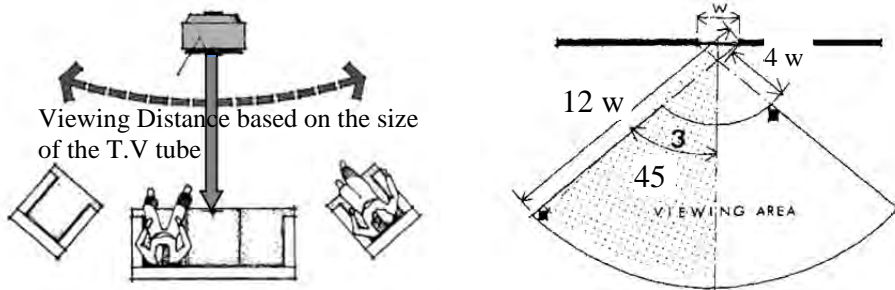


Figure 111: The viewing distance required for watching TV

Ref: Time saver standards for interior design and space planning

The minimum viewing distance from a TV set is calculated based on the size of the set, and it ranges between 1.5 meters to 3 meters for small televisions and between 4.54 meters to 7.47 meters for large ones.¹⁰⁶

c) Eating using low round table and seating on the floor:

The social survey by the researcher (Cited in chapter (1)) reveals that many low-income families are used to eating on the floor directly using a low round table that is known in the popular culture as (Tableia). The following two figures illustrate the required area which should be left free in order to allow for using this low round table.



Figure 112: low Round eating table (diameter 65-90 cm)
<http://www.khorshedplast.com/emisc1.html>

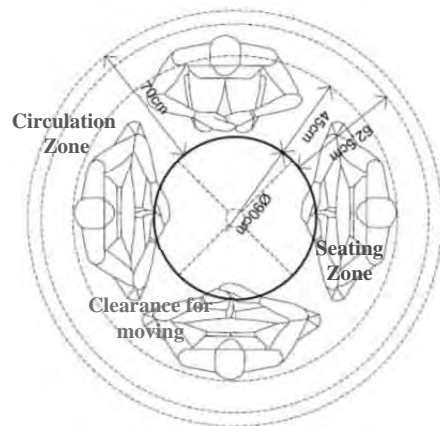


Figure 113: The required area for eating on the floor

¹⁰⁶ Joseph De chiara, Julius Pareno, Morth Zelnik. Time saver standards for interior design and space planning: Mc Graw-Hill inc., 1992.

d) Eating , studying using movable and foldable tables:

The following figures illustrate the required area for using movable and foldable tables which are frequently used by Egyptian low-income families in order to perform many home activities such as eating and studying.



Figure 114: Squared table 60x60 : 85x85 cm



Figure 115: Rounded table 60- 90 cm



Figure 117: Foldable table (120x70cm-90x60cm-70x50 cm)



Figure 116: required area for eating / one person

4.2.4.2 The bedroom:

The bedroom is an essential space in the dwelling and it is a private place where one must feel safe and comfortable enough to sleep. Low-income families usually use the bedroom only for sleeping, especially the master bedroom, sometimes they put another TV set which is usually wall mounted. The other bedroom is usually for children in which more activities are performed such as playing and studying. However, those activities are sometimes performed according to the area of the bedroom and the number of kids.

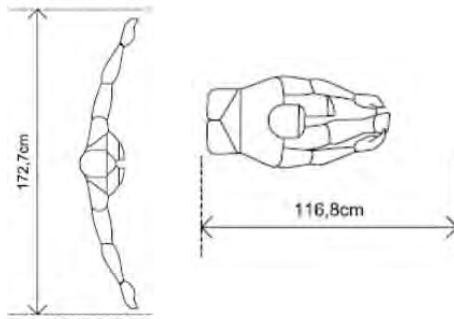


Figure 119: The required area for dressing

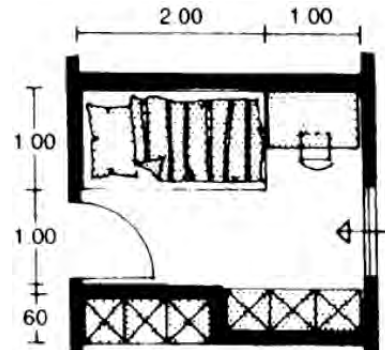


Figure 118: A minimum bedroom
Ref: Ernst and Peter Neufert.
Architects' Data. Blackwell Science.

The two figures shown above illustrate the needed area to be left free for movement, playing and dressing.

4.3 Shape parameters

This part examines space determinants as classified in two classes: Physical determinants such as the structure system and the surrounding walls, and rational determinants such as space proportion.

4.3.1 Physical determinants of the geometry

Structure and walls are the main physical determinants for any space. Therefore, the relation between these two elements and spaces should be considered with care so as not to impede the performance of home activities.

4.3.1.1 Structure and space:

Both structure and space are media of architecture. It is by reason of its structure that a building stands. The relationship between space and structure is not always simple and straightforward; it is subject to different approaches.

In terms of attitudes, one can choose and allow a structural strategy to define the places one wishes to create. This strategy (in coding the relation between space and structure) may take one of four basic stances:

- Structural order is dominant
- Spatial order is dominant
- A harmonic relationship between the two

- The space is separated from structural order

Structure tends to impose its own geometries. On the other hand, the objects and people, individually and in groups, can evoke their own geometries as elaborated in previous sections. In architecture there is a vital relationship between these geometries: sometimes they are in tension; sometimes they can be resolved into harmony; sometimes they can be overlaid but remain conceptually separate. An extra complication is that once a structural strategy is established it can influence spatial organization.¹⁰⁷

An important aspect of the art of architecture is to choose a structural strategy that will be in some sort of accord with the intended spatial organization.

4.3.1.2 Surrounding parallel walls

The concept of using two straight parallel walls is one of the simplest, oldest, and yet most enduring of architectural conceptions. This conception is found in prehistoric architecture, and it continues to be useful to this day. The obvious attraction of this most uncomplicated arrangement is its structural simplicity. It is easier to span a roof between two parallel walls than any other form.¹⁰⁸

This conception is often used in housing design based on the structural grid. However, the consideration of performing home activities in the created space should be taken into account.

4.3.2 Types of shape geometry

The circle and the square may emerge out of ‘social geometry’ or from the geometry of construction, but they are also pure, abstract, figures. Ideal geometry does not only include the circle and the square and their three-dimensional forms (the cube and the sphere). It also includes special proportions, such as the simple ratios of 1:2, 1:3, 2:3 or more complex ratios known as the Golden Section which is about 1:1.618.

Many twentieth-century architects have used ideal geometry to lend rationality or integrity to their plans, sections and elevations. Some,

¹⁰⁷ Simon Unwin. (2003). *Analysing Architecture*. New York: Routledge







¹⁰⁸ Ibid

seemingly bored with simple relationships, have experimented with complex arrangements in which one geometry is overlaid on another.¹⁰⁹

4.3.2.1 The Proportions of Rooms

Proportion of rooms is considered one of the main architects concerns. In *The Four Books of Architecture*, published in 1570, Andrea Palladio, (1508-1580), suggested seven sets of the most beautiful and harmonious proportions to be used generally in generating rooms. He suggests six proportions for a rectangular room in addition to a circle which is rarely used in the design of dwelling rooms. These six proportions are illustrated in the following table.¹¹⁰

Table 23: Room proportions suggested by Palladio

| | | |
|---|--|--|
|  <p>Square 1:1</p> |  <p>The diagonal of the square 1:1.414....etc.</p> |  <p>A square plus a third 3:4</p> |
|  <p>A square plus a half 2:3</p> |  <p>A square plus two-thirds 3:5</p> |  <p>Double square 1:2</p> |

4.3.2.2 The golden ratio:

This ratio is based on the division of any whole into two parts such that the whole is to the larger part as the larger is to the smaller. Thus in the line 'ac' in the following figure: ($ac: ab = ab: bc$), whereas in the rectangle the sum of the two diameters is to the longer diameter as the longer is to the shorter. Worked out arithmetically, this ratio is almost equivalent to (five to three).

¹⁰⁹ Simon Unwin. (2003). *Analyzing Architecture*. New York: Routledge

¹¹⁰ John Boyd-Brent. *The Proportions of Rooms*.

<http://www.aboutscotland.co.uk/harmony/prop3.html> (accessed 12 07, 2010).

Previously, The golden section was thought that it satisfies the requirements of the mind, and may be accepted as an approximate ideal.¹¹¹

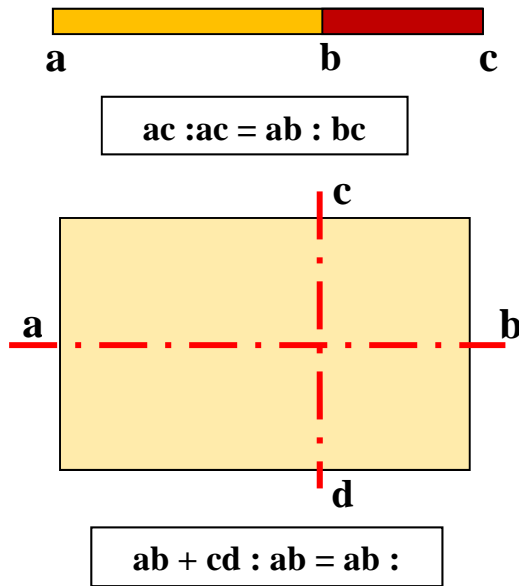


Figure 120: The proportions of the Golden Section

As long as sides of any room are expressible in small ratios, like 1:1 or 1:2, they are easily perceptible. As the number of sides units is increased the ratio becomes more difficult to perceive and the proportion more subtle, up to the point where the mind is unable to percept the ratio. Thus the ratio 2:3 is more subtle and more interesting than the ratio 1:1, yet it is easily sensed by the mind. On the other hand, ratios like 4:7, 7:12, or 9:14 involve a number of divisions beyond the power of the mind to grasp.

Long ago, Vitruvius stated that the length of a room should be to its breadth as 5:3, or as 3:2; or, in the case of very large apartments, as 2:1. The decorator will find in practice that when a room varies widely from this ideal its apparent proportions must be altered before the room can be made to seem satisfactory to a critical taste; and that, within the limits necessarily imposed by their function and particular situation, the various forms and surfaces in his treatment will be found to be increasingly

¹¹¹ Bernard C. Jakway. *The Principles Of Interior Decoration*. The Macmillan Company, 1925.

pleasing to the mind as they approach the proportions of the golden section.¹¹²

Not only considering the proportion of the habitable rooms is necessary for achieving the perceptual satisfaction for the users, but also there are many other factors that control the needed area and the proportion of it such as the performed activities, number of users and the economic aspects.

4.3.3 Relationship Between Area & Perimeter

It is common knowledge that the perimeter is the distance around the periphery of a shape and that the area is the space enclosed by a 2-D figure. The relation between area and perimeter is quite significant to low-income housing, as shall be elaborated. Naturally, performing home activities depends on the available area. On the other hand, the perimeter of the shape has a considerable influence in housing economic, and it is considered a forceful factor in reducing the cost of the dwelling.

Mathematically there is no single standard formula for determining the area of a figure based upon its perimeter or vice versa. However there are general conclusions that can be made based on either factor (area/perimeter). For instance, a rectangle with a perimeter of 24 units can have an area of 36 square units if it is a perfect square. A figure with the same perimeter of 24 units could have an area of 11 square units given the fact that its dimensions are 1 x 11. Generally speaking, for rectangular figures, the closer they get to being perfect squares, the greater their area. In the meantime; the greater the difference between length and width of the figure, the greater the perimeter. The variance is studied by deciding which variable is set as a constant, the area or the perimeter. This, in turn, identifies the method of determining room size. If the figure is defined by varying the area, then it will have the greatest area in the form of a square.¹¹³

4.3.4 The effect of the relation between area and perimeter on housing design

As mentioned in the previous section, there is a relation between the area and the perimeter of any rectangular shape. By applying this relation

¹¹² Ibid

¹¹³ General Relationship Between Area & Perimeter.

<http://www.physicsforums.com/showthread.php?t=271601> (accessed 02 20, 2011).

in designing a room, it is noticed that if the room shape is elongated, the shape perimeter is also increased, and thereby the cost is increased.

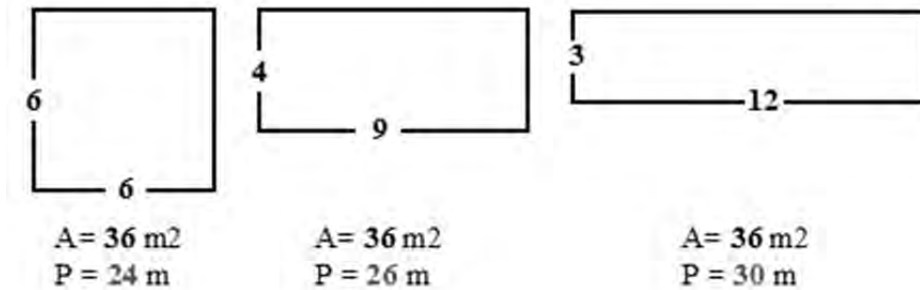


Figure 121: If the areas is kept at 36 m², and the perimeter is varied, then the Perimeter will be smallest for regular polygon (square)

4.4 Shape analysis approach for housing spaces

This method of analysis is based on classifying house spaces in two main categories:

- Zones: The places where home activities are performed and all habitable areas such as living spaces, bedrooms kitchens and bathrooms are located.
- Margins: auxiliary spaces like lobbies, balconies and storages.¹¹⁴

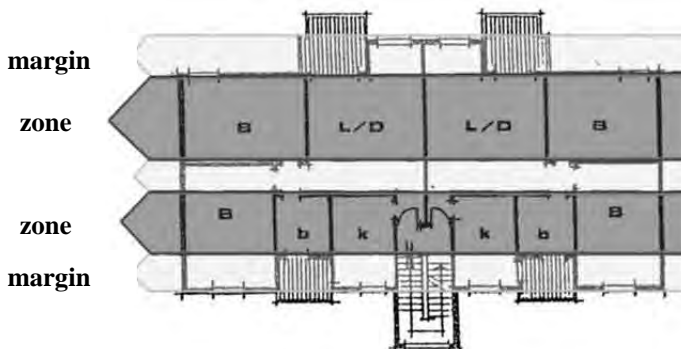


Figure 122: Analysis of traditional housing plans
Ref: Nasamt Abdel Kader, In Notes on Housing & Physical Planning

¹¹⁴ Nasamt Abdel Kader. "A modular pattern for the design of housing projects." In Notes on Housing & Physical Planning, by Dr.Nasamt Abdel Kader Dr.Sayed Eltouny. cairo: Elarabi, 1992.

Following from this classification, it is observed that there are common properties between residential plans in Egypt which can be illustrated as follows:¹¹⁵

- The depth of the housing unit is occupied by two parallel rows of functional spaces (zones)
- The total depth of the housing unit is in a relation with the dimensions of the functional spaces (zones), therefore, when the dimensions of the spaces are relatively small, the total depth of the unit is also small.

This method of analysis leads to generating a modular pattern for the design of housing projects based on the actual use of unit spaces and the hierarchy of spaces. However, this way of analysis overlooked the way of life of dwellers and how they perform their daily home activities.

4.5 Space syntax analysis

This method of analysis was first proposed by Hillier and Hanson in the mid-eighties. They described their work as dealing with topological and numerical parameters. The measures of accessibility that they proposed are functions of the number of direction changes made, the number of boundaries crossed, or the number of spaces traversed.¹¹⁶

The methods of syntactic analysis derive from considerations of behavioral significance; however, their application is directed at the quantitative description of space apart from the users of that space and their actual behavior in it.

According to this theory, the most fundamental, socially significant properties of space can be stated in terms of graphs. A graph consists of a set of nodes, or vertices, and a set of lines, or edges. Each line makes a link between two of the nodes of the graph. Graphs may not necessarily be linked into a single complex. But very often, an architectural researcher will deal with a continuously linked graph representing the fabric of public space in a settlement or the interior of given premises in a building. For this purpose, simple continuously connected graphs will be considered as purely relational patterns.

There are three basic concepts can be defined, one simple and the other two a little more sophisticated. The simple concept is depth. Depth

¹¹⁵ Ibid

¹¹⁶ Robert B. Bechtel, Arza Churchman. Handbook of Environmental Psychology. John Wiley & Sons, Inc., 2002.

characterizes the relationship of a node to the graph that contains it. The depth of a node is the sum of the lines that are necessary for a traveler to reach all other nodes in turn.

Thus defined, depth becomes the basic syntactic measure of distance. In most graphs, different nodes will have different depth values. Associated with this, the same graph will look different when studied from different nodes.

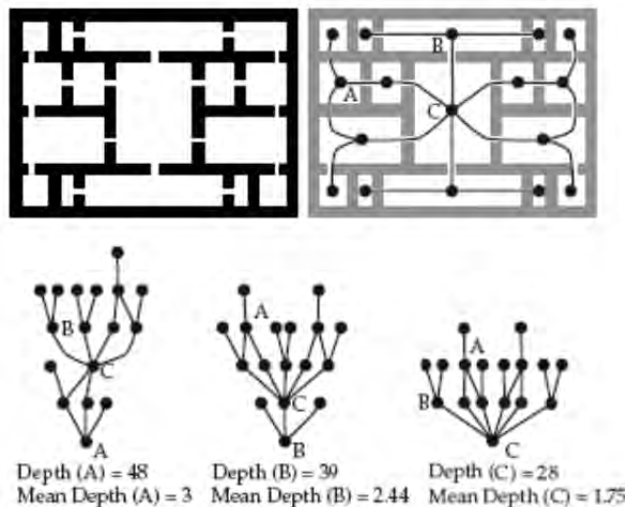


Figure 123: A plan represented as a graph of connections. The graph is rearranged as seen from three positions within the plan. - Ref: Robert B. Bechtel, Handbook of Environmental Psychology

Integration is the major graph-based measure used in the space syntax literature. Integration is an algebraic function of the mean depth of a node from all other nodes in a system. Referring to the previous example of a floor plan, Integration is a function of the mean depth (number of connections that must be traversed) if one were to move from every space (node) to every other space (node) on the floor. The higher the integration value of the node, the less its depth. Thus, Integration is a measure of syntactic accessibility.

Layout plans can be usefully read as discrete systems carrying social information only if we succeed in linking geometric intuition with our intuition regarding the human dimensions of inhabiting space.

Movement and prolonged occupation are fundamental poles of our experience of space. Movement paths are essentially one-dimensional. Seeing beyond the present position in some particular direction is an

aspect of how movement is possible. To capture the underlying spatial structure that is associated with movement, layouts can be represented as sets of intersecting lines. The “axial map” or “linear representation”

The axial map comprises the fewest and longest lines that are needed to cover all the ways of moving around a layout and to reach all the spaces, it means also that it comprises all visual lines between the connected spaces.

Accordingly, each point on a convex space can be linked to all other points by a line that does not cross the boundary of the space. In perceptual terms, this means that all points of a convex space are visible from all other points and that, if several people occupy the same convex space, each will be visually accessible to all others. Thus, the “convex map,” which comprises the fewest convex spaces that are needed to cover a layout, is proposed as an appropriate method for identifying two-dimensional spatial units.¹¹⁷



Figure 124: Linear representations (axial maps) of a settlement and a building plan. Note: More integrated lines are shown in darker shades.

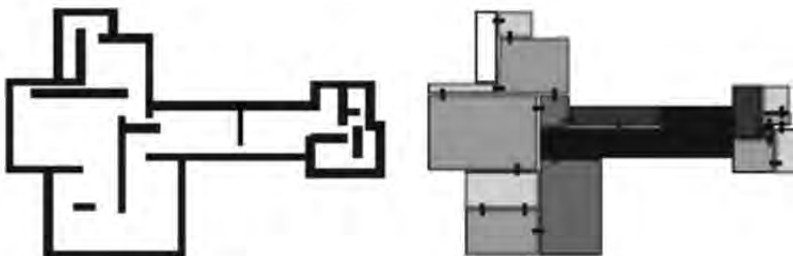
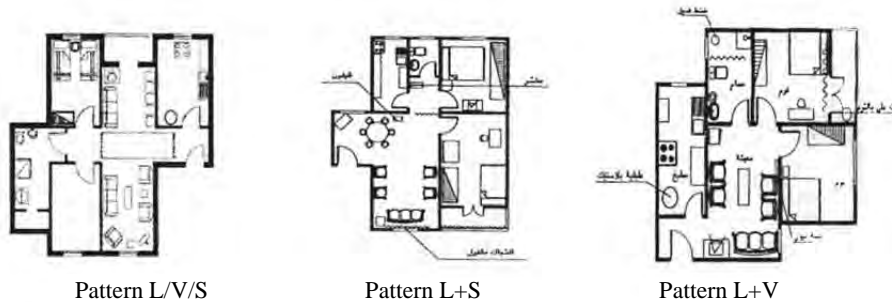


Figure 125: A plan and its division into the minimum number of connected convex spaces. Note: More integrated spaces are shown in darker shades - Ref: Robert B. Bechtel, Handbook of Environmental Psychology

¹¹⁷ Ibid

4.6 Patterns of home activities

Using space syntax analysis method, three different activity patterns could be noticed in new formal low-income housing based on the privacy levels of home spaces and the combination of home activities in one space. Dwellings are also divided in different ways in two domains: inhabitants and visitors.



**Figure 126: The three activity patterns in the formal new city housing –
Ref: Yaldiz Y. Eid, In Culture & Space in the built environment**

In the first pattern, the two activities “receiving visitors (V)” and “family living (L)” are combined in one space (L+V). In the second pattern, “family living” is combined in one space with ‘sleeping (S)’ while ‘receiving visitors’ is in a separate space (L+S). In the third pattern, each activity was independently enclosed in a space pattern (L/V/S).

These three patterns were advocated in a research project titled “The social health and psychological dimensions of the design of the dwelling and the residential environment” funded by the academy of scientific research and technology.¹¹⁸

¹¹⁸ Yaldiz Y. Eid, Dina K. Shehaeb. "Determinates of activity patterns in Egyptian homes: A space syntax analysis of use." In Culture & Space in the built environment. HBRC-Housing & Building National Research Center, 2006.

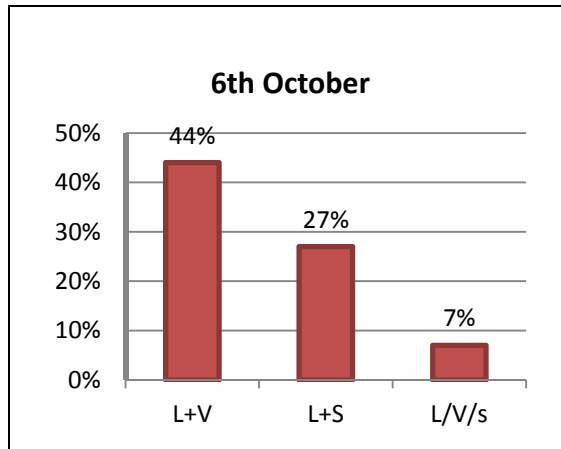


Figure 127: The distribution of the three activity patterns in formal mass housing- 6th October

As a partial result from the mentioned research, the evidence revealed that the first pattern (L+V) is the most common pattern in the low income formal mass-housing type.

This emphasizes the remarkable ongoing change in the relationships between people in our nation which was mentioned in chapter (1). Whereas, hosting other relatives in Egyptian homes rarely occurs nowadays.

4.7 Isovist theory

The “Isovist” theory by Benedikt offers a graphical representation of all the area that is visible around a particular position, providing researchers with a method to study plans in terms of visual fields.

Archea’s work on visual access and visual exposure established some of the early conceptual tools for exploring behavioral correlates with visual fields. As a result from his studies, it is observed that people tend to position themselves in space on the basis of both the extent to which they can observe other occupants of space, “visual access,” as well as the extent to which others can observe them, “visual exposure.” Archea defines the behavior-related characteristics of the environment as the manner in which it concentrates or diffuses information.¹¹⁹

¹¹⁹ Robert B. Bechtel, Arza Churchman. Handbook of Environmental Psychology. John Wiley & Sons, Inc., 2002.

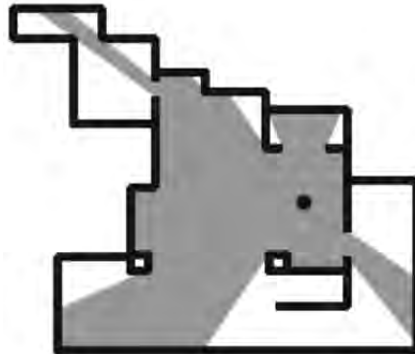


Figure 128: A plan and a visibility polygon (Isovist) drawn from a point in it.

Ref: Robert B. Bechtel, *Handbook of Environmental Psychology*

Isovists can be used in various applications to any given layout plan. To decide where the Isovists can be rooted, a predetermined convention must be followed. The three basic conventional approaches to rooting the Isovist analytical study can be displayed as follows:

- a) One convention is to cover the plan by a square grid of a given size, and then to draw one Isovist from each square unit.
- b) A second approach is to position Isovists according to a partition that identifies small convex areas within which visual information remains relatively stable.
- c) A third approach is to follow some independent convention, for example, to draw an Isovist from each convex space or from each room.¹²⁰

4.8 Determining spatial correlation between home spaces using grid analysis method

The main concept of this study is to determine the spatial relation between spaces based on calculating the percentage of the visible area from the correlated other spaces.

Based on (Isovist) theory and using the third method of space analysis, the correlation between dwelling spaces can be observed by comprising the visible area from two main points:

- The entrance of the dwelling as a beginning point to manifest the structure of dwelling spaces and the correlation between them.

¹²⁰ Ibid

- The center of the living room which is considered the heart of the dwelling and the center of living activities.

The main target of this study is to determine four main spatial relations as follows:

- First: the relation between the entrance and the living area and if there is an entrance lobby used as an intermediate space preventing hurting the privacy of the home.
- Second: the relation between the entrance and the kitchen.
- Third: the relation between the living room and the kitchen and to also illustrate the type of the kitchen; if it is open or closed.
- Forth: the relation between the living space and the other rooms

4.8.1 Methodology of the study


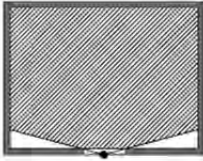
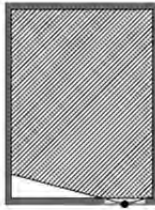
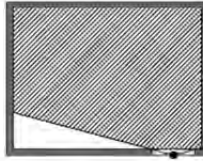
The correlation between any two spaces in the dwelling could be one of three basic cases: first case is that the space is connected directly to the other space. The second case is that the space is not connected to the other space and there is another intermediate space allocated between them and must be passed through. The third case is that the space is connected to the other through a transitional space such as lobby or corridor.

This correlation is revealed by the percentage of the visible area of the space, thus, the high percentage of the visible area indicates the direct correlation between spaces, and the less the percentage, the indirect relation is appeared.

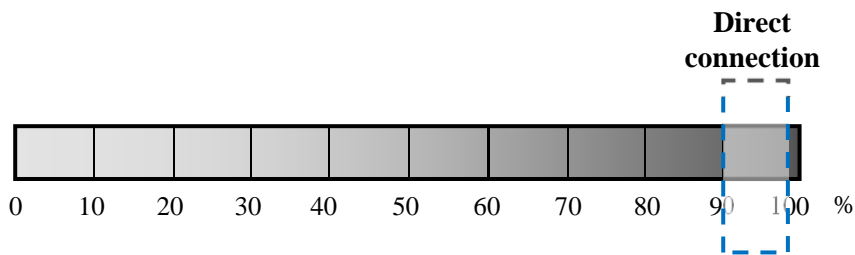
4.8.1.1 Direct connection between the entrance and the space:

It goes without saying, that the direct connection between the entrance and the space increases the total visible area of the space from the entrance.

Table 24: percentage of the visible area of the space from its entrance

| Case (1)- Entrance from the center | | Case (2)- Entrance from a side | |
|---|---|---|--|
|  |  |  |  |
| 98% | 95% | 96% | 90% |

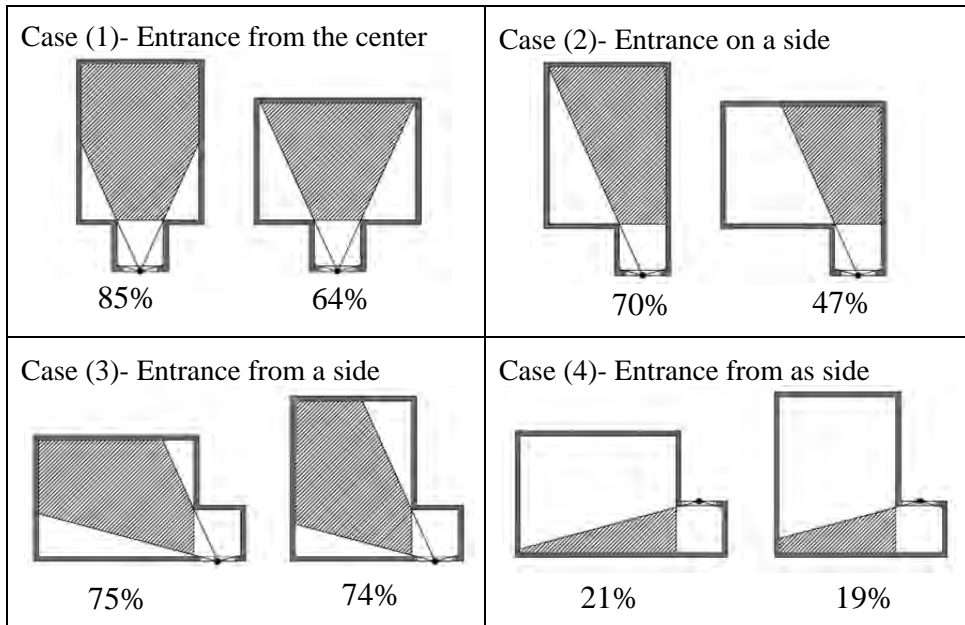
Calculating the percentage of the visible area from the space reveals that it falls between 90% and 98%, these percentages could be varied according to the form of the designed space and the proportions of it. However, the percentage of the visible area in this case lies within the very high range of percentages of the visible area, even in the case of the entrance from the middle of the space or from a side. Such a significant percentage indicates the direct correlation between the space and its entrance.

**Figure 129: The range of the visible area in the direct connection case**

4.8.1.2 Connection between the entrance and a space through transitional space:

Using an intermediate or transitional space significantly reduces the percentage of the visible area; the following table displays the common positions for the transitional space (entrance lobby).

Table 25: percentage of the visible area of the space from its entrance in the case of using a transitional space



The percentage of the visible area is between 19% and 85%, however, the mean percentage is about 57% and in the common cases the visible percentage lies in the average range of values. This great difference between the two percentages in the two distinct cases (direct connection and connecting through a transitional space) could help with investigating the correlation between the space and its entrance.

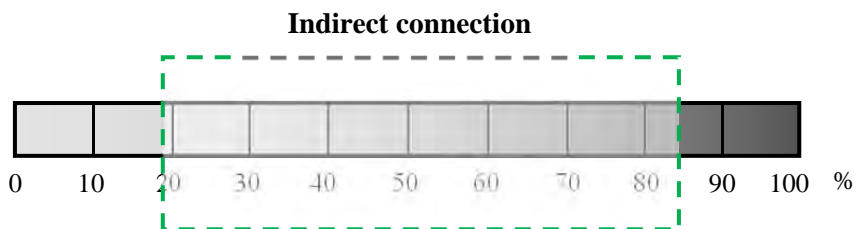


Figure 130: The range of the visible area in the indirect connection case

4.8.1.3 Direct connection between spaces

Applying the same studying method, the distinct cases of connection between two spaces connected directly without using a transitional space could be demonstrated as follows.

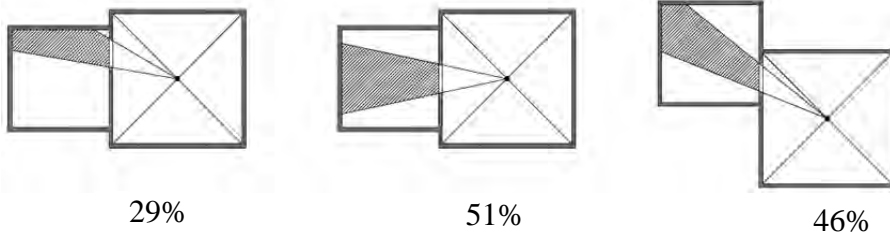


Figure 131: Common cases of connection between two directly connected spaces

The percentage of the visible area of a space from the center of the other space which is connected directly to it is between 29% and 46%.

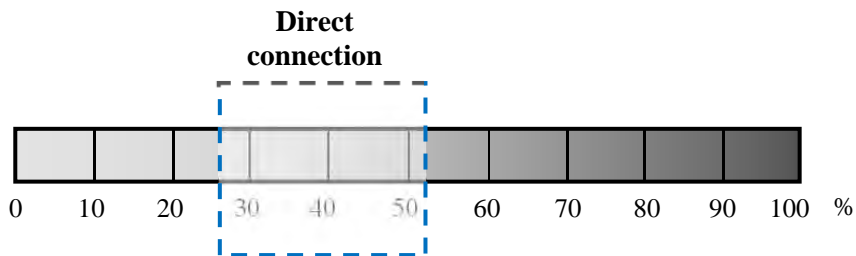


Figure 132: The range of the visible area in the direct connection case

4.8.1.4 Connection between spaces through a transitional space

If the space is connected to another through a transitional space (lobby); the percentage of the visible space may increase or decrease according to the position of the door of the space and the position of the transitional space.

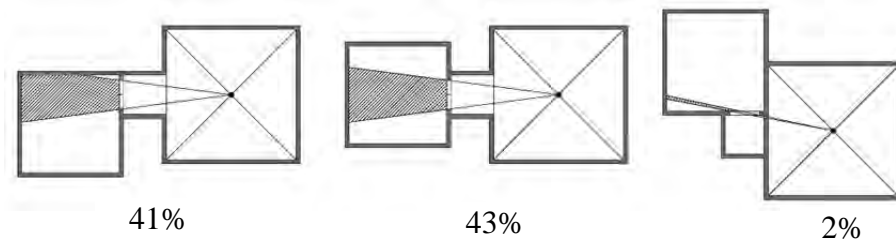


Figure 133: Common cases of connection between two spaces connected through a transitional space

The percentage of the visible area of a space from the center of the other space which is connected to it through a transitional space is between 2% and 41%.

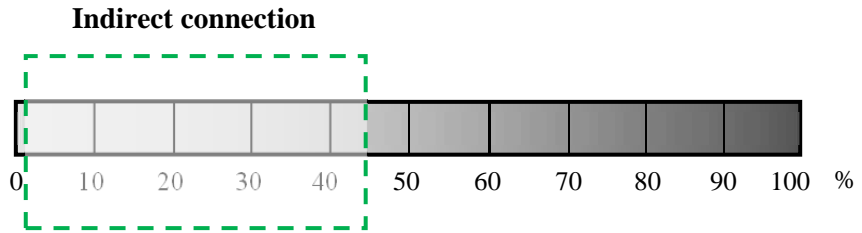


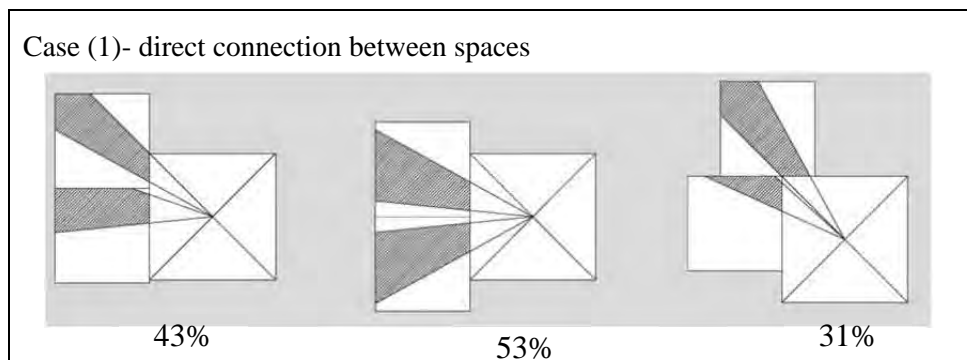
Figure 134: The range of the visible area in the indirect connection case

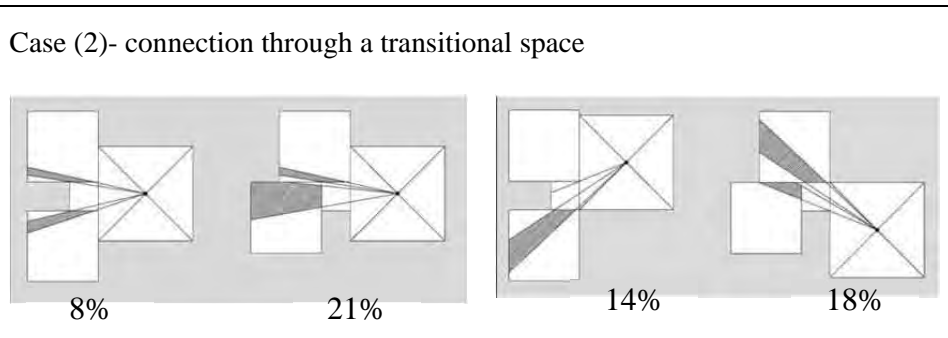
It may thus be concluded that there are no significant differences between the two types of connections, because there is no clear constraints in determining the relation between the spaces. However, if the main space is connected to more than one space directly or through a transitional space, there could be a significant difference in the percentage of the visible area in the two distinct cases.

4.8.1.5 Aggregation of spaces

The low-income dwelling often consists of three habitable room; a living room and two bedrooms. It is thus important to examine the aggregation method when calculating the visible areas from any spaces.

Table 26: the effect of the aggregation method on the visible area of connected spaces





From the previous table, it can be seen that there is a significant difference between the ranges of the visible area in the two cases. The percentage of the visible area from the two spaces if they are connected directly to the other main space is lying in the average range between 31% and 43 %, whereas if they are connected to the other main space through a transitional space, it falls in the low range between 8% and 21%.

Hence, the percentage of the visible area for each space indicates the correlation between these spaces to the convex point of isovist study. The correlation between spaces can be concluded by comparing the visible percentage of the space to predefined limits of the visible area for each space which was mentioned before.

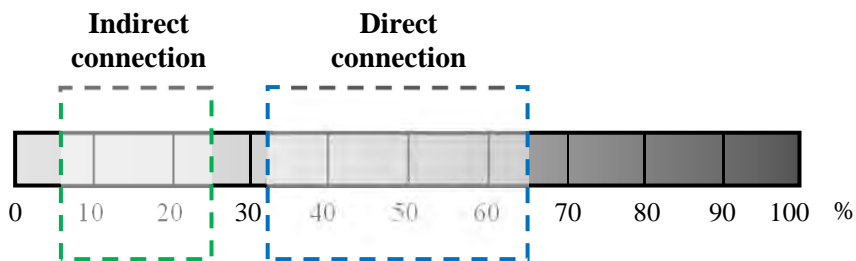


Figure 135: the range of visible percentage in the two cases

4.8.2 Determining visible area of the dwelling from the main entrance

This study investigates three main relations between the entrance of the dwelling and the other spaces applying the analysis method mentioned in previous sections.

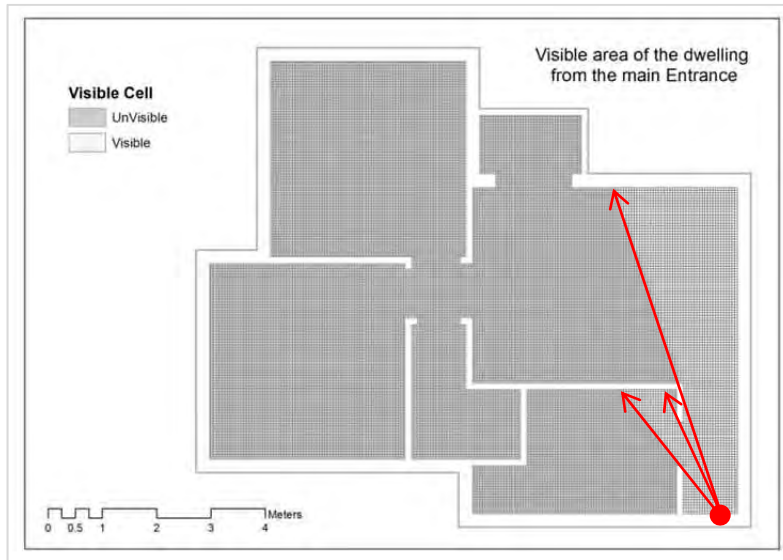


Figure 136: The visible area of the dwelling from the main entrance

Table 27: Percentage of the visible area of the dwelling from the main entrance:

| No. of visible cells | No. of all cells | Visible area in m2 | Percentage |
|---|------------------|--------------------|------------|
| Total visible area | | | |
| 3616 | 24538 | 9.0171 | 15% |
| Visible area of the living room | | | |
| 2392 | 7076 | 17.5705 | 34% |
| Visible area of the kitchen | | | |
| 2392 | 2936 | 5.98 | 9% |
| Visible area of the bedroom zone | | | |
| 0 | 0 | 0 | 0% |

As output from the table above, the correlation between dwelling spaces and the entrance could be investigated as follows.

4.8.2.1 The relation between the entrance and the living room:

The percentage of the visible area of the living room from the entrance of the dwelling is about 34 %. This percentage lies in the small range of values; this reveals that there is a connection between the living room and the entrance through a transitional space (entrance lobby).

4.8.2.2 The relation between the entrance and the kitchen:

The percentage of the visible area of the kitchen from the entrance of the dwelling is about 9 %. This reveals that there is a connection between the kitchen and the entrance and because of this percentage tends to the small range of values; this is likely to be an indirect relation between the kitchen and the entrance through a transitional space (entrance lobby).

4.8.2.3 The relation between the entrance and the zone of bedrooms:

The percentage of the visible area of the kitchen from the entrance of the dwelling is 0 %. This reveals that there is no connection between the entrance and the zone of bedrooms.

4.8.3 Determining visible area of the dwelling from the Living room

This study investigates three main relations between the entrance of the dwelling and the other spaces applying the analysis method mentioned in the previous sections.

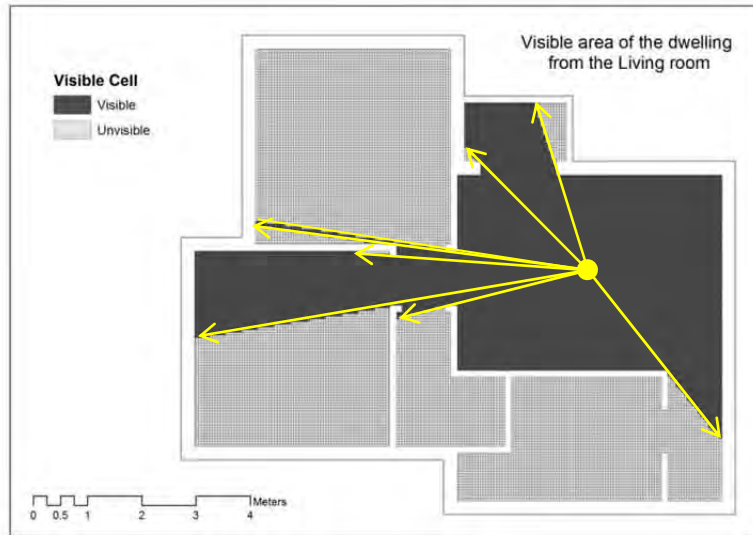


Figure 137: Visible area of the dwelling from the Living room

Table 28: Percentage of the visible area of the dwelling from the living room:

| No. of visible cells | No. of all cells | Visible area in m2 | Percentage |
|---|------------------|--------------------|------------|
| Total visible area | | | |
| 10659 | 24538 | 26.5125 | 43% |
| Visible area of the kitchen | | | |
| 0 | 2936 | 0 | 0% |
| Visible area of the zone of bedrooms | | | |
| 2011 | 10512 | 4.9725 | 19% |
| Visible area of the Bathroom | | | |
| 16 | 1520 | 0.038 | 1% |
| Visible area of the Balcony | | | |
| 656 | 864 | 1.614 | 79% |

As output from the table above, the correlation between dwelling spaces and the center of the living room could be investigated as follows.

4.8.3.1 The relation between the living room and the kitchen:

The percentage of the visible area of the kitchen from the center of the living room is 0 %. This reveals that the kitchen is connected to the living room through the entrance lobby and there is no direct relation between the zone of bedrooms and the kitchen.

4.8.3.2 The relation between the living room and the zone of bedrooms:

The percentage of the visible area of the zone of bedrooms from the center of the living room is about 19%. This percentage lies within the small range of values; this reveals that there is a connection between the zone of bedrooms and the center of the living room through a transitional space (lobby).

4.8.3.4 The relation between the living room and the Bathroom:

The percentage of the visible area of the Bathroom from the center of the living room is about 1%. This percentage tends to the small range of values and reveals that there is a connection between the Bathroom and the center of the living room through a transitional space.

4.8.3.5 The relation between the living room and the Balcony:

The percentage of the visible area of the Balcony from the center of the living room is about 79%. This percentage reveals that there is a direct connection between the balcony and the center of the living room.

Summary

This chapter has discussed the definition of the social space and the theories that deal with architectural spaces and space analysis. Some of these theories are based on social relations and the human behavior in the spaces. Other theories focus on the cognition and visual perception of spaces and the correlation between spaces through visual connections among them.

The spatial relation between spaces has been studied in this chapter based on calculating the percentage of the visible area from the correlated other spaces based on (Isovist) theory, and the correlation between dwelling spaces can be observed by comprising the visible area from two main points:

- The entrance of the dwelling as a beginning point to manifest the structure of dwelling spaces and the correlation between them.
- The center of the living room which is considered the heart of the dwelling and the center of living activities.

This chapter has focused studying the internal spaces of the dwelling in order to determine four main spatial relations as follows:

- First: the relation between the entrance and the living area and if there is an entrance lobby used as an intermediate space preventing hurting the privacy of the home.
- Second: the relation between the entrance and the kitchen.
- Third: the relation between the living room and the kitchen and to also illustrate the type of the kitchen; if it is open or closed.
- Forth: the relation between the living space and the other rooms

Part 3: Evaluating the functional performance of spaces in low-income houses

This Part consists of two chapters. The first chapter defines the evaluation criteria in order to set up the aimed expert system. The second chapter presents the devised computer expert system based on a mathematical logic known as (fuzzy logic).

Chapter 5: Evaluation Criteria according to economical aspects

Preface

To devise a new evaluation system for low-income dwellings in Egypt, evaluation criteria should be defined in order to build the aimed expert system with lower and higher values.

These criteria are based on several sources such as the lifestyle of Egyptian low-income dwellers which is considered the main source of the evaluation criteria. Furthermore, housing standards and design guidelines have been included as a parallel source of data that should not be neglected.

5.1 Evaluation criteria

Evaluation is defined as the systematic collection and analysis of data needed to make decisions; Rossi and Freeman (1993) define evaluation as "the systematic application of social research procedures for assessing the conceptualization, design, implementation, and utility of programs."¹²¹

On the other hand, as part of the concept of community participation, people must have the opportunity to develop their own design proposals and the dwellings should meet the needs and wishes of those who are to live in them.

Many important lessons can be learned from the negative responses to existing forms of housing. In the past, tenants were presented with a 'fait accompli', and given little or no choice.

The way to achieving better solutions for housing design is participation in design. Wherever possible, future users should be invited to take part in the design of their homes at every stage. This means evaluation of any new housing projects should be undertaken through the characteristics of its dwellers. These evaluation criteria should consider not only the economical factors and the cost of the construction, but also the needs.¹²²

There are four major sources that feed into the evaluation system for low-income dwellings which could be arranged according to their importance as follows:

¹²¹ William R. Shadish, Thomas D. Cook, Laura C. Leviton. Foundations of program evaluation: theories of practice. SAGE Publications, Inc., 1991.

¹²² Graham Towers Shelter is not enough, Transforming multi-storey housing. - Southampton: The Policy Press, 2000.

- a) Low-income dwellers' lifestyle (which is considered the main source)
- b) Housing standards, codes and design guidelines
- c) International low-income housing examples (social housing – affordable housing)
- d) Space saving strategies which affect the use of dwelling spaces and increase the quality of living.

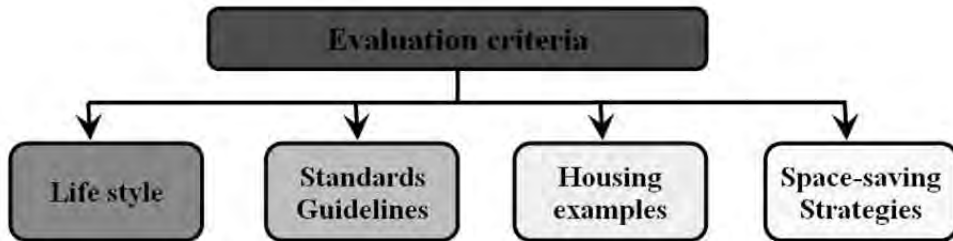


Figure 138: Sources of evaluation criteria

These four criteria will be clarified in the following parts.

5.1.1 Lifestyle of Low-income dwellers:

Determining the lifestyle of low-income groups is considered the main source of evaluation for any new dwellings in order to test whether or not these dwellings are suitable to the dwellers. Life style in general includes four basic sides; socio-cultural characteristics of the dwellers, their needs, their desires for new housing, and their way of coexistence in dwelling spaces.

The previous chapters have focused on low-income dwellers' lifestyle; there are three used techniques in order to investigate this objective. These three techniques are illustrated in the following figure.






Figure 139: The three used techniques in order to investigate dwellers' lifestyle

To calculate the average and the range for the result of the functional studies which were mentioned in the two previous chapters, it is very important to re-perform those studies.

For that purpose, all prior functional studies have been re-undertaken for three similar dwellings.¹²³ These three case studies are displayed in the following table.

Table 29: The three case studies

| Case (a) | Case (b) | Case (c) |
|---|---|--|
|  |  |  |

5.1.2 Codes, Standards, guidelines:

Standards for dwellings were first established by the Dudley Report in 1944. Like its predecessor, the second major report on housing standards concentrated on houses, for which it established new space standards based on room sizes.

Table 30: Comparison of recommended overall sizes for flats in successive government reports (figures in square meter)

| Size of flat | 1944 Housing Manual | 1949 Housing manual | Parker Morris report – 1961 |
|--------------|------------------------------|-----------------------------|-----------------------------|
| 1 Person | - | 27.87: 32.52 m ² | 30.47 m ² |
| 2 Persons | 40.13 m ² | 46.45 m ² | 45.52 m ² |
| 3 Persons | 52.12 m ² | - | 57.79 m ² |
| 4 Persons | 64.29 : 66.15 m ² | 65.03: 69.68 m ² | 71.07 m ² |
| 5 Persons | 68.75: 73.58 m ² | 78.97 m ² | 80.36 m ² |
| 6 Persons | - | 83.61: 88.26 m ² | 85.01 m ² |
| 7 Persons | - | 92.9 m ² | - |

¹²³ For more details about the three selected case studies, see (appendix 2)

The Dudley Report was accompanied by the 1944 Housing Manual which fleshed out these standards. These standards were further refined and developed by the 1949 Housing Manual. Standards were raised once more by the Parker Morris Report of 1961. This report was chiefly concerned with houses. Flats were essentially treated as stacked-up houses.¹²⁴

Following the example of these early standards, all nations have established their own codes. In every country today there is a housing guideline or code upheld by its state to ensure the essential requirements for the residents and to control the quality of their life.

The following table illustrates the housing guidelines and standards which will be taken into account by the researcher only in matters related to the basic needs that do not seem to depend on socio-cultural characteristics.

Table 31: Housing guidelines and standards




| Ref. no, | Reference Name |
|-----------------|---|
| H (1) | Metric Handbook - planning and Design data [Book] / ed. Littlefield David. - [s.l.] : Elsevier Ltd., 2008. - Third Edition. |
| H (2) | Housing Space Standards, A report by HATC Limited for the Greater London Authority [Report]. - London : Greater London Authority, 2006. |
| H (3) | International Residential Code, For one and two Family Dwellings [Book]. - [s.l.] : INTERNATIONAL CODE COUNCIL, INC., 2006. |
| H (4) | Affordable housing Design Guidelines [Online] // Queensland Government, Department of Communities. - September 2004. - 12 7, 2010. http://www.qchc.asn.au/Portals/0/Uploads/Affordable%20Housing/aff_hsg_des_guidelines.pdf . |
| H (5) | Egyptian Regulations for the Unified Construction [Report] : Official Gazette. - Cairo : (Elwaqae Elmasria), 2009. |


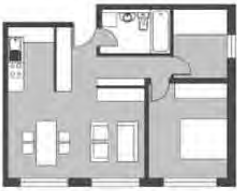



¹²⁴ Graham Towers Shelter is not enough, Transforming multi-storey housing [Book]. - Southampton : The Policy Press, 2000.

5.1.3 Housing examples:

Comparison with other similar and successful international examples of social and affordable housing is one of the methods of evaluation used in this research. Eight examples from around the world were selected for this end. All selected dwellings contain three habitable rooms (1 living room and 2 bedrooms) and they belong to social or affordable housing. The next table displays the eight examples and their location, net area and number of habitable rooms.

Table 32: The selected housing examples:

| | | | |
|--------------------|---|---|---------------------------|
| Example (1) |  | AHMM's mixed-tenure housing on the Grand Union Canal's Adelaide Wharf in Hackney, east London | |
| | | Net area: 66.1 m ² | No. of habitable rooms: 3 |
| | | Reference: Matthew Turner. PD The architects' website. http://www.bdonline.co.uk/how-ahmm-delivered-housing-with-real-value-at-adelaide-wharf/3127796.article (accessed 10 15, 2010). | |
| Example (2) |  | 8th & Howard Family Apartments - affordable housing San Francisco, CA | |
| | | Net area: 56.45 m ² | No. of habitable rooms: 3 |
| | | Reference: Ben Gates. "Enterprise, financing and solution for housing and communities." http://www.rosefellowship.org/images/uploads/2006-11-05_CCC-Urban_Family_Living_Precedents.pdf (accessed 9 15, 2010). | |
| Example (3) |  | Social housing (incremental housing), Iquique, Chile, Programa Chile-Barrio del Gobierno de Chile. | |
| | | Net area: 64.7 m ² | No. of habitable rooms: 3 |
| | | Reference: Nico Saieh. Arch Daily. http://www.archdaily.com/10775/quinta-monroy-elemental/ (accessed 02 12, 2011). | |

| | | | |
|-------------|---|--|---------------------------|
| Example (4) |  | Carabanchel Housing, Madrid, Spain, EMVS. Empresa Municipal de la Vivienda y Suelo de Madrid. | |
| | | Net area: 62 m ² | No. of habitable rooms: 3 |
| | | Reference: Nico Saieh. Arch Daily. http://www.archdaily.com/4750/carabanchel-housing-dosmasuno-arquitectos/ (accessed 2 20, 2011). | |
| Example (5) |  | Izola Social Housing, Izola, Slovenia, Slovenian Housing Fund and Community of Izola | |
| | | Net area: 50.64 m ² | No. of habitable rooms: 3 |
| | | Reference: Nico Saieh. Arch Daily. http://www.archdaily.com/3245/izola-social-housing-ofis-arhitekti/ (accessed 3 20, 2011). | |
| Example (6) |  | Social Housing in Milan / Milan, Italy | |
| | | Net area: 70.9 m ² | No. of habitable rooms: 3 |
| | | Reference: Nico Saieh. Arch Daily. Arch Daily. http://www.archdaily.com/93252/social-housing-in-milan-studiowok/ (accessed 3 13, 2011). | |
| Example (7) |  | Pipe-Stairwell Adaptable Housing (residential open Building) ,Cuiwei Residential Quarter, Beijing, China | |
| | | Net area: 60.6 m ² | No. of habitable rooms: 3 |
| | | Reference: Stephen Kendall,Jonathan Teicher Residential Open building [Book]. - London : Taylor & Francis, 2002. | |
| Example (8) |  | Housing complex, Frankfurt by A. Brenner, 1928–1929 | |
| | | Net area: 48 m ² | No. of habitable rooms: 3 |
| | | Reference: Karel Teige. The minimum dwelling. London: The MIT Press, 2002. | |

5.1.4 Space-saving strategies:

The main goal of using space-saving strategies is to improve the performance of living activities. Surly using these strategies influences the functional performance and the use of spaces, therefore, considering these methods will influence the efficiency of the dwelling.

5.2 Low-income family structure

To achieve the success of any new housing project, it is vital to select a suitable target group for it.

To select the housed target group, basically it is required to define this target group to develop a vision as consistent as possible with the way they coexist in the dwelling spaces.

5.2.1 Family size

As mentioned in chapter (1), the evidence from most social field studies emphasize that the average size of low-income families in urban communities is around five persons.¹²⁵

On the other hand, the average size of an Egyptian household, according to final results of 2006 population census is 4.2 persons.¹²⁶

5.2.2 The number of siblings

As concluded from social surveys which have been conducted on low-income families who live in the urban social housing in Egypt, low-income families who live in the urban communities consist of four or five members in average and most of them prefer to have two or three sons.¹²⁷

5.2.3 Percentage of Female kids to all Kids

The default house designed for social housing (governmental housing – cooperative housing) consists of three habitable rooms (two bed rooms and a living room)¹²⁸.

¹²⁵ د محمد احمد بيومي - د عفاف عبد العليم ناصر. علم الاجتماع العائلي. الإسكندرية: دار المعرفة الجامعية, 2009

¹²⁶ Central Agency for public mobilization and statistics .

http://www.capmas.gov.eg/pages_ar.aspx?pageid=573 (accessed 2 25, 2011).

¹²⁷ د سهير لطفي - د محمود الكردي - آخرون. المسح الاجتماعي الاقتصادي لمنطقة إيواء زينهم. القاهرة: المركز القومي للبحوث الاجتماعية والجنائية - برنامج بحوث العشوائيات في المجتمع المصري, 1999

¹²⁸ Ibid

However, the family may need another sleeping space, especially when they decide to separate between boys and girls according to their religious beliefs.

This percentage influences the need for other bed rooms. Although it could not be expected for more new nuclear families, it is a clear indicator for the need for more bedrooms

5.2.4 Performing other profitable work at home

Performing work at home to increase the family income may demand more space to carry out that work. It depends of course on the type of the work and its spatial needs.

Hence, knowing whether or not a profitable work may be performed in the house should be considered in the design phase and be evaluated in any new housing project.

The evidence from numerous social field studies shows that low-income families rarely use their home spaces in performing a profitable work.¹²⁹ According to the social survey undertaken by the researcher, it is concluded that Low-income families use home spaces in performing only the ordinary domestic activities and they do not need any specified spaces to perform any other external work.

5.3 Properties of the desired dwelling by low-income dwellers

Based on the social questionnaire accomplished by the researcher, and the previous studies for low-income groups in Egypt, certain desired specifications for new low-income housing should be based on their socio-cultural characteristics. These desires should be compared with housing standards and guidelines taking into account that the desires of the dwellers are the first priority.

5.3.1 Total area of the dwelling

Most low-income families accept to own a dwelling with an average area between 60 m² to 70 m².¹³⁰ A dwelling with this area is considered the minimum one that could meet dwellers needs in performing their essential home activities. This evidence is confirmed through the

¹²⁹ د سهير لطفي - د محمود الكردي - آخرون. المسح الاجتماعي الاقتصادي لمنطقة إيواء زينهم. القاهرة: المركز القومي للبحوث الاجتماعية والجنائية - برنامج بحوث العشوائيات في المجتمع المصري, 1999

¹³⁰ د سهير لطفي - د محمود الكردي - آخرون. المسح الاجتماعي الاقتصادي لمنطقة إيواء زينهم. القاهرة: المركز القومي للبحوث الاجتماعية والجنائية - برنامج بحوث العشوائيات في المجتمع المصري, 1999

previous social housing projects, where dwellers have extended their dwellings by over 20 m² in average from around 40 m² to 64.¹³¹

The following table addresses the area for a five person dwelling according to housing guidelines and standards

Table 33: Area of the dwelling according to the housing standards

| H (1) | H (2) | H (3) | H (4) | H (5) |
|----------------------|-------------------|-------|-------------------|-------|
| 65:70 m ² | 73 m ² | - | 65 m ² | - |

5.3.2 Total area of living room

The living room is considered the heart of the dwelling; its estimated area depends on the activities which are carried out in it. The two following tables illustrate the area of the living room according to the housing standards and the selected housing examples.

Table 34: Area of the living room according to the housing standards

| H (1) | H (2) | H (3) | H (4) | H (5) |
|----------------------|-------|-------------------|-------------------|--------------------|
| 15:20 m ² | 22.3 | 11 m ² | 18 m ² | 7.5 m ² |

Table 35: Area of the living room according to the selected housing examples

| Ex (1) | Ex (2) | Ex (3) | Ex (4) | Ex (5) | Ex (6) | Ex (7) | Ex (8) |
|-------------------|---------------------|---------------------|---------------------|-------------------|-------------------|---------------------|---------------------|
| 20 m ² | 21.8 m ² | 26.9 m ² | 20.2 m ² | 18 m ² | 30 m ² | 29.4 m ² | 22.6 m ² |

According to low-income dwellers' lifestyle, the living room is a multi-used space. Hence, it should be wide and suitable enough in order to allow for performing the needed activities easily.

5.3.3 Number of bedrooms

According to the social survey undertaken by the researcher, it is concluded that many Low-income families who have a dwelling that includes two bedrooms, need another bed room especially if the family includes boys and girls and they accept to reduce the areas of the bedrooms in order to increase their number.

¹³¹ Graham Tipple, Extending themselves - user initiated transformations of government-built housing in developing countries [Book]. - Oxford : LIVERPOOL UNIVERSITY PRESS, 2000.

Most Low-income families prefer to own a dwelling that includes three habitable rooms (two bedrooms and a living room).¹³²

5.3.4 Total area of the services (Kitchen-Bathroom)

The next two tables show the average of the specified area used for the kitchen and the bathroom, according to the selected housing examples and the standards.

Table 36: Total area of the services according to the selected housing examples

| Ex (1) | Ex (2) | Ex (3) | Ex (4) | Ex (5) | Ex (6) | Ex (7) | Ex (8) |
|--------------------|-------------------|--------------------|---------------------|--------------------|---------------------|--------------------|--------------------|
| 8.5 m ² | 12 m ² | 9.4 m ² | 11.2 m ² | 8.8 m ² | 12.5 m ² | 9.8 m ² | 6.6 m ² |

Table 37: Total area of the services according to the housing standards

| H (1) | H (2) | H (3) | H (4) | H (5) |
|-------|---------------------|-------|---------------------|--------------------|
| - | 10.4 m ² | - | 9.75 m ² | 4.5 m ² |

These averages will be used in determining the desired area used for that propose and will be fed into the aimed expert system in the next chapter.

5.3.5 Percentage of the balcony area to total dwelling area

According to survey, low-income dwellers manage the balcony as a multi-functional space; it is usually used as storage or as an access to the outdoor environment.

Table 38: Percentage of the balcony according to the selected housing examples

| Ex (1) | Ex (2) | Ex (3) | Ex (4) | Ex (5) | Ex (6) | Ex (7) | Ex (8) |
|--------|--------|--------|--------|--------|--------|--------|--------|
| 4.8% | 0% | - | 5.8% | - | - | - | - |

5.3.6 Percentage of the lobbies' area to total apartment area

This percentage should be as small as possible to prevent waste of area. On the other hand, according to the desires of the low-income dwellers, achieving the privacy of dwelling spaces through transitional spaces is one of their spatial priorities.

¹³² د سهير لطفي - د محمود الكردي - آخرون. المسح الاجتماعي الاقتصادي لمنطقة إيواء زينهم. القاهرة: المركز القومي للبحوث الاجتماعية والجنائية - برنامج بحوث العشوائيات في الجتمع المصري, 1999

The following table displays the percentage of the lobbies to the whole dwelling area in the selected housing examples which illustrates the range of this percentage.

Table 39: Percentage of the lobbies according to the selected housing examples

| Ex (1) | Ex (2) | Ex (3) | Ex (4) | Ex (5) | Ex (6) | Ex (7) | Ex (8) |
|--------|--------|--------|--------|--------|--------|--------|--------|
| 8.4% | 0% | 11.3% | 12% | 13.5% | 7.5% | 0% | 4.6% |

5.3.7 Percentage of the storage area to all apartment area

In London, in dwellings which had a built-in storage space, the amount of the storage area per person ranged between approximately 0.2 m² and 0.5 m².¹³³

On the other hand, according to the analytical study carried out by the researcher in order to determine the area used for storage in low-income dwellings, it is noticed that the dwellers use about 5% of the dwelling for that purpose.

The following table displays the percentage of the storage area according to housing standards.

Table 40: Percentage of the storage area according to the housing standards

| H (1) | H (2) | H (3) | H (4) | H (5) |
|--------|-------|-------|-------|-------|
| 1.5:2% | 2.7% | - | - | - |

5.4 Spatial relations of the desired dwelling

This element of the proposed evaluation process addresses the desired relations between home spaces based on the (Isovist) theory which was reviewed in the previous chapter.

5.4.1 Determining spatial relations based on the visible area from the entrance

This part investigates the relation between the entrance and all dwelling spaces. These relations will be explained in the following sections.

¹³³ ROOM TO SWING A CAT? The Amount and Use of Space in New Dwellings in London & the South East [Online] // HATC. - March 2010. - 11 20, 2010.
http://www.hatc.co.uk/room_to_swing_a_cat.pdf.

5.4.1.1 Total visible area of the dwelling from the main entrance:

According to the social survey, most low-income families prefer to have a transitional space between the entrance and the other spaces despite the probable waste of area. The reason for providing this space is to preserve the privacy of these spaces.

For this purpose, the percentage of the visible area of the dwelling should be as small as possible.

5.4.1.2 The Visible area of the living room from the Entrance:

If the entrance is connected directly to the living space, the visible area of the living room will increase. On the contrary, if there is a transitional space, certainly, this area will decrease.

According to the social survey, most low-income families prefer to have a transitional space between the entrance and the living room.

Based on the analytical study illustrated in chapter four, the percentage of the visible area of the dwelling fluctuated between 1% and 85% and tends to be in the small range of values.

5.4.1.3 The visible area of the kitchen from the Entrance:

Accordingly, most low-income families find that the relation between the entrance and the kitchen is more essential than the relation between the kitchen and the bedroom zone.

Based on the analytical study illustrated in chapter four, the percentage of the visible area of the kitchen should not equal 0% to investigate the relation between the entrance and the kitchen. Also the percentage should tend to the small range of values.

5.4.2 Determining spatial relations based on the visible area from the center of the living room

This part investigates the relation between the center of the living room and all dwelling spaces. These relations will be explained in the following sections.

5.4.2.1 Total visible area of the dwelling from the center of the living room:

This percentage indicates the direct connection between all dwelling spaces and reveals the privacy level of home private zones.

Generally, the Living room is considered the main space to receive guests and strangers; therefore, the visible area of all dwellings spaces form the center of the living room should tend to the small range of values to keep the privacy of dwelling spaces.

5.4.2.2 The visible area of the kitchen from the living room:

Most low-income families reject the idea of the open kitchen. The reason for rejecting it is the lack in providing privacy to the woman when she is cooking.

Based on the analytical study illustrated in chapter four, the percentage of the visible area of the kitchen should be fluctuated between 0% and 60%. If this value is around 80% or greater, this may indicate that the kitchen is combined with the living room (open kitchen).

5.4.2.3 The visible area of the two bedrooms from the center of the living room:

The percentages of the visible areas in the two bed rooms from the center of the living room indicate the relation between them, whereas, if the two percentages tend to the small range of values, this reveals that there is an indirect relation between the living room and the zone of bedrooms and they may be connected through a transitional space. If the visible percentage of one bedroom tends to the medium range of values and the other bedroom tends to small range of values, this also indicates that the zone of bedrooms is connected to the living room through a transitional space.

Contrarily, if the two percentages tend to the high range of values or one of them tends to the high and the other tends to the medium, this reveals that there is no transitional space and the bedrooms are connected directly to the living room.

5.4.2.4 The visible area of the Bathroom from the center of the living room:

The bathroom is the one of the most private spaces in the dwelling and should not be connected directly to the other spaces especially to the living room which usually receives guests and strangers in it

5.4.2.5 The visible area of the Balcony from the center of the living room

This percentage investigates the relation between the balcony and the living room and whether it is connected to the living room or connected to any other room.

According to the social survey, most low-income families prefer to have a balcony connected directly to the living room. Therefore, the percentage of the visible area should not be zero and should tend to the small range of values.

5.5 Use of space according to dwellers' lifestyle

This part illustrates how low-income families deal with the spaces of the dwelling according to their lifestyle and daily home activities. This part evaluates the percentage of the used areas in several activities.

5.5.1 Percentage of the total occupied area with fixed furniture

The avoidance of feeling 'cramped' is based on the free visible area left without occupation with furniture in a given space. Using space-saving furniture could increase the free area of the dwelling.

Low-income families usually take into account the free area of the dwelling and sometimes they dispense with some pieces of furniture in order to achieve that purpose.

Table 41: Percentage of the total occupied area with fixed furniture in the three analytical cases

| Case (a) | Case (b) | Case (c) |
|-----------------|-----------------|-----------------|
| 43% | 37% | 44% |

Table 42: Percentage of the total occupied area with fixed furniture in the selected housing examples

| Ex (1) | Ex (2) | Ex (3) | Ex (4) | Ex (5) | Ex (6) | Ex (7) | Ex (8) |
|--------|--------|--------|--------|--------|--------|--------|--------|
| 33.8% | 30% | 30% | 29% | 34% | 26% | 44% | 35% |

These averages will be used in determining the desired area used for that purpose and will be fed into the expert system in the next chapter.

5.5.2 Percentage of the total occupied area with temporary furniture

Based on the three case studies which have been analyzed, the average percentage of the total occupied area with temporary furniture is shown in the following table.

Table 43: Percentage of the total occupied area with temporary furniture in the three analytical cases

| Case (a) | Case (b) | Case (c) |
|----------|----------|----------|
| 2% | 5% | 5% |

By using space saving strategies such as using movable or folding furniture, this percentage of the used area will be increased.

5.5.3 Percentage of the total occupied area with elevated furniture

The following table displays the percentage of the occupied area with elevated furniture units in the three analyzed cases.

Table 44: Percentage of the total occupied area with elevated furniture in the three analytical cases

| Case (a) | Case (b) | Case (c) |
|----------|----------|----------|
| 9% | 10% | 9% |

Also, this percentage will increase if space-saving furniture is used in the dwelling.

5.5.4 Percentage of the total occupied area used for storage

This percentage indicates the wasted area of the dwelling used by the dwellers in order to store food and rarely used appliances.

Table 45: Percentage of the total occupied area used for storage in the three analytical cases

| Case (a) | Case (b) | Case (c) |
|----------|----------|----------|
| 4% | 5% | 7% |

5.5.5 Percentage of the total used area for circulation

The following two tables display the used area for circulation in the three analyzed cases and the selected housing examples whereas, by controlling this percentage, the unused area could be decreased in order to improve the efficiency of the used space.

Table 46: Percentage of the total used area for circulation in the three analytical cases

| Case (a) | Case (b) | Case (c) |
|----------|----------|----------|
| 29% | 30% | 28% |

Table 47: Percentage of the total used area for circulation in the selected housing examples

| Ex (1) | Ex (2) | Ex (3) | Ex (4) | Ex (5) | Ex (6) | Ex (7) | Ex (8) |
|--------|--------|--------|--------|--------|--------|--------|--------|
| 25% | 23% | 20% | 24% | 25% | 26% | 26% | 28% |

5.5.6 Percentage of the total used empty (unoccupied) area

The following table displays the percentage of the total unoccupied area, which is used to perform temporary activities such as (playing – praying – eating) and also used as a required clearance area for the use of units of furniture.

Table 48: Percentage of the total used empty area in the three analytical cases

| Case (a) | Case (b) | Case (c) |
|----------|----------|----------|
| 66% | 65% | 70% |

5.5.7 Percentage of the shared area in multiple activities

This percentage indicates how low-income families use the habitable rooms as flexible spaces in order to perform more home activities in the same area.

Table 49: Percentage of the total shared area in multiple activities in the three analytical cases

| Case (a) | Case (b) | Case (c) |
|----------|----------|----------|
| 15% | 10% | 12% |

By increasing this percentage the efficiency of the space will increase.

5.5.8 Percentage of the total area used in performing all home activities

The following table illustrates how low-income families coexist in all available area in the three analyzed cases.

Table 50: Percentage of the total area used in performing all home activities in the three analytical cases

| Case (a) | Case (b) | Case (c) |
|----------|----------|----------|
| 88% | 85% | 90% |

The higher the percentage of the used area, the higher the efficiency of the dwelling.

5.5.9 Conflicting areas which hinder the performance of home activities.

Determining the percentage of conflicting areas can be used as an indicator of the efficacy of furnishing, as opposed to non-influential conflicting areas which do not hinder the performance of home activities.

5.5.9.1 Percentage of the Intersection of activity areas with the existing furniture

The following table displays the percentage of the intersection area that results from the intersection of the existing furniture with the area used in performing home activities.

Table 51: Percentage of the Intersection of activities area with the existing furniture in the three analytical cases

| Case (a) | Case (b) | Case (c) |
|----------|----------|----------|
| 4% | 5% | 4% |

5.5.9.2 Percentage of the Intersection of circulation area with the existing furniture

The following table shows the percentage of the intersection area that results from the intersection of the existing furniture with the area which should be left free for circulation purposes.

Table 52: Percentage of the Intersection of circulation area with the existing furniture in the three analytical cases

| Case (a) | Case (b) | Case (c) |
|----------|----------|----------|
| 1% | 2% | 2% |

5.6 Housing Indicators

This part argues for the housing indicators proposed by the researcher and discuss whether these indicators take into accounts all previously cited socio-cultural properties of the inhabitants. It also examines if there is a different way to indicate the level of the housing based on the dwellers’ lifestyle.

5.6.1 Crowding as a housing indicator

Definitions of crowding have been developed for several purposes, principally:¹³⁴

- Statistical reporting
- Research
- Regulation
- Administration e.g. for allocating housing and delivering social assistance.

¹³⁴ Alison Gray. (2001). Definitions of Crowding and the Effects of Crowding on Health: a Literature Review. Retrieved 02 01, 2011, from <http://www.msd.govt.nz/documents/about-msd-and-our-work/publications-resources/archive/2001-definitions-of-crowding.pdf>

Statistical definitions are descriptive and are used for enumerating data. In general, housing regulations are designed to protect residents' health or welfare or both. On the other hand, the administrative definitions are generally part of a rationing process for allocating scarce resources.

In this situation, crowding is usually set alongside other factors, such as income and the availability of a suitable housing condition.

On the other hand, crowding as a subjective measure refers to people's psychological response to density, to their feelings of being crowded, having a lack of privacy or an increase in unwanted interactions or psychological stressors.

Density is an objective measure and refers to the number of people in any given space - per square meter, per room, per dwelling or per hectare. The term has no positive or negative connotations. The distinction is important "because the same objective density may or may not be uncomfortable depending on the situation. High density doesn't always lead to crowding". There appears to be no research proving that there is a single point of density at which everyone will be affected in terms of health or at which everyone will feel crowded.¹³⁵

5.6.2 Statistical definitions of crowding

Statistical definitions of crowding are based on elements that are easily countable and widely understood and set a level above which crowding is deemed to occur. However, statistical definitions have considerable limitations. Typical measures used in statistical definitions include occupancy rate, room occupancy rate and bedroom occupancy.

5.6.2.1 Occupancy rate

Occupancy rate is calculated by dividing the total number of occupants of permanent private dwellings by the total number of occupied permanent private dwellings. The result is the average number of persons per occupied dwelling. Hence, this measure allows for no adjustment for either the type of household or the size of the dwelling.¹³⁶

¹³⁵ Ibid

¹³⁶ Ibid

5.6.2.2 Room occupancy rate (persons per room)

“Persons per room” is widely used as an indicator of crowding. Although this appears to be an objective measure, the point at which dwellings are deemed to be crowded is subjectively determined. It is not usually clear whether this judgment is based on social norms or on health grounds.

The definition of “persons per room” is based on defining what counts as a “room”. The term “room” makes assumptions about housing design, layout and the use of space. The measure also makes no allowance for different-sized rooms or for the amenities available to residents. Predominantly, all rooms are counted except for a laundry, bathroom and toilet. Some countries use a measure that does not count the kitchen and living room.¹³⁷

The “per room” measure has other limitations. It cannot take into account an individual’s needs or differentiate between age and sex relationships in terms of culturally prescribed sleeping arrangements. Both these indicators would be useful for establishing social norms and for establishing the health effects of particular living arrangements.¹³⁸

The level at which room density has been defined as crowded has changed over time, apparently to reflect changes in standards and expectations in the use of dwelling spaces. The impact of such changes on health has not been documented. In the 1940s in the United States the definition of crowding was more than two people per room. This was lowered to 1.5 people by 1950 and to one person by 1960, with standards becoming more rigorous as the phenomenon of crowding declined. A ratio of one person per room is in line with the standard prevailing in most European countries.¹³⁹

There has been a debate about whether the criteria for crowding should be adjusted upwards in time of economic hardship. Myers et al (1996) argue that adopting a less stringent standard of overcrowding (e.g. two people per room) would more clearly identify those most in need. In their view, “applying a high standard to the living conditions of those too poor to achieve it offers them small relief if society is unwilling to make up the difference between what we say people should have, and what we

¹³⁷ Ibid

¹³⁸ Ibid

¹³⁹ Ibid

are willing to provide to help them achieve it”¹⁴⁰ Their argument illustrates the extent to which it is difficult to separate statistical definitions from social expectations and economic pressures.¹⁴¹

5.6.2.3 Bedroom occupancy

Bedroom occupancy is also used as an indicator of crowding. This can either be a simple calculation of the ratio of residents to bedrooms, or based on a formula that takes account of household size and composition to determine how many bedrooms a household “needs”.

The preference for bedroom occupancy over per room rate appears to be based on the former’s ability to take household structure into account. The emphasis appears to be much more on social acceptability, community expectations and cultural values. Critics of the bedroom occupancy measure note that¹⁴²:

- There can be a wide variation in the number of rooms associated with any given number of bedrooms, so the measure is likely to overestimate crowding in larger houses
- Households may have additional space which they have chosen not to use as a bedroom, so that again, overcrowding may be overestimated.
- A more useful index would incorporate both the number of rooms and the number of bedrooms in a dwelling.
- Definitions of bedrooms or acceptable sleeping arrangements are cultural constructs based on western notions of the value of physical and emotional privacy.
- The floor area of bedrooms is rarely defined.

Each household varies in its need for space and in its perceptions of crowding. Furthermore, living arrangements are dynamic and will change as the age and composition of households change.

Using the simple measure, the level at which a house is considered crowded has been variously set at more than 1.5 or two people per bedroom and at more than two or three persons per bedroom.¹⁴³

¹⁴⁰ Ibid

¹⁴¹ Ibid

¹⁴² Ibid

¹⁴³ Ibid

5.6.2.4 The bedroom standard

Bedroom standard formulas are sensitive to both household size and composition but inevitably reflect majority norms.

In Britain, the “bedroom standard” compares the number of bedrooms available to a household with a calculation of its bedroom requirements. The calculation is based on the age, sex and marital status composition of the household and the relationship of the members to one another.

The Canadian standard differs from that used in Britain. Children under five of different sexes are permitted in Canada to share a room, compared with children under ten in Britain. The age at which young adults should have their own room is also lower - 18 years compared with 21 years in Britain.

In Britain, each pair of adolescents aged ten to 20 of the same sex can share a bedroom. Any person aged ten to 20 left over after this pairing is paired with a child under ten of the same sex. If this is not possible, that person has a separate bedroom.¹⁴⁴

5.6.3 Duration of use as a new indicator for housing efficiency

The main debate of using Crowding standards is cleared in using these standards by statisticians, policy makers or administrators without any consideration of the views of the inhabitants.¹⁴⁵

In reference to the previous analytical study of the duration of home activity performance, a new indicator could be proposed based on how the inhabitants live and how they deal with dwelling spaces.

¹⁴⁴ Ibid

¹⁴⁵ Ibid

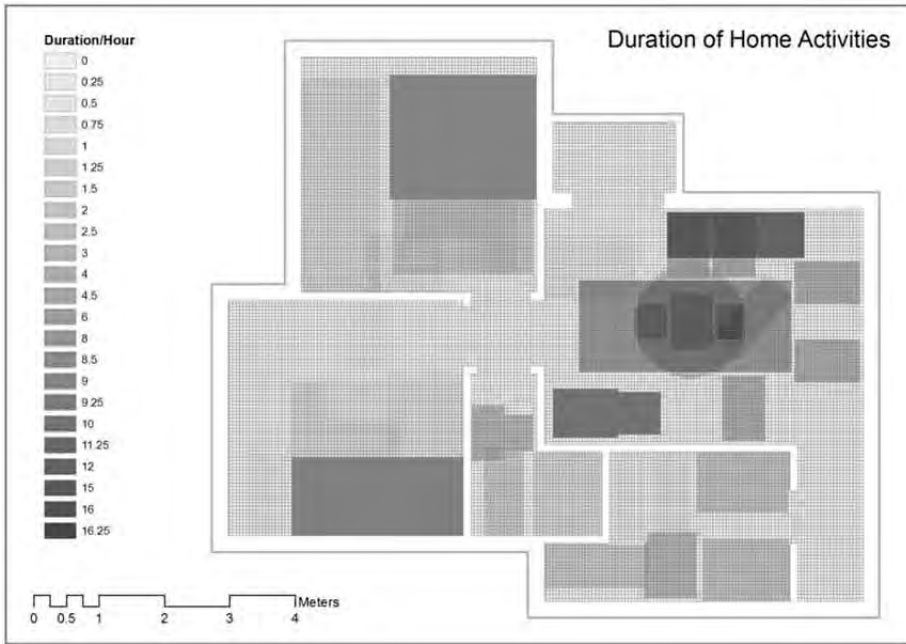


Figure 140: Duration of use as a new indicator for housing efficiency

5.6.3.1 Calculation method of the indicator.

The following table displays the duration of use for all grid cells categorized according to hours of use.

Table 53: Duration of home activities

| No | HR | No. cells | Total duration | Area |
|----|------|-----------|----------------|---------|
| 1 | 0 | 9223 | 0 | 22.7165 |
| 2 | 0.25 | 900 | 225 | 2.2074 |
| 3 | 0.5 | 1130 | 565 | 2.773 |
| 4 | 0.75 | 443 | 332.25 | 1.0865 |
| 5 | 1 | 2538 | 2538 | 6.305 |
| 6 | 1.25 | 45 | 56.25 | 0.1125 |
| 7 | 1.5 | 1091 | 1636.5 | 2.6899 |
| 8 | 2 | 1258 | 2516 | 3.0874 |
| 9 | 2.5 | 518 | 1295 | 1.295 |
| 10 | 3 | 554 | 1662 | 1.385 |
| 11 | 4 | 886 | 3544 | 2.215 |

| | | | | |
|--------------|-------|--------------|-----------------|----------------|
| 12 | 4.5 | 43 | 193.5 | 0.1075 |
| 13 | 6 | 50 | 300 | 0.125 |
| 14 | 8 | 703 | 5624 | 1.7575 |
| 15 | 8.5 | 1812 | 15402 | 4.53 |
| 16 | 9 | 1272 | 11448 | 3.156 |
| 17 | 9.25 | 179 | 1655.75 | 0.4475 |
| 18 | 10 | 856 | 8560 | 2.14 |
| 19 | 11.25 | 41 | 461.25 | 0.1025 |
| 20 | 12 | 224 | 2688 | 0.56 |
| 21 | 15 | 351 | 5265 | 0.8775 |
| 22 | 16 | 364 | 5824 | 0.91 |
| 23 | 16.25 | 57 | 926.25 | 0.1425 |
| Total | | 24538 | 72717.75 | 60.7292 |

As an outcome from the table above:

Total used cells = 24538

Hence, mean cell use duration equals total duration divided by the number of total used cells

Mean of cell use duration = $72717.75 / 24538 = 2.96$ hr

If (A) = the total used cells

And (B) = the total duration

Then D.I. (duration indicator) = (B / A)

Figure 141: Calculation of the duration indicator

Certainly, it is obvious that more work needs to be done to take account of all aspects that may affect this measure in indicating the levels of housing. Furthermore, to generate standards that classify the levels of housing, it is necessary to apply this study on a lot of dwellings with various conditions and different levels.

5.6.3.2 Variables affecting the housing Duration Indicator (DI)

Many variables may influence this indicator, having a positive or negative impact on the value it delivers.

- Dwellers' lifestyle
- Area of the dwelling

This variable has a negative impact on the indicator; if the area is increased, the indicator value decreases.

- Number of family members

This variable has a positive impact on the indicator; if the family has many members and many siblings; the indicator value decreases.

- Area and number of the habitable rooms

This variable has a negative impact on the indicator; if the area is increased, the indicator value drops.

- Furnishing units used.

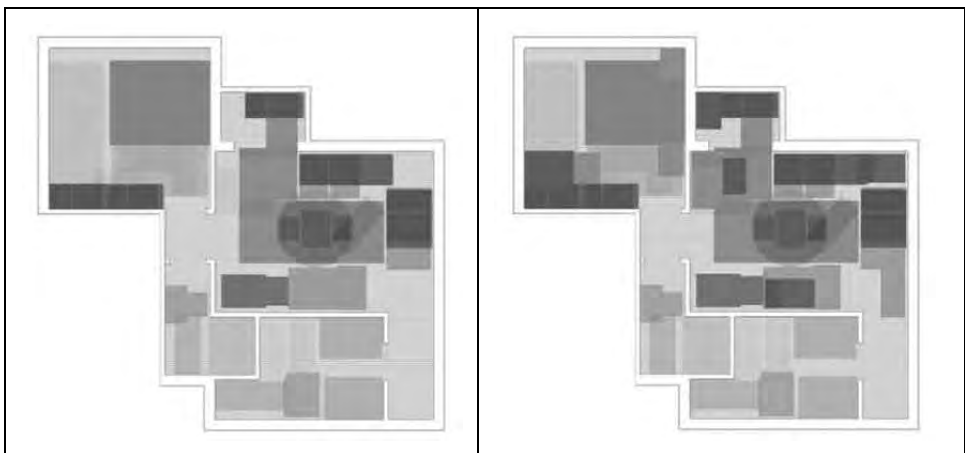


Figure 142: The effects of the variables in the map of the duration of use

The previous figure illustrates the effects of the variables in the map of the duration of use. These changes affect the indicator which comes from the calculation of the duration of use for each cell. The left figure shows the noticeable increasing of red colored cells when a room has been removed from the dwelling. The right figure displays the increase in red cells in duration map if the family has another member added to the same dwelling unit presented in the left figure.

Summary.

In this chapter, evaluation criteria have been defined in order to mock up an expert evaluation system for low-income dwellers in Egypt.

There are four major sources that feed into the evaluation system which could be arranged according to their importance as follows:

- Low-income dwellers' lifestyle which contains four basic sides; socio-cultural characteristics of the dwellers, their needs, their desires for new housing, and their way of coexistence in dwelling spaces
- Housing standards, codes and design guidelines
- International low-income housing examples (social housing – affordable housing)
- Space saving strategies which affect the use of dwelling spaces and increase the quality of living.

These criteria are presumed to meet with the concept of community participation, and fall in four main items:

- Selecting a suitable target group for any new low-income housing,
- Properties of the dwelling desired by low-income dwellers,
- Spatial relations of the desired dwelling,
- Use of the spaces according to dwellers' lifestyle.

This chapter discussed various housing indicators used by experts and researchers, and posed the question of whether these indicators take into accounts all socio-cultural properties of the inhabitants. It also proposed a different way (a duration indicator) to indicate the level of the housing based on the dwellers' lifestyle, making use of the researcher's method for temporal analysis of dwelling spaces.

Chapter 6: Devising a Functional evaluation expert system based on fuzzy logic

Preface

This chapter is considered pinnacle of the research; it demonstrates how to translate and express the dwellers' lifestyle, their socio-cultural needs and demanded spatial requirements for their dwellings to numerals data, which could be evaluated according to any given social and/or economical factors.

Based on the basic evaluation criteria which have been mentioned in the previous chapter, this chapter presents the devised computer expert system based on a mathematical logic which is known as fuzzy logic. This logic is viewed by the researcher to be an appropriate method to translate the social data into a numerical system which could signify the efficiency of the dwelling by evaluating all dwelling factors as variables channeled into a mathematical formula.

6.1 Introduction to fuzzy logic

Fuzzy sets were first invented by Professor LA Zadeh in 1965. They were first seen only as a technique for mathematically expressing linguistic ambiguity.

Contemporary technology is constantly getting more closely connected with people's daily lives, and it has indeed become necessary that computers understand the logic of humans. The problem is that there is a noticeable deal of ambiguity in our social life, and it cannot be handled by standard logical processing. Therefore, fuzzy sets can be considered an appropriate tool of logic that can express this 'ambiguity'. Furthermore, the problem of agreement between people and technology can become extremely complicated, requiring no collaboration between the natural sciences and the humanities and social sciences, fields that have up until now progressed independently. Fuzzy sets are a communication medium that speaks to both the logical nature of the sciences and the complexity of the humanities and social sciences.¹⁴⁶

Fuzzy set theory is now established as a mathematical measure of a wide variety of ambiguous phenomena, including the concept of probability.¹⁴⁷

¹⁴⁶ Toshiro Terano, Kiyoji Asai, Michio Sugeno. FUZZY SYSTEMS Theory and its applications. London: ACADEMIC PRESS, INC, 1992

¹⁴⁷ Ibid.

Thus, in the light of this brief definition of Fuzzy logic, it may be argued that the concept of fuzzy sets is a suitable mathematical approach to expressing those many distinct, ambiguous elements which have a great impact in creating a successful residential environment, yet their targeted values cannot be estimated in rigid numbers that may serve as sharp limits for evaluation.

It will not be sociologically plausible to say that if a dwelling scores less (or more) than a particular value of X that designates a certain variable of dwellers' lifestyle on the evaluation scale, then this dwelling will not be appropriate for any other household that shares the same socio-cultural properties. Other families or household units with similar properties may be more comfortable with $(X + 1)$, or with $(X - 1)$ due to certain determinants that cannot be predicted or accounted for, given the nature of research input commonly used for social housing. So it stands to reason that what we are targeting here is not an exact X , but rather a 'fuzzy' field, set or range that surrounds this X . If a dwelling falls within this fuzzy set, then it is more likely to suit a greater number of similar households than may be the case if we only targeted a specific value X .

6.1.1 The concept of fuzzy logic

As mentioned above, Fuzzy logic is a logic that seeks to better conform to the complicated methods and principles of human reasoning, both individually and socially. Classical logic, on the other hand, and as common practice, deals with propositions that are either true or false. Each proposition has an opposite. This classical logic, therefore, deals with combinations of variables that represent propositions. As each variable stands for a hypothetical proposition, any combination of them eventually assumes a truth value (either true or false), but never is in between or both (i.e., not true and false at the same time).

The main content of classical logic is the study of rules that allow new logical variables to be produced as functions of certain existing variables.

For example: suppose there is a set X of all real numbers between 0 and 10 which we call the universe of discourse. A subset (A) of X is defined of all real-numbers in the range between 5 and 8. $A = [5,8]$

The following figure shows the set A by its characteristic function, this function assigns a number 1 or 0 to each element in X , depending on whether the element is in the subset A or not.

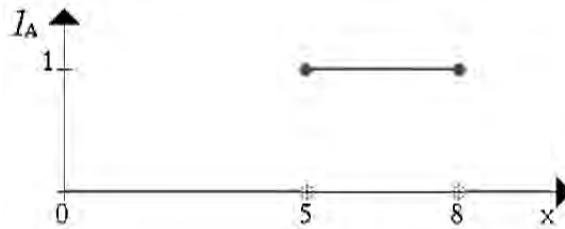


Figure 143: The classical set

Because one and only one truth value (either true or false) is assumed by a logical function of a (finite) number of logical variables, the classical logic is also called a two-valued logic.

The fundamental assumption upon which the classical logic is based is that every proposition is either true or false. However, it is well accepted that many propositions may in fact be both partially true and partially false. To describe such partial truth values by some new rules, in a way to extend and generalize the two-valued logic, multi-valued logics were proposed and developed. Hence the membership function can take only two values, 1 or 0.¹⁴⁸

6.1.2 Types of fuzzy variables

There are two types of fuzzy variables, continuous and discrete continuous variables as shown in Fig 10 l(a) and (b). Fig (a) shows a bell type and (b) a triangular type, and both of them specify a fuzzy variable.¹⁴⁹

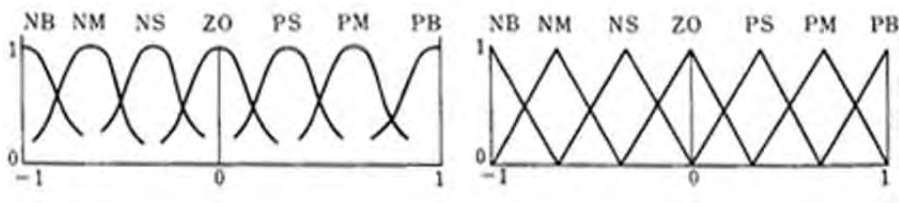


Figure 144: (a) Bell Shaped

(b) Triangular

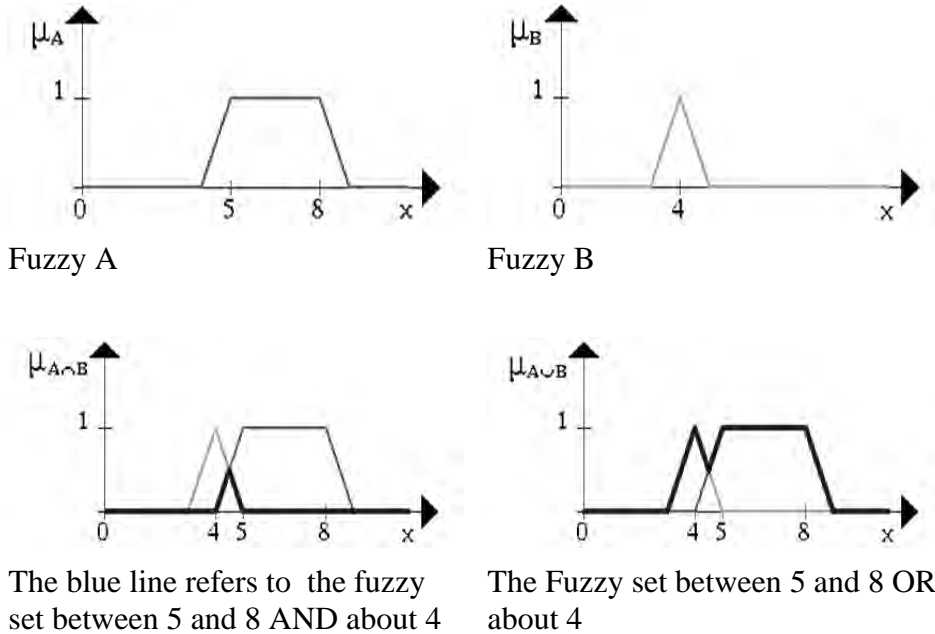
¹⁴⁸ George Bojadziev, Maria Bojadziev. Fuzzy Logic For Business, Finance and Management. Singapore: World Scientific Publishing Co. Pte. Ltd,2007.

¹⁴⁹ Toshiro Terano, Kiyoji Asai, Michio Sugeno. Fuzzy systems Theory and its applications. London: ACADEMIC PRESS, INC,1992.

6.1.3 Operations on Fuzzy Sets

The basic operations on fuzzy sets are similar to the operations on classical sets which are: intersect, unify and negate fuzzy sets.

In order to clarify this, we give a few examples. Let A be a fuzzy interval between 5 and 8 and B be a fuzzy number about 4. The corresponding figures are shown below.¹⁵⁰



The blue line refers to the fuzzy set between 5 and 8 AND about 4

The Fuzzy set between 5 and 8 OR about 4

Figure 145: the basic operations on fuzzy sets

This following figure gives an example for a negation. The blue line is the NEGATION of the fuzzy set A.

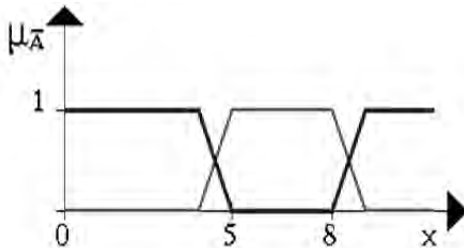


Figure 146: A negation example for a fuzzy set

¹⁵⁰ Peter Bauer, Stephan Nouak, Roman Winkler. (n.d.). Retrieved 12 7, 2010, from A brief course in Fuzzy Logic and Fuzzy Control: <http://www.esru.strath.ac.uk/Reference/concepts/fuzzy/fuzzy.htm>

6.1.4 Applications of fuzzy logic

A fuzzy set is a group made from the constants, variables, and functions of the object system, the expression of which is more ambiguous than models that are not based on groupings.

When there is little data, when the total number of the data has no meaning, or when the occurrence of events is not clear, probability cannot express the amount of ambiguity. Thus we move on to using these fuzzy sets to make a goal or model for which the goals must first be clear.

This is done by gradation of the boundaries of the states, relationships, constraints, and goals of the system model made with ordinary sets.

Many fields of application can use the fuzzy logic. Among other things, it may be used to:

- a) Express human experiences, common sense, etc., in a form that machines can use.
- b) Make models of human feelings or language.
- c) Imitate human pattern recognition, overall judgment, or general understanding.
- d) Convert information into a form that people can easily understand.
- e) Compress large amounts of information.
- f) Make models of human psychology or behavior
- g) Make models of societal systems.

All of the above applications are 'ambiguous'.¹⁵¹

6.2 Evaluation and decision making in a fuzzy environment

As mentioned in the previous chapter, Evaluation is the systematic collection and analysis of data needed to make decisions.

In this sense, decision making is a process of problem solving which results in an action. It is a choice between various ways of getting an end accomplished. Decision making plays an important role in business, finance, management, economics, social and political science,

¹⁵¹ Toshiro Terano, Kiyoji Asai, Michio Sugeno. Fuzzy systems Theory and its applications. London: ACADEMIC PRESS, INC, 1992.

engineering and computer science, biology, and medicine. It is a difficult process due to factors like incomplete and imprecise information, subjectivity, linguistics, which tend to be presented in real-life situations to lesser or greater degree. These factors indicate that a decision-making process takes place in a fuzzy environment. There are two methods for decision making based on fuzzy sets and fuzzy logic. First to be introduced is the Bellman-Zadeh (1970) approach, according to which decision making is defined as intersection of goals and constraints described by fuzzy sets. The second approach for making decisions combines goals and constraints using fuzzy averaging. Applications are made to various real-life situations requiring selection or evaluation type decisions and to pricing models.¹⁵²

6.2.1 Approaches to decision making

There are two main approaches to decision making that can be distinguished as follows.

- a) Descriptive decision making considers a decision as a specific process of information processing. It studies the cognitive processes that lead to decisions and the way information is processed in these processes. For example, the ways humans deal with conflicts, perceive the viability of the solutions and commit themselves to those solutions are studied. Descriptive decision making searches for explanations for the ways individuals or groups of individuals arrive at decisions so that methods can be developed for influencing and guiding the decision process.¹⁵³
- b) Normative decision making considers a decision as a rational act of choice amongst the viable alternatives. This is a prescriptive view which studies mathematical theories for modeling decision making.¹⁵⁴

¹⁵² George Bojadziev, Maria Bojadziev. *Fuzzy Logic For Business, Finance and Management*. Singapore: World Scientific Publishing Co. Pte. Ltd, 2007.

¹⁵³ Joao M. C. Sousa, Uzay Kaymak. *Fuzzy decision making in modeling and control*, World Scientific Series in Robotics and Intelligent Systems - Volume 27. London: World Scientific, 2002.

¹⁵⁴ Ibid

6.2.3 Decision Making by Intersection of Fuzzy Goals and Constraints

In the normative decision making approach, decision making is characterized by selection or choice from alternatives which are available to the decision maker. In the process of decision making, there are specialized goals that should be reached and specialized constraints that should be kept.

For example if there is a simple decision-making model consisting of a goal described by a fuzzy set G with membership function $\mu_G(x)$ and a constraint described by a fuzzy set C with membership function $\mu_C(x)$, where x is an element of the crisp set of alternatives A_{alt} .

The decision is a fuzzy set D with membership function $\mu_D(x)$, expressed as intersection of G and C , It is a multiple decision resulting in the selection of the crisp set $[d_1, d_2]$ from the set of alternatives A_{alt} ; $\mu_D(x)$ that indicates the degree to which any $x \in [d_1; d_2]$ belongs to the decision D . A schematic presentation is shown on the next figure where $x \in A_{alt} \mu_R$ and G and C have monotone continuous membership functions. ¹⁵⁵

For further elaboration, curve C in the figure below (fuzzy set C) represents the degree (in fraction from 0 to 1) to which a certain constraint is met for any value of x . The fuzzy set G represents the degree to which a certain goal may be achieved for any value of x . the space in the intersection of the two sets, represents all values of x where the goals could be achieved and the constraints could be met, which is represented by a third fuzzy set (D), which is defined as the set outside of which any choice (decision making) of a value for x would either achieve less than the best possible achievement in favor of better commitment to constraints, or the other way round. This means that the point of intersection of the two curves represents the optimal point of decision making (X_{max}), or the value for x where both: the greatest possible goal achievement and the highest possible commitment to constraints can be accomplished simultaneously.

¹⁵⁵ George Bojadziev, Maria Bojadziev. Fuzzy Logic For Business, Finance and Management. Singapore: World Scientific Publishing Co. Pte. Ltd, 2007.

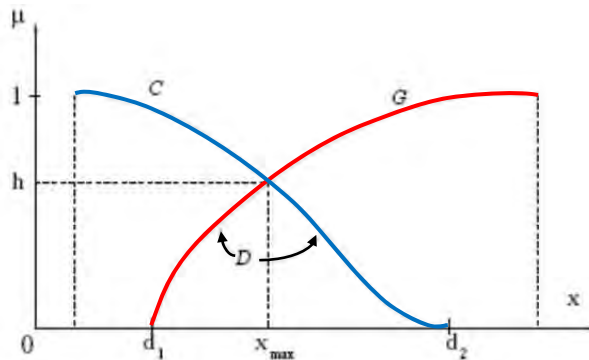


Figure 147: Fuzzy goal G, constraint C, decision D, max decision x_{max}

6.3 Using a Fuzzy tool to create the evaluation system

To start producing this ambitious fuzzy system, it is necessary to understand the process of creating fuzzy system using the selected tool based on the result of the analysis method.

The mathematics of fuzzy sets is available in most popular mathematical software programs; however, using these software programs requires a sufficient background of mathematics and programming skills. These requirements could amount to a serious obstacle to architects in using this logic.

6.3.1 Used software

In attempt to overcome this obstacle, a leading fuzzy tool was used by the researcher (FuzzyTech -release 5.54) to create this new and experimental system. It is one of the world's leading families of software development tools for fuzzy logic and neural-fuzzy solutions.¹⁵⁶

One of the advantages of this tool is that it makes it easy to create the desired system using a graphical method, where inputs and outputs are displayed as triangular or bell shaped curves and can be plotted directly by means of a graphical method defining the higher and the lower values. This method is illustrated in the following sections.

¹⁵⁶ The fuzzyTECH Home Page. (n.d.). Retrieved 1, 25, 2011, from <http://www.fuzzytech.com/>

6.3.2 Input variables

“Fuzzy Input” indicates that the variable is passed into the fuzzy logic system as a “fuzzy” variable, which is presented as a vector of membership degrees. This is primarily used in decision support applications where the input stems from a linguistic source.

The following figure shows how to draw an input curve, the X axis represents the alternatives of the studying factor; (for example the number of family members or the area of the desired dwelling....) the used unit in X axis is varied according to the studying factor. The Y axis represents the fuzzy degree which lies between Zero and One; according to the fuzzy theory, there are many other middle values between zero and one such as (0.1 , 0.2 , 0.3 ,..... To 1).

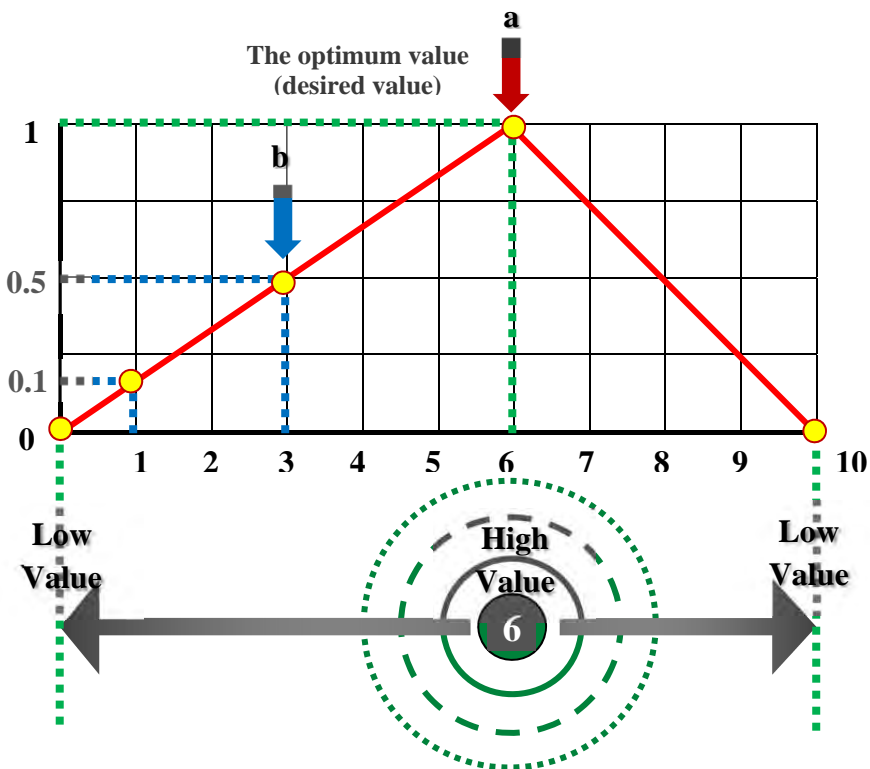


Figure 148: Drawing input variables

In the previous figure, the point [a:(6,1)] is considered the highest value of the fuzzy curve, this means that the value at this point is the exact desired value. The point (a) which is the top of the curve should be drawn according to the desire of the dwellers and the near range of values the point (a) should contain all other accepted values, which are obtained from other sources of data such as housing standards and the successful examples. At point (b) according to the drawn fuzzy curve; it lies at 0.5 on the Y axis, which means that the value 3 is 0.5 desired and 0.5 undesired at the same time.

6.3.3 Rule blocks

The rule block contains the rules of the system describing the control strategy. It defines the relation between the (inputs) which refer to the obtained social data and the (outputs) which refer to the goal.

The rule block using the mentioned program takes the form of (If-Then) equation as a control strategy between the inputs and the outputs.

For example; **If** the input (1) is desired and the input (2) is desired **then** the output is High.

Accordingly, these equations are expressed linguistically, which requires drawing an inverted curve for each input in order to express the case of (**If not**). For example; **If** the input (1) is desired and the input (2) is **not** desired **then** the output is Low.

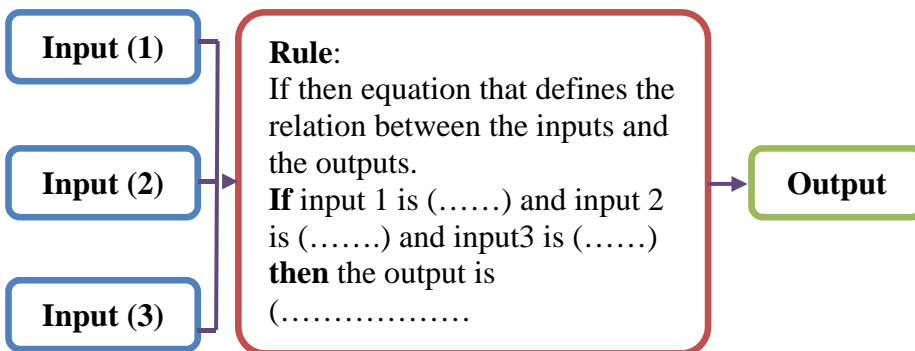


Figure 149: Example of using the rule in controlling the relation between the inputs and the output.

Based on the process of creating a fuzzy system in the used software, creating rule blocks could be done by specifying the influence of input variables to an output variable. The rule block wizard uses these information to determine the set of rules and to be created in a form of (If-Then) equations.

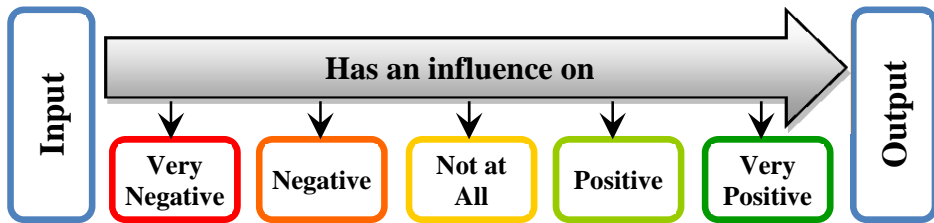


Figure 150: The influence of an input variable on an output variable

6.3.4 Output variables

In analogy to a “Fuzzy Input”, “Fuzzy Output” outputs a vector of the membership degrees of the inference result. The triangular fuzzy curve of the output could be predefined as many ranges and also as a linguistic expression. These ranges have been defined based on carrying out many trials with the data inputs and the controlling rules.

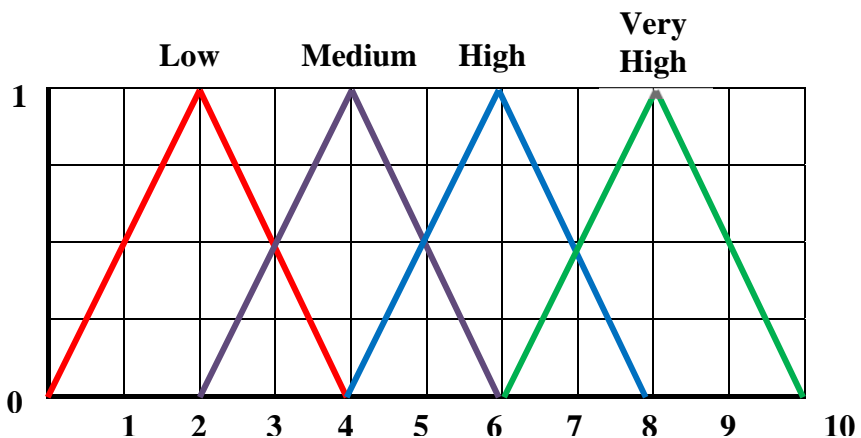


Figure 151: example for an output fuzzy curve

6.3.5 The structure of the devised expert system

The devised expert system consists of six partial fuzzy sets; the first four fuzzy sets are connected together in one main fuzzy set the result of which is considered the main goal of the system, whereas, the functional efficiency of the dwelling is being calculated. The other two partial fuzzy sets are calculating the two housing indicators; lifestyle indicator and crowding indicator.¹⁵⁷

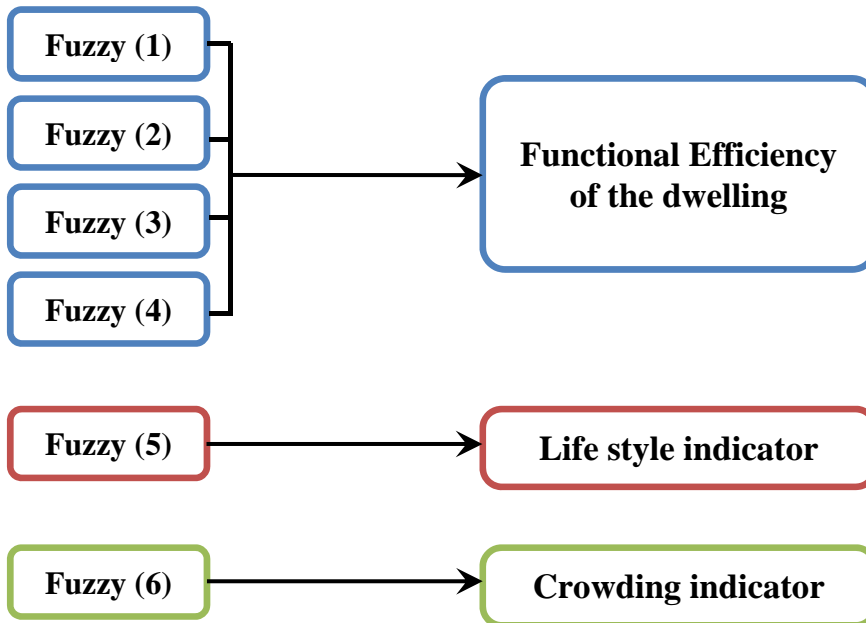


Figure 152: The structure of the devised expert system

6.4 Determining the Functional Efficiency of the dwelling

To determine the functional efficiency of a low-income dwelling, there are four main factors that should be calculated. Each one of these factors is considered a separate fuzzy set that includes many outputs and generates a partial clear output. The relation between the inputs and the outputs is controlled by a rule. All these produced outputs are connected together in one main fuzzy set.

¹⁵⁷ For more details about the structure of the devised fuzzy system, see appendix (5)

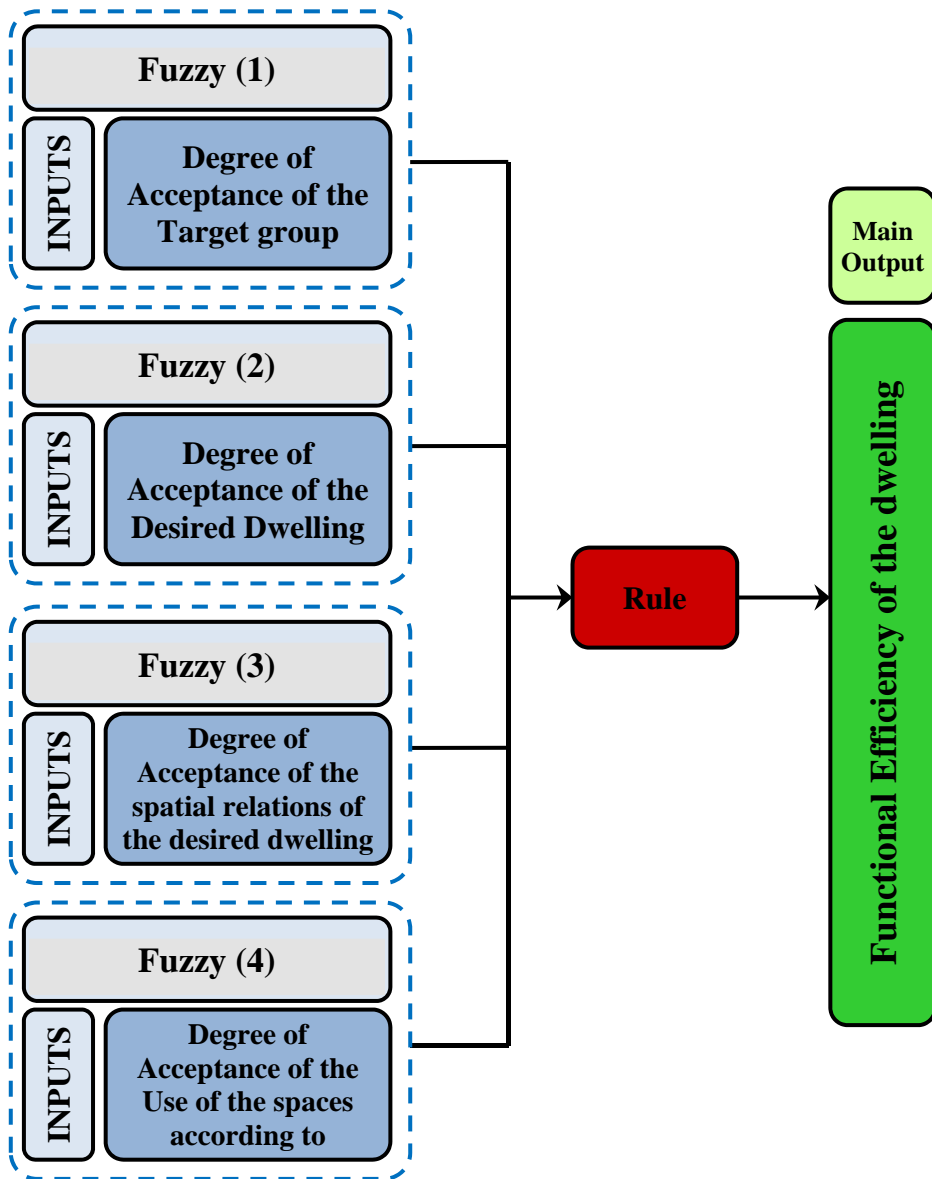


Figure 153: The flow chart of the fuzzy system in order to determine the Functional Efficiency of the dwelling

6.4.1 Fuzzy (1): Degree of Acceptance of the Target Group

Selecting a suitable target group for any new housing project is a necessary step to achieving its goals. The following chart displays the fuzzy set which is design in order to investigate the degree of acceptance of the target group.¹⁵⁸

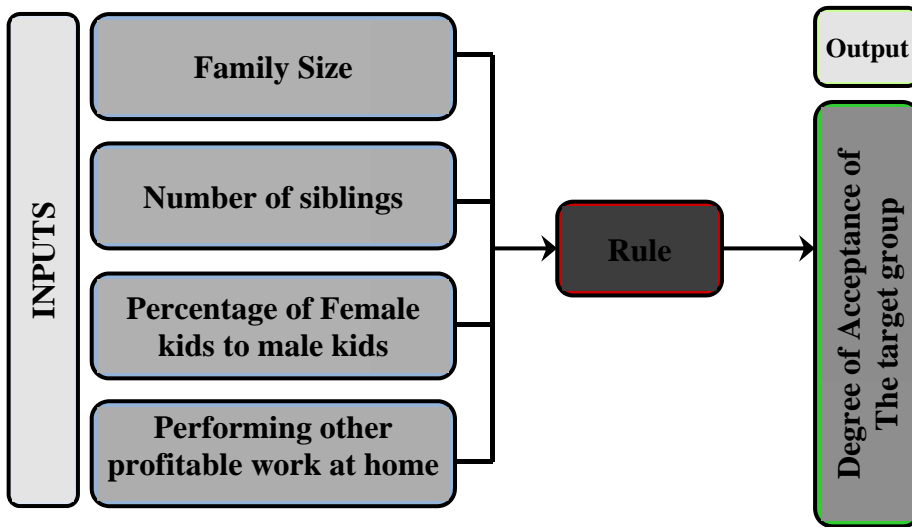


Figure 154: A flow chart illustrating the fuzz set (1)

6.4.1.1 Input variables

There are four inputs as illustrated in the following fuzzy graphs.

a) Family size

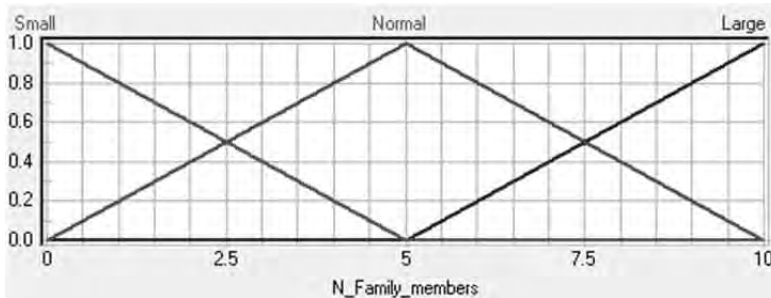
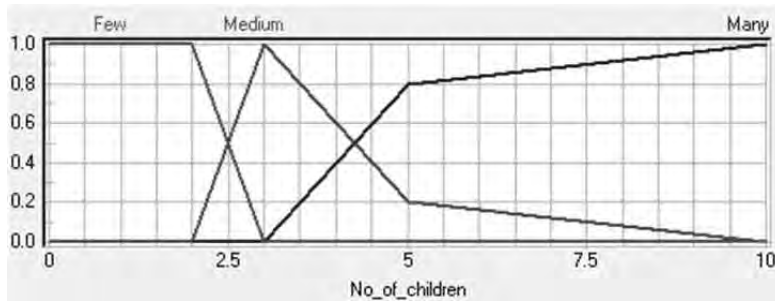
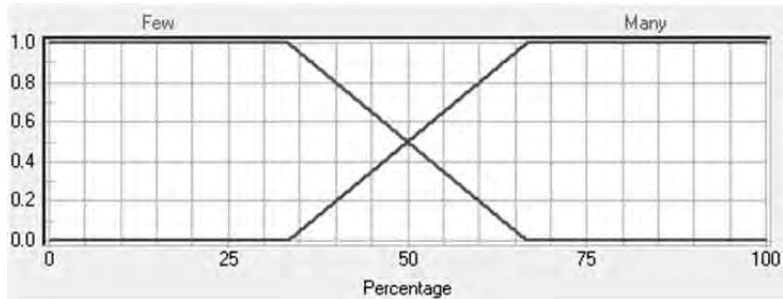


Figure 155: Fuzzy (1) – Inputs – Family size

¹⁵⁸ For more details about inputs, outputs and rules for fuzzy (1), see appendix (5)

b) Number of siblings**Figure 156: Fuzzy (1) – Inputs – Number of siblings****c) Percentage of Female kids to all kids****Figure 157: Fuzzy (1) – Inputs – Percentage of female kids to all kids****d) Performing other profitable work at home**

This value is not a fuzzy value; it is a clear value (yes or no)

6.4.1.2 Rules

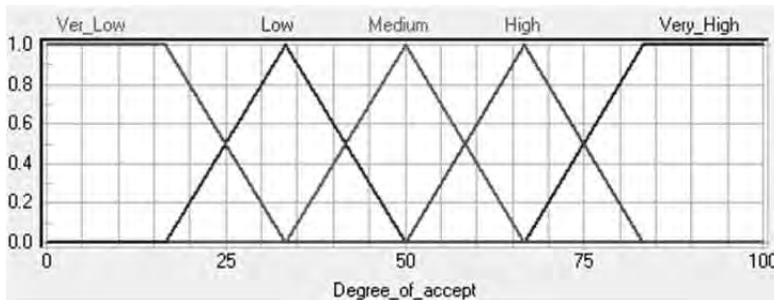
Those rules control the relation between the four inputs which are considered the result of the socio-cultural study and the outputs which is considered the main goal aiming at the evaluation of the degree of acceptance of the target group. The key rules are displayed in the following table which demonstrates the effect of each value on the targeted output.

Table 54: Fuzzy (1) – Rules

| Input | The effect on the output |
|--|--------------------------|
| Family size | Very Negative |
| Number of sibling | Negative |
| Percentage of Female kids to male kids | Negative |

6.4.1.3 Output variables

The output which is consider the goal of this fuzzy set is displayed in the following fuzzy graphs and signifies the degree of acceptance of the selected target group.

**Figure 158: Fuzzy (1) – Output – Degree of Acceptance of The target group**

6.4.2 Fuzzy (2): Degree of Acceptance of the Desired Dwelling

This fuzzy investigates the desired specifications for new low-income housing based on the dwellers' socio-cultural characteristics taking into account the housing standards and guidelines, however the desires of the dwellers are often in the first priorities. The targeted goal of this fuzzy is to investigate the degree of acceptance of the desired Dwelling as shown in the following figure.¹⁵⁹

¹⁵⁹ For more details about inputs, outputs and rules for fuzzy (2), see appendix (5)

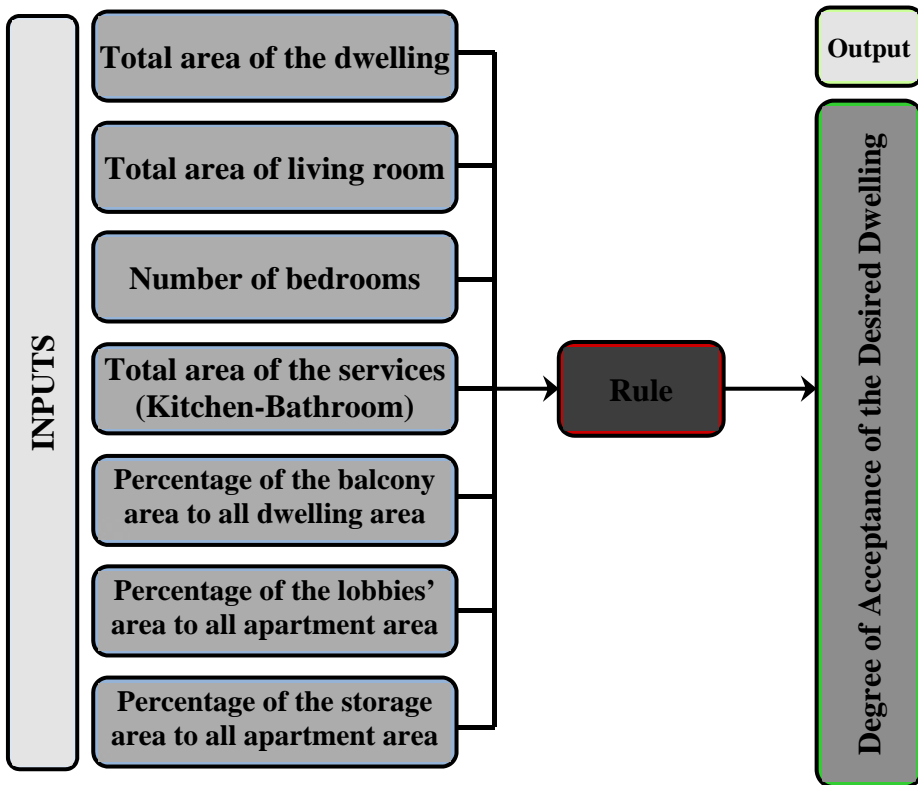


Figure 159: A flow chart for fuzzy (2)

6.4.2.1 Input variables

There are seven inputs which can be illustrated in the following fuzzy graphs

- a) Total area of the dwelling

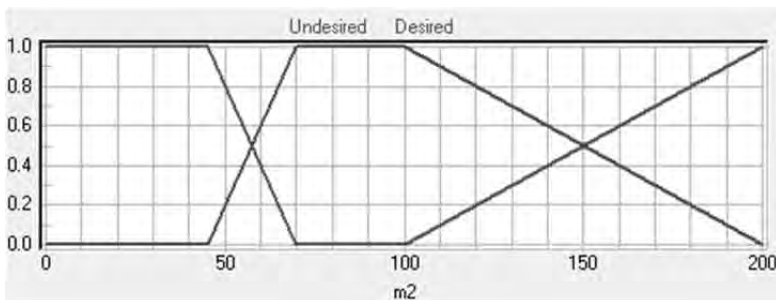


Figure 160: Fuzzy (2) – inputs – Total area of the dwelling

b) Total area of the living room

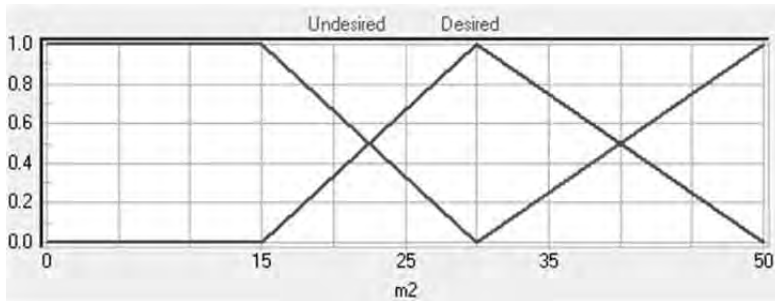


Figure 161: Fuzzy (2) – inputs – Total area of the living room

c) Number of bedrooms

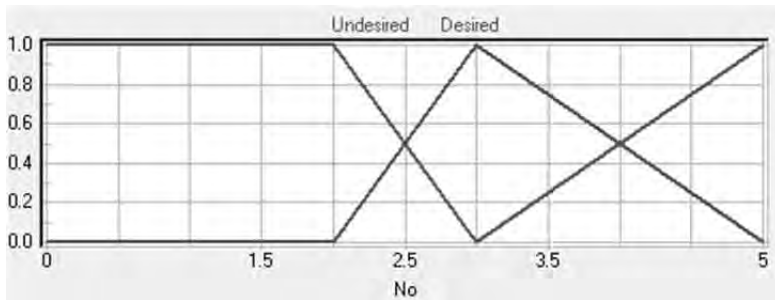


Figure 162: Fuzzy (2) – inputs – Number of bedrooms

d) Total area of the services (Kitchen-Bathroom)

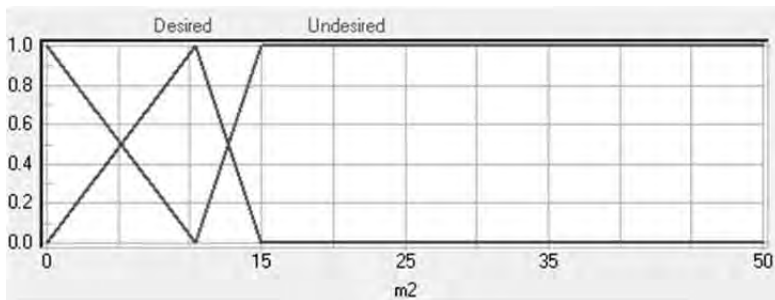


Figure 163: Fuzzy (2) – inputs – Total area of the services

e) Percentage of the area on the balcony to all dwelling area

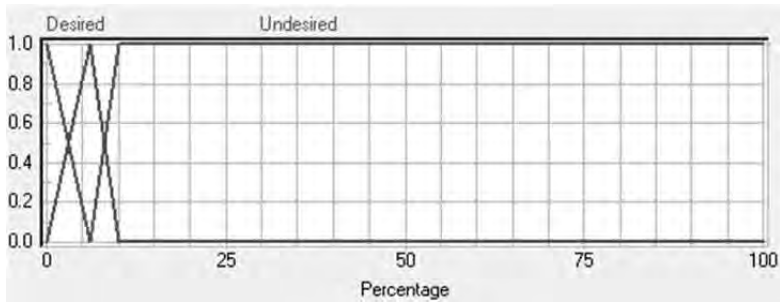


Figure 164: Fuzzy (2) – inputs – percentage of the area of the balcony

f) Percentage of the lobbies' area to total apartment area

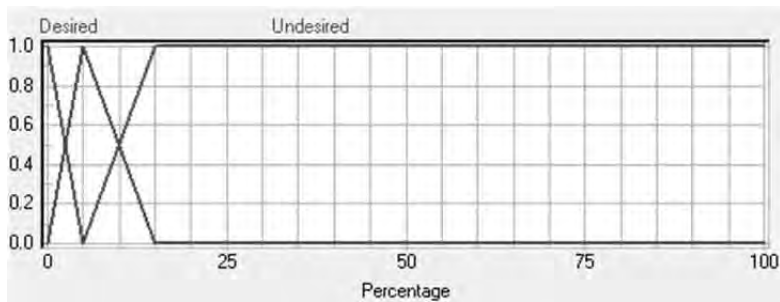


Figure 165: Fuzzy (2) – inputs – percentage of the lobbies' area to total apartment area

g) Percentage of the storage area to all apartment area

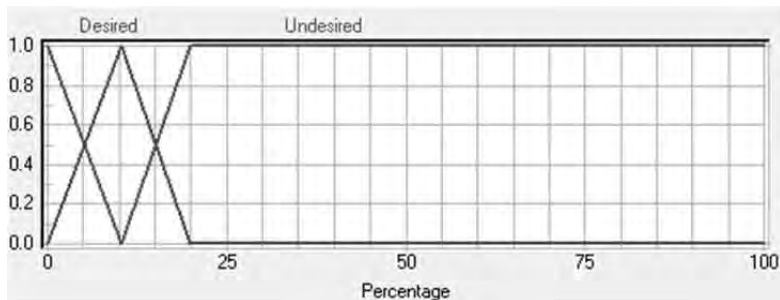


Figure 166: Fuzzy (2) – inputs – percentage of the storage area to all apartment area

6.4.2.2 Rules

The rule block controls the relation between the seven inputs which is considered the result of the socio-cultural study and the outputs which aims to investigate the degree of acceptance of the desired dwelling. The key rules are shown in the following table which demonstrates the effect of each value on the targeted output.

Table 55: Fuzzy (2) – Rules

| Input | The effect on the output |
|---|--------------------------|
| Total area of the dwelling | Very Positive |
| Total area of living room | Very Positive |
| Number of bedrooms | Positive |
| Total area of the services (Kitchen-Bathroom) | Negative |
| Percentage of the balcony area to all dwelling area | Negative |
| Percentage of the lobbies' area to all apartment area | Negative |
| Percentage of the storage area to all apartment area | Negative |

6.4.2.3 Output variables

The following fuzzy graphs display the targeted output which is considered the result of this fuzzy set that investigates the degree of acceptance of the desired dwelling.

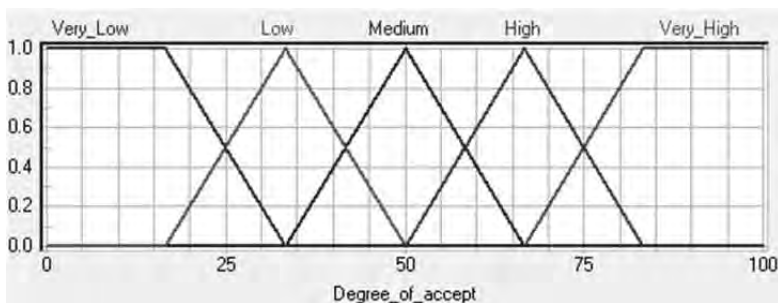


Figure 167: Fuzzy (2) – outputs - Degree of Acceptance of the Desired Dwelling

6.4.3 Fuzzy (3): Degree of Acceptance of the spatial relations of the desired dwelling

This fuzzy set consists of two secondary fuzzy sets; Fuzzy (3A) which aims to infer the degree of acceptance of the spatial relations of the desired dwelling based on the visible area from the entrance and Fuzzy (3B) which aims to assess the degree of acceptance of the spatial relations of the desired dwelling based on the visible area from the center of the living room. These partial two fuzzy sets are illustrated as follows.

160

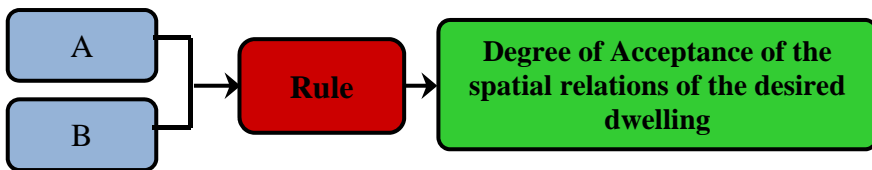


Figure 168: Fuzzy (3) - The two partial fuzzy sets

A. Spatial relations based on the visible area from the entrance

The following figure illustrates the elements of fuzzy (3A)

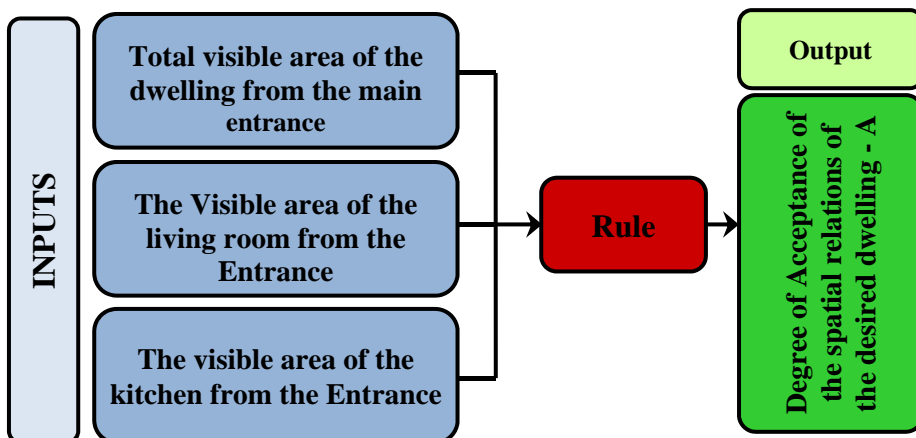


Figure 169: A flow chart for fuzzy (3) - A

¹⁶⁰ For more details about inputs, outputs and rules for fuzzy (3), see appendix (5)

6.4.3.1 Input variables

Three inputs are connected together through the block rule. These variables can be illustrated in the following fuzzy graphs

- a) Total visible area of the dwelling from the main entrance

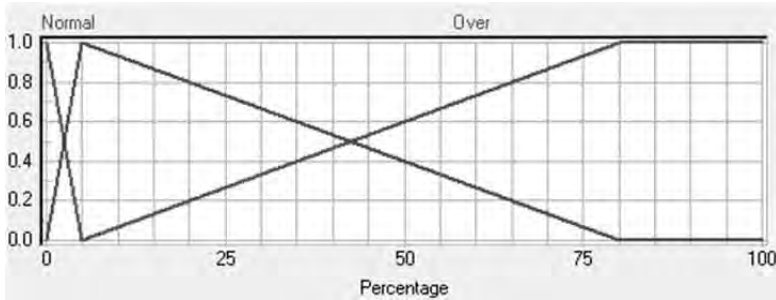


Figure 170: Fuzzy (3) A – inputs – Total visible area of the dwelling from the main entrance

- b) The Visible area of the living room from the Entrance

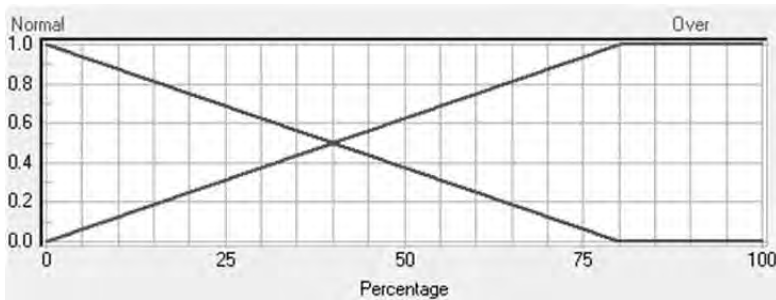


Figure 171: Fuzzy (3) A – inputs – The Visible area of the living room from the Entrance

- c) The visible area of the kitchen from the Entrance

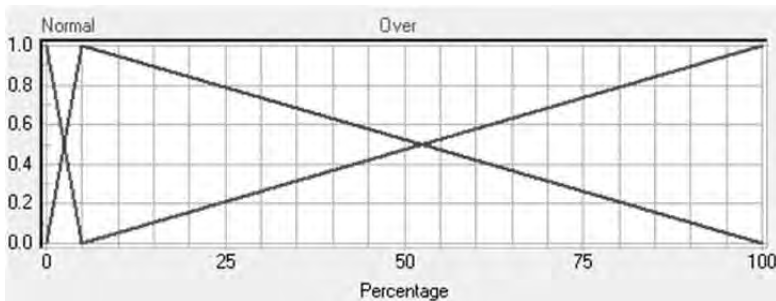


Figure 172: Fuzzy (3) A – inputs – The visible area of the kitchen from the Entrance

6.4.3.2 Rules

The rule block controls the relation between the three inputs which have been obtained from the analytical spatial studies and the outputs, which are considered the main goal of the evaluation. The key rules are shown in the following table which demonstrates the effect of each value on the targeted output.

Table 56: Fuzzy (3) A – Rules

| Input | The effect on the output |
|---|--------------------------|
| Total visible area of the dwelling from the main entrance | Negative |
| The Visible area of the living room from the Entrance | Negative |
| The visible area of the kitchen from the Entrance | Not at all |

6.4.3.3 Output variables

The output which is considered the goal of this fuzzy set is illustrated in the following fuzzy graphs.

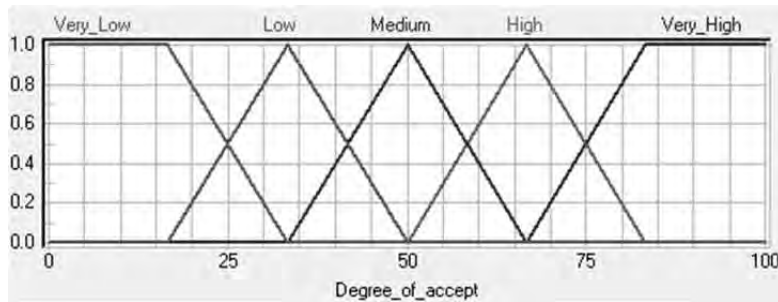


Figure 173: Fuzzy (3) A – outputs - Degree of Acceptance of the spatial relations of the desired dwelling - A

B. Spatial relations based on the visible area from the center of the living room

The following figure illustrates the elements of fuzzy (3B)

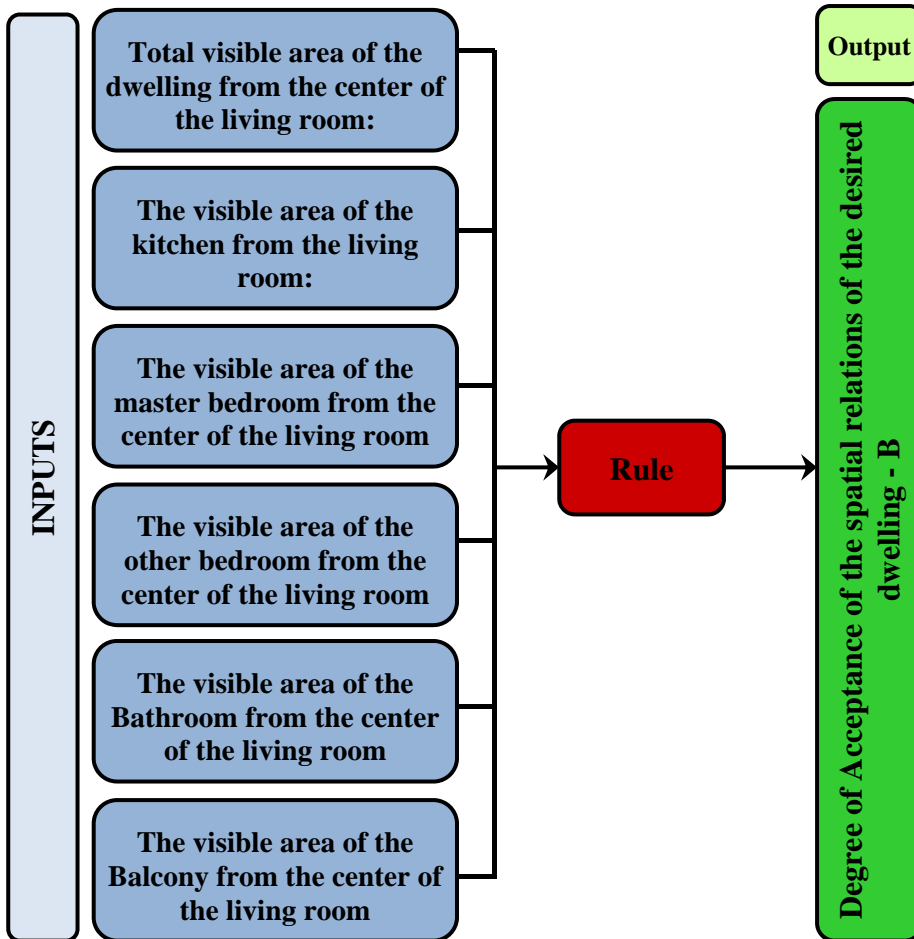


Figure 174: A flow chart for fuzzy (3) - B

6.4.3.4 Input variables

There are seven inputs which can be illustrated in the following fuzzy graphs

- a) Total visible area of the dwelling from the center of the living room

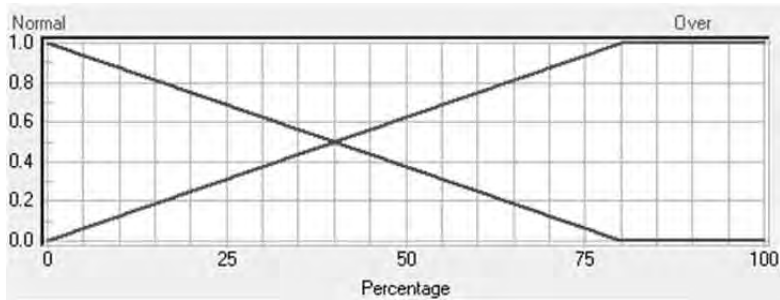


Figure 175: Fuzzy (3) B – inputs – Total visible area of the dwelling from the center of the living room

- b) The visible area of the kitchen from the living room

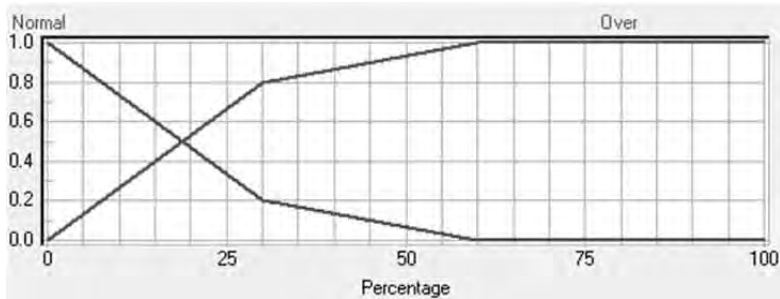


Figure 176: Fuzzy (3) B – inputs – The visible area of the kitchen from the living room

- c) The visible area of the master bedroom from the center of the living room

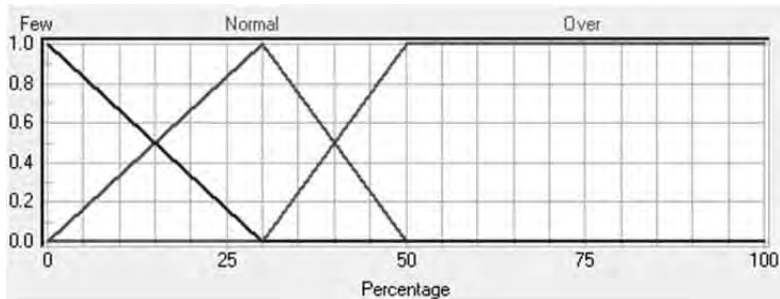


Figure 177: Fuzzy (3) B – inputs – The visible area of the master bedroom from the center of the living room

- d) The visible area of the other bedroom from the center of the living room

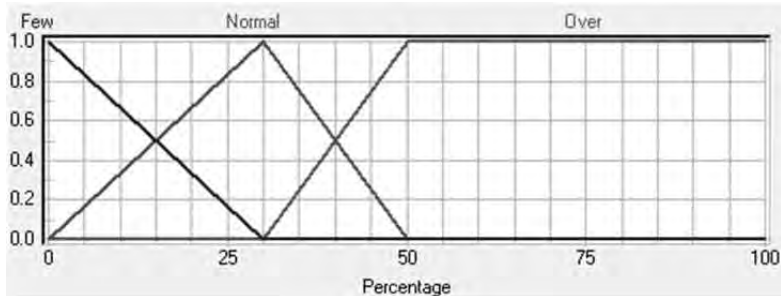


Figure 178: Fuzzy (3) B – inputs – The visible area of the other bedroom from the center of the living room

- e) The visible area of the Bathroom from the center of the living room

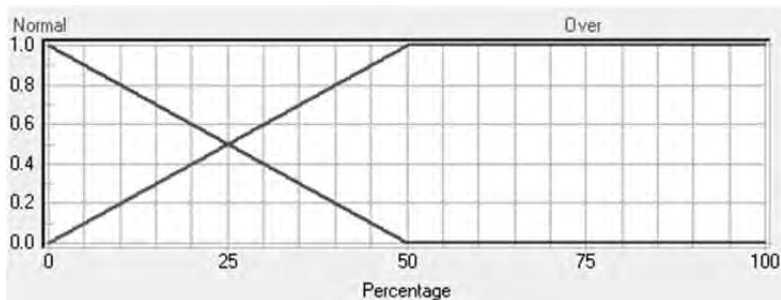


Figure 179: Fuzzy (3) B – inputs – The visible area of the Bathroom from the center of the living room

- f) The visible area of the Balcony from the center of the living room

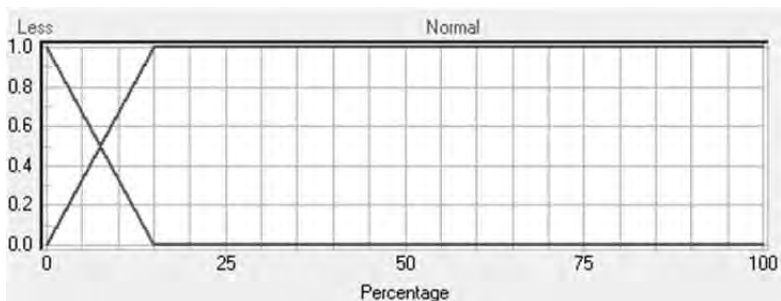


Figure 180: Fuzzy (3) B – inputs – The visible area of the Balcony from the center of the living room

6.4.3.5 Rules

The following table illustrates the rule block which controls the relation between the six inputs which have been obtained from analytical spatial studies and the outputs which are considered the main goal of the evaluation.

Table 57: Fuzzy (3) B – Rules

| Input | The effect on the output |
|--|---------------------------------|
| Total visible area of the dwelling from the center of the living room: | Negative |
| The visible area of the kitchen from the living room: | Negative |
| The visible area of the master bedroom from the center of the living room: | Negative |
| The visible area of the other bedroom from the center of the living room: | Negative |
| The visible area of the Bathroom from the center of the living room: | Negative |
| The visible area of the Balcony from the center of the living room | Positive |

6.4.3.6 Output variables

The following figure illustrates the output which aims to infer the degree of acceptance of the spatial relations of the desired dwelling based on the visible area from the center of the living room.

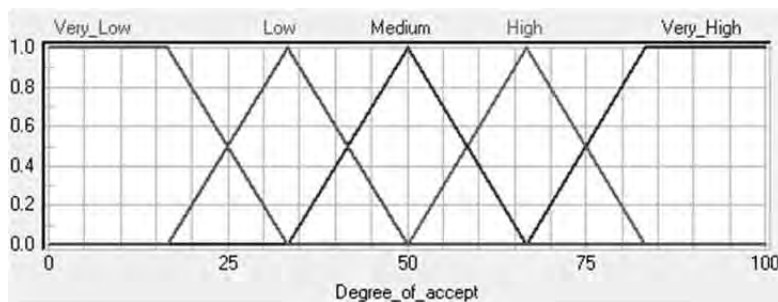


Figure 181: Fuzzy (3) B – output - Degree of Acceptance of the spatial relations of the desired dwelling - B

6.4.4 Fuzzy (4): Degree of Acceptance of the Use of spaces according to dwellers' lifestyle

This fuzzy set consists of two secondary fuzzy sets; Fuzzy (4-A) investigates the use of the spaces according to dwellers' lifestyle. Fuzzy (4-B) investigates areas that conflict during performing the home activities. These partial two fuzzy sets are illustrated as follows.¹⁶¹

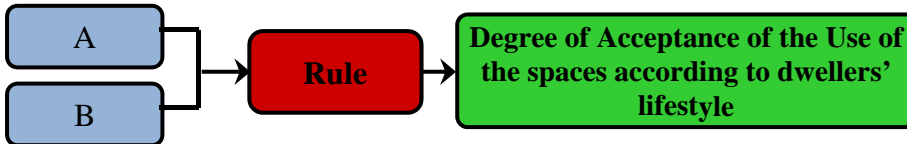


Figure 182: A flow chart for Fuzzy (4)

A. Use of the dwelling spaces according to dwellers' lifestyle

The following figure illustrates the elements of fuzzy (4-A)

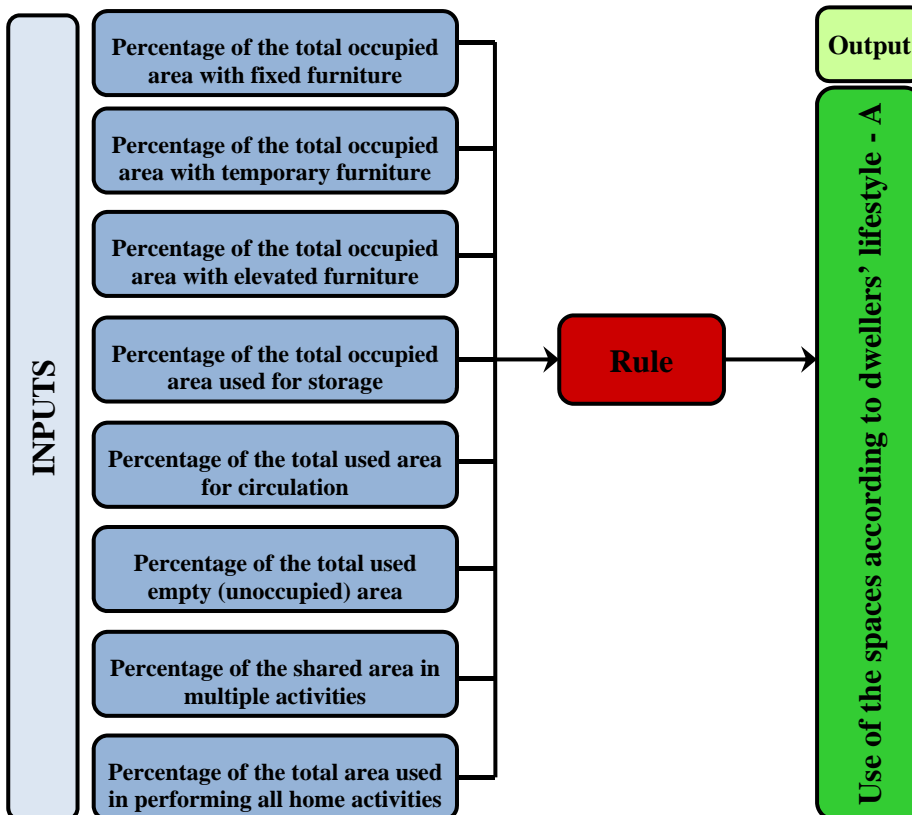


Figure 183: A flow chart for fuzzy (4) - A

¹⁶¹ For more details about inputs, outputs and rules for fuzzy (4), see appendix (5)

6.4.4.1 Input variables

There are eight inputs which can be illustrated in the following fuzzy graphs.

- a) Percentage of the total occupied area with fixed furniture

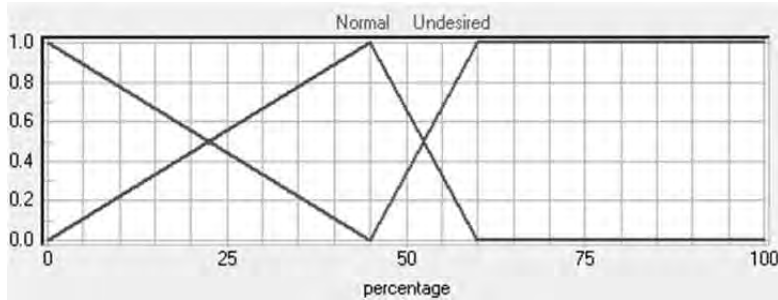


Figure 184: Fuzzy (4) A – inputs – percentage of the total occupied area with fixed furniture

- b) Percentage of the total occupied area with temporary furniture

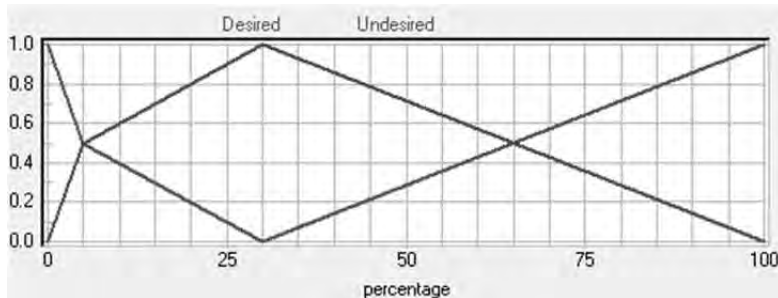


Figure 185: Fuzzy (4) A – inputs – percentage of the total occupied area with temporary furniture

- c) Percentage of the total occupied area with elevated furniture

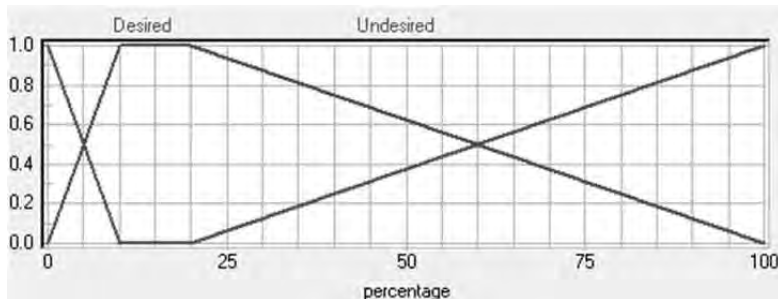


Figure 186: Fuzzy (4) A – inputs – percentage of the total occupied area with elevated furniture

d) Percentage of the total occupied area used for storage

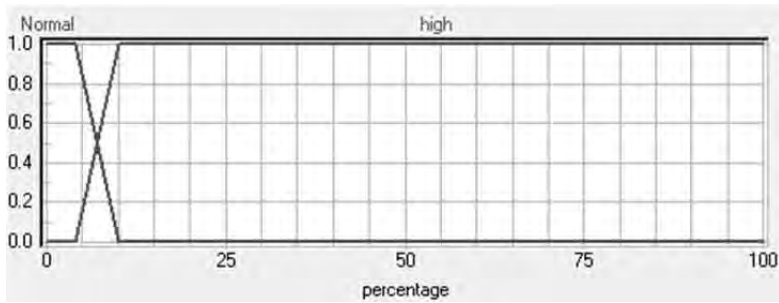


Figure 187: Fuzzy (4) A – inputs – percentage of the total occupied area used for storage

e) Percentage of the total used area for circulation

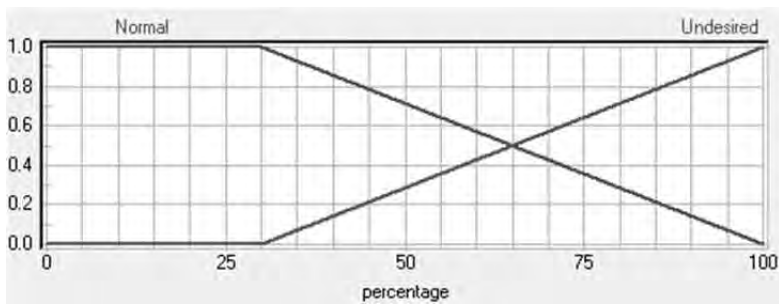


Figure 188: Fuzzy (4) A – inputs – percentage of the total used area for circulation

f) Percentage of the total used empty (unoccupied) area

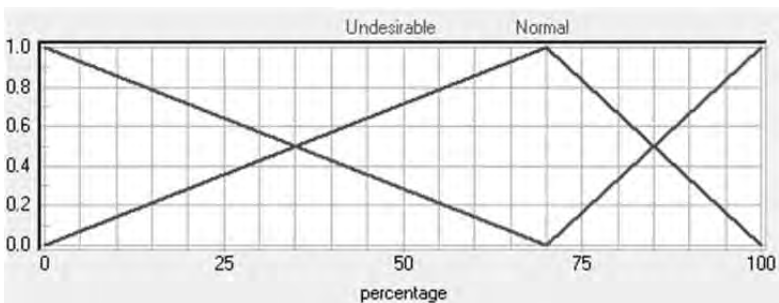


Figure 189: Fuzzy (4) A – inputs – percentage of the total used empty (unoccupied) area

g) Percentage of the shared area in multiple activities

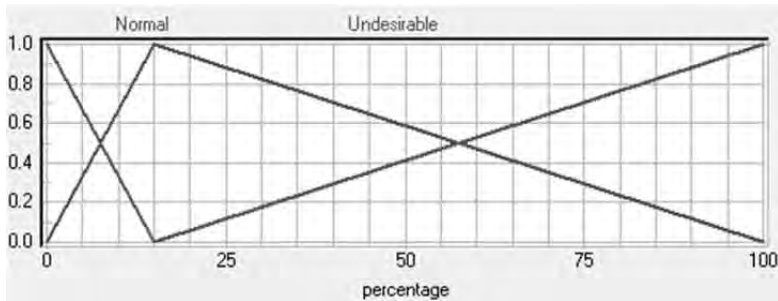


Figure 190: Fuzzy (4) A – inputs – percentage of the shared area in multiple activities

h) Percentage of the total area used in performing all home activities

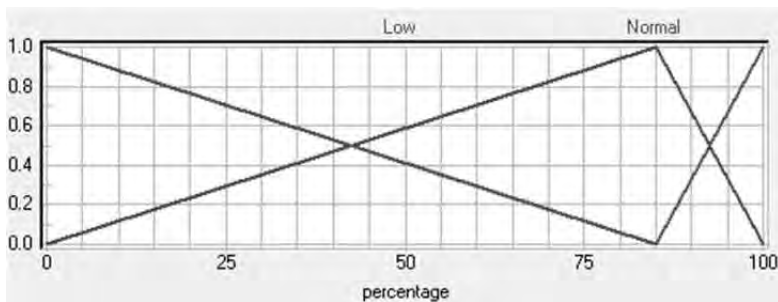


Figure 191: Fuzzy (4) A – inputs – percentage of the total area used in performing all home activities

6.4.4.2 Rules

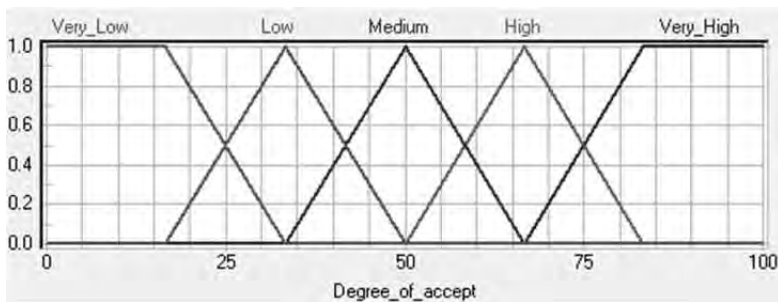
The rule block controls the relation between the eight inputs which resulted from the analysis of the functional studies and the outputs which are considered the main goal of the evaluation. The key rules are displayed in the following table which demonstrates the effect of each value on the targeted output.

Table 58: Fuzzy (4) A – Rules

| Input | The effect on the output |
|---|---------------------------------|
| Percentage of the total occupied area with fixed furniture | Very Negative |
| Percentage of the total occupied area with temporary furniture | Positive |
| Percentage of the total occupied area with elevated furniture | Positive |
| Percentage of the total occupied area used for storage | Negative |
| Percentage of the total used area for circulation | Negative |
| Percentage of the total used empty (unoccupied) area | Positive |
| Percentage of the shared area in multiple activities | Very Positive |
| Percentage of the total area used in performing all home activities | Very Positive |

6.4.4.3 Output variables

The output which investigates the Use of the spaces according to dwellers' lifestyle is displayed in the following fuzzy graphs.

**Figure 192: Fuzzy (4) A- output - Use of the spaces according to dwellers' lifestyle**

B. Conflicting areas

This fuzzy investigates the conflicting areas and whether or not these areas hinder the performance of home activities.

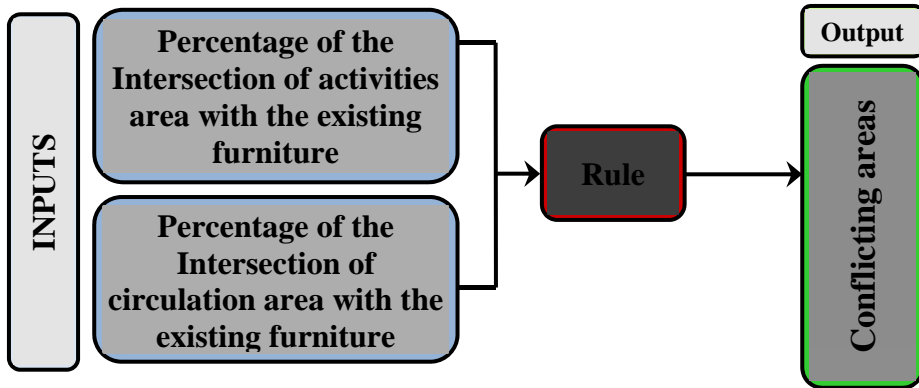


Figure 193: A flow chart for Fuzzy (4) B

6.4.4.4 Input variables

There are two inputs that can be illustrated in the following fuzzy graphs.

- a) Percentage of the Intersection of activities area with the existing furniture

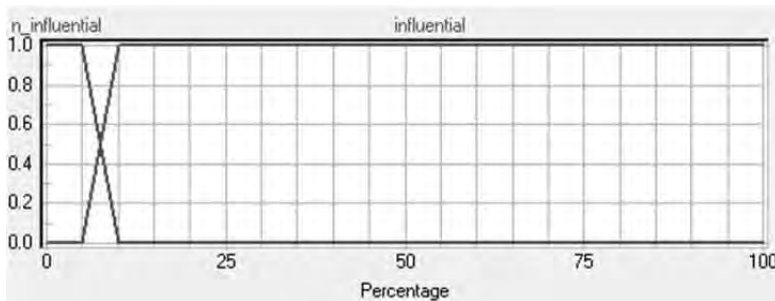


Figure 194: Fuzzy (4) B – inputs – percentage of the Intersection of activities area with the existing furniture

b) Percentage of the Intersection of circulation area with the existing furniture

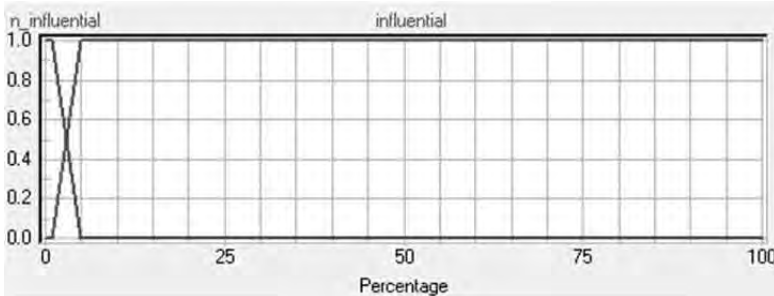


Figure 195: Fuzzy (4) B – inputs – percentage of the Intersection of circulation area with the existing furniture

6.4.4.5 Rules

This rule block shown in the following figure controls the relation between the two inputs and the outputs.

Table 59: Fuzzy (4) B – Rules

| Input | The effect on the output |
|--|--------------------------|
| Percentage of the Intersection of activities area with the existing furniture | Negative |
| Percentage of the Intersection of circulation area with the existing furniture | Negative |

6.4.4.6 Output variables

The output of this fuzzy set is displayed in the following fuzzy graphs calculating the percentage of the conflicting areas.

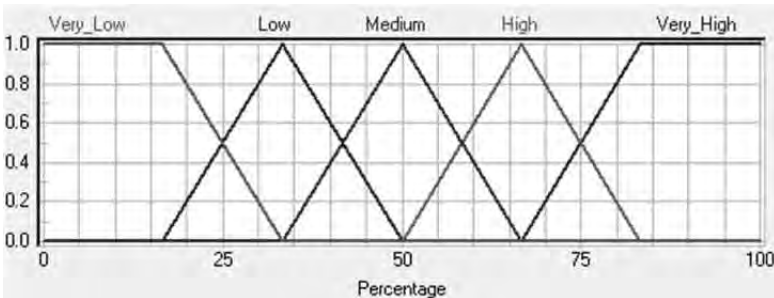


Figure 196: Fuzzy (4) B – output - Conflicting areas

6.5 Evaluating Housing indicators

These two fuzzy sets aim to evaluate the two housing indicators; the lifestyle indicator which is obtained from the analysis of the duration of use map and the crowding indicator.

6.5.1 Fuzzy (5): Indicator (1): Life style indicator

This fuzzy set combines all duration factors for all habitable rooms in the dwelling and generates an output which is considered an indicator for the dwellers lifestyle.¹⁶²

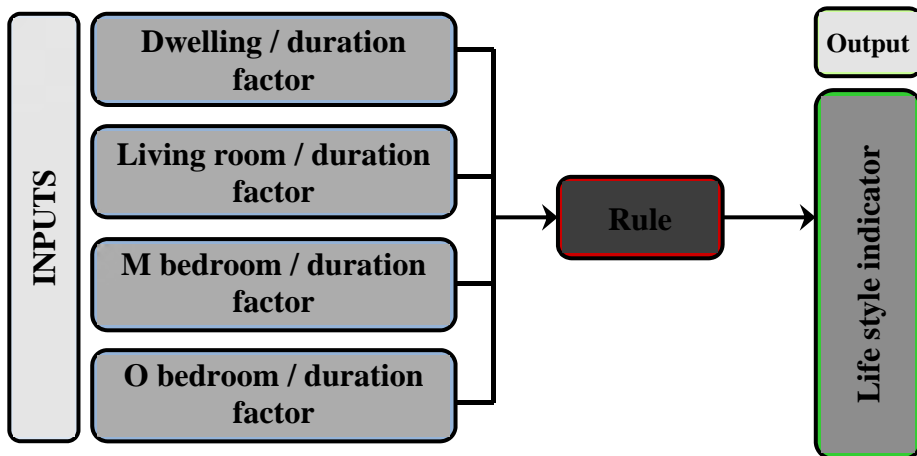


Figure 197: A flow chart illustrates Fuzzy (5)

6.5.1.1 Input variables

There are four inputs which can be illustrated in the following fuzzy graphs.

a) Dwelling / duration factor

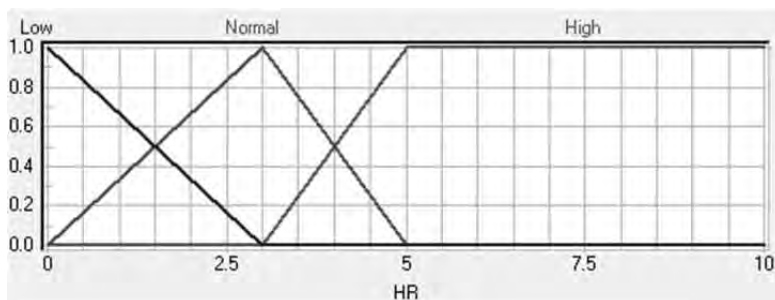


Figure 198: Fuzzy (5)- inputs – Dwelling / duration factor

¹⁶² For more details about inputs, outputs and rules for fuzzy (5), see appendix (5)

b) Living room / duration factor

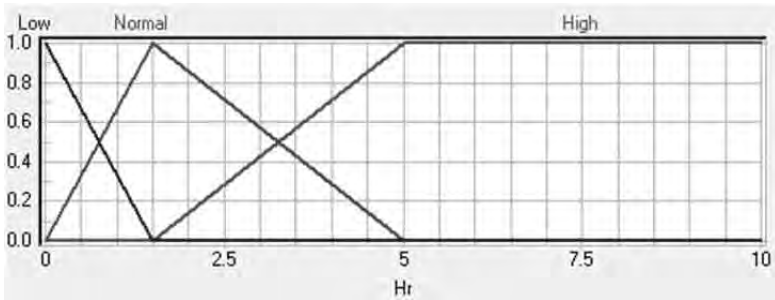


Figure 199: Fuzzy (5) – inputs – living room / duration factor

c) Master bedroom / duration factor

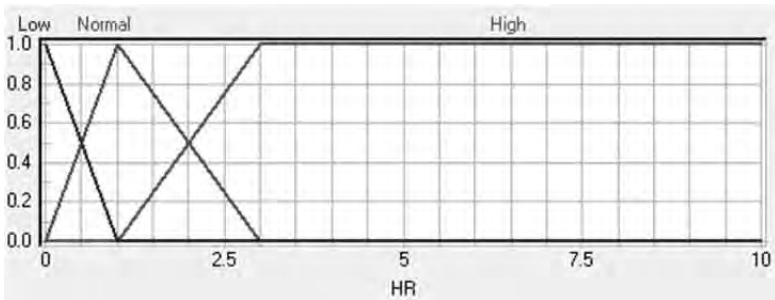


Figure 200: Fuzzy (5) – inputs – M bedroom / duration factor

d) Other bedroom / duration factor

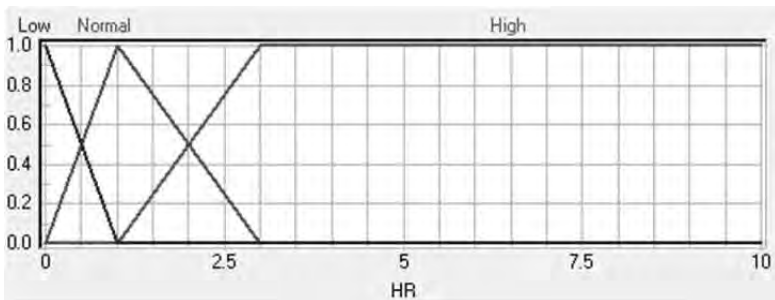


Figure 201: Fuzzy (5) – inputs – O bedrooms / duration factor

6.5.1.2 Rules

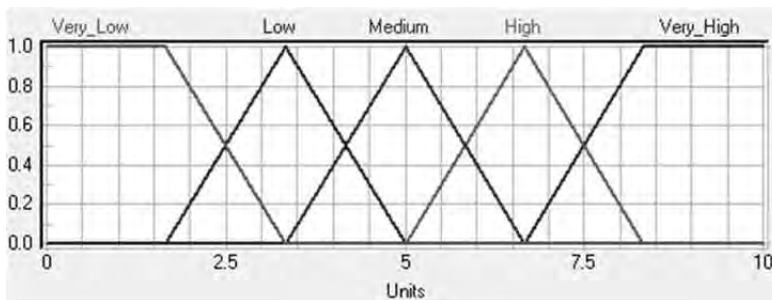
The rule block combines the inputs which are considered the result of the analytical study and the outputs which aimed to indicate the lifestyle of the dwellers. The key rules are displayed in the following table which demonstrates the effect of each value on the targeted output.

Table 60: Fuzzy (5) – Rules

| Input | The effect on the output |
|----------------------------------|--------------------------|
| Dwelling / duration factor | Positive |
| Living room / duration factor | Positive |
| Master bedroom / duration factor | Positive |
| Other bedroom / duration factor | Positive |

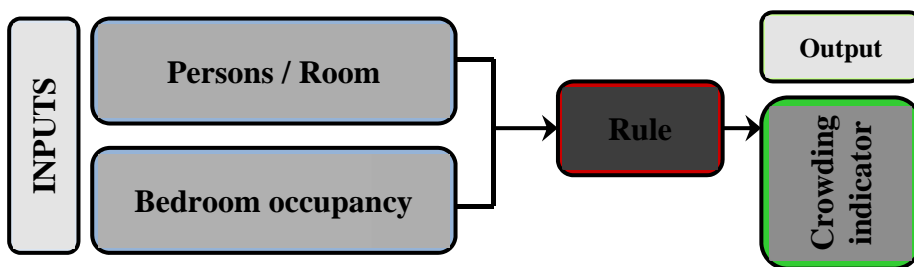
6.5.1.3 Output variables

The output which is considered the goal of this fuzzy set is displayed in the following fuzzy graphs.

**Figure 202 : Fuzzy (5) – output - Life style indicator**

6.5.2 Fuzzy (6): Indicator (2): Crowding indicator

The following figure displays the structure of the fuzzy set which combines the two main housing indicators and investigates an output which is considered an indicator for the crowding in the dwelling.

**Figure 203: A flow chart illustrates Fuzzy (6)**

6.5.2.1 Input variables

There are two inputs which can be illustrated in the following fuzzy graphs.

a) Persons / Room

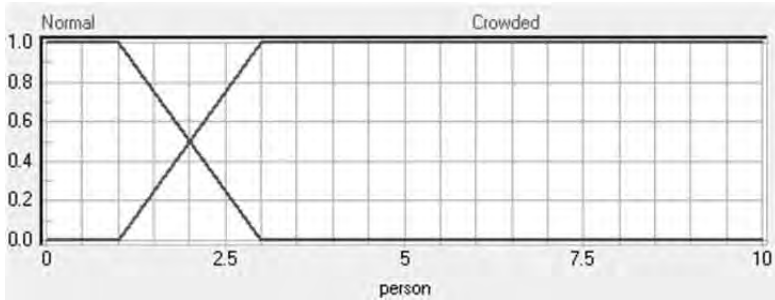


Figure 204: Fuzzy (6) – inputs – Person / Room

b) Bedroom occupancy

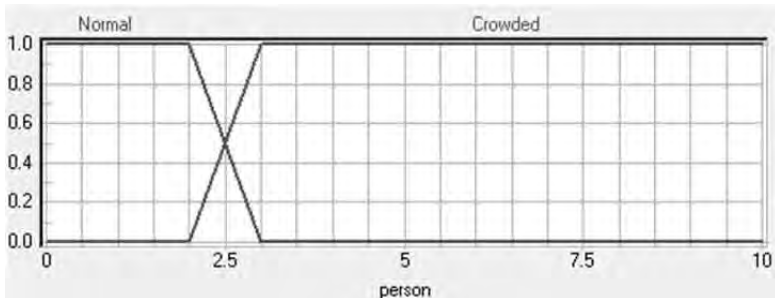


Figure 205: Fuzzy (6) – inputs – Bedroom occupancy

6.5.2.2 Rules

The rule block controls the relation between the two inputs which refer to the main housing indicators and the outputs which investigate the crowding in the dwelling.

Table 61: Fuzzy (6) – Rules

| Inputs Name | The effect on the output |
|-------------------|--------------------------|
| Persons / Room | Positive |
| Bedroom occupancy | Positive |

6.5.2.3 Output variables

The output which investigates the crowding in the dwelling is displayed in the following fuzzy graphs.

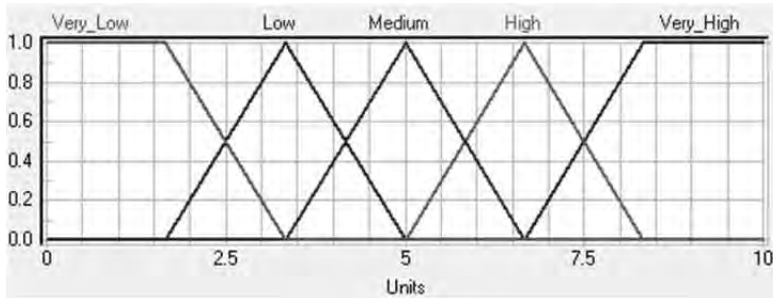


Figure 206: Fuzzy (6) – output - Crowding indicator

6.6 User interface proposal for the devised evaluation system

All these mentioned fuzzy sets have been produced using a mathematical tool. This tool is likely to be difficult to use, especially for architects or other decision makers. Therefore, a simple user interface was designed for this mathematical model. This interface could be used easily for the targeted dwellers and designed dwellings with no need for editing the fuzzy elements (inputs- rules-outputs). To use this proposed interface, it is required to carry out the analytical studies for the dwelling which is required to be evaluated and also to define the target group. The following two figures show the proposed user interface:

The screenshot shows a software application window titled 'Functional Efficiency'. It has a tabbed interface with the following tabs: 'Target Group', 'Desired Dwelling', 'Spatial Relations', 'Use of the Spaces', and 'Indicators'. The 'Indicators' tab is active, displaying a list of input fields with numerical values and percentage signs. The fields are:

- Use of the spaces according to dwellers' lifestyle
- The occupied area with fixed furniture: 50 %
- The occupied area with temporary furniture: 10 %
- The total occupied area with elevated furniture: 15 %
- The occupied area used for storage: 4 %
- The total used area for circulation: 30 %
- The used free area: 50 %
- The shared area in multiple activities: 20 %
- The total usable area: 85 %
- Conflicting areas
- Intersection of activities area with the existing furniture: 5 %
- Intersection of circulation area with the existing furniture: 1 %

At the bottom of the window, there is a 'Calculate Efficiency' button and a text label 'PhD project by : Eng Ayman Moahmmmed Assen'. A 'Next' button is also visible at the bottom right of the input area.

Figure 207: The proposed user interface (inputs)

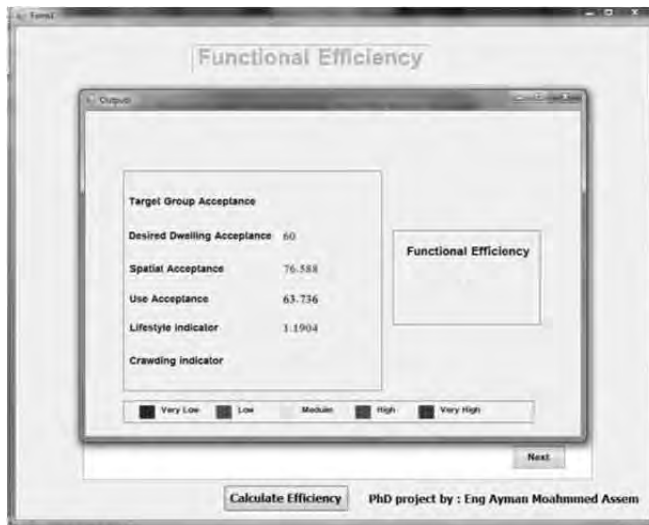


Figure 208: The proposed user interface (outputs)

Summary

This chapter has presented the devised computer expert system based on a mathematical logic known as fuzzy logic.

The Fuzzy logic refers to the study of complex methods and principles of human reasoning; therefore, it is considered an appropriate method to translate the social data into a numeral system which could effectively assess the efficiency of the dwelling by evaluating all dwelling elements.

This fuzzy logic is preferred to be used in the creation of targeted evaluation system because evaluation is the systematic collection and analysis of data needed to make decisions and the process of decision-making often takes place in a fuzzy environment.

(Fuzzy Tech) is the fuzzy tool that was used to produce this new and experimental system. The structure of the fuzzy set using this tool consists of three elements; Fuzzy Input, Fuzzy Output and a rule block that defines the relation between the (inputs) and the (outputs).

The devised expert system consists of six partial fuzzy sets; the first four fuzzy sets are connected together in one main fuzzy set the result of which is considered the main goal of the system, whereas, the functional efficiency of the dwelling is being calculated. The other two partial fuzzy sets are calculating the two housing indicator; lifestyle indicator and crowding indicator.

**CONCLUSIONS, RECOMMENDATIONS AND FURTHER
STUDIES**

CONCLUSIONS, RECOMMENDATIONS AND FURTHER STUDIES

CONCLUSIONS, RECOMMENDATIONS AND FURTHER STUDIES**A. Conclusions**

This thesis draws on the fact that significant changes in the lifestyle of low-income families in the Egyptian urban communities throughout the previous decades have come to influence their needs and desires in designing their new housing. It demonstrated that there is an obvious discordance in priorities in providing functional needs of space between low-income dwellers' vision on the one hand, and designers' vision on the other.

A-1- Characteristics of low-income families

The general socio-economic characteristics of low-income dwellers can be summarized as follows:

- In the current time, the majority of low-income families belong to the middle class which appears to be moving toward the lower class.
- The nuclear family type is widespread among low-income families in urban communities which consist of the husband, the wife and their children and may include any of family relatives.
- Low-income families who live in urban communities consist of four or five members in average

A-2- Lifestyle of low-income dwellers

This thesis has portrayed the lifestyle of low-income groups and how they live in their dwellings and how they meet their needs. The general aspects of the lifestyle of low-income dwellers can be summed up in the following points.

- The majority of low-income families rarely host guests, and there is no need to have a separate guest room, as they usually receive their guests in the living room.
- Low-income families often use their home spaces in performing only the ordinary home activities and they do not perform any other external profitable work.

- In spite of the fact that low-income families usually live in small dwellings and suffer from the limited income, they are keen on acquiring new (and relatively pricey) electrical appliances such as TV sets, satellite receivers and automatic washing machines.
- Most low-income families think that it is not necessary to have an entrance lobby and there is generally an essential spatial relation between the entrance and the kitchen. On the other hand, they prefer to connect the balcony to the living room in order to make it accessible to all members without wasting the privacy of the sleeping zone.
- The living space showed to be a multi-use space where family members perform various activities in different times of the day such as eating, watching television, praying, playing, studying and hosting guests. Moreover, it is noticeable that they actually use the floor of the dwelling in performing various activities without using furniture such as eating.

A-3- Defects of existing low-income dwellings

This thesis has demonstrated that there is a serious lack of knowledge on the part of the local architect concerning social and behavioral aspects of low-income dwellers. This has led to the fact that most low-income dwellers attempt to meet their spatial and functional needs on their own. For this reason most low-income families attempt to increase the area of their habitable spaces such as living room and bedrooms in order to perform their essential living activities using the following common solutions:

- Re-division of the designed space is a solution used by low-income families, especially in bedrooms to achieve the separation between boys and girls in sleeping areas.
- Changing the use of the designed space is a solution used by low-income families, especially when they need an additional sleeping space. They often create a sleeping space by closing the balcony. This solution is common when the family includes sons and daughters.

On the other hand, there is a the real demand for small and compact furniture units in order to achieve the optimal use of the available space and save the area of the small dwelling and to

provide other needed spaces such as adding another sleeping space and solving the problem of lack in storage areas.

A-4- The requirements of the desired dwelling

- Low-income families need flexible spaces that could be used to perform various activities. They accept the idea of multi-use space, and they find there is no need to have a separate dining or guest room.
- Most low-income families are willing to accept any new ideas in order to achieve new space saving strategies.
- Low-income families have the desire to redesign some spaces according to their needs. In some cases, they would undertake a necessary alteration in house design on their own to meet their needs.

A-5- Devising a Functional evaluation expert system for low-income dwellers based on their lifestyle

- In this thesis, certain criteria of evaluation for a given dwelling design have been defined in order to build the devised expert system based on several sources such as the lifestyle of Egyptian low-income dwellers, housing standards and other successful housing examples.
- As an overall result of the research, a computer expert system was devised, based on a mathematical logic known as fuzzy logic. This expert system determines the efficiency of the dwelling by evaluating all dwelling elements based on the given evaluation criteria.

B. Recommendations

- In the present time, no profitable work is being performed by the dwellers in the dwelling because of the lifestyle of low-income dwellers and their socio-cultural characteristics. However, there is an inevitable need to encourage them to carry out small profitable jobs in the dwelling in order to improve their standard of living and to encourage small projects that help the prosperity of the national economy in general. This requires providing a new domestic work

environment that allows the possibility of performing small profitable works from home.

- As a result from the social study, most low-income families have many and various new electrical appliances such as TV sets, computers and automatic washing machines. Therefore, the designer should take into account the spatial needs for those appliances in order to provide the optimum and ideal use, avoiding waste of space.
- Based on studying the socio-cultural characteristics and the lifestyle of low-income dwellers, the designers of low-income dwellings should design the furnishing scheme of the dwelling, proposing several scenarios using space saving strategies. Furthermore, they should take into account the dwellers' functional and spatial need considering the locally manufactured furniture for low-income groups.
- Many unusual low-income housing design approaches could be adopted in order to solve our housing problem, such as establishing a small and tiny house using the concept of incremental houses and the concept of residential open buildings. When applying these concepts, it is essential to take into account the principles which create healthier housing environments achieving 'quality of life' principles.
- As a part of the concept of community participation, the evaluation of any new housing project should be undertaken through the careful consideration of characteristics and needs/demands of its dwellers. Accordingly, it is highly recommended to use the devised expert system in judging housing competitions and evaluating projects for low-income groups.

C. Further Studies

- It is necessary to study the socio-cultural characteristics of the dwellers in other communities in Egypt such as rural, coastal and Bedouin communities. This study should investigate their spatial needs, whereas these communities have distinct customs, tradition and lifestyle. Naturally those people live in distinctive residential environments, which demand distinct research processes for each.

- Studying the new space saving strategies and the social acceptance of these new concepts and studying what is suitable to the dwellers socio-cultural characteristics and manufacturing conditions.
- Ergonomics is a discipline that can serve both social goals and economic goals. At society level, ergonomics can contribute to the reduction of costs due to preventable health problems. Accordingly, it is recommended for local researchers to study ergonomics in performing home activities according to the local aspects and the socio-cultural characteristics of the inhabitants.
- The concept of determining the spatial relation between spaces based on calculating the percentage of the visible area from the correlated other spaces, has been demonstrated in the thesis. However, this concept still needs a deeper study in order to use it as a tool to investigate the spatial relation in several building types
- The (lifestyle indicator) needs further work to be done to take into account all aspects that affect this measure to indicate the levels of housing.
- To generate standards that classify the levels of housing, it is necessary to undertake the study of the duration of use in a lot of dwellings with various conditions and different levels.
- In order to use the concept of the devised expert system, further studies are needed for developing or creating more flexible systems that take into account other housing types and other dweller groups.

CONCLUSIONS, RECOMMENDATIONS AND FURTHER STUDIES

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APPENDICES

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| APPENDICES |
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| Appendix 1: Questionnaire – Statistical study |
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Architectural objectives from the social survey:

1. Determining the changes of Social characteristics in low-income lifestyle:

- Eating together as an indicator for family coherence
(Question no. 5)
- Social interaction and hosting guests
(Question no. 10)
- Performing external profitable works using home spaces:
(Question no. 46) and having a sewing machine (Question no. 54)
Social interaction
- Separation between boys and girls in sleeping spaces
(Question no. 29), (Question no. 31)
(Question no. 30) This objective is in a relation with the family structure (family size, no. of sons, having boys and girls and the area of the dwelling)

2. Monitoring the daily routine of low-income family members (period of activities) :

- Studying period: (Question no. 23)
Praying period: (Question no. 25)
Watching TV: (Question no. 27)

3. Determining the spatial needs and priorities of spaces:

- The need of a specified space used as a dining space
(Question no. 4)
(Question no. 5)
(Question no. 6)
(Question no. 7)
(Question no. 8)
- The need of a specified space for receiving guests (salon)
(Question no. 10)
(Question no. 11)
(Question no. 12) This objective is in a relation with the family structure (family size, no. of sons, having boys and girls)

(Question no. 13)

- The importance of the balcony

(Question no.14)

(Question no.15)

(Question no.16)

(Question no.17) This objective is in a relation with the family structure (family size, no. of sons, having boys and girls and the area of the dwelling) to determine the priorities of spaces

- The need of a storage

(Question no. 18)

(Question no. 19)

(Question no. 20)

4. Coexistence with the existing housing spaces

- Determining the existing electrical appliances:

Using the table of existing appliances :

(Question no. 47)

(Question no. 48)

(Question no. 49)

(Question no. 50)

(Question no. 51)

(Question no. 52)

(Question no. 53)

(Question no. 54)

- Usage of house spaces in performing the essential activities:

Eating: (Question no. 4)

Watching TV: (Question no. 26)

Studying: (Question no. 21)

Playing: (Question no. 24)

Praying: (Question no. 28)

Sleeping: (Question no. 31) , (Question no. 32) , (Question no. 33)

5. Determining the change of space use according to functional priorities:

- Re-division of spaces: (Question no. 30)

This objective is in a relation with the family structure (family size, no. of sons, having boys and girls and the area of the dwelling)

- Adding new spaces: (Question no. 17)

This objective is in a relation with the family structure (family size, no. of sons, having boys and girls and the area of the dwelling)

6. Determining the Existing house defects and desired house requirements

- Number of bed rooms: (Question no. 30) , (Question no. 35)
This objective is in a relation with the family structure (family size, no. of sons, having boys and girls and the area of the dwelling)
- Acceptance of non-traditional ideas
Open Kitchen: (Question no. 36)
Flexibility of spaces and Multi-use room: (Question no. 37), (Question no. 38), (Question no. 31), (Question no. 32), (Question no. 6), (Question no. 7)
Using space saving furniture: (Question no. 22), (Question no. 32), (Question no. 33), (Question no. 34), (Question no. 37), (Question no. 38)
- Applicability to redesign spaces: (Question no. 45)
- Privacy hurting : (Question no. 1), (Question no. 2), (Question no.3)
- Acceptance of other architectural elements:
Bathroom natural lighting: (Question no. 39)
The clear height of the existing home: (Question no. 41), (Question no. 42)

استمارة استقراء حالة (مشروعات الإسكان الاقتصادي وكيفية تعامل
المستخدمين مع المسكن)
هذه الاستمارة من ضمن خطة العمل البحثي الخاصة برسالة دكتوراة المهندس :
أيمن عاصم المدرس المساعد - بكلية الهندسة جامعة عين شمس

| رقم الاستمارة | | معلومات خاصة بمشروع الإسكان : | | | |
|--|--|-------------------------------|--|--------------|--|
| | | 1 اسم المنطقة (الحي) | | | |
| | | 2 سنة البناء | | | |
| | | 3 أهداف المشروع | | | |
| إسكان شباب | | إسكان تعاوني | | إسكان حكومي | |
| 4 نمط الإسكان الاقتصادي | | | | | |
| 5 نوع الإسكان الاقتصادي | | مسكن ممتد - أرض + المرافق | | عمارات سكنية | |
| | | 6 معلومات أخرى | | | |
| معلومات خاصة بالعقار (العمارة السكنية) : | | | | | |
| | | 1 موقع العقار | | | |
| | | سكني مختلط | | سكني | |
| | | 3 عدد الأدوار + أرضي | | | |
| 4 الحالة الإنشائية | | متصدع سليم | | | |
| 5 حالة التشطيب | | متوسط | | جيد | |
| 6 توافر الخدمات | | متوفرة : ماعدا : | | | |
| 7 الامتدادات (التعديلات) | | أفقي : | | رأسي : | |
| | | 8 عدد الوحدات بالدور | | | |
| | | 9 معلومات أخرى عن العقار | | | |
| معلومات خاصة بالأسرة | | | | | |
| | | عدد أفراد الأسرة | | | |
| عائل الأسرة | | الأب | | الأم | |
| | | الدخل الشهري | | | |
| | | معدل الإنفاق الشهري | | | |
| | | هيكل الأسرة : | | | |

| المهنة | المستوى التعليمي | العمر | النوع | | | |
|--------|------------------|-------|-------|-----|-------|--|
| | | | | | الأب | |
| | | | | | الأم | |
| | | | أنثى | ذكر | ابن 1 | |
| | | | أنثى | ذكر | ابن 2 | |
| | | | أنثى | ذكر | ابن 3 | |
| | | | أنثى | ذكر | ابن 4 | |
| | | | أنثى | ذكر | ابن 5 | |
| | | | أنثى | ذكر | ابن 6 | |

| معلومات خاصة بالوحدة السكنية : | | | | | | | | | | |
|--------------------------------|--------|------------|------|------|-------|------|-------------|-------------------------|---|---|
| إيجار قديم | | إيجار جديد | | | تمليك | | | الحالة القانونية | | 1 |
| | | | | | | | | طريقة الحصول على الوحدة | | 2 |
| 2م | | | | | | | | مساحة الوحدة السكنية | | 3 |
| | | | | | | | | عدد الغرف | | 4 |
| صالون | بلكونة | مطبخ | حمام | طعام | نوم | صالة | تصنيف الغرف | | 5 | |
| | | | | | | | | ارتفاع السقف | | 6 |
| | | | | | | | | معلومات أخرى | | 7 |
| | | | | | | | | | | |
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ما هي الأجهزة الكهربائية الموجودة بالشقة وأين توجد (اكتب العدد):

| 1 | الجهاز | الغرفة | الحمام | المطبخ | الحمام | النوم | الصالون | الطريقة | البكارية |
|----|-----------------|--------|--------|--------|--------|-------|---------|---------|----------|
| 2 | ثلاجة | | | | | | | | |
| 3 | غسالة يدوية | | | | | | | | |
| 4 | غسالة أوتوماتيك | | | | | | | | |
| 5 | ديب فريزر | | | | | | | | |
| 6 | بوتجاز | | | | | | | | |
| 7 | تلفزيون | | | | | | | | |
| 8 | رسيفر + دش | | | | | | | | |
| 9 | تكييف | | | | | | | | |
| 10 | مروحة | | | | | | | | |
| 11 | كمبيوتر | | | | | | | | |
| 12 | سخان | | | | | | | | |
| 13 | شفاط | | | | | | | | |
| 14 | ماكينة خياطة | | | | | | | | |

يفضل وجود صور لوصف الوحدة السكنية بقدر الإمكان

| | | | |
|---|---|----------------------------|---|
| 1 | هل تجد أنه من الضروري وجود فراغ خاص بالمدخل أم يمكن الدخول إلى غرفة المعيشة مباشرة؟ | | |
| | لا بد من وجود فراغ المدخل برغم من إهداره للمساحة | من المفضل وجود فراغ المدخل | يمكن الدخول مباشرة إلى غرفة المعيشة في سبيل توفير المساحة |
| | تعليق: | | |

| | | | |
|---|---|-------------------|---------------------|
| 2 | هل المدخل (باب الشقة) يجرح خصوصية فراغات المسكن (يكشف جميع الفراغات)؟ | | |
| | يجرح جميع الفراغات | يجرح بعض الفراغات | لا أجد مشكلة في ذلك |
| | تعليق: | | |

| | | | |
|---|--|-------------------------------------|---------------------|
| 3 | هل تجد أن هناك علاقة مهمة بين المدخل والمطبخ؟ أم أن العلاقة أكبر بين المطبخ وجناح النوم؟ | | |
| | العلاقة أكبر بين المدخل والمطبخ | العلاقة أكبر بين المطبخ وجناح النوم | العلاقتين غير مهمين |
| | تعليق: | | |

| | | |
|---|---------------------------------|--------------------------|
| 4 | أين تقوم الأسرة بتناول طعامها ؟ | |
| | على طبلية أو مائدة قابلة للطي | في غرفة المعيشة (الصالة) |
| | على مائدة الطعام (السفرة) | |
| | تعليق : | |

| | | |
|---|--|-----|
| 5 | هل يجتمع جميع أفراد الأسرة لتناول الطعام ؟ | |
| | لا | نعم |
| | أحياناً | |
| | إن كانت الإجابة بـ (لا) فما السبب : | |

| | | |
|---|---|----------|
| 6 | هل تجد أن تخصيص فراغ للطعام (غرفة السفرة) مهم في الوحدة السكنية ؟ | |
| | متوسط الأهمية | مهم جداً |
| | يمكن الاستغناء عنه | |
| | تعليق : | |

| | | |
|---|--|-----|
| 7 | هل يمكن أن يكون تناول الطعام في فراغ المعيشة ؟ | |
| | لا | نعم |
| | في وقت الضرورة | |
| | تعليق : | |

| | | |
|---|--|------|
| 8 | وتفضل أن يكون بأثاث ثابت أم متحرك أم باستعمال نفس أثاث المعيشة ؟ | |
| | متحرك | ثابت |
| | نفس أثاث المعيشة | |
| | تعليق : | |

| | | |
|---|--|----------------|
| 9 | هل يتم استخدام مائدة الطعام (سواء كانت متحركة أو ثابتة) في اي استخدام آخر ؟؟ (يمكن اختيار أكثر من إجابة) | |
| | إعداد الطعام | مذاكرة الأولاد |
| | عمل آخر | |
| | تعليق : | |

| | | |
|----|--------------------------|----------------------------|
| 10 | أين يتم استقبال الضيوف ؟ | |
| | في الصالون | في غرفة المعيشة (الصالة) |
| | في أي مكان | (|
| | تعليق : | |

| | | |
|----|----------------------------------|-----------|
| 11 | إلى أي مدى يتم استقبال الضيوف ؟؟ | |
| | بشكل أسبوعي | بشكل يومي |
| | نادراً ما يأتي أحد | |
| | تعليق : | |

| | | |
|----|---|----------|
| 12 | هل تجد أن فراغ الصالون فراغ مهم في الوحدة السكنية ؟ | |
| | متوسط الأهمية | مهم جداً |
| | غير مهم على الإطلاق | |
| | أهميته : | |

| | | |
|----|---|-------------------------------|
| 13 | هل تفضل أن يكون فراغ الصالون منفصل أم يمكن أن يكون متصل مع فراغ المعيشة (الصالة)؟ | |
| | منفصل | متصل مع غرفة المعيشة (الصالة) |
| | تعليق : | |

| | | |
|----|---------------------------------------|---------------|
| 14 | هل ترى أن فراغ الشرفة (البلكونة) مهم؟ | |
| | مهم جداً | متوسط الأهمية |
| | غير مهم على الإطلاق | |
| | تعليق : | |

| | | |
|----|--|---------------|
| 15 | ما هي أهمية فراغ الشرفة (البلكونة)؟؟ (يمكن اختيار أكثر من إجابة) | |
| | تخزين | تربية حيوانات |
| | تهوية | |
| | تعليق : | |

| | | |
|----|--|---------|
| 16 | هل تفضل أن تكون الشرفة (البلكونة) بغرفة النوم أم بغرفة المعيشة (الصالة)؟ (يمكن اختيار أكثر من إجابة) | |
| | النوم | المعيشة |
| | تعليق : | |

| | | |
|----|--|----|
| 17 | هل ترى من الأفضل الاستغناء عن الشرفة (البلكونة) في مقابل زيادة مساحة الغرفة؟ | |
| | نعم | لا |
| | تعليق : | |

| | | |
|----|---|--------|
| 18 | أين تقوم بتخزين مستلزمات البيت والأشياء الغير مستخدمة والأثاث القديم؟ (يمكن اختيار أكثر من إجابة) | |
| | البلكونة | المطبخ |
| | في أي مكان | |
| | تعليق : | |

| | | |
|----|--|---------------|
| 19 | هل من المهم وجود مكان ثابت للتخزين (مخزن - سندرة)؟ | |
| | مهم جداً | متوسط الأهمية |
| | غير مهم على الإطلاق | |
| | تعليق : | |

| | | |
|----|--|---------|
| 20 | أين تفضل أن يوجد هذا المكان المخصص للتخزين؟؟ (يمكن اختيار أكثر من إجابة) | |
| | المطبخ | أي مكان |
| | مكان آخر (أذكره) | |
| | تعليق : | |

| | | |
|----|--|-----------|
| 21 | أين يذاكر الأولاد؟ (يمكن اختيار أكثر من إجابة) | |
| | في غرفة النوم | في الصالة |
| | في مكان آخر (أذكره) | |

| | | |
|----|--|-----------------------|
| | تعليق : | |
| 22 | على ماذا يذاكر الأولاد؟ (يمكن اختيار أكثر من إجابة) | |
| | مكتب | مائدة الطعام |
| | شئ آخر (أذكره) | |
| | تعليق : | |
| 23 | كم تستغرق فترة مذاكرة الأولاد في المتوسط؟؟ | |
| | أقل من 3 ساعات يومياً | 3 إلى 6 ساعات يومياً |
| | أكثر من 6 ساعات يومياً | |
| | تعليق : | |
| 24 | أين يلعب الأولاد (كمبيوتر أو غيره)؟ (يمكن اختيار أكثر من إجابة) | |
| | في غرفة النوم | في الصلاة |
| | في مكان آخر (أذكره) | |
| | تعليق : | |
| 25 | كم تستغرق فترة لعب الأولاد في المتوسط؟؟ | |
| | أقل من 3 ساعات يومياً | 3 إلى 6 ساعات يومياً |
| | أكثر من 6 ساعات يومياً | |
| | تعليق : | |
| 26 | أين يوجد التليفزيون؟ (يمكن اختيار أكثر من إجابة) | |
| | في غرفة النوم | في الصلاة |
| | في مكان آخر (أذكره) | |
| | تعليق : | |
| 27 | كم تستغرق فترة مشاهدة التليفزيون في المتوسط؟؟ | |
| | أقل من 3 ساعات يومياً | 3 إلى 6 ساعات يومياً |
| | أكثر من 6 ساعات يومياً | |
| | تعليق : | |
| 28 | أين يصلي أفراد الأسرة؟ | |
| | في غرفة النوم | في الصلاة |
| | في أي مكان | |
| | تعليق : | |
| 29 | هل ترى أنه من الضروري الفصل بين الأولاد والبنات في غرف النوم؟ | |
| | ضروري | لا أعرف |
| | لا يهم | |
| | تعليق : | |
| 30 | إن كنت ترى أنه من الضروري الفصل بين الأولاد والبنات فما هو الحل في ظل ضيق المساحة؟ | |
| | الفصل باستخدام ستارة | نوم الأولاد في الصلاة |
| | حل آخر | |
| | تعليق : | |

| | | |
|---------|--|-----|
| 31 | هل ينام أحد في غرفة المعيشة (الصاله) ؟ | |
| | لا | نعم |
| تعليق : | | |

| | | |
|---------|----------------------------------|-------------------|
| 32 | إن كانت الإجابة بنعم فأين ينام؟؟ | |
| | على الكنبه | على سرير يتم فتحه |
| | على الأرض | |
| تعليق : | | |

| | | |
|---------|-----------------------|-----|
| 33 | هل لديك سرير بدورين ؟ | |
| | لا | نعم |
| تعليق : | | |

| | | |
|---------|---|--------------------------|
| 34 | هل تجد أن أفكار مثل السرير العلوي (سرير بدورين) جيدة في توفير المساحة داخل الوحدة السكنية ؟ | |
| | أفكار جيدة جداً وتوفر المساحة | أفكار غير مفضلة |
| | الإطلاق | أفكار مرفوضة على الإطلاق |
| تعليق : | | |

| | | |
|---------|--|----------|
| 35 | هل من الأفضل تقليل مساحات غرف النوم وزيادة عددها ؟ | |
| | لا المساحة مهمة أيضاً | نعم أفضل |
| تعليق : | | |

| | | |
|----------|---|---------|
| 36 | هل تجد أن فكرة المطبخ المفتوح تساعد على زيادة استغلال المساحة ؟ أم أنها فكرة مرفوضة ؟ | |
| | فكرة جيدة | لا أفضل |
| | فكرة مرفوضة | |
| لماذا؟ : | | |

| | | |
|---------|---|-----|
| 37 | هل تجد أن الفرش المتحرك والقابل للطي يوفر المساحة ؟ | |
| | لا | نعم |
| تعليق : | | |

| | | |
|---------|---|--------|
| 38 | ما هي الأنشطة التي يمكن أن تؤدي من خلال الفرش المتحرك ؟ | |
| | النوم | الطعام |
| | أخري (أذكره) | |
| تعليق : | | |

| | | |
|---------|--|---------------|
| 39 | هل تجد أن إنارة الحمام أو المطبخ طبيعياً (عن طريق شبك) أمر مهم ؟ | |
| | مهم جداً | متوسط الأهمية |
| | غير مهم على الإطلاق | |
| تعليق : | | |

| | | |
|----|---|--|
| 40 | أيهما تفضل زيادة مساحة الغرف أم زيادة عددها ؟ | |
|----|---|--|

| | | | |
|----|---|----------------------------------|---------------------------------|
| | زيادة المساحة | زيادة عدد الغرف | |
| | تعليق : | | |
| 41 | هل ارتفاع الوحدة مناسب ؟ | | |
| | مناسب | غير مناسب | |
| | تعليق : | | |
| 42 | وهل يمكن تقليل ارتفاع الوحدة في بعض الفراغات في سبيل توفير مساحة أكبر للشقة ؟ | | |
| | يمكن تقليل الارتفاع في الحمام والمطبخ | يمكن تقليل الارتفاع في غرف النوم | لا يمكن التقليل عن هذا الارتفاع |
| | تعليق : | | |
| 43 | ما هي الغرف التي تحتاج إلى زيادة مساحتها ؟ | | |
| | أذكرها | | |
| | تعليق : | | |
| 44 | ما هي الغرف الغير موجودة في شقتك وأنت في احتياج إليها ؟ | | |
| | أذكرها | | |
| | تعليق : | | |
| 45 | هل تجد انه من الأفضل أن تقوم أنت وأسرتهك بتقسيم فراغات وحدتك السكنية ؟ | | |
| | نعم | لا | |
| | تعليق : | | |
| 46 | هل هناك أية أعمال تحقق مكسب يتم عملها من داخل الشقة ؟ | | |
| | نعم | لا | |
| | ما هي : | | |
| 47 | في رأيك ما هي مشاكل المسكن الذي تعيش فيه الآن ؟ | | |
| | | | |
| | | | |
| 48 | في رأيك ما هي مواصفات المسكن الذي ترغب أن تعيش فيه المستقبل ؟ | | |
| | | | |
| | | | |
| 49 | ملاحظات: | | |
| | | | |

Statistical Analysis:**Table 62: Family Structure – Statistics**

| | No. family | No. children | No. boys | No. girls | Flat. area | No. rooms |
|-------------------------------|-------------------|---------------------|-----------------|------------------|-------------------|------------------|
| N. Valid | 62 | 62 | 62 | 62 | 62 | 62 |
| N. Missing | 0 | 0 | 0 | 0 | 0 | 0 |
| Mean | 4.55 | 2.55 | 1.45 | 1.13 | 69.53 | 3.06 |
| Std. Error of Mean | .213 | .203 | .141 | .131 | .971 | .045 |
| Median | 4.00 | 2.50 | 1.00 | 1.00 | 70.00 | 3.00 |
| Mode | 5 | 3 | 2 | 1 | 70 | 3 |
| Std. Deviation | 1.676 | 1.596 | 1.111 | 1.032 | 7.647 | .356 |
| Variance | 2.809 | 2.547 | 1.235 | 1.065 | 58.483 | .127 |
| Skewness | 2.482 | 2.085 | 1.014 | 1.028 | -2.114 | .931 |
| Std. Error of Skewness | .304 | .304 | .304 | .304 | .304 | .304 |
| Kurtosis | 11.247 | 8.735 | 1.976 | 1.839 | 5.905 | 4.892 |
| Std. Error of Kurtosis | .599 | .599 | .599 | .599 | .599 | .599 |
| Range | 11 | 10 | 5 | 5 | 43 | 2 |
| Minimum | 2 | 0 | 0 | 0 | 37 | 2 |
| Maximum | 13 | 10 | 5 | 5 | 80 | 4 |

Frequency Tables**Table 63: Frequency Table - No. family**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-------|-----------|---------|---------------|--------------------|
| Valid | 2 | 5 | 8.1 | 8.1 | 8.1 |
| | 3 | 5 | 8.1 | 8.1 | 16.1 |
| | 4 | 22 | 35.5 | 35.5 | 51.6 |
| | 5 | 23 | 37.1 | 37.1 | 88.7 |
| | 6 | 4 | 6.5 | 6.5 | 95.2 |
| | 7 | 1 | 1.6 | 1.6 | 96.8 |
| | 10 | 1 | 1.6 | 1.6 | 98.4 |
| | 13 | 1 | 1.6 | 1.6 | 100.0 |
| | Total | 62 | 100.0 | 100.0 | |

Table 64: Frequency Table - No. children

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-------|-----------|---------|---------------|--------------------|
| Valid | 0 | 5 | 8.1 | 8.1 | 8.1 |
| | 1 | 5 | 8.1 | 8.1 | 16.1 |
| | 2 | 21 | 33.9 | 33.9 | 50.0 |
| | 3 | 24 | 38.7 | 38.7 | 88.7 |
| | 4 | 4 | 6.5 | 6.5 | 95.2 |
| | 5 | 1 | 1.6 | 1.6 | 96.8 |
| | 8 | 1 | 1.6 | 1.6 | 98.4 |
| | 10 | 1 | 1.6 | 1.6 | 100.0 |
| | Total | 62 | 100.0 | 100.0 | |

Table 65: Frequency Table - No. boys

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-------|-----------|---------|---------------|--------------------|
| Valid | 0 | 12 | 19.4 | 19.4 | 19.4 |
| | 1 | 21 | 33.9 | 33.9 | 53.2 |
| | 2 | 23 | 37.1 | 37.1 | 90.3 |
| | 3 | 3 | 4.8 | 4.8 | 95.2 |
| | 4 | 1 | 1.6 | 1.6 | 96.8 |
| | 5 | 2 | 3.2 | 3.2 | 100.0 |
| | Total | 62 | 100.0 | 100.0 | |

Table 66: Frequency Table - No. girls

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-------|-----------|---------|---------------|--------------------|
| Valid | 0 | 19 | 30.6 | 30.6 | 30.6 |
| | 1 | 23 | 37.1 | 37.1 | 67.7 |
| | 2 | 15 | 24.2 | 24.2 | 91.9 |
| | 3 | 4 | 6.5 | 6.5 | 98.4 |
| | 5 | 1 | 1.6 | 1.6 | 100.0 |
| | Total | 62 | 100.0 | 100.0 | |

Table 67: Frequency Table - Flat area

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-------|-----------|---------|---------------|--------------------|
| Valid | 37 | 1 | 1.6 | 1.6 | 1.6 |
| | 45 | 1 | 1.6 | 1.6 | 3.2 |
| | 50 | 1 | 1.6 | 1.6 | 4.8 |
| | 60 | 4 | 6.5 | 6.5 | 11.3 |
| | 63 | 5 | 8.1 | 8.1 | 19.4 |
| | 65 | 2 | 3.2 | 3.2 | 22.6 |
| | 68 | 1 | 1.6 | 1.6 | 24.2 |
| | 69 | 1 | 1.6 | 1.6 | 25.8 |
| | 70 | 19 | 30.6 | 30.6 | 56.5 |
| | 72 | 3 | 4.8 | 4.8 | 61.3 |
| | 74 | 1 | 1.6 | 1.6 | 62.9 |
| | 75 | 18 | 29.0 | 29.0 | 91.9 |
| | 76 | 3 | 4.8 | 4.8 | 96.8 |
| | 79 | 1 | 1.6 | 1.6 | 98.4 |
| | 80 | 1 | 1.6 | 1.6 | 100.0 |
| | Total | 62 | 100.0 | 100.0 | |

Table 68: Frequency Table - No. rooms

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|---|-----------|---------|---------------|--------------------|
| Valid | 2 | 2 | 3.2 | 3.2 | 3.2 |
| | 3 | 54 | 87.1 | 87.1 | 90.3 |
| | 4 | 6 | 9.7 | 9.7 | 100.0 |
| Total | | 62 | 100.0 | 100.0 | |

Table 69: Descriptive Statistics:

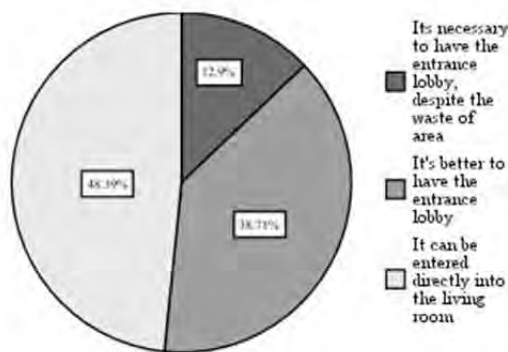
| | N | Range | Minimum | Maximum | Mean | Std. Deviation | Variance | Skewness | | Kurtosis | |
|-------------|-----------|-----------|-----------|-----------|-----------|----------------|-----------|-----------|------------|-----------|------------|
| | Statistic | Statistic | Statistic | Statistic | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic | Std. Error |
| no.family | 62 | 11 | 2 | 13 | 4.55 | 1.676 | 2.809 | 2.482 | .304 | 11.247 | .599 |
| no.children | 62 | 10 | 0 | 10 | 2.55 | 1.596 | 2.547 | 2.085 | .304 | 8.735 | .599 |
| no.boys | 62 | 5 | 0 | 5 | 1.45 | 1.111 | 1.235 | 1.014 | .304 | 1.976 | .599 |
| no.girls | 62 | 5 | 0 | 5 | 1.13 | 1.032 | 1.065 | 1.028 | .304 | 1.839 | .599 |
| flat.area | 62 | 43 | 37 | 80 | 69.53 | 7.647 | 58.483 | -2.114 | .304 | 5.905 | .599 |
| no.rooms | 62 | 2 | 2 | 4 | 3.06 | .356 | .127 | .931 | .304 | 4.892 | .599 |

Frequencies for all asked questions:

Q1. Do you find it necessary to have an entrance lobby or you can enter directly into the living room?

- a. It's necessary to have the entrance lobby, despite the waste of area
- b. It's better to have the entrance lobby
- c. It can be entered directly into the living room

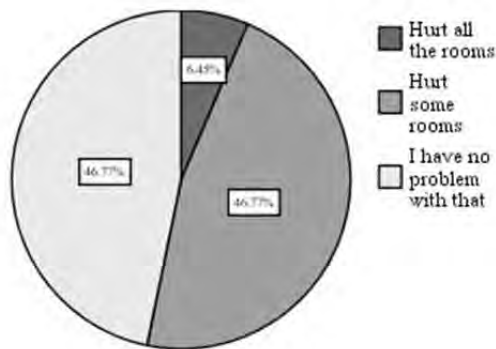
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|--|-----------|---------|---------------|--------------------|
| Valid It's necessary to have the entrance lobby, despite the waste of area | 8 | 12.9 | 12.9 | 12.9 |
| It's better to have the entrance lobby | 24 | 38.7 | 38.7 | 51.6 |
| It can be entered directly into the living room | 30 | 48.4 | 48.4 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q2. Is the entrance (opening the door of the apartment) hurt the privacy of home spaces (all rooms are always viewed from outdoor)?

- a. Hurt all the rooms
- b. Hurt some rooms
- c. I have no problem with that

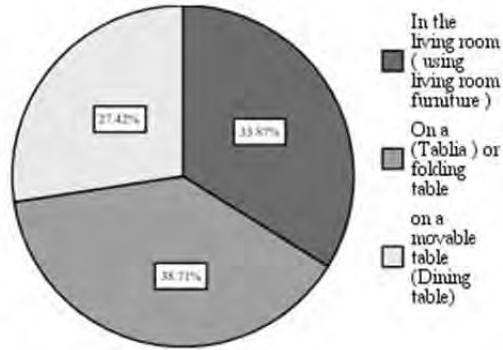
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|-----------------------------|-----------|---------|---------------|--------------------|
| Valid Hurt all the rooms | 4 | 6.5 | 6.5 | 6.5 |
| Hurt some rooms | 29 | 46.8 | 46.8 | 53.2 |
| I have no problem with that | 29 | 46.8 | 46.8 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q3. Do you find that there is an important relationship between the entrance and kitchen? Or, the relationship between the kitchen and bedrooms is greater?

- a. Greater relationship between the entrance and kitchen
- b. Greater relationship between the kitchen and bedrooms
- c. The both are not important

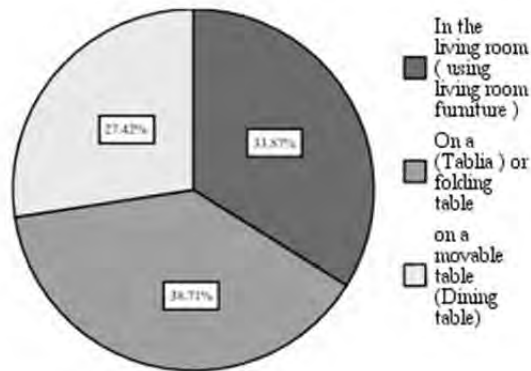
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|-----------|---------|---------------|--------------------|
| Valid Greater relationship between the entrance and kitchen | 49 | 79.0 | 79.0 | 79.0 |
| Greater relationship between the kitchen and bedrooms | 7 | 11.3 | 11.3 | 90.3 |
| The both are not important | 6 | 9.7 | 9.7 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q4. Where does the family eat the daily meals? In the living room (using living room furniture)

- a. On a (Tablia) or folding table
- b. on a movable table (Dining table)

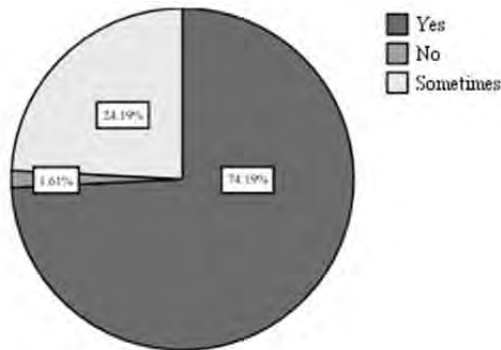
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|-----------|---------|---------------|--------------------|
| Valid In the living room (using living room furniture) | 21 | 33.9 | 33.9 | 33.9 |
| On a (Tablia) or folding table | 24 | 38.7 | 38.7 | 72.6 |
| on a movable table (Dining table) | 17 | 27.4 | 27.4 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q5. Do all family members gather to eat?

- a. Yes
- b. No
- c. Sometimes

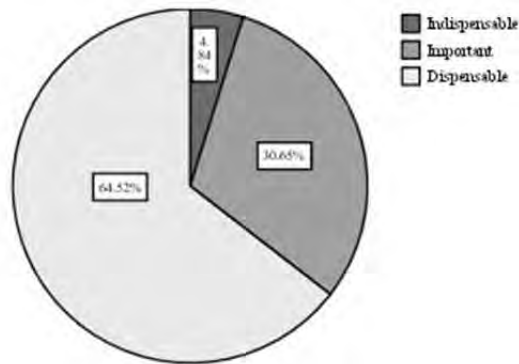
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|-----------|-----------|---------|---------------|--------------------|
| Valid Yes | 46 | 74.2 | 74.2 | 74.2 |
| No | 1 | 1.6 | 1.6 | 75.8 |
| Sometimes | 15 | 24.2 | 24.2 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q6. Do you find that having a Dining Room is important in the house?

- a. Indispensable
- b. Important
- c. Dispensable

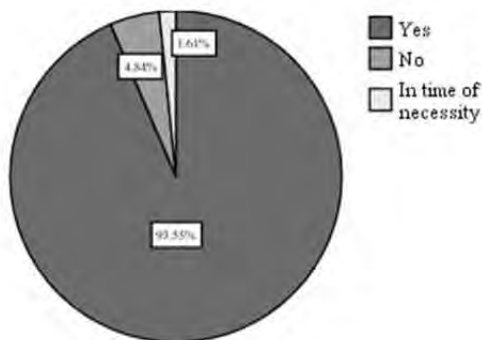
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------------------|-----------|---------|---------------|--------------------|
| Valid Indispensable | 3 | 4.8 | 4.8 | 4.8 |
| Important | 19 | 30.6 | 30.6 | 35.5 |
| Dispensable | 40 | 64.5 | 64.5 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q7. Could your family eat their meals in the living room space?

- a. Yes
- b. No
- c. In time of necessity

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------------------|-----------|---------|---------------|--------------------|
| Valid Yes | 58 | 93.5 | 93.5 | 93.5 |
| No | 3 | 4.8 | 4.8 | 98.4 |
| In time of necessity | 1 | 1.6 | 1.6 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |

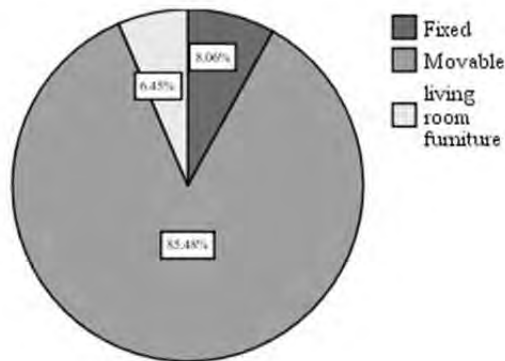


Q8. Do you prefer the dining furniture is to be fixed or movable or using the same living room furniture?

- d. Fixed
- a. movable

b. living room furniture

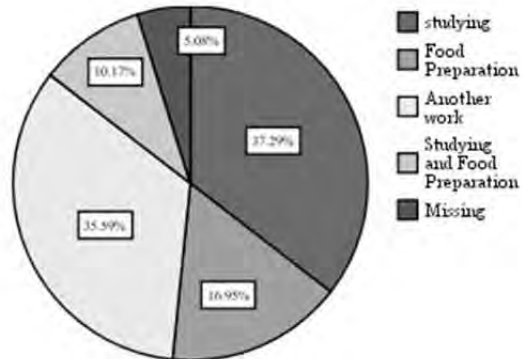
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-----------------------|-----------|---------|---------------|--------------------|
| Valid | Fixed | 5 | 8.1 | 8.1 | 8.1 |
| | Movable | 53 | 85.5 | 85.5 | 93.5 |
| | living room furniture | 4 | 6.5 | 6.5 | 100.0 |
| | Total | 62 | 100.0 | 100.0 | |



Q9. Do you use the dining table (whether movable or fixed) in any other activity??

- a. Studying
- b. Food Preparation
- c. Not used

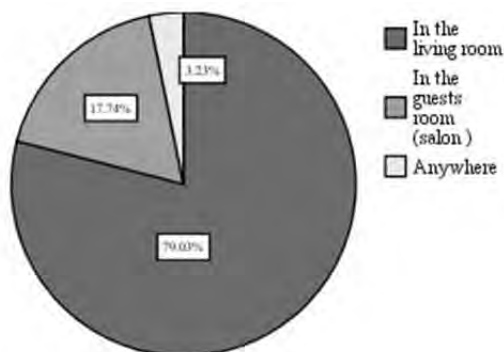
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------|-------------------------------|-----------|---------|---------------|--------------------|
| Valid | Studying | 22 | 35.5 | 37.3 | 37.3 |
| | Food Preparation | 10 | 16.1 | 16.9 | 54.2 |
| | Another work | 21 | 33.9 | 35.6 | 89.8 |
| | Studying and Food Preparation | 6 | 9.7 | 10.2 | 100.0 |
| | Total | 59 | 95.2 | 100.0 | |
| Missing | missing | 3 | 4.8 | | |
| | Total | 62 | 100.0 | | |



Q10. Where do you host your guests?

- a. In the living room
- b. In the guests room (salon)
- c. Anywhere

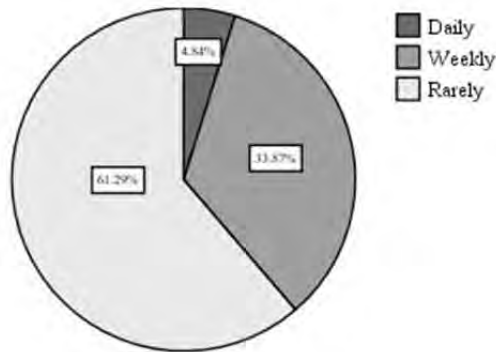
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|-----------------------------|-----------|---------|---------------|--------------------|
| Valid In the living room | 49 | 79.0 | 79.0 | 79.0 |
| In the guests room (salon) | 11 | 17.7 | 17.7 | 96.8 |
| Anywhere | 2 | 3.2 | 3.2 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q11. How often do you receive guests?

- a. Daily
- b. Weekly
- c. Rarely

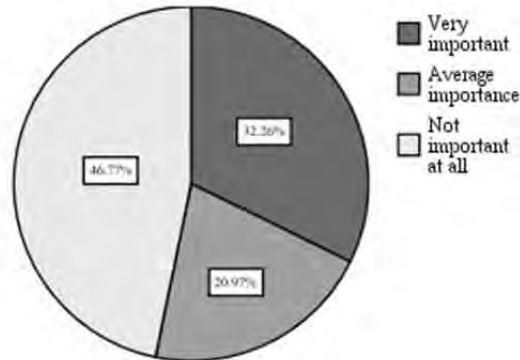
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------------|-----------|---------|---------------|--------------------|
| Valid Daily | 3 | 4.8 | 4.8 | 4.8 |
| Weekly | 21 | 33.9 | 33.9 | 38.7 |
| Rarely | 38 | 61.3 | 61.3 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q12. Do you find that the guests room (Salon) Is an important room in the house?

- a. Very important
- b. Average importance
- c. Not important at all

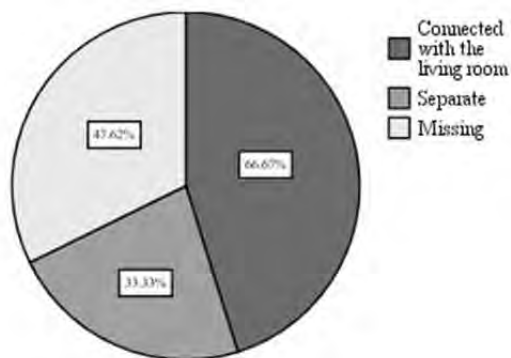
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------------------|-----------|---------|---------------|--------------------|
| Valid Very important | 20 | 32.3 | 32.3 | 32.3 |
| Average importance | 13 | 21.0 | 21.0 | 53.2 |
| Not important at all | 29 | 46.8 | 46.8 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q13. Do you prefer to have a separate guests room (salon), or it can be connected with the living room?

- a. Separate
- b. Connected with the living room

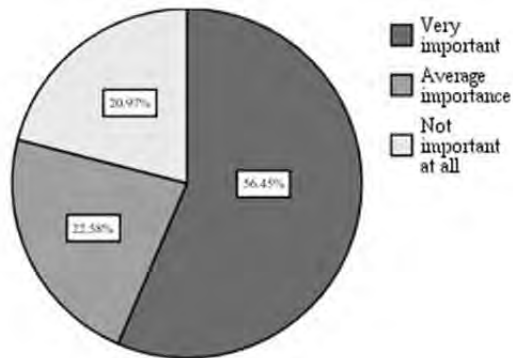
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------|--------------------------------|-----------|---------|---------------|--------------------|
| Valid | Connected with the living room | 28 | 45.2 | 66.7 | 66.7 |
| | Separate | 14 | 22.6 | 33.3 | 100.0 |
| | Total | 42 | 67.7 | 100.0 | |
| Missing | missing | 20 | 32.3 | | |
| | Total | 62 | 100.0 | | |



Q14. Do you find that having a balcony is important?

- a. Very important
- b. Average importance
- c. Not important at all

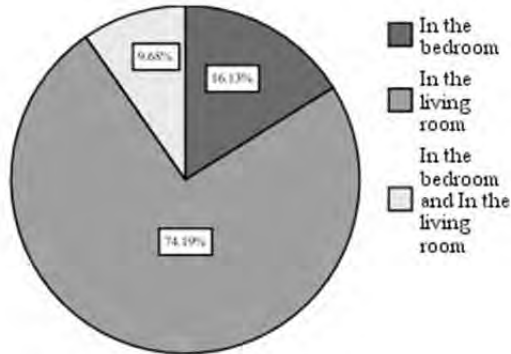
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------------------|-----------|---------|---------------|--------------------|
| Valid Very important | 35 | 56.5 | 56.5 | 56.5 |
| Average importance | 14 | 22.6 | 22.6 | 79.0 |
| Not important at all | 13 | 21.0 | 21.0 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q15. What is the importance of the balcony?

- a. Store
- b. Poultry Breeding
- c. Ventilation

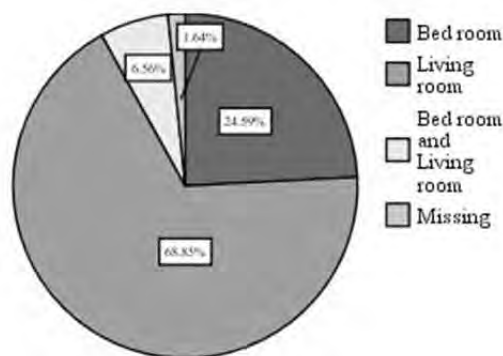
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|-----------------------|-----------|---------|---------------|--------------------|
| Valid Store | 8 | 12.9 | 13.3 | 13.3 |
| Ventilation | 38 | 61.3 | 63.3 | 76.7 |
| Store and Ventilation | 14 | 22.6 | 23.3 | 100.0 |
| Total | 60 | 96.8 | 100.0 | |
| Missing missing | 2 | 3.2 | | |
| Total | 62 | 100.0 | | |



Q16. Do you prefer the balcony to be connected to the bedroom or living room ?

- a. Bed room
- b. Living room

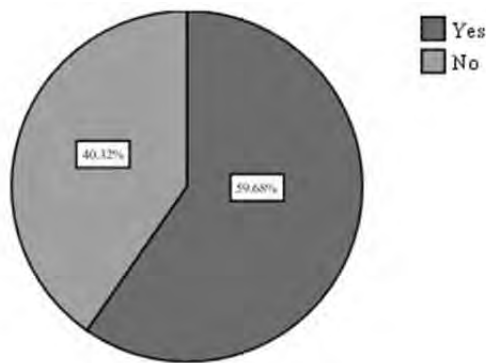
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------|--------------------------|-----------|---------|---------------|--------------------|
| Valid | Bed room | 15 | 24.2 | 24.6 | 24.6 |
| | Living room | 42 | 67.7 | 68.9 | 93.4 |
| | Bed room and Living room | 4 | 6.5 | 6.6 | 100.0 |
| | Total | 61 | 98.4 | 100.0 | |
| Missing | missing | 1 | 1.6 | | |
| | Total | 62 | 100.0 | | |



Q17. Do you think it is better to dispense with the terrace (balcony) in order to increase the area of the connected room?

- a. Yes
- b. No

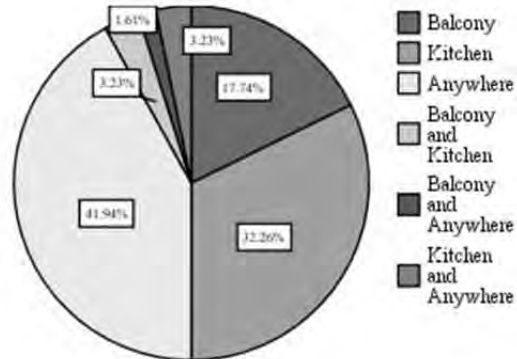
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|-----------|-----------|---------|---------------|--------------------|
| Valid Yes | 37 | 59.7 | 59.7 | 59.7 |
| No | 25 | 40.3 | 40.3 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q18. Where do you store the home goods and things that are not used and old furniture?

- a. Balcony
- b. Kitchen
- c. Anywhere

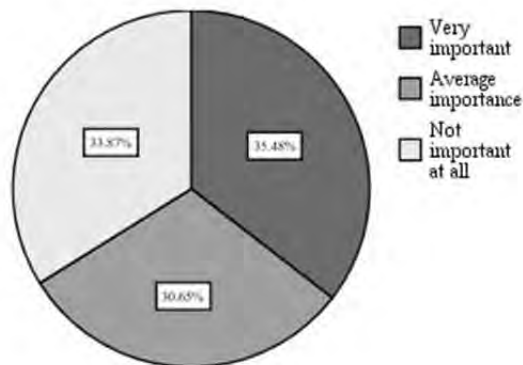
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------------------|-----------|---------|---------------|--------------------|
| Valid Balcony | 11 | 17.7 | 17.7 | 17.7 |
| Kitchen | 20 | 32.3 | 32.3 | 50.0 |
| Anywhere | 26 | 41.9 | 41.9 | 91.9 |
| Balcony and Kitchen | 2 | 3.2 | 3.2 | 95.2 |
| Balcony and Anywhere | 1 | 1.6 | 1.6 | 96.8 |
| Kitchen and Anywhere | 2 | 3.2 | 3.2 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q19. Is it important to have a specific place fo storage (storage – attic (Sandara))?

- a. Very important
- b. Average importance
- c. Not important at all

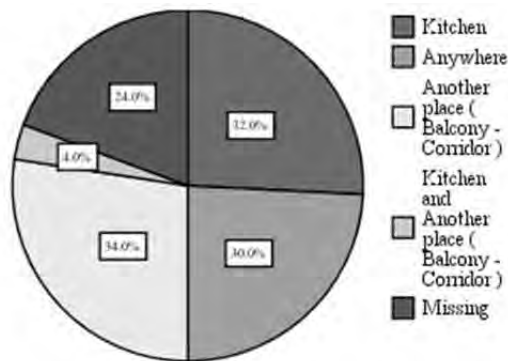
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------------------|-----------|---------|---------------|--------------------|
| Valid Very important | 22 | 35.5 | 35.5 | 35.5 |
| Average importance | 19 | 30.6 | 30.6 | 66.1 |
| Not important at all | 21 | 33.9 | 33.9 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q20. Where do you prefer to have this space for storage?

- a. Kitchen
- b. Anywhere
- c. Another place (Balcony - Corridor)

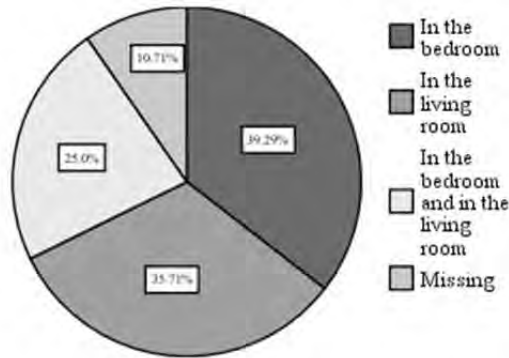
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------|--|-----------|---------|---------------|--------------------|
| Valid | Kitchen | 16 | 25.8 | 32.0 | 32.0 |
| | Anywhere | 15 | 24.2 | 30.0 | 62.0 |
| | Another place (Balcony - Corridor) | 17 | 27.4 | 34.0 | 96.0 |
| | Kitchen and Another place (Balcony - Corridor) | 2 | 3.2 | 4.0 | 100.0 |
| | Total | 50 | 80.6 | 100.0 | |
| Missing | missing | 12 | 19.4 | | |
| | Total | 62 | 100.0 | | |



Q21. Where do your sons study their homework ?

- a. In the bedroom
- b. In the living room
- c. In another place

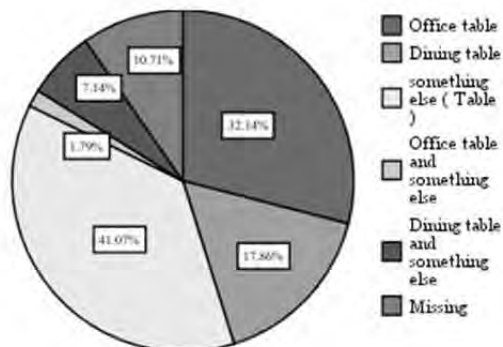
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------|---------------------------------------|-----------|---------|---------------|--------------------|
| Valid | In the bedroom | 22 | 35.5 | 39.3 | 39.3 |
| | In the living room | 20 | 32.3 | 35.7 | 75.0 |
| | In the bedroom and in the living room | 14 | 22.6 | 25.0 | 100.0 |
| | Total | 56 | 90.3 | 100.0 | |
| Missing | missing | 6 | 9.7 | | |
| | Total | 62 | 100.0 | | |



Q22. On what do your sons study their homework?

- a. Office table
- b. Dining table
- c. something else (Table)

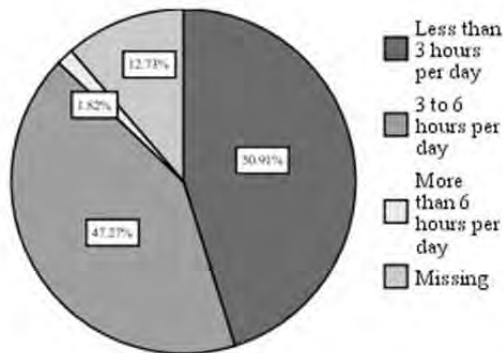
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------------------------------|-----------|---------|---------------|--------------------|
| Valid Office table | 18 | 29.0 | 32.1 | 32.1 |
| Dining table | 10 | 16.1 | 17.9 | 50.0 |
| something else (Table) | 23 | 37.1 | 41.1 | 91.1 |
| Office table and something else | 1 | 1.6 | 1.8 | 92.9 |
| Dining table and something else | 4 | 6.5 | 7.1 | 100.0 |
| Total | 56 | 90.3 | 100.0 | |
| Missing missing | 6 | 9.7 | | |
| Total | 62 | 100.0 | | |



Q23. How long do your sons study their homework in average?

- a. Less than 3 hours per day
- b. 3 to 6 hours per day
- c. More than 6 hours per day

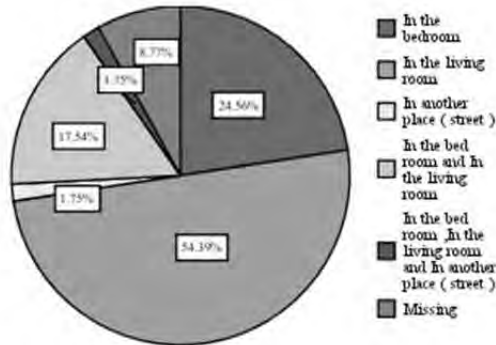
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------|---------------------------|-----------|---------|---------------|--------------------|
| Valid | Less than 3 hours per day | 28 | 45.2 | 50.9 | 50.9 |
| | 3 to 6 hours per day | 26 | 41.9 | 47.3 | 98.2 |
| | More than 6 hours per day | 1 | 1.6 | 1.8 | 100.0 |
| | Total | 55 | 88.7 | 100.0 | |
| Missing | missing | 7 | 11.3 | | |
| | Total | 62 | 100.0 | | |



Q24. Where do your sons play (computer or something else)?

- a. In the bedroom
- b. In the living room
- c. In another place (street)

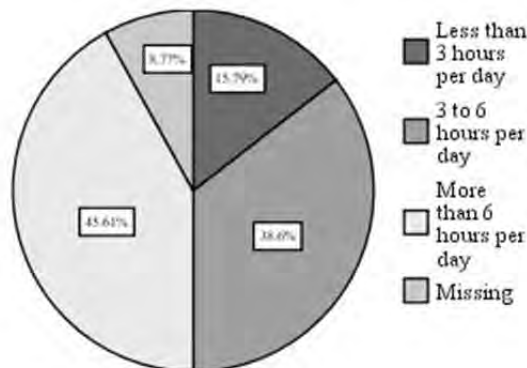
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------|---|-----------|---------|---------------|--------------------|
| Valid | In the bedroom | 14 | 22.6 | 24.6 | 24.6 |
| | In the living room | 31 | 50.0 | 54.4 | 78.9 |
| | In another place (street) | 1 | 1.6 | 1.8 | 80.7 |
| | In the bed room and In the living room | 10 | 16.1 | 17.5 | 98.2 |
| | In the bed room ,In the living room and In another place (street) | 1 | 1.6 | 1.8 | 100.0 |
| | Total | 57 | 91.9 | 100.0 | |
| Missing | missing | 5 | 8.1 | | |
| | Total | 62 | 100.0 | | |



Q25. How long do your sons play in average?

- a. Less than 3 hours per day
- b. 3 to 6 hours per day
- c. More than 6 hours per day

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------------------------------|-----------|---------|---------------|--------------------|
| Valid Less than 3 hours per day | 9 | 14.5 | 15.8 | 15.8 |
| Valid 3 to 6 hours per day | 22 | 35.5 | 38.6 | 54.4 |
| Valid More than 6 hours per day | 26 | 41.9 | 45.6 | 100.0 |
| Valid Total | 57 | 91.9 | 100.0 | |
| Missing missing | 5 | 8.1 | | |
| Missing Total | 62 | 100.0 | | |

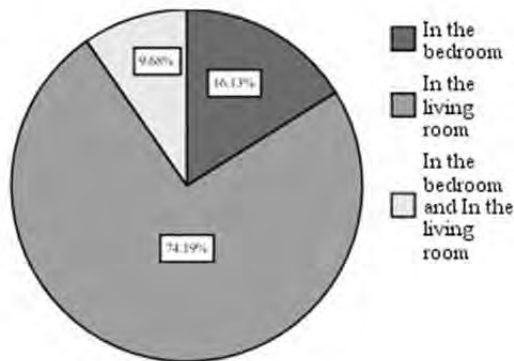


Q26. In which room do your family watch the television ?

- a. In the bedroom
- b. In the living room

c. In another place

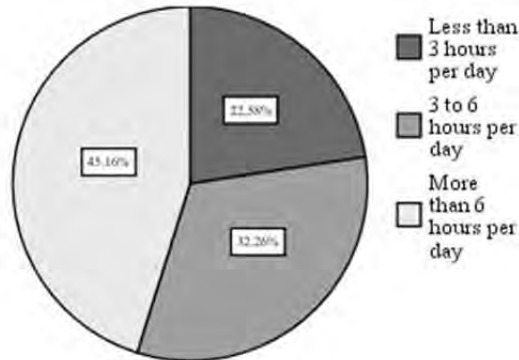
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------------------------------------|-----------|---------|---------------|--------------------|
| Valid In the bedroom | 10 | 16.1 | 16.1 | 16.1 |
| In the living room | 46 | 74.2 | 74.2 | 90.3 |
| In the bedroom and In the living room | 6 | 9.7 | 9.7 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q27. How long does your family watch the television in average?

- a. Less than 3 hours per day
- b. 3 to 6 hours per day
- c. More than 6 hours per day

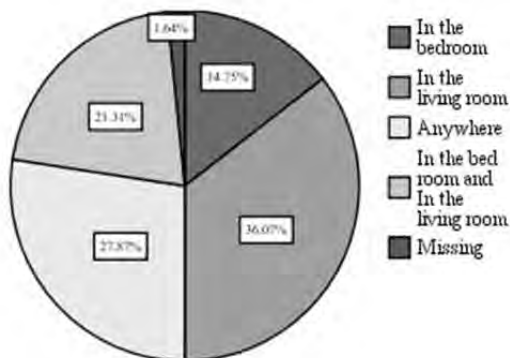
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------------------------------|-----------|---------|---------------|--------------------|
| Valid Less than 3 hours per day | 14 | 22.6 | 22.6 | 22.6 |
| 3 to 6 hours per day | 20 | 32.3 | 32.3 | 54.8 |
| More than 6 hours per day | 28 | 45.2 | 45.2 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q28. Where do your family members pray?

- a. In the bedroom
- b. In the living room
- c. Anywhere

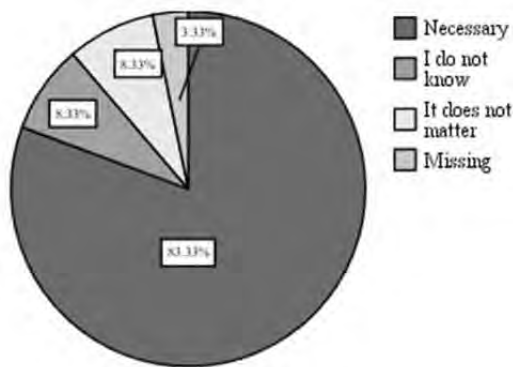
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------|--|---------|---------------|--------------------|
| Valid | In the bedroom | 9 | 14.5 | 14.8 |
| | In the living room | 22 | 35.5 | 36.1 |
| | Anywhere | 17 | 27.4 | 27.9 |
| | In the bed room and In the living room | 13 | 21.0 | 21.3 |
| | Total | 61 | 98.4 | 100.0 |
| Missing | missing | 1 | 1.6 | |
| | Total | 62 | 100.0 | |



Q29. Do you think that it is necessary to separate between boys and girls in the bedroom?

- a. Necessary
- b. I do not know
- c. It does not matter

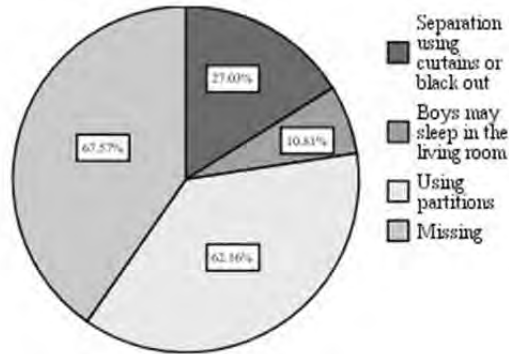
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------|--------------------|-----------|---------|---------------|--------------------|
| Valid | Necessary | 50 | 80.6 | 83.3 | 83.3 |
| | I do not know | 5 | 8.1 | 8.3 | 91.7 |
| | It does not matter | 5 | 8.1 | 8.3 | 100.0 |
| | Total | 60 | 96.8 | 100.0 | |
| Missing | missing | 2 | 3.2 | | |
| | Total | 62 | 100.0 | | |



Q30. If you believe that it is necessary to separate between boys and girls, what is the solution despite the lack of space?

- a. Separation using curtains or black out
- b. Boys may sleep in the living room
- c. Using partitions

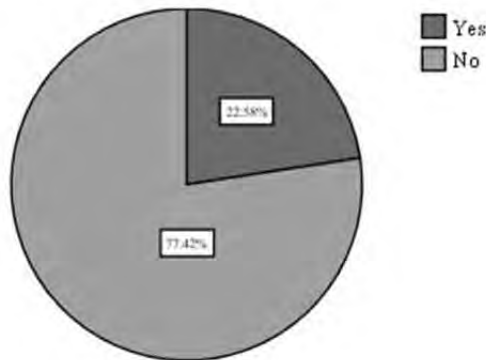
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------|--|-----------|---------|---------------|--------------------|
| Valid | Separation using curtains or black out | 10 | 16.1 | 27.0 | 27.0 |
| | Boys may sleep in the living room | 4 | 6.5 | 10.8 | 37.8 |
| | Using partitions | 23 | 37.1 | 62.2 | 100.0 |
| | Total | 37 | 59.7 | 100.0 | |
| Missing | missing | 25 | 40.3 | | |
| | Total | 62 | 100.0 | | |



Q31. Does any member of the family sleep in the living room?

- a. Yes
- b. No

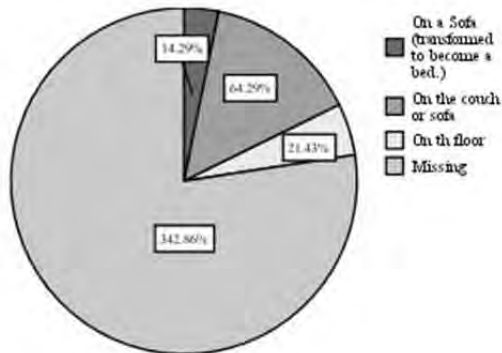
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|-----------|-----------|---------|---------------|--------------------|
| Valid Yes | 14 | 22.6 | 22.6 | 22.6 |
| No | 48 | 77.4 | 77.4 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q32. If yes, Where does he sleep??

- a. On a Sofa (transformed to become a bed.)
- b. On the couch or sofa
- c. On the floor

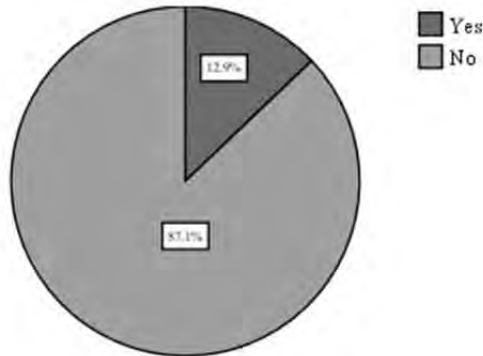
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------|--|-----------|---------|---------------|--------------------|
| Valid | On a Sofa (transformed to become a bed.) | 2 | 3.2 | 14.3 | 14.3 |
| | On the couch or sofa | 9 | 14.5 | 64.3 | 78.6 |
| | On th floor | 3 | 4.8 | 21.4 | 100.0 |
| | Total | 14 | 22.6 | 100.0 | |
| Missing | inapplicable | 48 | 77.4 | | |
| Total | | 62 | 100.0 | | |



Q33. Do you have Bunk Beds?

- a. Yes
- b. No

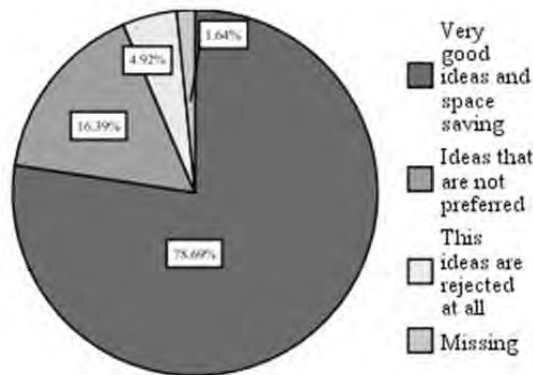
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-------|-----------|---------|---------------|--------------------|
| Valid | Yes | 8 | 12.9 | 12.9 | 12.9 |
| | No | 54 | 87.1 | 87.1 | 100.0 |
| | Total | 62 | 100.0 | 100.0 | |



Q34. Do you find that ideas such as the bunk beds are good at saving of space in the house?

- a. Very good ideas and space saving
- b. Ideas that are not preferred
- c. This ideas are rejected at all

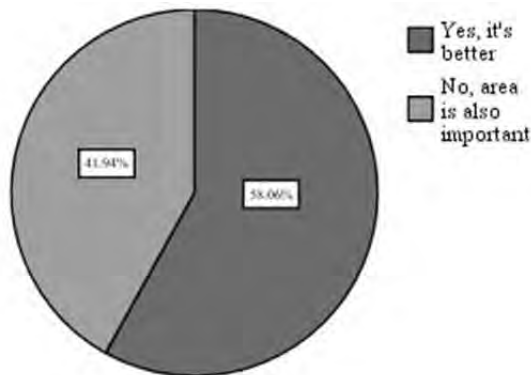
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------|----------------------------------|-----------|---------|---------------|--------------------|
| Valid | Very good ideas and space saving | 48 | 77.4 | 78.7 | 78.7 |
| | Ideas that are not preferred | 10 | 16.1 | 16.4 | 95.1 |
| | This ideas are rejected at all | 3 | 4.8 | 4.9 | 100.0 |
| | Total | 61 | 98.4 | 100.0 | |
| Missing | missing | 1 | 1.6 | | |
| Total | | 62 | 100.0 | | |



Q35. Is it better to reduce the areas of the bedrooms and to increase their number?

- a. Yes, it's better
- b. No, area is also important

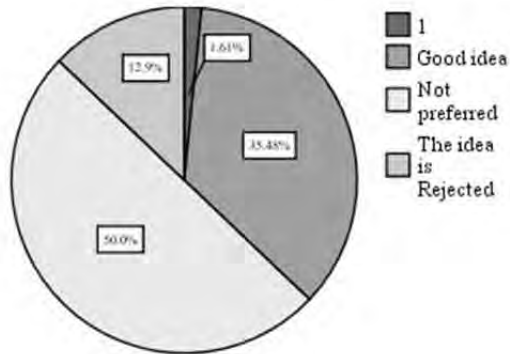
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------------------------|-----------|---------|---------------|--------------------|
| Valid Yes, it's better | 36 | 58.1 | 58.1 | 58.1 |
| No, area is also important | 26 | 41.9 | 41.9 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q36. Do you find that the idea of open kitchen helps to increase the use of space? Or is it rejected?

- a. Good idea
- b. Not preferred
- c. The idea is Rejected

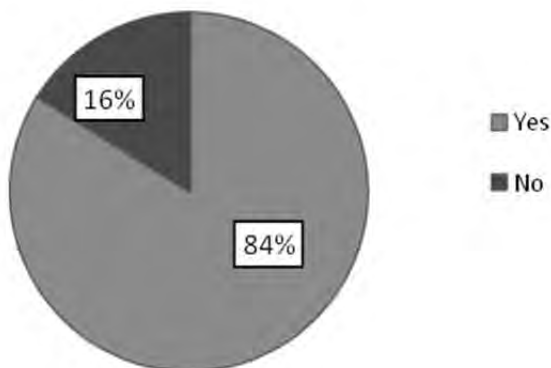
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------------------|-----------|---------|---------------|--------------------|
| Valid | 1 | 1.6 | 1.6 | 1.6 |
| Good idea | 22 | 35.5 | 35.5 | 37.1 |
| Not preferred | 31 | 50.0 | 50.0 | 87.1 |
| The idea is Rejected | 8 | 12.9 | 12.9 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q37. Do you find that the movable and folding furniture saves the area of spaces?

- a. Yes
- b. No

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------|-----|-----------|---------|---------------|--------------------|
| Valid | Yes | 52 | 84 | 84 | 84 |
| | No | 10 | 16 | 16 | 16 |
| Total | | 62 | 100 | 100.0 | |
| Missing | | | | | |
| Total | | 62 | 100.0 | | |

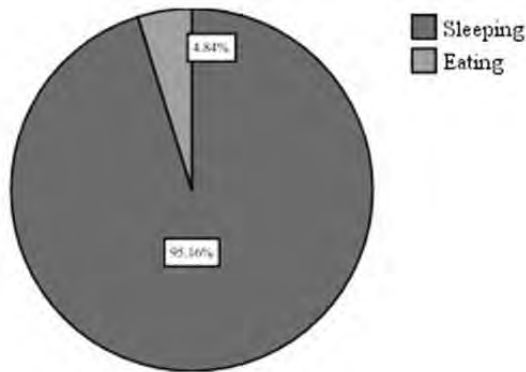


Q38. What are the activities that can be performed through movable furniture?

- a. Sleeping

- b. Eating
- c. Both

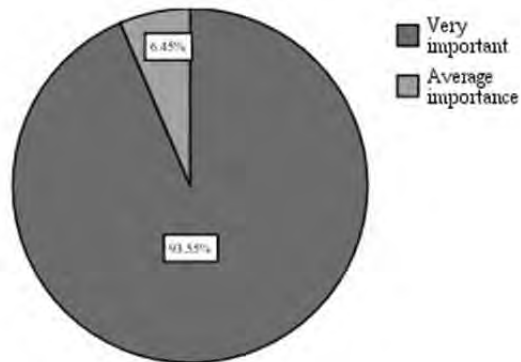
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------------|-----------|---------|---------------|--------------------|
| Valid Sleeping | 30 | 48 | 48 | 48 |
| Eating | 15 | 24 | 24 | 24 |
| Both | 17 | 27 | 27 | 27 |
| Total | 62 | 100.0 | 100.0 | |



Q39. Do you find that lighting the bathroom or the kitchen naturally (through window) is important?

- a. Very important
- b. Average importance
- c. Not important at all

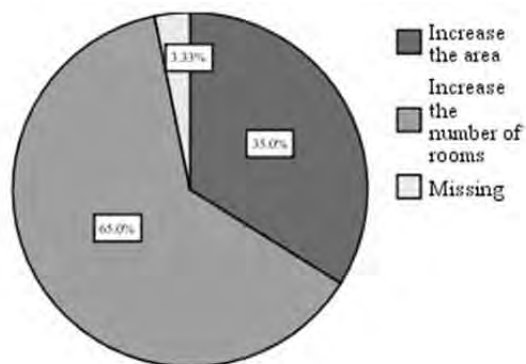
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------------------|-----------|---------|---------------|--------------------|
| Valid Very important | 58 | 93.5 | 93.5 | 93.5 |
| Average importance | 4 | 6.5 | 6.5 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q40. Which one do you prefer : to increase room area or to increase their number?

- a. Increase the area
- b. Increase the number of rooms

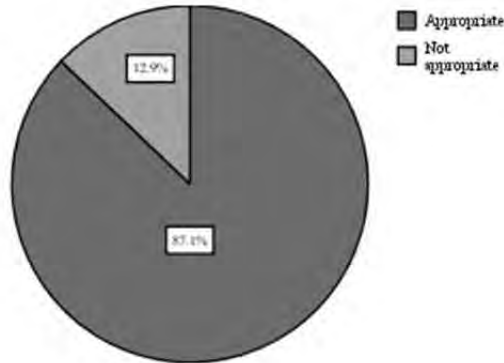
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------|------------------------------|-----------|---------|---------------|--------------------|
| Valid | Increase the area | 21 | 33.9 | 35.0 | 35.0 |
| | Increase the number of rooms | 39 | 62.9 | 65.0 | 100.0 |
| | Total | 60 | 96.8 | 100.0 | |
| Missing | missing | 2 | 3.2 | | |
| | Total | 62 | 100.0 | | |



Q41. Is the clear height of the house appropriate?

- a. Appropriate
- b. Not appropriate

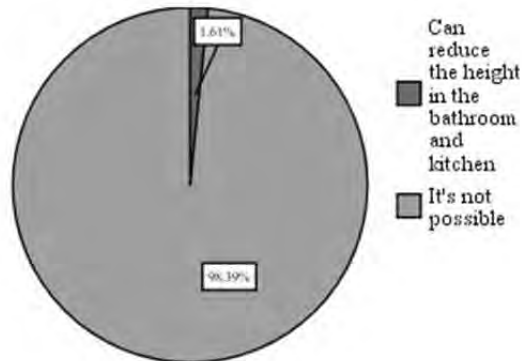
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------------------|-----------|---------|---------------|--------------------|
| Valid Appropriate | 54 | 87.1 | 87.1 | 87.1 |
| Not appropriate | 8 | 12.9 | 12.9 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q42. Is it possible to reduce the clear height in some rooms in order to save more areas in the apartment?

- a. Can reduce the height in the bathroom and kitchen
- b. Can reduce the height in the bedrooms
- c. It's not possible

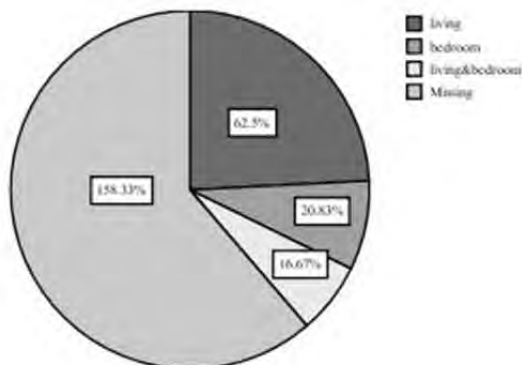
| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|-----------|---------|---------------|--------------------|
| Valid Can reduce the height in the bathroom and kitchen | 1 | 1.6 | 1.6 | 1.6 |
| It's not possible | 61 | 98.4 | 98.4 | 100.0 |
| Total | 62 | 100.0 | 100.0 | |



Q43. What are the rooms that need to increase its area?

- a. living room
- b. Bed room
- c. Both

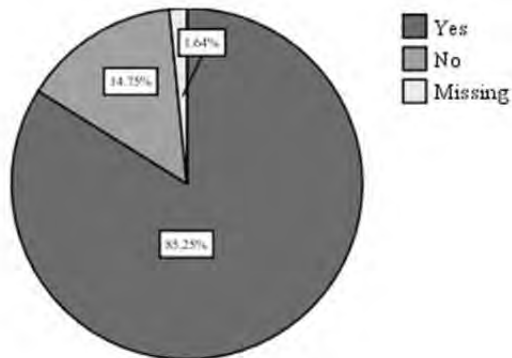
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------|----------------|-----------|---------|---------------|--------------------|
| Valid | living | 15 | 24.2 | 62.5 | 62.5 |
| | bedroom | 5 | 8.1 | 20.8 | 83.3 |
| | living&bedroom | 4 | 6.5 | 16.7 | 100.0 |
| | Total | 24 | 38.7 | 100.0 | |
| Missing | missing | 38 | 61.3 | | |
| Total | | 62 | 100.0 | | |



Q45. Do you find it is better that you and your family redesign the spaces in your home?

- a. Yes
- b. No

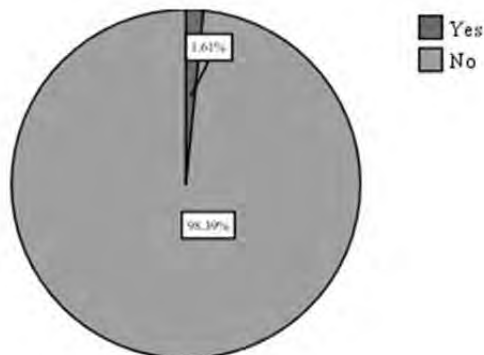
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------|---------|-----------|---------|---------------|--------------------|
| Valid | Yes | 52 | 83.9 | 85.2 | 85.2 |
| | No | 9 | 14.5 | 14.8 | 100.0 |
| | Total | 61 | 98.4 | 100.0 | |
| Missing | missing | 1 | 1.6 | | |
| Total | | 62 | 100.0 | | |



Q46. Are there any Profitable work you do in your home?

- a. Yes
- b. No

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-------|-----------|---------|---------------|--------------------|
| Valid | Yes | 1 | 1.6 | 1.6 | 1.6 |
| | No | 61 | 98.4 | 98.4 | 100.0 |
| | Total | 62 | 100.0 | 100.0 | |



Appendix 2: Case studies

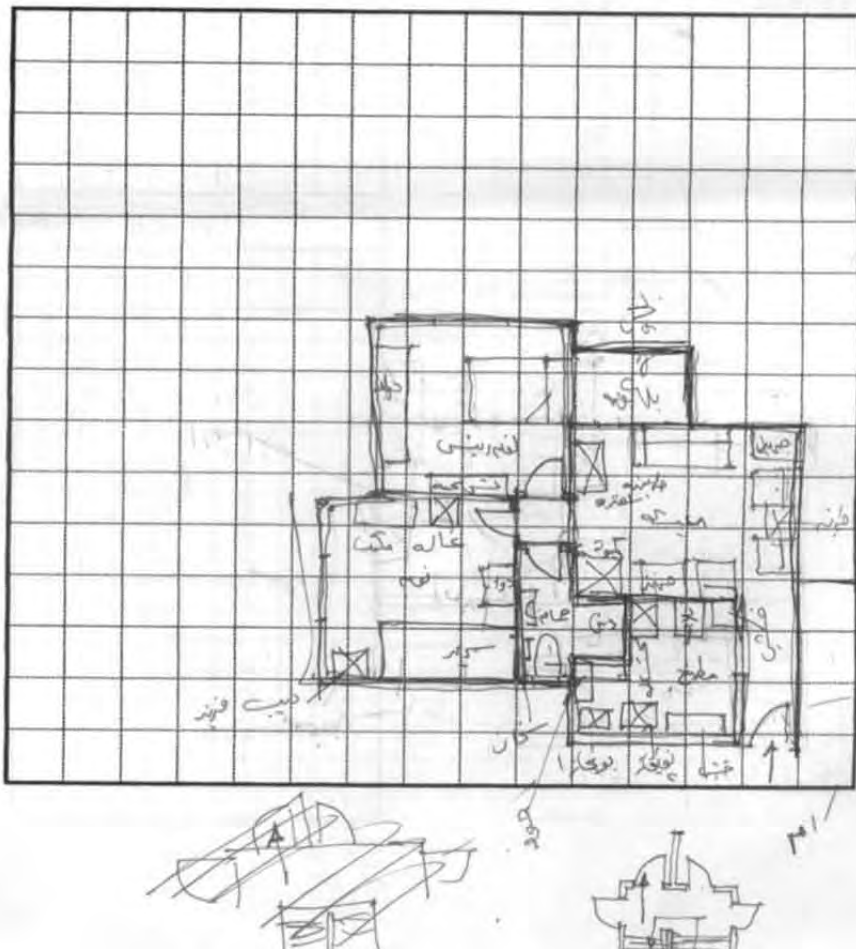
Case (A)

استمارة استقراء حالة (مشروعات الإسكان الاقتصادي وكيفية تعامل المستخدمين مع الممكن)

| معلومات خاصة بمشروع الإسكان : | | | | | |
|--|-------------------------|--|------------------|-------------------|---------------|
| 1 | اسم المشروع | مشروع سوزان مبارك (مستقبل ٢) كودى ليدل | | | |
| 2 | اسم المنطقة (الحي) | مستقبل ٢ | | | |
| 3 | سنة البناء | ٩٥ | | | |
| 4 | أهداف المشروع | كودى النفل | | | |
| 5 | نمط الإسكان الاقتصادي | إسكان حكومي | إسكان تعاوني | إسكان شباب | |
| 6 | نوع الإسكان الاقتصادي | عصارات سكنية | مساكن صغيرة | مسكن ممتد - نواة | أرض + المرافق |
| 7 | معلومات أخرى عن المشروع | | | | |
| معلومات خاصة بالعقار (العمارة السكنية) : | | | | | |
| 1 | موقع العقار | ٥ | | | |
| 2 | استخدام العقار | سكني | سكني مختلط | | |
| 3 | عدد الأتوار | أرضي + ٤ | | | |
| 4 | الحالة الإنشائية | سليم | | | |
| 5 | حالة التشطيب | جيد | متوسط | متصدع | رديء |
| 6 | توافر الخدمات | متوفرة | مأعدا : | | |
| 7 | الامتدادات (التعلبات) | أقني : | راسي : | | |
| 8 | عدد الوحدات بالدور | ٤ | | | |
| 9 | معلومات أخرى عن العقار | | | | |
| معلومات خاصة بالأسرة | | | | | |
| عدد أفراد الأسرة | | ٥ | | | |
| عائل الأسرة | | الأب | الأم | الأبناء | |
| الدخل الشهري | | ٥٠٠ | | | |
| معدل الإنفاق الشهري | | ١ | | | |
| هيكل الأسرة : | | | | | |
| | | العمر | المستوى التعليمي | المهنة | التنوع |
| الأب | | ٤٦ | دبلوم صنائع | شركة لظفر للسياحة | |
| الأم | | ٤٢ | استراحة | معلمة | |
| ابن ١ | ذكر | ٢٠ | دبلوم صنائع عالي | مهندس | |
| ابن ٢ | ذكر | ١٦ | ثانوي ابتدائي | | |
| ابن ٣ | ذكر | ١٣ | مبتدئ ابتدائي | | |
| ابن ٤ | ذكر | | | | |
| ابن ٥ | ذكر | | | | |
| ابن ٦ | ذكر | | | | |
| | ذكر | | | | |
| | ذكر | | | | |

| معلومات خاصة بالوحدة السكنية : | | | | |
|--------------------------------|------------------------------|------------|------------|--------|
| الحالة القانونية | تملك | إيجار جديد | إيجار قديم | 1 |
| طريقة الحصول على الوحدة | ملك ٧١ سكان و ١٢٣ | | | |
| مساحة الوحدة السكنية | ٢٣٠ م ^٢ | | | |
| عدد الغرف | ٥ غرف مع حمام و مطبخ | | | |
| تصنيف الغرف | ١ صالة | ٢ نوم | ٣ مطبخ | ٤ حمام |
| حالة التشطيب العامة | مبني | | | |
| الألوان القابلة على المسكن | ١ صالة فايف (١١ المبنى كبرى) | | | |
| ارتفاع السقف | ٢٨٠ | | | |
| سمك الحوائط | الداخلية | ٦٢ | الخارجية | ٢٥ |

كروكي توزيع فراغات الوحدة السكنية :



| كروكي وظيفي للفرقة | | اسم الفراغ : <u>الاجتماع</u> | | استخدامات فراغات الوحدة السكنية | |
|--------------------------------------|--|------------------------------|--------------|---------------------------------|----------------|
| | | المساحة | ٤ × ٢,٥ | أبعاد الفراغ | ١ |
| | | مساحة الفتحات | ١١ متر تباري | لون الحائط | ٢ |
| | | ثابت+متحرك | ثابت | نوع الفرش | ٣ |
| استخدامات الفراغ (يوميًا) بالمساعة : | | | | | |
| | | القيام بالنشاط | عدد الساعات | من إلى | النشاط |
| | | ١٣ | ١٠-١٠ | ١٠-١٠ | النوم |
| | | ٣٠ | ١٠-١٠ | ١٠-١٠ | تناول الطعام |
| | | ٣٠ | ١٠-١٠ | ١٠-١٠ | المذاكرة |
| | | ١٠ | ١٠-١٠ | ١٠-١٠ | اللعب والتسلية |
| | | ١٠ | ١٠-١٠ | ١٠-١٠ | الكمبيوتر |
| | | ١٠ | ١٠-١٠ | ١٠-١٠ | مشاهدة التلفاز |
| | | ١٠ | ١٠-١٠ | ١٠-١٠ | عمل (تحديد) |
| | | ١٠ | ١٠-١٠ | ١٠-١٠ | الصلاة |
| | | ١٠ | ١٠-١٠ | ١٠-١٠ | مقابلة ضيوف |
| | | ١٠ | ١٠-١٠ | ١٠-١٠ | إعداد الطعام |
| | | ١٠ | ١٠-١٠ | ١٠-١٠ | تخزين |
| | | ١٠ | ١٠-١٠ | ١٠-١٠ | تربية حيوانات |
| | | ١٠ | ١٠-١٠ | ١٠-١٠ | طهو الطعام |
| | | ١٠ | ١٠-١٠ | ١٠-١٠ | ١٤ |

| كروكي وظيفي للفرقة | | اسم الفراغ : <u>النوم الميسر</u> | | استخدامات فراغات الوحدة السكنية | |
|--------------------------------------|--|----------------------------------|--------------|---------------------------------|----------------|
| | | المساحة | ٢,٥ × ٢,٥ | أبعاد الفراغ | ١ |
| | | مساحة الفتحات | ١١ متر تباري | لون الحائط | ٢ |
| | | ثابت+متحرك | ثابت | نوع الفرش | ٣ |
| استخدامات الفراغ (يوميًا) بالمساعة : | | | | | |
| | | القيام بالنشاط | عدد الساعات | من إلى | النشاط |
| | | ٣١ | ١٠-١٠ | ١٠-١٠ | النوم |
| | | ٣١ | ١٠-١٠ | ١٠-١٠ | تناول الطعام |
| | | ٣١ | ١٠-١٠ | ١٠-١٠ | المذاكرة |
| | | ٣١ | ١٠-١٠ | ١٠-١٠ | اللعب والتسلية |
| | | ٣١ | ١٠-١٠ | ١٠-١٠ | الكمبيوتر |
| | | ٣١ | ١٠-١٠ | ١٠-١٠ | مشاهدة التلفاز |
| | | ٣١ | ١٠-١٠ | ١٠-١٠ | عمل (تحديد) |
| | | ٣١ | ١٠-١٠ | ١٠-١٠ | الصلاة |
| | | ٣١ | ١٠-١٠ | ١٠-١٠ | مقابلة ضيوف |
| | | ٣١ | ١٠-١٠ | ١٠-١٠ | إعداد الطعام |
| | | ٣١ | ١٠-١٠ | ١٠-١٠ | تخزين |
| | | ٣١ | ١٠-١٠ | ١٠-١٠ | تربية حيوانات |
| | | ٣١ | ١٠-١٠ | ١٠-١٠ | طهو الطعام |
| | | ٣١ | ١٠-١٠ | ١٠-١٠ | ١٤ |

| كروكي وظيفي للفرقة | | اسم الفراغ : نوم الأول > | |
|--------------------|-----------------|-------------------------------------|-----------------------------|
| | | المساحة | أبعاد الفراغ 25×35 |
| | | مساحة الفتحات | لون الحائط |
| | ١٥٢١ | ثابت+متحرك | ثابت |
| | | متحرك | ثابت |
| | | استخدامات الفراغ (يومياً) بالساعة : | |
| | | التشمط | من إلى عدد الساعات |
| | | النوم | ٩ - ٥٦ |
| | | تناول الطعام | |
| | | المذاكرة | |
| | | اللعب والتسلية | ١٥٢١ |
| | وقت الـ (١٥:٣٠) | الكمبيوتر | |
| | | مشاهدة التلفاز | |
| | | عمل (تحديد) | |
| | | الصلاة | |
| | | مقابلة ضيوف | |
| | | إعداد الطعام | |
| | | تخزين | |
| | | تربية حيوانات | |
| | | طهو الطعام | |
| | | | ١٤ |

استخدامات فراغات الوحدة السكنية

| كروكي وظيفي للفرقة | | اسم الفراغ : | |
|--------------------|--|-------------------------------------|--------------------|
| | | المساحة | أبعاد الفراغ × |
| | | مساحة الفتحات | لون الحائط |
| | | ثابت+متحرك | ثابت |
| | | متحرك | ثابت |
| | | استخدامات الفراغ (يومياً) بالساعة : | |
| | | التشمط | من إلى عدد الساعات |
| | | النوم | |
| | | تناول الطعام | |
| | | المذاكرة | |
| | | اللعب والتسلية | |
| | | الكمبيوتر | |
| | | مشاهدة التلفاز | |
| | | عمل (تحديد) | |
| | | الصلاة | |
| | | مقابلة ضيوف | |
| | | إعداد الطعام | |
| | | تخزين | |
| | | تربية حيوانات | |
| | | طهو الطعام | |
| | | | ١٤ |

استخدامات فراغات الوحدة السكنية

| استخدامات فراغات الوحدة السكنية | | اسم الفراغ : الحمام | | | | كروكي وتخطيط للغرفة | | | |
|--------------------------------------|--------------|---------------------|---------------|--------------|----------------|---------------------|--|--|--|
| | أبعاد الفراغ | ١ × ٢ | المساحة | | | | | | |
| | لون الحائط | ١١ | مساحة الفتحات | ٦ × ١ | | | | | |
| | نوع الفرش | ثابت | متحرك | ثابت + متحرك | | | | | |
| استخدامات الفراغ (يومياً) بالمساحة : | | | | | | | | | |
| | التشغيل | من | إلى | عدد الساعات | القيام بالنشاط | | | | |
| ١ | الغسيل | ١١ | ١٢ | | ١١ | | | | |
| ٢ | | | | | | | | | |
| ٣ | | | | | | | | | |

| استخدامات فراغات الوحدة السكنية | | اسم الفراغ : المطبخ | | | | كروكي وتخطيط للغرفة | | | |
|--------------------------------------|---------------|---------------------|---------------|--------------|----------------|---------------------|--|--|--|
| | أبعاد الفراغ | ٢ × ٢ | المساحة | | | | | | |
| | لون الحائط | ١١ | مساحة الفتحات | ٦ × ١ | | | | | |
| | نوع الفرش | ثابت | متحرك | ثابت + متحرك | | | | | |
| استخدامات الفراغ (يومياً) بالمساحة : | | | | | | | | | |
| | التشغيل | من | إلى | عدد الساعات | القيام بالنشاط | | | | |
| ١ | تناول الطعام | | | | | | | | |
| ٢ | إعداد الطعام | | | | ١١ | | | | |
| ٣ | تخزين | | | | ١٢ | | | | |
| ٤ | تربية حيوانات | | | | | | | | |
| ٥ | طهو الطعام | | | | ١١ | | | | |
| ٧ | الغسيل | ١١ | ١٢ | | ١١ | | | | |

| استخدامات فراغات الوحدة السكنية | | اسم الفراغ : شرفة (بلكونة) | | | | كروكي وتخطيط للغرفة | | | |
|--------------------------------------|---------------|----------------------------|---------------|--------------|----------------|---------------------|--|--|--|
| | أبعاد الفراغ | ١ × ٢ | المساحة | | | | | | |
| | لون الحائط | ١١ | مساحة الفتحات | ١ × ٢ | | | | | |
| | نوع الفرش | ثابت | متحرك | ثابت + متحرك | | | | | |
| استخدامات الفراغ (يومياً) بالمساحة : | | | | | | | | | |
| | التشغيل | من | إلى | عدد الساعات | القيام بالنشاط | | | | |
| ١ | تخزين | | | | | | | | |
| ٢ | تربية حيوانات | | | | | | | | |
| ٣ | تناول طعام | | | | | | | | |
| ٤ | الغسيل | | | | | | | | |
| ٥ | | | | | | | | | |
| ٧ | | | | | | | | | |

| أسئلة تتعلق بالبناء الوظيفي للفراغات الممكنة : | | | |
|--|--|-------------------------------------|---|
| ١ | هل تجد أنه من الضروري وجود فراغ خاص بالمدخل أم يمكن الدخول إلى غرفة المعيشة مباشرة ؟ | | |
| | لا بد من وجود فراغ المدخل برغم من إدارته للمساحة | من المفضل وجود فراغ المدخل | يمكن الدخول مباشرة إلى غرفة المعيشة في مسيل توفير المساحة |
| | تعليق | | |
| ٢ | هل تجد أن هناك علاقة مهمة بين المدخل والمطبخ ؟ أم أن العلاقة أكبر بين المطبخ وجناح النوم ؟ | | |
| | العلاقة أكبر بين المدخل والمطبخ | العلاقة أكبر بين المطبخ وجناح النوم | العلاقتين غير مهمين |
| | ولماذا ؟ | المصطفى | |
| | تعليق | | |
| ٣ | هل تجد أن فراغ الطعام (السفرة) مهم في الوحدة السكنية ؟ | مهم جدا | متوسط الأهمية |
| | هل يمكن أن يكون تناول الطعام في فراغ المعيشة ؟ | نعم | لا |
| | وتفضل أن يكون باثلاث ثابت أم متحرك أم باستعمال نفس أثاث المعيشة ؟ | ثابت | متحرك |
| | تعليق | حليب | |
| ٤ | هل تجد أن فراغ الصالون فراغ مهم في الوحدة السكنية ؟ | مهم جدا | متوسط الأهمية |
| | وهل تفضل أن يكون منفصل أم يمكن أن يكون مع فراغ المعيشة ؟ | منفصل | متصل مع غرفة المعيشة |
| | تعليق | | |
| ٥ | هل تجد أن فكرة المطبخ المفتوح تساعد على زيادة استغلال المساحة ؟ أم أنها فكرة مرفوضة ؟ | فكرة جيدة | لا أفضل |
| | ولماذا ؟ | فكرة مرفوضة | |
| | تعليق | | |
| ٦ | هل من الأفضل تقليل مساحات غرف النوم وزيادة عددها ؟ | نعم أفضل | لا المساحة مهمة أيضا |
| | تعليق | | |
| ٧ | هل ترى أن فراغ الشرفة (البلكونة) مهم ؟ | مهم جدا | متوسط الأهمية |
| | وما أهميته ؟ | استغلالها مساحات إضافية للنوم | |
| | هل تفضل أن تكون الشرفة (البلكونة) بغرفة النوم أم بغرفة المعيشة ؟ | النوم | المعيشة |
| | هل ترى من الأفضل الاستغناء عن الشرفة (البلكونة) في مقابل زيادة مساحة الغرفة ؟ | نعم | لا |
| | تعليق | | |
| ٨ | هل من المهم وجود مكان ثابت للتخزين (مخزن - سندرة) ؟ | مهم جدا | متوسط الأهمية |
| | وأي تفضل أن يوجد ؟ | المطبخ | مكان آخر (أنكره) |
| | تعليق | لا أكرهه في المطبخ مكان المنور | |

| | | | |
|--|--|---------------------|------------------------------------|
| ٩ | هل تجد أن الفرش المتحرك والقابل للطي يوفر المساحة ؟ | نعم ✓ | لا |
| | ما هي الأنشطة التي يمكن أن تؤدي من خلال الفرش المتحرك ؟ | | |
| | النوم ✓ | الطعام ✓ | المذاكرة ✓ |
| | أخرى (أنكره) | | |
| تطبيق | | | |
| ١٠ | هل تجد أن أفكار مثل السرير الطوي (سرير بدورين) جيدة في توفير المساحة داخل الوحدة السكنية ؟ | | |
| | أفكار جيدة جداً وتوفر المساحة ✓ | أفكار غير مفضلة | أفكار مرفوضة على الإطلاق |
| | لماذا ؟ | | |
| تطبيق | | | |
| ١١ | هل تجد أن هناك مساحة في مسكنك غير مستغلة الاستغلال الكافي ؟ | مستغلة تماماً | يمكن استغلال المساحة أفضل من هذا ✓ |
| | وكيف يمكن الاستفادة من تلك المساحة الاستغلال الأمثل ؟ البليونه اذا كانت عربة نيم | | |
| تطبيق | البليونه اذا لم يكن المطبخ اذا لم يكن القدماءه ما السر | | |
| تطبيق | | | |
| تطبيق | | | |
| أسئلة تتعلق بتحقيق الراحة داخل فراغات المسكن : | | | |
| ١٢ | هل تجد مساحات الفتحات (الشبكيه) مناسبة ؟ | مناسبة ✓ | متوسطة |
| | وإذا كانت غير مناسب فيجب زيارتها في | غرفة المعيشة | النوم |
| | ولماذا؟ | المطبخ | أخرى |
| تطبيق | | | |
| ١٣ | هل تجد الإضاءة الطبيعية كافية لإضاءة جميع الغرف نهراً ؟ | كافية ✓ | كافية في بعضهم |
| | غير كافية | | |
| تطبيق | | | |
| ١٤ | هل المناخ داخل الوحدة السكنية مناسب صيفاً ؟ | مناسب ✓ | متوسط |
| | هل المناخ داخل الوحدة السكنية مناسب شتاءاً ؟ | مناسب ✓ | متوسط |
| | إذا كان غير مناسب فما السبب ؟ | | |
| تطبيق | | | |
| ١٥ | هل تجد أن إضاءة الحمام طبيعياً أمر مهم ؟ | مهم جداً ✓ | متوسط الأهمية |
| | غير مهم على الإطلاق | | |
| تطبيق | | | |
| أسئلة تتعلق بتحقيق الخصوصية داخل فراغات المسكن : | | | |
| ١٦ | هل الممثل (باب الشقة) يجرح خصوصية فراغات المسكن (يكشف جميع الفراغات) ؟ | لا أجد مشكلة في ذلك | يجرح بعض الفراغات ✓ |
| | يجرح جميع الفراغات | | |
| تطبيق | | | |

| | | | |
|----|--|----------------------------------|---------------------------------|
| ١٧ | هل تجد الخصوصية المطلوبة في الحمام ؟ | نعم ✓ | لا |
| | إذا كانت الإجابة بـ لا فما السبب ؟ | | |
| | تعليق | | |
| ١٨ | هل تجد الخصوصية المطلوبة في فراغات النوم ؟ | نعم ✓ | لا |
| | إذا كانت الإجابة بـ لا فما السبب ؟ | | |
| | تعليق | | |
| | تعليق | | |
| ١٩ | هل تشعر بالأمن داخل الوحدة ؟ | نعم ✓ | لا |
| | إذا كانت الإجابة بـ لا فما السبب ؟ | | |
| | تعليق | | |
| | تعليق | | |
| ٢٠ | أيهما تفضل زيادة مساحة الغرف أم زيادة عددها ؟ | زيادة المساحة | زيادة عدد الغرف ✓ |
| | تعليق | | |
| ٢١ | ما هي الغرف التي تحتاج إلى زيادة مساحتها ؟ | النوم ✓ | المطبخ |
| | تعليق | | |
| ٢٢ | ما هي الغرف التي تحتاجها وغير موجودة في وحدتك السكنية الحالية ؟ | غرفة لأم السيد | |
| | تعليق | | |
| ٢٣ | هل ارتفاع الوحدة مناسب ؟ | مناسب ✓ | متوسط |
| | وهل يمكن أن يقل الارتفاع العام للوحدة السكنية عن ارتفاع مسطحة ؟ | يمكن | يمكن ولكن في حدود |
| | وهل هو مناسب لجميع الفراغات المختلفة أم يمكن تقليله في بعضها ؟ | | لا يمكن |
| | يمكن تقليل الارتفاع في الحمام والمطبخ | يمكن تقليل الارتفاع في غرف النوم | لا يمكن التقليل عن هذا الارتفاع |
| | تعليق | | |
| ٢٤ | في رأيك ما الذي يمكن عمله حتى تصبح وحدتك السكنية ناجحة من الناحية الوظيفية ؟ | | |
| | تعليق | | |
| | تعليق | | |
| ٢٥ | هل تجد انه من الأفضل أن تقوم أنت وأسرته بتقسيم فراغات وحدتك السكنية ؟ | نعم ✓ | لا |
| | وماذا كنت ستفعل ؟ | | |
| | تعليق | | |
| | تعليق | | |

| Case study (a): | | |
|------------------------|---------------------------|------------------------------|
| 1 | Dwelling area | 63 m² |
| 2 | No. of habitable rooms | 3 rooms |
| 3 | No. of bedrooms | 2 bedrooms |
| 4 | No. of family members | 5 persons |
| 5 | No. of children | 3 (2 boys + 1 girl) |
| 6 | Architectural plan | |



Figure 209: Architectural plan for case (a)

| | | |
|----------|------------------------------------|--|
| 7 | Dwelling spaces description | |
|----------|------------------------------------|--|

Living room (illustrative images)



Figure 210: Living room (a-1)



Figure 211: Living room (a-2)



Figure 212: Living room (a-3)



Figure 213: Living room (a-4)

Master bedroom (illustrative images)



Figure 214: Master bedroom (a-1)



Figure 215: Master bedroom (a-2)



Figure 216: Master bedroom (a-3)



Figure 217: Master bedroom (a-4)

The other bedroom (illustrative images)



Figure 218: Bedroom (a-1)



Figure 219: Bedroom (a-2)



Figure 220: Bedroom (a-3)



Figure 221: Bedroom (a-4)

Utilities areas (illustrative images)



Figure 222: Bathroom (a-1)



Figure 223: Bathroom (a-2)



Figure 224: Kitchen (a-1)



Figure 225: Kitchen (a-2)



Figure 226: Kitchen (a-3)



Figure 227: Kitchen (a-4)



Figure 228: Lobby (a-1)



Figure 229: Balcony (a-1)

Case (B):

3 (b)

استمارة استقراء حالة (مشروع الإسكان الاقتصادي وكيفية تعامل المستخدمين مع المسكن)

المحلل: محمد دى الدهل

المنطقة: مستنيل

سنة البناء: ٩١

أهداف المشروع: محمد دى الدهل

نمط الإسكان الاقتصادي: إسكان حكومي، إسكان تعاوني، إسكان شباب

نوع الإسكان الاقتصادي: صارات سكنية، مملكن صغية، مملكن ممتد - نواة، أرض + المرافق

معلومات أخرى عن المشروع:

معلومات خاصة بالمطار (الصارة السكنية) :

1 مواقع المطار: ٥

2 استخدام المطار: سكني

3 عدد الأتوار: أرضي +

4 الحالة الإنشائية: سليم

5 حالة التطبيب: متوسط

6 توافق الخدمات: متوفرة

7 الامتدادات (التحديات): أقي: رأسي

8 عدد الوحدات بالدور: ٤

9 معلومات أخرى عن المطار:

معلومات خاصة بالأسرة :

عدد أفراد الأسرة: ٤

عائل الأسرة: الأب x مومي، الأم

المخل الشهرى: ٩٠٠

محل الإنفاق الشهرى: ٣٠٠ - ٤٠٠

هيكل الأسرة :

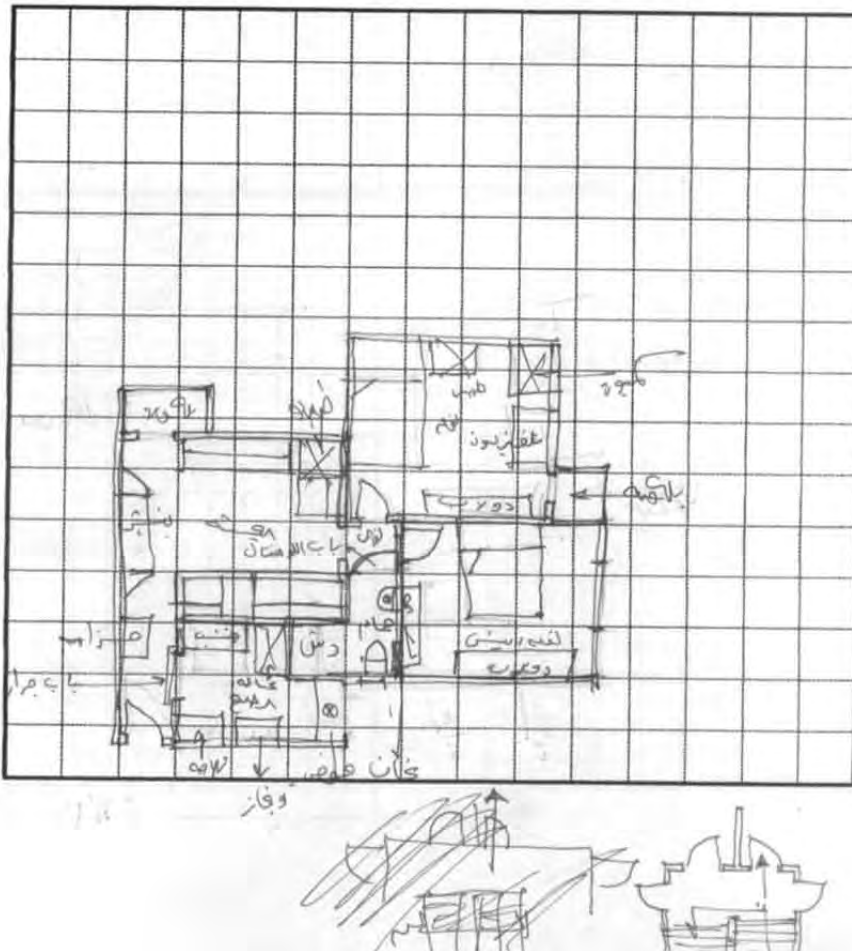
| المهنة | المستوى التعليمي | العمر | النوع | | |
|--------|------------------|-------|-------|-----|--|
| أب | دبلوم مسالخ | ٥٢ | | | |
| أم | دبلوم قارة | ٤٤ | | | |
| ابن ١ | ١٤ | ١٢ | أنثى | ذكر | |
| ابن ٢ | ١٣ | ١٢ | أنثى | ذكر | |
| ابن ٣ | ٨ | ٨ | أنثى | ذكر | |
| ابن ٤ | | | أنثى | ذكر | |
| ابن ٥ | | | أنثى | ذكر | |
| ابن ٦ | | | أنثى | ذكر | |
| | | | أنثى | ذكر | |
| | | | أنثى | ذكر | |

السيد: إبراهيم

المنطقة: مستنيل

| معلومات خاصة بالوحدة السكنية : | | | | |
|--------------------------------|----------------------------|---------------------------------------|-------------|------------|
| ١ | الحالة القانونية | تمليك | إيجار جديد | إيجار قديم |
| ٢ | طريقة الحصول على الوحدة | ملك النعمان ١١٠ طاب | | |
| ٣ | مساحة الوحدة السكنية | ٢٣ ٦٣ | | |
| ٤ | عدد الغرف | ٤ | | |
| ٥ | تصنيف الغرف | ١ صالة ٢ نوم ٣ نوم ٤-٥ طعام حمام مطبخ | بلكون | صالون |
| ٦ | حالة التشطيب العامة | مقود | | |
| ٧ | الكلوان الغالبة على المسكن | البحر | | |
| ٨ | ارتفاع السقف | ٢٨ | | |
| | سمك الحوائط | الداخلية ١٢ | الخارجية ٢٥ | |

كروكي توزيع فراغات الوحدة السكنية :



| كروكي وتعليق للغرفة | | اسم الفراغ : الفراغ | | | استخدامات فراغات الوحدة السكنية |
|-------------------------------------|--|---------------------|--------|--------------|---------------------------------|
| | | المساحة | ٢٥ × ٤ | أبعاد الفراغ | |
| | | مساحة الفتحات | ١٠ | لون الحائط | |
| | | ثابت + متحرك | ثابت | نوع الفرش | |
| استخدامات الفراغ (يوميًا) بالساعة : | | | | | |
| | | عدد الساعات | من | إلى | |
| | | النوم | | ١ | |
| | | تناول الطعام | | ٢ | |
| | | المذاكرة | ١٠ - ٤ | ٣ | |
| | | للعب والتسلية | | ٤ | |
| | | الكمبيوتر | | ٥ | |
| | | مشاهدة التلفاز | | ٧ | |
| | | عمل (تحديد) | | ٧ | |
| | | الصلاة | | ٨ | |
| | | مقابلة ضيوف | ٩ - ٧ | ٩ | |
| | | إعداد الطعام | ١٠ - ٩ | ١٠ | |
| | | تخزين | | ١١ | |
| | | تربية حيوانات | | ١٢ | |
| | | طهو الطعام | | ١٣ | |
| | | | | ١٤ | |

| كروكي وتعليق للغرفة | | اسم الفراغ : النوم | | | استخدامات فراغات الوحدة السكنية |
|-------------------------------------|--|--------------------|---------|--------------|---------------------------------|
| | | المساحة | ٢٥ × ٢٥ | أبعاد الفراغ | |
| | | مساحة الفتحات | ١٠ | لون الحائط | |
| | | ثابت + متحرك | ثابت | نوع الفرش | |
| استخدامات الفراغ (يوميًا) بالساعة : | | | | | |
| | | عدد الساعات | من | إلى | |
| | | النوم | | ١ | |
| | | تناول الطعام | | ٢ | |
| | | المذاكرة | | ٣ | |
| | | للعب والتسلية | | ٤ | |
| | | الكمبيوتر | | ٥ | |
| | | مشاهدة التلفاز | | ٧ | |
| | | عمل (تحديد) | | ٧ | |
| | | الصلاة | | ٨ | |
| | | مقابلة ضيوف | | ٩ | |
| | | إعداد الطعام | | ١٠ | |
| | | تخزين | | ١١ | |
| | | تربية حيوانات | | ١٢ | |
| | | طهو الطعام | | ١٣ | |
| | | | | ١٤ | |

| كروكي وظيفي للرفة | | اسم الفراغ : $\frac{1}{2} \times \frac{1}{2}$ | |
|-------------------|--|---|---------------------------------------|
| | | المساحة | أبعاد الفراغ |
| | | مساحة الفتحات | لون الحائط |
| | | ثابت+متحرك | نوع الفرش |
| | | | استخدامات الفراغ (يومياً) بالساعة : |
| | | القيم بالنشاط | النشاط |
| | | | من إلى |
| | | | عدد الساعات |
| | | | النوم |
| | | | تناول الطعام |
| | | | المذاكرة |
| | | | اللعب والتسلية |
| | | | الكمبيوتر |
| | | | مشاهدة التلفاز |
| | | | عمل (تحديد) |
| | | | الصلاة |
| | | | مقابلة ضيوف |
| | | | إعداد الطعام |
| | | | تخزين |
| | | | تربية حيوانات |
| | | | طهو الطعام |
| | | | ١٤ |

استخدامات فراغات الوحدة السكنية

| كروكي وظيفي للرفة | | اسم الفراغ : | |
|-------------------|--|---------------|---------------------------------------|
| | | المساحة | × |
| | | مساحة الفتحات | لون الحائط |
| | | ثابت+متحرك | نوع الفرش |
| | | | استخدامات الفراغ (يومياً) بالساعة : |
| | | القيم بالنشاط | النشاط |
| | | | من إلى |
| | | | عدد الساعات |
| | | | النوم |
| | | | تناول الطعام |
| | | | المذاكرة |
| | | | اللعب والتسلية |
| | | | الكمبيوتر |
| | | | مشاهدة التلفاز |
| | | | عمل (تحديد) |
| | | | الصلاة |
| | | | مقابلة ضيوف |
| | | | إعداد الطعام |
| | | | تخزين |
| | | | تربية حيوانات |
| | | | طهو الطعام |
| | | | ١٤ |

استخدامات فراغات الوحدة السكنية

| استخدامات فراغات الوحدة السكنية | | اسم الفراغ : الحمام | | | كروكي وظيفي للفرقة | | | |
|---------------------------------|--|-------------------------------------|-------|---------------|--------------------|----------------|--|--|
| | | أبعاد الفراغ | ٢ x ١ | المساحة | | | | |
| | | لون الحائط | أبيض | مساحة الفتحات | ٦٠ x ١ | | | |
| | | نوع الفرش | ثابت | متحرك | ثابت+متحرك | | | |
| | | استخدامات الفراغ (يوميًا) بالساعة : | | | | | | |
| | | النشاط | من | إلى | عدد الساعات | القيام بالنشاط | | |
| ١ | | الغسيل | ١٠ | ١١ | ١ | | | |
| ٢ | | | | | | | | |
| ٣ | | | | | | | | |

| استخدامات فراغات الوحدة السكنية | | اسم الفراغ : المطبخ | | | كروكي وظيفي للفرقة | | | |
|---------------------------------|--|-------------------------------------|-------|---------------|--------------------|----------------|--|--|
| | | أبعاد الفراغ | ٣ x ٣ | المساحة | | | | |
| | | لون الحائط | أبيض | مساحة الفتحات | ٦٠ x ١ | | | |
| | | نوع الفرش | ثابت | متحرك | ثابت+متحرك | | | |
| | | استخدامات الفراغ (يوميًا) بالساعة : | | | | | | |
| | | النشاط | من | إلى | عدد الساعات | القيام بالنشاط | | |
| ١ | | تناول الطعام | | | | | | |
| ٢ | | إعداد الطعام | | | | الغذاء والقهوة | | |
| ٣ | | تخزين | | | | مساحة المطبخ | | |
| ٤ | | تربية حيوانات | | | | | | |
| ٥ | | طهو الطعام | | | | غسل الأطباق | | |
| ٧ | | الغسيل | | | | | | |

دور حطب مسح جدران ودهان

| استخدامات فراغات الوحدة السكنية | | اسم الفراغ : غرفة (بلكونة) | | | كروكي وظيفي للفرقة | | | |
|---------------------------------|--|-------------------------------------|-------|---------------|--------------------|----------------|--|--|
| | | أبعاد الفراغ | ٢ x ١ | المساحة | | | | |
| | | لون الحائط | أبيض | مساحة الفتحات | ٦٠ x ١ | | | |
| | | نوع الفرش | ثابت | متحرك | ثابت+متحرك | | | |
| | | استخدامات الفراغ (يوميًا) بالساعة : | | | | | | |
| | | النشاط | من | إلى | عدد الساعات | القيام بالنشاط | | |
| ١ | | تخزين | | | | | | |
| ٢ | | تربية حيوانات | | | | | | |
| ٣ | | تناول طعام | | | | | | |
| ٤ | | الغسيل | | | | غسل البلكونة | | |
| ٥ | | | | | | | | |
| ٧ | | | | | | | | |

مساحة
١ x ١
تخزين

| أسئلة تتعلق بالبناء الوظيفي للفراغات الممسكن : | | | |
|--|--|-------------------------------------|---|
| ١ | هل تجد أنه من الضروري وجود فراغ خاص بالمدخل أم يمكن الدخول إلى غرفة المعيشة مباشرة ؟ | | |
| | لا بد من وجود فراغ المدخل برغم من إدارته للمساحة | من المفضل وجود فراغ المدخل | يمكن الدخول مباشرة إلى غرفة المعيشة في مسيل توفير المساحة |
| | تعليق | | |
| ٢ | هل تجد أن هناك علاقة مهمة بين المدخل والمطبخ ؟ أم أن العلاقة أكبر بين المطبخ وجناح النوم ؟ | | |
| | العلاقة أكبر بين المدخل والمطبخ | العلاقة أكبر بين المطبخ وجناح النوم | العلاقين غير مهمين |
| | ولماذا ؟ | | |
| | تعليق | | |
| ٣ | هل تجد أن فراغ الطعام (السفرة) مهم في الوحدة السكنية ؟ | مهم جداً | متوسط الأهمية |
| | هل يمكن أن يكون تناول الطعام في فراغ المعيشة ؟ | نعم | لا |
| | وتفضل أن يكون باثابت أم متحرك أم باستعمال نفس أثاث المعيشة ؟ | ثابت | متحرك |
| | تعليق | ليس بيضاء ، على الأيمن | |
| ٤ | هل تجد أن فراغ الصالون فراغ مهم في الوحدة السكنية ؟ | مهم جداً | متوسط الأهمية |
| | هل تفضل أن يكون منفصل أم يمكن أن يكون مع فراغ المعيشة ؟ | منفصل | متصل مع غرفة المعيشة |
| | تعليق | | |
| ٥ | هل تجد أن فكرة المطبخ المفتوح تساعد على زيادة استغلال المساحة ؟ أم أنها فكرة مرفوضة ؟ | لا أفضل | فكرة مرفوضة |
| | ولماذا ؟ | كثير استغلها ومكنت | |
| | تعليق | | |
| ٦ | هل من الأفضل تقليل مساحات غرف النوم وزيادة عددها ؟ | نعم أفضل | لا المساحة مهمة أيضاً |
| | تعليق | | |
| ٧ | هل ترى أن فراغ الشرفة (البلكونة) مهم ؟ | مهم جداً | متوسط الأهمية |
| | وما أهميته ؟ | المنتش | |
| | هل تفضل أن تكون الشرفة (البلكونة) بغرفة النوم أم بغرفة المعيشة ؟ | النوم | المعيشة |
| | هل ترى من الأفضل الاستغناء عن الشرفة (البلكونة) في مقابل زيادة مساحة الشرفة ؟ | نعم | لا |
| | تعليق | | |
| ٨ | هل من المهم وجود مكان ثابت للتخزين (مخزن - سندرة) ؟ | مهم جداً | متوسط الأهمية |
| | وأي تفضل أن يوجد؟ | المطبخ | مكان آخر (أنكره) |
| | تعليق | لا يكون غرفة البنا | |

| | | | |
|--|--|-------------------|----------------------------------|
| ٩ | هل تجد أن القرش المتحرك والقفل اللطيف يوفر المساحة ؟ | نعم ✓ | لا |
| ما هي الأنشطة التي يمكن أن تؤدي من خلال القرش المتحرك ؟ | | | |
| | التنوم ✓ | الطعام ✓ | المذاكرة ✓ |
| | آخرى (أنكره) | | |
| تعليق | | | |
| ١٠ | هل تجد أن أفكار مثل السرير الطوي (سرير بدورين) جيدة في توفير المساحة داخل الوحدة السكنية ؟ | | |
| | أفكار جيدة جداً وتوفر المساحة | أفكار غير مفضلة | أفكار مرفوضة على الإطلاق |
| لماذا ؟ <i>بسبب المساحة</i> | | | |
| تعليق | | | |
| ١١ | هل تجد ان هناك مساحة في مسكنك غير مستغلة الإستغلال الكافي ؟ | مستغلة تماماً | يمكن استغلال المساحة أفضل من هذا |
| وكيف يمكن الاستفادة من تلك المساحة الإستغلال الأمثل ؟ <i>بلاستيك غرسة ١٠ لترات</i> | | | |
| تعليق | | | |
| تعليق | | | |
| تعليق | | | |
| أسئلة تتعلق بتحقيق الراحة داخل فراغات المسكن : | | | |
| ١٢ | هل تجد مساحات الفتح (الشبايك) مناسبة ؟ | مناسبة ✓ | متوسطة |
| | وإذا كانت غير مناسبة فيجب زيادتها في | غرفة المعيشة | التنوم |
| | ولماذا ؟ | المطبخ | أخرى |
| تعليق | | | |
| ١٣ | هل تجد الإتارة الطبيعية كافية لإتارة جميع الغرف نهائياً ؟ | كافية ✓ | كافية في بعضهم |
| | غير كافية | | |
| تعليق | | | |
| ١٤ | هل المناخ داخل الوحدة السكنية مناسب صيفاً ؟ | مناسب ✓ | متوسط |
| | هل المناخ داخل الوحدة السكنية مناسب شتاءً ؟ | مناسب ✓ | متوسط |
| | إذا كان غير مناسب فما السبب ؟ | | غير مناسب |
| <i>بسبب عدم أناسا بهي</i> | | | |
| تعليق | | | |
| ١٥ | هل تجد أن إتارة الحمام طبيعياً أمر مهم ؟ | مهم جداً ✓ | متوسط الأهمية |
| | غير مهم على الإطلاق | | |
| تعليق | | | |
| أسئلة تتعلق بتحقيق الخصوصية داخل فراغات المسكن : | | | |
| ١٦ | هل المدخل (باب الشقة) يجرح خصوصية فراغات المسكن (يكشف جميع الفراغات) ؟ | | |
| | يجرح جميع الفراغات | يجرح بعض الفراغات | لا أجد مشكلة في ذلك ✓ |
| تعليق | | | |

| | | | |
|----|--|----------------------------------|---------------------------------|
| ١٧ | هل تجد الخصوصية المطلوبة في الحمام ؟ | نعم | لا |
| | إذا كانت الإجابة بـ لا فما السبب ؟ | | |
| | تعليق | | |
| ١٨ | هل تجد الخصوصية المطلوبة في فراغات النوم ؟ | نعم | لا |
| | إذا كانت الإجابة بـ لا فما السبب ؟ | | |
| | تعليق | | |
| | تعليق | | |
| ١٩ | هل تشعر بالأمن داخل الوحدة ؟ | نعم | لا |
| | إذا كانت الإجابة بـ لا فما السبب ؟ | | |
| | تعليق | | |
| | تعليق | | |
| ٢٠ | أيهما تفضل زيادة مسلحة الغرف أم زيادة عددها ؟ | زيادة المساحة | زيادة عدد الغرف |
| | تعليق | | |
| ٢١ | ما هي الغرف التي تحتاج إلى زيادة مساحتها ؟ | النوم | المطبخ الحمام |
| | تعليق | | |
| ٢٢ | ما هي الغرف التي تحتاجها وغير موجودة في وحدتك السكنية الحالية ؟ | | |
| | تعليق | | |
| ٢٣ | هل ارتفاع الوحدة مناسب ؟ | مناسب | متوسط غير مناسب |
| | وهل يمكن أن يقل الارتفاع العام للوحدة السكنية عن ارتفاع مسكنك ؟ | يمكن | يمكن ولكن في حدود لا يمكن |
| | وهل هو مناسب لجميع الفراغات المختلفة أم يمكن تقليله في بعضها ؟ | | |
| | يمكن تقليل الارتفاع في الحمام والمطبخ | يمكن تقليل الارتفاع في غرف النوم | لا يمكن التقليل عن هذا الارتفاع |
| | تعليق | | |
| ٢٤ | في رأيك ما الذي يمكن عمله حتى تصبح وحدتك السكنية ناجحة من الناحية الوظيفية ؟ | | |
| | تعليق | | |
| | تعليق | | |
| | تعليق | | |
| ٢٥ | هل تجد انه من الأفضل أن تقوم أنت وأسرته بتقسيم فراغات وحدتك السكنية ؟ | نعم | لا |
| | وماذا كنت ستفعل ؟ | | |
| | تعليق | | |
| | تعليق | | |




| Case study (b): | | |
|---|--|---------------------|
| 1 | Dwelling area | 63 m2 |
| 2 | No. of habitable rooms | 3 rooms |
| 3 | No. of bedrooms | 2 bedrooms |
| 4 | No. of family members | 4 persons |
| 5 | No. of children | 3 (3 girls) |
| 6 | Architectural plan | |
|  | | |
| Figure 230: Architectural plan for case (b) | | |
| 7 | Dwelling spaces description | |
| Living room (illustrative images) | | |
|  |  | |
| Figure 231: Living room (b-1) | Figure 232: Living room (b-2) | |



Figure 233: Living room (b-3)



Figure 234: Living room (b-4)

Master bedroom (illustrative images)



Figure 235: Master bedroom (b-1)



Figure 236: Master bedroom (b-2)

The other bedroom (illustrative images)



Figure 237: Bedroom (b-1)



Figure 238: Bedroom (b-2)



Figure 239: Bedroom (b-3)



Figure 240: Bedroom (b-4)

Utilities areas (illustrative images)



Figure 241: Bathroom (b-1)



Figure 242: Bathroom (b-2)



Figure 243: Kitchen (b-1)



Figure 244: Kitchen (b-2)



Figure 245: Kitchen (b-3)



Figure 246: Kitchen (b-4)

Case (C)

(C) 4

استمارة استقراء حالة (مشروعات الإسكان الاقتصادي وكيفية تعامل المستخدمين مع الممكن)

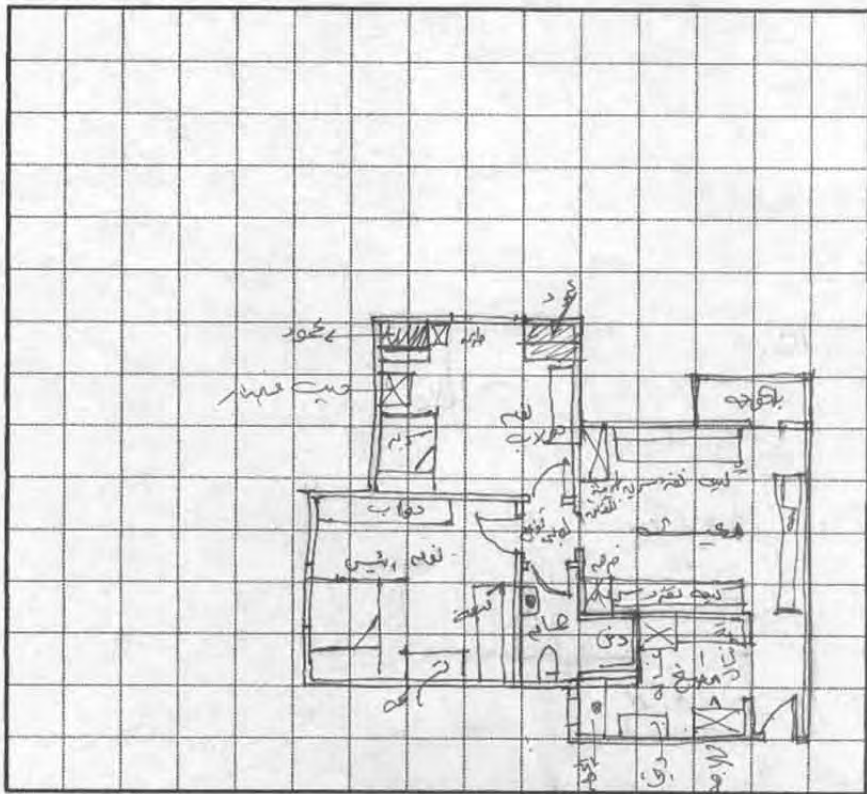
| معلومات خاصة بمشروع الإسكان : | | | |
|--|-------------------------|--------------|--------------|
| 1 | اسم المشروع | | |
| 2 | اسم المنطقة (الحي) | | |
| 3 | سنة البناء | | |
| 4 | أهداف المشروع | | |
| 5 | نمط الإسكان الاقتصادي | إسكان حكومي | إسكان تعاوني |
| 6 | نوع الإسكان الاقتصادي | عمارات سكنية | مسكن صفيحة |
| 7 | معلومات أخرى عن المشروع | | |
| معلومات خاصة بالعقار (العمارة السكنية) : | | | |
| 1 | موقع العقار | | |
| 2 | استخدام العقار | | |
| 3 | عدد الأدوار | | |
| 4 | الحالة الإنشائية | | |
| 5 | حالة التشطيب | | |
| 6 | توافر الخدمات | | |
| 7 | الامتدادات (التعلقات) | | |
| 8 | عدد الوحدات بالدور | | |
| 9 | معلومات أخرى عن العقار | | |
| معلومات خاصة بالأسرة | | | |
| عدد أفراد الأسرة | | | |
| عائل الأسرة | | | |
| المحل الشهري | | | |
| محل الإئفاق الشهري | | | |
| هيكل الأسرة : | | | |
| المهنة | المستوى التعليمي | العمر | النوع |
| الأب | الاستاذ | 51 | ذكر |
| الأم | المتوسطة | 44 | أنثى |
| ابن 1 | دبلوم تجارة | 28 | ذكر |
| ابن 2 | دبلوم تجارة | 25 | أنثى |
| ابن 3 | دبلوم تجارة | 23 | أنثى |
| ابن 4 | دبلوم تجارة | 20 | أنثى |
| ابن 5 | | | أنثى |
| ابن 6 | | | أنثى |
| | | | أنثى |
| | | | أنثى |

ملاحظات يدوية:

- إسكان مستجيب
- الدور الرابع
- يعتبر أول
- مستجيب

| معلومات خاصة بالوحدة السكنية : | | | |
|--------------------------------|-----------------------------|-----------------------------------|---------------------------------|
| ١ | الحالة القانونية | تمليك | إيجار جديد |
| ٢ | طريقة الحصول على الوحدة | ✓ | إيجار قديم |
| ٣ | مساحة الوحدة السكنية | ٦٣ | ٢٠ |
| ٤ | عدد الغرف | ٤ | |
| ٥ | تصنيف الغرف | ١ صالة ٢ نوم ٣ نوم ٤ نوم | صالون مطبخ حمام بلكونة |
| ٦ | حالة التشطيب العامة | مستوى جيد | |
| ٧ | الألوان القالبية على المسكن | الزرق والبيج | |
| ٨ | ارتفاع السقف | ٢,٨٠ | |
| | سمك الحوائط | الداخلية | الخارجية |
| | | ١٢ | ٢٥ |

كروكي توزيع فراغات الوحدة السكنية :



| اسم الفراغ : | | المساحة | | كروكي وظيفي للغرفة | |
|-------------------------------------|----------------|---------|-----|--------------------|----------------|
| ١ | أبعاد الفراغ | ٢٥ | × | ٢٥ | المساحة |
| | لون الحائط | ١٢ | متر | ١٧ | مساحة الفتحات |
| | نوع الفرش | ثابت | | متحرك | ثابت+متحرك |
| استخدامات الفراغ (يومياً) بالساعة : | | | | | |
| | النشاط | من | إلى | عدد الساعات | القيام بالنشاط |
| ١ | النوم | ١٢ | - | ٧ | |
| ٢ | تناول الطعام | ١٢ | - | ١٣ | |
| ٣ | المذاكرة | | | | |
| ٤ | اللعب والتسلية | | | | |
| ٥ | الكمبيوتر | | | | |
| ٦ | مشاهدة التلفاز | ١٢ | - | ٤ | |
| ٧ | عمل (تحديد) | | | | |
| ٨ | الصلاة | | | | |
| ٩ | مقابلة ضيوف | ٩ | - | ١٠ | |
| ١٠ | إعداد الطعام | ٦ | - | ٥ | |
| ١١ | تخزين | | | | |
| ١٢ | تربية حيوانات | | | | |
| ١٣ | طهو الطعام | | | | |
| ١٤ | | | | | |

استخدامات فراغات الوحدة السكنية

| اسم الفراغ : | | المساحة | | كروكي وظيفي للغرفة | |
|-------------------------------------|----------------|---------|-----|--------------------|----------------|
| ٢ | أبعاد الفراغ | ٢٥ | × | ٣٥ | المساحة |
| | لون الحائط | ١١ | متر | ١٧ | مساحة الفتحات |
| | نوع الفرش | ثابت | | متحرك | ثابت+متحرك |
| استخدامات الفراغ (يومياً) بالساعة : | | | | | |
| | النشاط | من | إلى | عدد الساعات | القيام بالنشاط |
| ١ | النوم | ٨ | - | ١١ | |
| ٢ | تناول الطعام | | | | |
| ٣ | المذاكرة | | | | |
| ٤ | اللعب والتسلية | | | | |
| ٥ | الكمبيوتر | | | | |
| ٦ | مشاهدة التلفاز | | | | |
| ٧ | عمل (تحديد) | | | | |
| ٨ | الصلاة | | | | |
| ٩ | مقابلة ضيوف | | | | |
| ١٠ | إعداد الطعام | | | | |
| ١١ | تخزين | | | | |
| ١٢ | تربية حيوانات | | | | |
| ١٣ | طهو الطعام | | | | |
| ١٤ | | | | | |

استخدامات فراغات الوحدة السكنية

| كروكي وظيفي للرفة | | اسم الفراغ : رقم ١/٣ | |
|-------------------|--|--|------------------|
| | | المساحة | أبعاد الفراغ |
| | | مساحة الفتحات | لون الحائط |
| | | ثابت+متحرك | نوع الفرش |
| | | استخدامات الفراغ (يومياً) بالمساعة : | |
| | | النشاط | من إلى |
| | | عدد الساعات | القيام بالنشاط |
| | | | ١ النوم |
| | | | ٢ تناول الطعام |
| | | | ٣ المذاكرة |
| | | | ٤ اللعب والتسلية |
| | | | ٥ الكمبيوتر |
| | | | ٦ مشاهدة التلفاز |
| | | | ٧ عمل (تحديد) |
| | | | ٨ الصلاة |
| | | | ٩ مقابلة ضيوف |
| | | | ١٠ إعداد الطعام |
| | | | ١١ تخزين |
| | | | ١٢ تربية حيوانات |
| | | | ١٣ طهو الطعام |
| | | | ١٤ |

| كروكي وظيفي للرفة | | اسم الفراغ : | |
|-------------------|--|--|------------------|
| | | المساحة | أبعاد الفراغ |
| | | مساحة الفتحات | لون الحائط |
| | | ثابت+متحرك | نوع الفرش |
| | | استخدامات الفراغ (يومياً) بالمساعة : | |
| | | النشاط | من إلى |
| | | عدد الساعات | القيام بالنشاط |
| | | | ١ النوم |
| | | | ٢ تناول الطعام |
| | | | ٣ المذاكرة |
| | | | ٤ اللعب والتسلية |
| | | | ٥ الكمبيوتر |
| | | | ٦ مشاهدة التلفاز |
| | | | ٧ عمل (تحديد) |
| | | | ٨ الصلاة |
| | | | ٩ مقابلة ضيوف |
| | | | ١٠ إعداد الطعام |
| | | | ١١ تخزين |
| | | | ١٢ تربية حيوانات |
| | | | ١٣ طهو الطعام |
| | | | ١٤ |

| كروكي وظيفي للغرفة | | | | اسم الفراغ : الحمام | | | | استخدامات فراغات الوحدة السكنية |
|--------------------|--|--|--|---------------------------------------|-------------|--------------|---|---------------------------------|
| | | | | المساحة | ٩ × ١ | أبعاد الفراغ | ٥ | |
| | | | | مساحة الفتحات | ٦٠ × ١ | لون الحائط | | |
| | | | | ثابت + متحرك | متحرك | نوع الفرش | | |
| | | | | استخدامات الفراغ (يومياً) بالساعة : | | | | |
| | | | | القيام بالنشاط | عدد الساعات | من إلى | | |
| | | | | | | ٨١ - ٧٦ | ١ | |
| | | | | | | | ٢ | |
| | | | | | | | ٣ | |

| كروكي وظيفي للغرفة | | | | اسم الفراغ : المطبخ | | | | استخدامات فراغات الوحدة السكنية |
|--------------------|--|--|--|---------------------------------------|-------------|--------------|---|---------------------------------|
| | | | | المساحة | ٢ × ٢ | أبعاد الفراغ | ٦ | |
| | | | | مساحة الفتحات | ٦٠ × ١ | لون الحائط | | |
| | | | | ثابت + متحرك | متحرك | نوع الفرش | | |
| | | | | استخدامات الفراغ (يومياً) بالساعة : | | | | |
| | | | | القيام بالنشاط | عدد الساعات | من إلى | | |
| | | | | | | | ١ | |
| | | | | | | | ٢ | |
| | | | | | | | ٣ | |
| | | | | | | | ٤ | |
| | | | | | | | ٥ | |
| | | | | | | ٨١ - ٧٦ | ٧ | |

| كروكي وظيفي للغرفة | | | | اسم الفراغ : شرقية (بلكوتة) | | | | استخدامات فراغات الوحدة السكنية |
|--------------------|--|--|--|---------------------------------------|-------------|--------------|---|---------------------------------|
| | | | | المساحة | ٢ × ١ | أبعاد الفراغ | ٦ | |
| | | | | مساحة الفتحات | ٦٠ × ١ | لون الحائط | | |
| | | | | ثابت + متحرك | متحرك | نوع الفرش | | |
| | | | | استخدامات الفراغ (يومياً) بالساعة : | | | | |
| | | | | القيام بالنشاط | عدد الساعات | من إلى | | |
| | | | | | | | ١ | |
| | | | | | | | ٢ | |
| | | | | | | | ٣ | |
| | | | | | | | ٤ | |
| | | | | | | | ٥ | |
| | | | | | | | ٧ | |

| أسئلة تتعلق بالبناء الوظيفي للراغبات المسكن : | | | |
|---|--|-------------------------------------|---|
| ١ | هل تجد أنه من الضروري وجود فراغ خاص بالمدخل أم يمكن الدخول إلى غرفة المعيشة مباشرة ؟ | | |
| | لا بد من وجود فراغ المدخل برغم من إهداره للمساحة | من المفضل وجود فراغ المدخل | يمكن الدخول مباشرة إلى غرفة المعيشة في سبيل توفير المساحة |
| | تعليق | | |
| ٢ | هل تجد أن هناك علاقة مهمة بين المدخل والمطبخ ؟ أم أن العلاقة أكبر بين المطبخ وجناح النوم ؟ | | |
| | العلاقة أكبر بين المدخل والمطبخ | العلاقة أكبر بين المطبخ وجناح النوم | العلاقين غير مهمين |
| | ولماذا ؟ <i>المساحة</i> | | |
| | تعليق | | |
| ٣ | هل تجد أن فراغ الطعام (السفرة) مهم في الوحدة السكنية ؟ | مهم جدا | متوسط الأهمية |
| | هل يمكن أن يكون تناول الطعام في فراغ المعيشة ؟ | نعم | لا |
| | وتفضل أن يكون ثابت أم متحرك أم باستعمال نفس أثاث المعيشة ؟ | ثابت | متحرك |
| | تعليق <i>أثبات</i> | | |
| ٤ | هل تجد أن فراغ الصالون فراغ مهم في الوحدة السكنية ؟ | مهم جدا | متوسط الأهمية |
| | وهل تفضل أن يكون منفصل أم يمكن أن يكون مع فراغ المعيشة ؟ | منفصل | متصل مع غرفة المعيشة |
| | تعليق | | |
| ٥ | هل تجد أن فكرة المطبخ المفتوح تساعد على زيادة استقلال المساحة ؟ أم أنها فكرة مرفوضة ؟ | لا أفضل | فكرة مرفوضة |
| | ولماذا ؟ <i>لعدم قرب المطبخ</i> | | |
| | تعليق | | |
| ٦ | هل من الأفضل تقليل مساحات غرف النوم وزيادة عددها ؟ | نعم أفضل | لا المساحة مهمة أيضا |
| | تعليق | | |
| ٧ | هل ترى أن فراغ الشرفة (البلكونة) مهم ؟ | مهم جدا | متوسط الأهمية |
| | وما أهميته ؟ | | |
| | هل تفضل أن تكون الشرفة (البلكونة) بغرفة النوم أم بغرفة المعيشة ؟ | النوم | المعيشة |
| | هل ترى من الأفضل الاستغناء عن الشرفة (البلكونة) في مقابل زيادة مساحة الغرفة ؟ | نعم | لا |
| | تعليق | | |
| ٨ | هل من المهم وجود مكان ثابت للتخزين (مخزن - سندرة) ؟ | مهم جدا | متوسط الأهمية |
| | وأي تفضل أن يوجد؟ | المطبخ | مكان آخر (أنكره) |
| | تعليق <i>المطبخ</i> | | |

| | | | |
|---|---|-------------------|----------------------------------|
| ٩ | هل تجد أن الفرش المتحرك والقابل للطي يوفر المساحة ؟ | نعم ✓ | لا |
| ما هي الأنشطة التي يمكن أن تؤدي من خلال الفرش المتحرك ؟ | | | |
| | التنويم ✓ | الطعام ✓ | المذاكرة |
| | أخرى (أذكره) | | |
| تعليق | | | |
| ١٠ | هل تجد أن أفكار مثل السيرير العلوي (سيرير بدورين) جيدة في توفير المساحة داخل الوحدة السكنية ؟ | | |
| | أفكار جيدة جداً وتوفر المساحة ✓ | أفكار غير مفضلة | أفكار مرفوضة على الإطلاق |
| لماذا ؟ | | | |
| تعليق | | | |
| ١١ | هل تجد ان هناك مساحة في مسكنك غير مستغلة الاستغلال الكافي ؟ | مستغلة تماماً ✓ | يمكن استغلال المساحة أفضل من هذا |
| وكيف يمكن الاستفادة من تلك المساحة الاستغلال الأمثل ؟ | | | |
| تعليق | | | |
| تعليق | | | |
| تعليق | | | |
| أسئلة تتعلق بتحقيق الراحة داخل فراغات المسكن : | | | |
| ١٢ | هل تجد مساحات الفتحاح (الشبايرك) مناسبة ؟ | مناسبة ✓ | مناسبة |
| | وإذا كانت غير متمم فيجب زيادتها في | غرفة المعيشة | المطبخ |
| | وإذا كانت غير متمم فيجب زيادتها في | غرفة المعيشة | المطبخ |
| | وإذا كانت غير متمم فيجب زيادتها في | غرفة المعيشة | المطبخ |
| ولماذا؟ | | | |
| تعليق | | | |
| ١٣ | هل تجد الإنارة الطبيعية كافية لإنارة جميع الغرف نهاراً ؟ | كافية ✓ | كافية في بعضهم |
| | غير كافية | | |
| تعليق | | | |
| ١٤ | هل المناخ داخل الوحدة السكنية مناسب صيفاً ؟ | مناسب ✓ | متوسط |
| | هل المناخ داخل الوحدة السكنية مناسب شتاءً ؟ | مناسب | متوسط ✓ |
| | إذا كان غير مناسب فما السبب ؟ | | |
| تعليق | | | |
| ١٥ | هل تجد أن إنارة الحمام طبيعياً أمر مهم ؟ | مهم جداً ✓ | متوسط الأهمية |
| | غير مهم على الإطلاق | | |
| تعليق | | | |
| أسئلة تتعلق بتحقيق الخصوصية داخل فراغات المسكن : | | | |
| ١٦ | هل المنخل (باب الشقة) يجرح خصوصية فراغات المسكن (يكشف جميع الفراغات) ؟ | | |
| | يجرح جميع الفراغات | يجرح بعض الفراغات | لا أجد مشكلة في ذلك |
| تعليق | | | |

| | | | |
|----|--|----------------------------------|---------------------------------|
| ١٧ | هل تجد الخصوصية المطلوبة في الحمام ؟ | نعم ✓ | لا |
| | إذا كانت الإجابة بـ لا فما السبب ؟ | | |
| | تعليق | | |
| ١٨ | هل تجد الخصوصية المطلوبة في فراغات النوم ؟ | نعم ✓ | لا |
| | إذا كانت الإجابة بـ لا فما السبب ؟ | | |
| | تعليق | | |
| | تعليق | | |
| ١٩ | هل تشعر بالأمن داخل الوحدة ؟ | نعم ✓ | لا |
| | إذا كانت الإجابة بـ لا فما السبب ؟ | | |
| | تعليق | | |
| | تعليق | | |
| ٢٠ | أيهما تفضل زيادة مساحة الغرف أم زيادة عددها ؟ | زيادة المساحة ✓ | زيادة عدد الغرف |
| | تعليق | | |
| ٢١ | ما هي الغرف التي تحتاج إلى زيادة مساحتها ؟ | التوأم ✓ | المطبخ الحمام ✓ |
| | تعليق | | |
| ٢٢ | ما هي الغرف التي تحتاجها وغير موجودة في وحدتك السكنية الحالية ؟ | | |
| | تعليق | | |
| ٢٣ | هل ارتفاع الوحدة مناسب ؟ | مناسب ✓ | متوسط غير مناسب |
| | وهل يمكن أن يقل الارتفاع العام للوحدة السكنية عن ارتفاع مسكنك ؟ | يمكن | يمكن ولكن في حدود لا يمكن |
| | وهل هو مناسب لجميع الفراغات المختلفة أم يمكن تقليله في بعضها ؟ | | |
| | يمكن تقليل الارتفاع في الحمام والمطبخ | يمكن تقليل الارتفاع في غرف النوم | لا يمكن التقليل عن هذا الارتفاع |
| | تعليق | | |
| ٢٤ | في رأيك ما الذي يمكن عمله حتى تصبح وحدتك السكنية ناجحة من الناحية الوظيفية ؟ | | |
| | تعليق | | |
| | تعليق | | |
| | تعليق | | |
| ٢٥ | هل تجد انه من الأفضل أن تقوم أنت وأسرته بتقسيم فراغات وحدتك السكنية ؟ | نعم ✓ | لا |
| | وماذا كنت ستفعل ؟ | | |
| | تعليق | | |
| | تعليق | | |

| Case study (c): | | |
|------------------------|---------------------------|------------------------------|
| 1 | Dwelling area | 63 m² |
| 2 | No. of habitable rooms | 3 rooms |
| 3 | No. of bedrooms | 2 bedrooms |
| 4 | No. of family members | 5 persons |
| 5 | No. of children | 3 (2 boys + 1 girl) |
| 6 | Architectural plan | |



Figure 247: Architectural plan for case (c)

| | | |
|----------|------------------------------------|--|
| 7 | Dwelling spaces description | |
|----------|------------------------------------|--|

Living room (illustrative images)



Figure 248: Living room (c-1)



Figure 249: Living room (c-2)



Figure 250: Living room (c-3)



Figure 251: Living room (c-4)

Master bedroom (illustrative images)



Figure 252: Master bedroom (c-1)



Figure 253: Master bedroom (c-2)



Figure 254: Master bedroom (c-3)



Figure 255: Master bedroom (c-4)

The other bedroom (illustrative images)



Figure 256: Bedroom (c-1)



Figure 257: Bedroom (c-2)



Figure 258: Bedroom (c-3)



Figure 259: Bedroom (c-4)

Utilities areas (illustrative images)



Figure 260: Bathroom (c-1)



Figure 261: Bathroom (c-2)



Figure 262: Kitchen (c-1)



Figure 263: Kitchen (c-2)



Figure 264: Kitchen (c-3)



Figure 265: Kitchen (c-4)



Figure 266: Lobby (c-1)



Figure 267: Balcony (c-1)

Appendix 3: Design Experiment

The following e-mail was sent to many architects as a request to participate in the experiment of studying the relation between the architect and the inhabitants in order to induce the differences in the way of thinking of both of them and how they deal with the spaces of the dwelling.

The sent e-mail to the architects as a request for participation:

طلب مشاركة في رسالة الدكتوراه التي أقوم بإعدادها

موضوع البحث الذي أقوم بإعداده يتعلق بالأداء الوظيفي لفرغات مسكن محدودي الدخل و من متطلبات البحث رصد العلاقة بين المصمم المعماري والمستخدم للفراغ السكني .. وفي هذه النقطة أحتاج لمشاركة المهندسين المعماريين في إعداد هذا الجزء من الدراسة .. وجزاكم الله خيراً على المشاركة المفيدة بإذن الله مرفق .. ملف أوتوكاد به وحدة سكنية مبنية بالفعل ويسكنها أسرة مكونة من 5 أفراد .. ولرصد العلاقة بين المصمم والمستخدم .. أرجو فرش المسقط الأفقي للوحدة السكنية باستخدام بلوكات الفرش المرفقة في نفس الملف أو باستخدام أي طريقة أخرى تفضلونها.

ملاحظات :

- الأسرة تتكون من 5 أفراد (أب وأم وولدين و بنت في مراحل سنية مختلفة ما بين الإعدادي والثانوي)
- مستوى الأسرة متوسط .. جميعهم متعلمين .. والوحدة السكنية مبنية في إطار مشروع إسكان حكومي
- مساحة الشقة والغرف ثابتة ولا يمكن زيادتها
- يمكن تغيير أماكن الفتحات إذا تطلب الأمر
- البلوكات المرفقة استرشادية .. مع إمكانية استخدام أي بلوكات للفرش من اختياركم
- من الأهداف المهمة تحقيق أقصى استغلال للفراغ

أرجو إعادة إرسال هذا الطلب إلى جميع المعماريين ممن تعرفون.. لتحقيق الدقة في الدراسة

م/ أيمن عاصم

مدرس مساعد بقسم الهندسة المعمارية – هندسة عين شمس

ayman.assem@gmail.com

A request for participation in my PhD thesis

I'm preparing a study deals with the functional performance in low-income house spaces. This requires finding the relation between the designer and the user of the designed spaces. In this part I need your participation strongly..

Please find attached an AutoCAD file contains a housing unit already built and inhabited by a family of five members.. To monitor the relationship between the designer and user.. I hope you furnish the attached house plan using the given blocks or any other blocks you have ...

Notes:

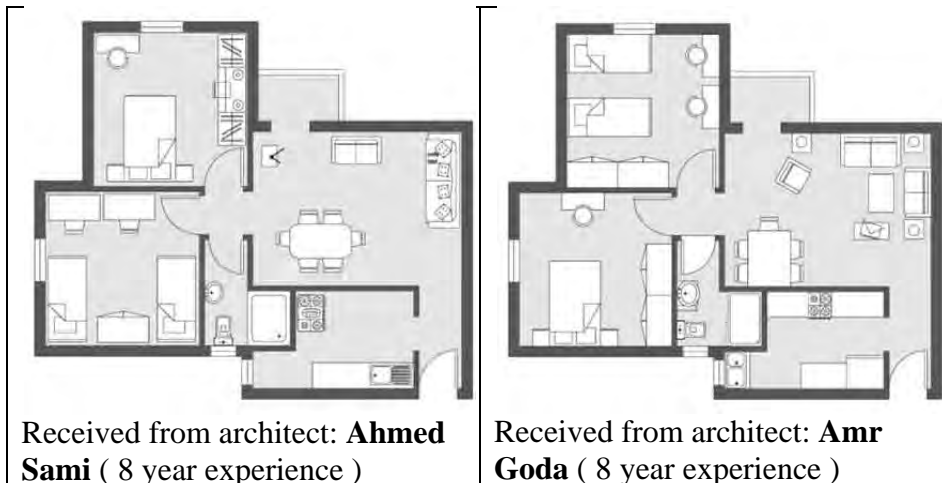
- The family consists of five members (father, mother and two sons and a daughter)
- The socio-cultural class of the family is moderate.. The housing unit is one of a governmental housing project
- The area of the apartment and rooms cannot be increased
- You can replace the openings if necessary
- You can use the attached furniture blocks, or you can use any suitable blocks
- The main objective of the study is to achieve the maximum use of the house spaces

Please re-send this e- mail to all architects you know..

Thank you

Ayman Assem

ayman.assem@gmail.com





Received from architect: **Eman Hussein** (10 year experience)



Received from architect: **Engy Hbib** (2 year experience)



Received from architect: **Hossam Massoud** (10 year experience)



Received from architect: **Hossam Mahmoud** (10 year experience)



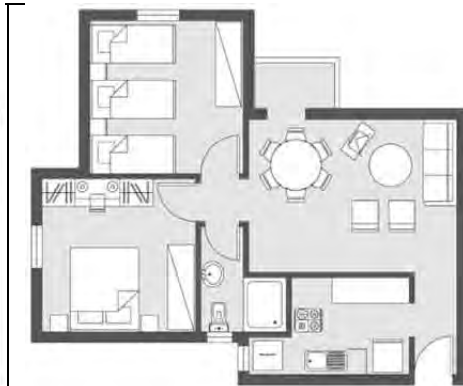
Received from architect: **Haytham Abdelslam** (8 year experience)



Received from architect: **Mohamed Mekawy** (3 year experience)



Received from architect: **Mohamed Mohsen** (2 year experience)



Received from architect: **Mohamed Asar** (13 year experience)



Received from architect: **Mohamed Soliman** (8 year experience)



Received from architect: **Mostafa Essam** (2 year experience)



Received from architect: **Rania Matarawy** (2 year experience)



Received from architect: **Sara Fayez** (2 year experience)

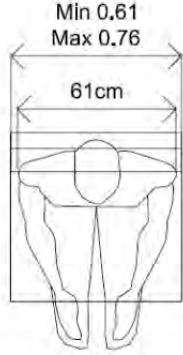
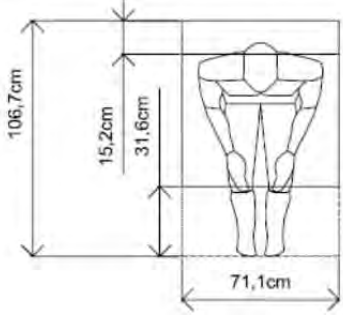


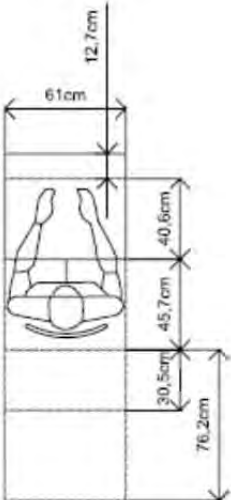
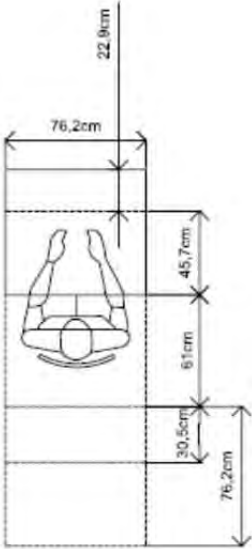
Received from architect: **Shimaa Mostafa** (5 year experience)



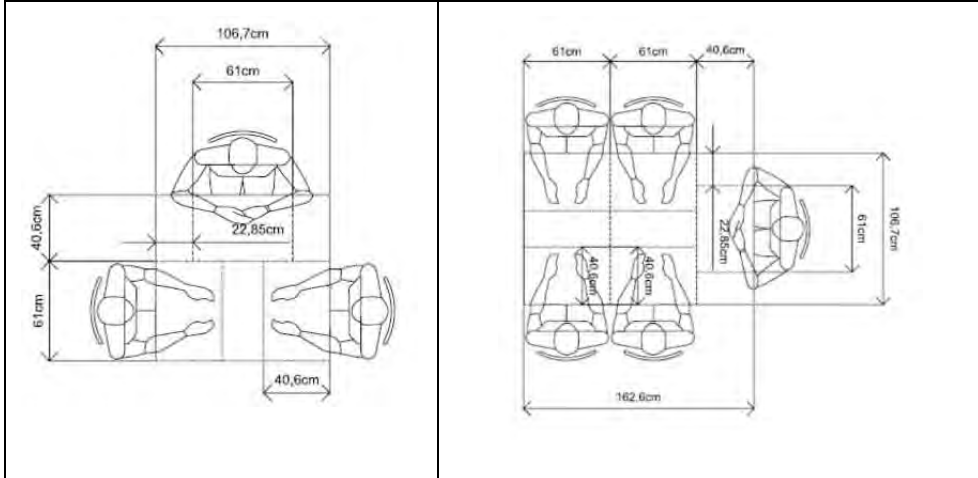
Received from architect: **Tamer Samir** (15 year experience)

Appendix 4: Anthropometric used table

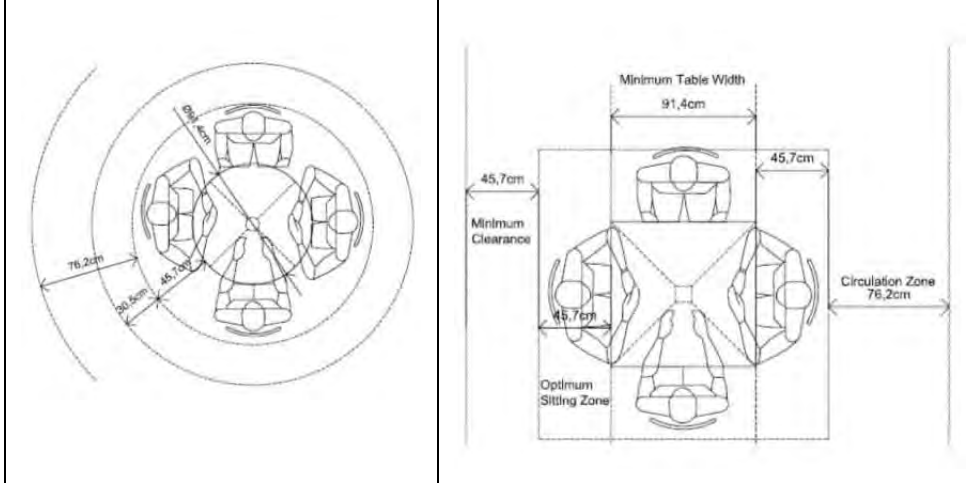
| Seating Width (in general) | |
|--|---|
| <p>Minimum dimension = 61</p> <p>Maximum dimension = 76</p> |  |
| Sofa Seating (Minimum dimension) | |
| <p>Minimum width = 121.9 cm</p> <p>Minimum depth (sofa + clearance) = 106.7</p> <p>Minimum clearance = 31.6 cm</p> |  |

| <p>Minimum dimension for eating space (one person) using dining table</p> | |
|--|---|
| <p>Minimum dimension = 76.2 Maximum dimension = 91.4</p> |  <p>The diagram shows a top-down view of a person sitting at a table. The table width is 61 cm. The person's back is 12.7 cm from the table edge. The person's arms are 40.6 cm from the table edge. The person's legs are 45.7 cm from the table edge. The person's feet are 30.5 cm from the table edge. The total depth of the eating space is 76.2 cm.</p> |
| <p>Maximum dimension for eating space (one person) using dining table</p> | |
| <p>Minimum dimension = 121.9 Maximum dimension = 152.4</p> |  <p>The diagram shows a top-down view of a person sitting at a table. The table width is 76.2 cm. The person's back is 22.9 cm from the table edge. The person's arms are 45.7 cm from the table edge. The person's legs are 61 cm from the table edge. The person's feet are 30.5 cm from the table edge. The total depth of the eating space is 76.2 cm.</p> |

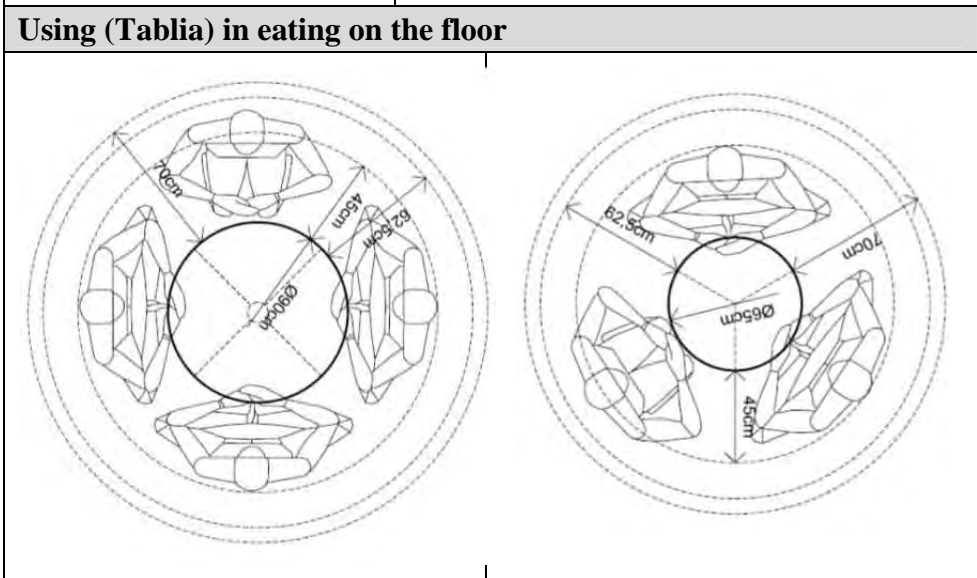
Dining tables



Varios types of dining tables



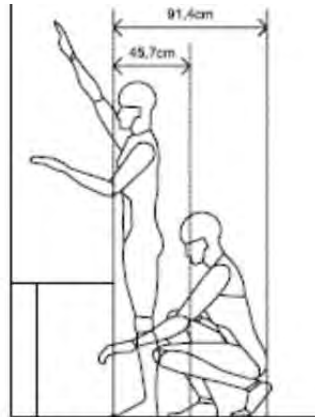
| Seating on the floor | |
|---|--|
| <p>width dimension = 62.5:70</p> <p>depth dimension = 62.5:87.5</p> | |



Furniture accessibility (wall unit) - minimum space for a cabinet with door

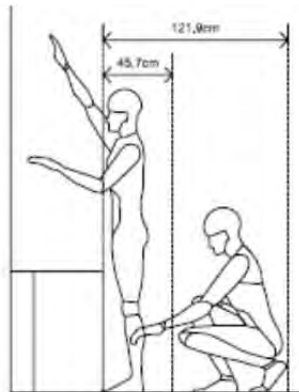
Working zone = 45.7 cm

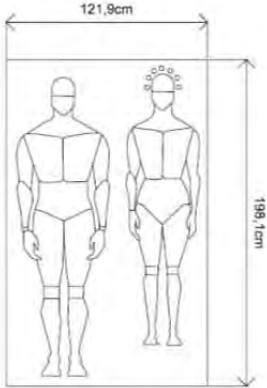
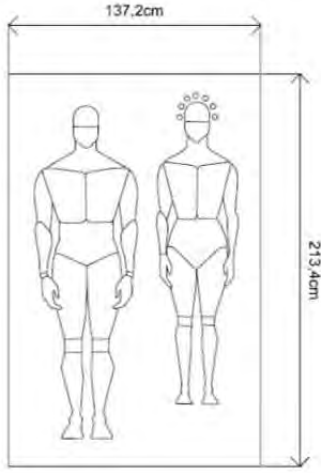
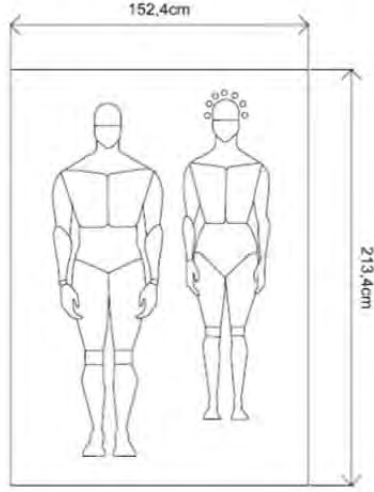
Clearance zone for opening cabinet doors = 121.9 cm

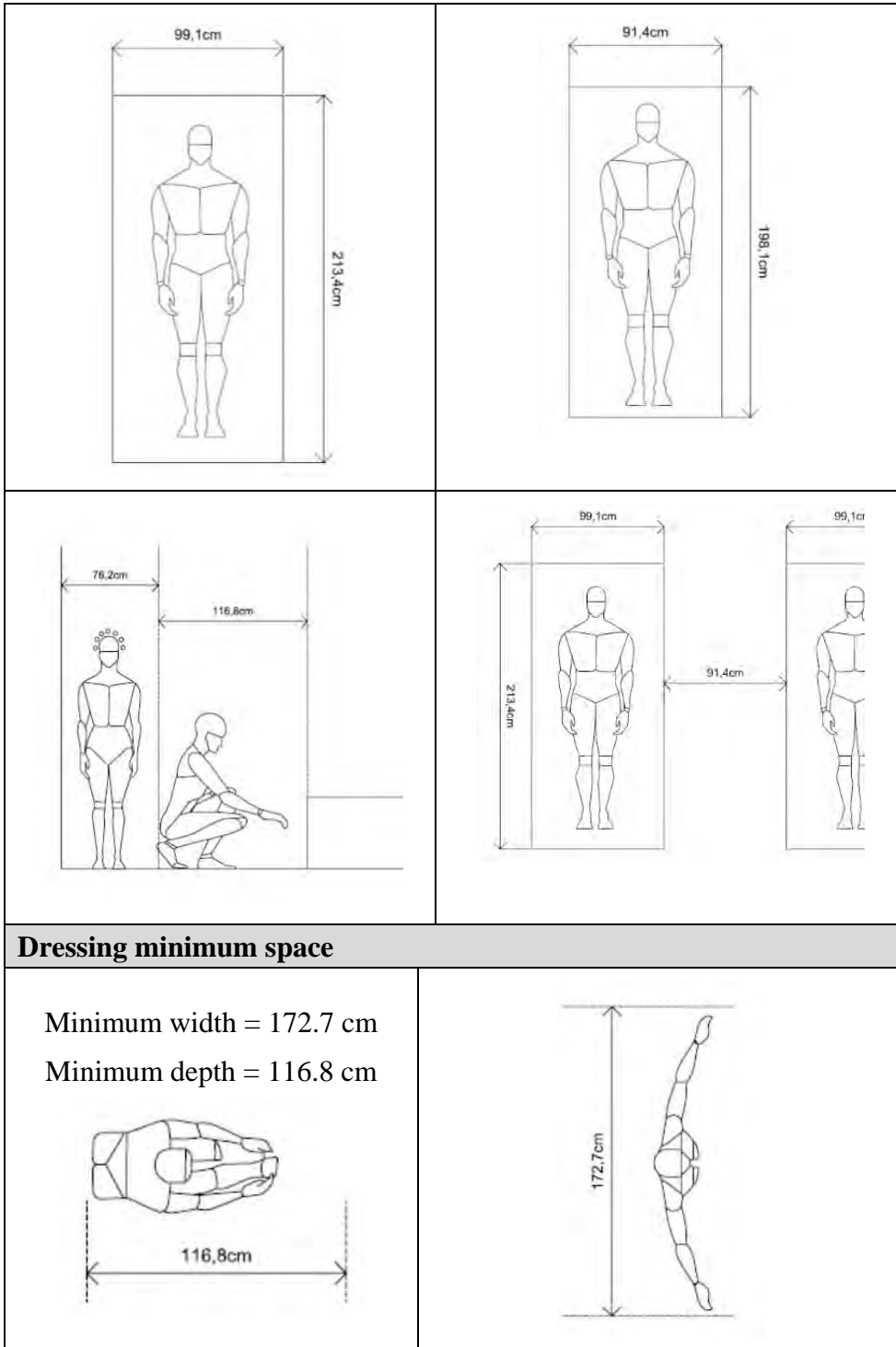

Furniture accessibility (wall unit) - minimum space for a cabinet with drawers

Working zone = 45.7 cm

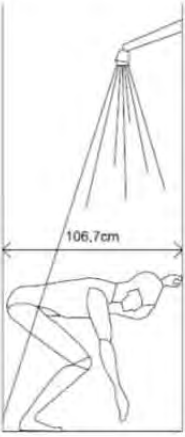
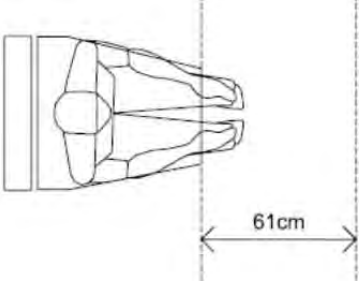
Clearance zone for opening cabinet drawers = 121.9 cm



| Sleeping spaces | |
|---|---|
| <p>Two persons bed:</p> <p>Minimum dimension = 198.1*121.9 cm</p> <p>Optimum dimension = 213.4*137.2 cm</p> <p>Maximum dimension = 213.4*152.4 cm</p> <p>One persons bed:</p> <p>Minimum dimension = 198.1* 91.4 cm</p> <p>Optimum dimension = 213.4* 99.1 cm</p> <p>Clearance between two beds = 91.4 cm</p> <p>Working zone beside the bed = 116.8 cm</p> |  |
|  |  |



| | |
|--|--|
| Kitchen preparation center | |
| <p>furniture dimension = 61 cm Accessible area = 45.7 cm Working zone = 45.7 cm Minimum width = 91.4 cm</p> | |
| Sink center | |
| <p>Sink dimension = 61 cm Working zone = 101.6 cm Circulation clearance = 76.2 cm</p> | |
| Bathtub (hand basin) minimum space | |
| <p>Bathtub dimension = 53:66 cm Working zone = 45.7 cm Circulation clearance = 76.2 cm</p> | |

| Showering space | |
|---|---|
| <p>Minimum working zone dimension = 106.7 cm</p> |  |
| Closet minimum clearance | |
| <p>Minimum clearance in the front of a closet = 106.7 cm</p> <p>Closet dimensions = various</p> |  |

Appendix 5: Fuzzy system report

1 General Information

Author: Ayman Assem
 Created: Saturday, January 22, 2011
 Print Date: Friday, July 01, 2011

Edition

Edition Name: fuzzyTECH 5.54d Professional Edition
 Neuro Modul: NeuroFuzzy: add-on Module installed

.1 List of Abbreviations

| | |
|------------------------|---|
| Activ_inter_Furn | Intersection of activities area with the existing furniture |
| Activ_shar_area | The shared area in multiple activities |
| Area_living_room | Total area of living room |
| Area_Services | Total area of services (Kitchen-Wc) |
| Balco_Vis_A_Liv | The visible area of the Balcony from the center of the living room |
| Bath_Vis_A_Liv | The visible area of the Bathroom from the center of the living room |
| Bedroom_occup | Bedroom occupancy |
| Cir_inter_Furn | Intersection of circulation area with the existing furniture |
| Dwelling_DF | Dwelling duration factor |
| Enter_Vis_Area | Determining all visible area of the dwelling from the main entrance |
| Family_Size | Total number of family members |
| Kitch_Vis_A_Liv | The visible area of the kitchen from the living room |
| Kitchen_Vis_A_Entrance | Determining Kitchen type by determining the visible area of the kitchen from the Entrance |
| Living_room_DF | Living room duration factor |
| Living_Vis_Area | Determining Visible area of the living room |
| M_bed_room_DF | Master bed room duration factor |
| MB_Vis_A_Liv | The visible area of the Master bedroom from the center of the living room |
| No_of_Bed_Rooms | Number of bed rooms |
| No_of_children | Total number of children |
| O_bed_rooms_DF | Other bed rooms duration factor |
| OB_Vis_A_Liv | The visible area of the other bedroom from the center of the living room |
| Perc_Balcony | Percentage of the balcony area to all apartment area |
| Perc_F_M | Percentage of Female kids to male kids |
| Perc_Lobbies | Percentage of the storage area to all apartment area |
| Perc_Storage | Percentage of the storage area to all apartment area |
| Tot_Circul_area | The total used area for circulation |
| Tot_Occ_area_EF | The total occupied area with elevated furniture |
| Tot_Occ_area_fur | The occupied area with fixed furniture |
| Tot_Occ_area_str | The occupied area used for storage |
| Tot_Occ_area_TF | The occupied area with temporary furniture |
| Tot_Used_area | The total usable area |
| Total_Area | Total area of the dwelling |
| Used_empty_area | The used free area |
| Vis_Area_Liv | The visible area of the dwelling from the center of the living room |
| Crowding_indicat | Crowding indicator |
| D_Dwelling_Accep | Desired Dwelling Acceptance |
| F_Efficiency | Functional Efficiency |
| Life_style_ind | Lifestyle indicator |
| Spatial_Accep | Spatial Acceptance |
| Spatial_Accep_en | Spatial Acceptance |
| T_Group_Accept | Target Group Degree of Acceptance |
| Use_Accep | Use Acceptance |
| Compute MBF | Compute Membership Function (Fuzzification Method) |
| CoM | Center of Maximum (Defuzzification Methode) |
| MoM | Mean of Maximum (Defuzzification Methode) |
| BSUM | Bounded Sum Fuzzy Operator for Result Aggregation |

| | |
|-------|---------------------------------------|
| MIN | Fuzzy Operator for AND Aggregation |
| MAX | Fuzzy Operator for OR Aggregation |
| GAMMA | Compensatory Operator for Aggregation |
| PROD | Fuzzy Operator for Composition |
| LV | Linguistic Variable |
| MBF | Membership Function |
| RB | Rule Block |

2 Functional_Efficiency

.1 Project Description

| | |
|------------------------|------|
| Input Variables | 36 |
| Output Variables | 11 |
| Intermediate Variables | 0 |
| Rule Blocks | 11 |
| Rules | 1316 |
| Membership Functions | 135 |

Table 1: Project Statistics

.2 System Structure

The system structure identifies the fuzzy logic inference flow from the input variables to the output variables. The fuzzification in the input interfaces translates analog inputs into fuzzy values. The fuzzy inference takes place in rule blocks which contain the linguistic control rules. The output of these rule blocks are linguistic variables. The defuzzification in the output interfaces translates them into analog variables.

The following figure shows the whole structure of this fuzzy system including input interfaces, rule blocks and output interfaces. The connecting lines symbolize the data flow.

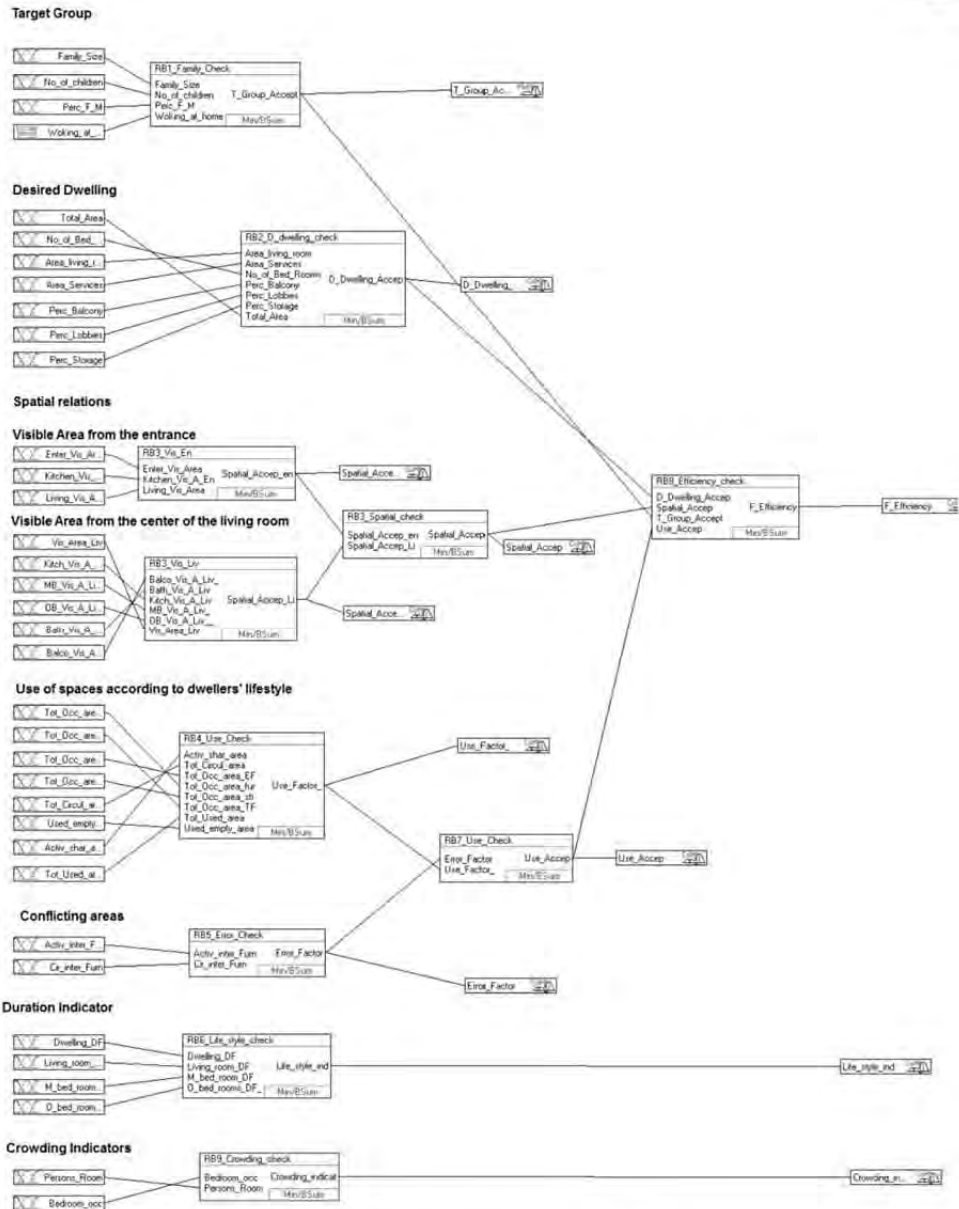


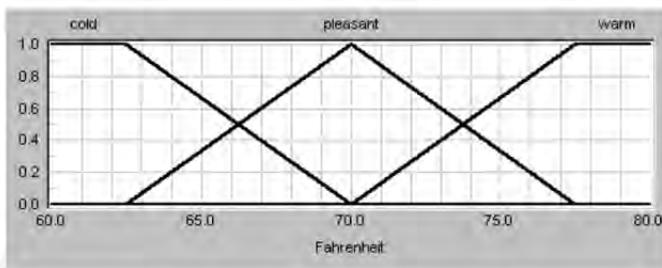
Figure 1: Structure of the Fuzzy Logic System

.3 Variables

This chapter contains the definition of all linguistic variables and of all membership functions. Linguistic variables are used to translate real values into linguistic values. The possible values of a linguistic variable are not numbers but so called 'linguistic terms'.

For example:

To translate the real variable 'temperature' into a linguistic variable three terms, 'cold', 'pleasant' and 'warm' are defined. Depending on the current temperature level each of these terms describes the 'temperature' more or less well. Each term is defined by a membership function (MBF). Each membership function defines for any value of the input variable the associated degree of membership of the linguistic term. The membership functions of all terms of one linguistic variable are normally displayed in one graph. The following figure plots the membership functions of the three terms for the example 'temperature'.



Membership Function of 'temperature'

A 'temperature' of 66 °F is a member of the MBFs for the terms:

- cold to the degree of 0.8
- pleasant to the degree of 0.2
- warm to the degree of 0.0

Linguistic variables have to be defined for all input, output and intermediate variables. The membership functions are defined using a few definition points only.

The following tables list all variables of the system as well as the respective fuzzification or defuzzification method. Also the properties of all base variables and the term names are listed.

.1 Inputs

| # | Variable Name | Type | Unit | Min | Max | Default | Term Names |
|---|------------------|------|------------|-----|-----|---------|------------------------------|
| 1 | Activ_inter_Furn | XX | Percentage | 0 | 100 | 5 | n_influential influential |
| 2 | Activ_shar_area | XX | percentage | 0 | 100 | 20 | Normal Undesired |
| 3 | Area_living_room | XX | m2 | 0 | 50 | 25 | Undesired Desired |
| 4 | Area_Services | XX | m2 | 0 | 50 | 5 | Undesired Desired |
| 5 | Balco_Vis_A_Liv | XX | Percentage | 0 | 100 | 15 | Less Normal |
| 6 | Bath_Vis_A_Liv | XX | Percentage | 0 | 100 | 5 | Normal Over |

| # | Variable Name | Type | Unit | Min | Max | Default | Term Names |
|----|----------------------|------|----------------------|-----|-----|---------|---------------------------|
| 7 | Bedroom_occ | XX | person | 0 | 10 | 2 | Normal Crowded |
| 8 | Cir_inter_Furn | XX | Percentage | 0 | 100 | 1 | n_influent influential |
| 9 | Dwelling_DF | XX | HR | 0 | 10 | 3 | Low Normal High |
| 10 | Enter_Vis_Area | XX | Percentage | 0 | 100 | 5 | Normal Over |
| 11 | Family_Size | XX | N_Family_m embers | 0 | 10 | 5 | Small Normal Large |
| 12 | Kitch_Vis_A_Liv | XX | Percentage | 0 | 100 | 0 | Normal Over |
| 13 | Kitchen_Vis_A_E n | XX | Percentage | 0 | 100 | 15 | Normal Over |
| 14 | Living_room_DF | XX | Hr | 0 | 10 | 2 | Low Normal High |
| 15 | Living_Vis_Area | XX | Percentage | 0 | 100 | 35 | Normal Over |
| 16 | M_bed_room_DF | XX | HR | 0 | 10 | 1 | Low Normal High |
| 17 | MB_Vis_A_Liv | XX | Percentage | 0 | 100 | 5 | Normal Few Over |
| 18 | No_of_Bed_Roo ms | XX | No | 0 | 5 | 3 | Undesired Desired |
| 19 | No_of_children | XX | No_of_childr en | 0 | 10 | 3 | Few Medium Many |
| 20 | O_bed_rooms_D F | XX | HR | 0 | 10 | 1 | Low Normal High |
| 21 | OB_Vis_A_Liv | XX | Percentage | 0 | 100 | 5 | Normal Few Over |
| 22 | Perc_Balcony | XX | Percentage | 0 | 100 | 6 | Desired Undesired |
| 23 | Perc_F_M | XX | Percentage | 0 | 100 | 33 | Few Many |
| 24 | Perc_Lobbies | XX | Percentage | 0 | 100 | 6 | Desired Undesired |
| 25 | Perc_Storage | XX | Percentage | 0 | 100 | 10 | Desired Undesired |
| 26 | Persons_Room | XX | person | 0 | 10 | 1.5 | Normal Crowded |
| 27 | Tot_Circul_area | XX | percentage | 0 | 100 | 30 | Normal Undesired |
| 28 | Tot_Occ_area_EF | XX | percentage | 0 | 100 | 15 | Desired Undesired |
| 29 | Tot_Occ_area_fur | XX | percentage | 0 | 100 | 50 | Normal Undesired |
| 30 | Tot_Occ_area_str | XX | percentage | 0 | 100 | 4 | Normal high |
| 31 | Tot_Occ_area_IF | XX | percentage | 0 | 100 | 10 | Desired Undesired |
| 32 | Tot_Used_area | XX | percentage | 0 | 100 | 85 | Low Normal |
| 33 | Total_Area | XX | m2 | 0 | 200 | 70 | Undesired Desired |
| 34 | Used_empty_area | XX | percentage | 0 | 100 | 50 | Undesired |

| # | Variable Name | Type | Unit | Min | Max | Default | Term Names |
|----|----------------|------|------------|-----|-----|---------|-------------------|
| | | | | | | | Normal |
| 35 | Vis_Area_Liv | | Percentage | 0 | 100 | 30 | Normal Over |
| 36 | Woking_at_home | | - | 0 | 1 | 1 | 000 yes 001 no |

Table 2: Variables of Group "Inputs"

Fuzzification Methods

- Compute MBF
- Categorical Variable
- Fuzzy Input

- Look up MBF
- Display

2. Outputs

| # | Variable Name | Type | Unit | Min | Max | Default | Term Names |
|----|------------------|------|----------------------|-----|-----|---------|--|
| 37 | Crowding_indicat | | Units | 0 | 10 | 0 | Very_Low Low Medium High Very_High |
| 38 | D_Dwelling_Accep | | Degree_of_a ccept | 0 | 100 | 0 | Very_Low Low Medium High Very_High |
| 39 | Error_Factor | | Percentage | 0 | 100 | 0 | Very_Low Low Medium High Very_High |
| 40 | F_Efficiency | | Units | 0 | 100 | 0 | Very_Low Low Medium High Very_High |
| 41 | Life_style_ind | | Units | 0 | 10 | 0 | Very_Low Low Medium High Very_High |
| 42 | Spatial_Accep | | Degree_of_a ccept | 0 | 100 | 0 | Very_Low Low Medium High Very_High |
| 43 | Spatial_Accep_en | | Degree_of_a ccept | 0 | 100 | 0 | Very_Low Low Medium High Very_High |
| 44 | Spatial_Accep_Li | | Degree_of_a ccept | 0 | 100 | 0 | Very_Low Low Medium High Very_High |
| 45 | T_Group_Accept | | Degree_of_a ccept | 0 | 100 | 0 | Ver_Low Low Medium |







| # | Variable Name | Type | Unit | Min | Max | Default | Term Names |
|----|---------------|---|---------------------|-----|-----|---------|--|
| | | | | | | | High Very High |
| 46 | Use_Accep |  | Degree_of_a cept | 0 | 100 | 0 | Very_Low Low Medium High Very_High |
| 47 | Use_Factor_ |  | Percentage | 0 | 100 | 0 | Very_Low Low Medium High Very_High |

Table 3: Variables of Group "Outputs"

Defuzzification Methods

-  Center of Maximum (CoM)
-  Center of Area (CoA)
-  Fuzzy Output
-  Mean of Maximum (MoM)
-  Hyper CoM
-  Force

The default value of an output variable is used if no rule is firing for this variable. Different methods can be used for the defuzzification, resulting either into the 'most plausible result' or the 'best compromise'.

The 'best compromise' is produced by the methods:

- CoM (Center of Maximum)
- CoA (Center of Area)
- CoA BSUM, a version especially for efficient VLSI implementations

The 'most plausible result is produced by the methods:

- MoM (Mean of Maximum)
- MoM BSUM, a version especially for efficient VLSI implementations

3 Crawding_indicatros













| # | Variable Name | Type | Unit | Min | Max | Default | Term Names |
|----|---------------|---|--------|-----|-----|---------|-------------------|
| 7 | Bedroom_occ |  | person | 0 | 10 | 2 | Normal Crowded |
| 26 | Persons_Room |  | person | 0 | 10 | 1.5 | Normal Crowded |

Table 4: Variables of Group "Crawding_indicatros"

Fuzzification Methods

-  Compute MBF
-  Look up MBF
-  Categorical Variable
-  Display
-  Fuzzy Input/Fuzzy Output

Defuzzification Methods






-  Center of Maximum (CoM)
-  Mean of Maximum (MoM)
-  Center of Area (CoA)
-  Hyper CoM
-  Force

4 Spatial_relations






| # | Variable Name | Type | Unit | Min | Max | Default | Term Names |
|----|----------------------|------|------------|-----|-----|---------|-----------------------|
| 5 | Baleo_Vis_A_Liv | XX | Percentage | 0 | 100 | 15 | Less Normal |
| 6 | Bath_Vis_A_Liv | XX | Percentage | 0 | 100 | 5 | Normal Over |
| 21 | OB_Vis_A_Liv | XX | Percentage | 0 | 100 | 5 | Normal Few Over |
| 17 | MB_Vis_A_Liv | XX | Percentage | 0 | 100 | 5 | Normal Few Over |
| 12 | Kitch_Vis_A_Liv | XX | Percentage | 0 | 100 | 0 | Normal Over |
| 35 | Vis_Area_Liv | XX | Percentage | 0 | 100 | 30 | Normal Over |
| 15 | Living_Vis_Area | XX | Percentage | 0 | 100 | 35 | Normal Over |
| 10 | Enter_Vis_Area | XX | Percentage | 0 | 100 | 5 | Normal Over |
| 13 | Kitchen_Vis_A_E n | XX | Percentage | 0 | 100 | 15 | Normal Over |

Table 5: Variables of Group "Spatial_relations"

Fuzzification Methods

-  Compute MBF
-  Look up MBF
-  Categorical Variable
-  Display
-  Fuzzy Input/Fuzzy Output

Defuzzification Methods






-  Center of Maximum (CoM)
-  Mean of Maximum (MoM)
-  Center of Area (CoA)
-  Hyper CoM
-  Force

5 Errorr_Check






| # | Variable Name | Type | Unit | Min | Max | Default | Term Names |
|---|------------------|------|------------|-----|-----|---------|------------------------------|
| 8 | Cir_inter_Furn | XX | Percentage | 0 | 100 | 1 | n_influential influential |
| 1 | Activ_inter_Furn | XX | Percentage | 0 | 100 | 5 | n_influential influential |

Table 6: Variables of Group "Errorr_Check"

Fuzzification Methods

-  Compute MBF
-  Look up MBF
-  Categorical Variable
-  Display
-  Fuzzy Input/Fuzzy Output

Defuzzification Methods

-  Center of Maximum (CoM)
-  Mean of Maximum (MoM)
-  Center of Area (CoA)
-  Hyper CoM
-  Force

.6 Duration_Factor

| # | Variable Name | Type | Unit | Min | Max | Default | Term Names |
|----|----------------|------|------|-----|-----|---------|-----------------------|
| 9 | Dwelling_DF | | Hr | 0 | 10 | 3 | Low Normal High |
| 14 | Living_room_DF | | Hr | 0 | 10 | 2 | Low Normal High |
| 16 | M_bed_room_DF | | Hr | 0 | 10 | 1 | Low Normal High |
| 20 | O_bed_rooms_DF | | Hr | 0 | 10 | 1 | Low Normal High |

Table 7: Variables of Group "Duration_Factor"

Fuzzification Methods

- Compute MBF
- Look up MBF
- Categorical Variable
- Display
- Fuzzy Input/Fuzzy Output

Defuzzification Methods

- Center of Maximum (CoM)
- Mean of Maximum (MoM)
- Center of Area (CoA)
- Hyper CoM
- Force

.7 Expect_use

| # | Variable Name | Type | Unit | Min | Max | Default | Term Names |
|----|------------------|------|------------|-----|-----|---------|----------------------|
| 32 | Tot_Used_area | | percentage | 0 | 100 | 85 | Low Normal |
| 34 | Used_empty_area | | percentage | 0 | 100 | 50 | Undesired Normal |
| 29 | Tot_Occ_area_fur | | percentage | 0 | 100 | 50 | Normal Undesired |
| 2 | Activ_shar_area | | percentage | 0 | 100 | 20 | Normal Undesired |
| 31 | Tot_Occ_area_TF | | percentage | 0 | 100 | 10 | Desired Undesired |
| 28 | Tot_Occ_area_EF | | percentage | 0 | 100 | 15 | Desired Undesired |
| 30 | Tot_Occ_area_str | | percentage | 0 | 100 | 4 | Normal high |
| 27 | Tot_Circul_area | | percentage | 0 | 100 | 30 | Normal Undesired |

Table 8: Variables of Group "Expect_use"

Fuzzification Methods

- Compute MBF
- Look up MBF
- Categorical Variable
- Display
- Fuzzy Input/Fuzzy Output

Defuzzification Methods

- Center of Maximum (CoM)
- Mean of Maximum (MoM)
- Center of Area (CoA)
- Hyper CoM
- Force

8 Desired_dwelling

| # | Variable Name | Type | Unit | Min | Max | Default | Term Names |
|----|------------------|------|------------|-----|-----|---------|----------------------|
| 33 | Total_Area | | m2 | 0 | 200 | 70 | Undesired Desired |
| 18 | No_of_Bed_Rooms | | No | 0 | 5 | 3 | Undesired Desired |
| 3 | Area_living_room | | m2 | 0 | 50 | 25 | Undesired Desired |
| 4 | Area_Services | | m2 | 0 | 50 | 5 | Undesired Desired |
| 25 | Perc_Storage | | Percentage | 0 | 100 | 10 | Desired Undesired |
| 24 | Perc_Lobbies | | Percentage | 0 | 100 | 6 | Desired Undesired |
| 22 | Perc_Balcony | | Percentage | 0 | 100 | 6 | Desired Undesired |

Table 9: Variables of Group "Desired_dwelling"

Fuzzification Methods

- Compute MBF
- Look up MBF
- Categorical Variable
- Display
- Fuzzy Input/Fuzzy Output

Defuzzification Methods

- Center of Maximum (CoM)
- Mean of Maximum (MoM)
- Center of Area (CoA)
- Hyper CoM
- Force

9 Target_Group

| # | Variable Name | Type | Unit | Min | Max | Default | Term Names |
|----|----------------|------|------------------|-----|-----|---------|--------------------------|
| 23 | Perc_F_M | | Percentage | 0 | 100 | 33 | Few Many |
| 36 | Woking_at_home | | - | 0 | 1 | 1 | 000 yes 001 no |
| 19 | No_of_children | | No_of_children | 0 | 10 | 3 | Few Medium Many |
| 11 | Family_Size | | N_Family_members | 0 | 10 | 5 | Small Normal Large |

Table 10: Variables of Group "Target_Group"

Fuzzification Methods

- Compute MBF
- Look up MBF
- Categorical Variable
- Display
- Fuzzy Input/Fuzzy Output

Defuzzification Methods

- Center of Maximum (CoM)
- Mean of Maximum (MoM)
- Center of Area (CoA)
- Hyper CoM
- Force

.10 Input Variable "Activ_inter_Furn"

Intersection of activities area with the existing furniture

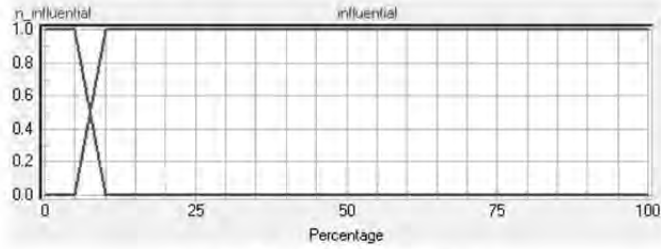


Figure 2: MBF of "Activ_inter_Furn"

| Term Name | Shape/Par. | Definition Points (x, y) |
|---------------|------------|-----------------------------------|
| n_influential | linear | (0, 1) (5, 1) (10, 0) (100, 0) |
| influential | linear | (0, 0) (5, 0) (10, 1) (100, 1) |

Table 11: Definition Points of MBF "Activ_inter_Furn"

.11 Input Variable "Activ_shar_area"

Percentage of the shared area in multiple activities

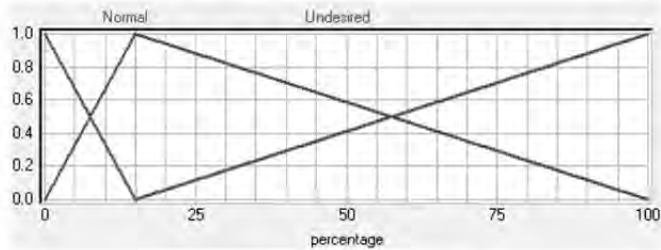


Figure 3: MBF of "Activ_shar_area"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--------------------------|
| Normal | linear | (0, 0) (15, 1) (100, 0) |
| Undesired | linear | (0, 1) (15, 0) (100, 1) |

Table 12: Definition Points of MBF "Activ_shar_area"

.12 Input Variable "Area_living_room"

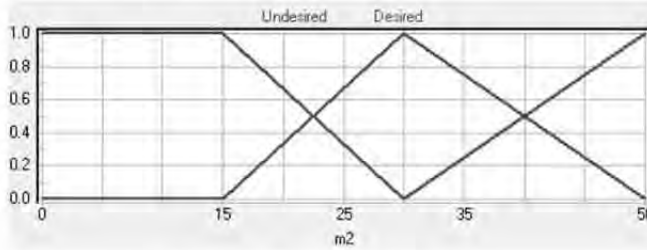


Figure 4: MBF of "Area_living_room"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|-----------------------------------|
| Undesired | linear | (0, 1) (15, 1) (30, 0) (50, 1) |
| Desired | linear | (0, 0) (15, 0) (30, 1) (50, 0) |

Table 13: Definition Points of MBF "Area_living_room"

.13 Input Variable "Area_Services"

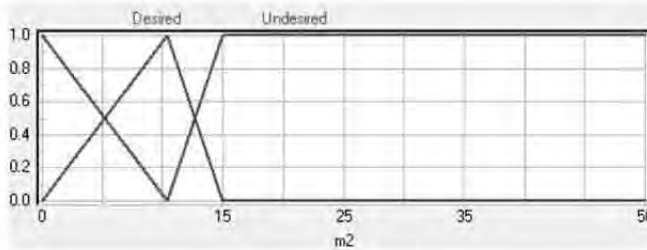


Figure 5: MBF of "Area_Services"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|-------------------------------------|
| Undesired | linear | (0, 1) (10.4, 0) (15, 1) (50, 1) |
| Desired | linear | (0, 0) (10.4, 1) (15, 0) (50, 0) |

Table 14: Definition Points of MBF "Area_Services"

.14 Input Variable "Balco_Vis_A_Liv_"

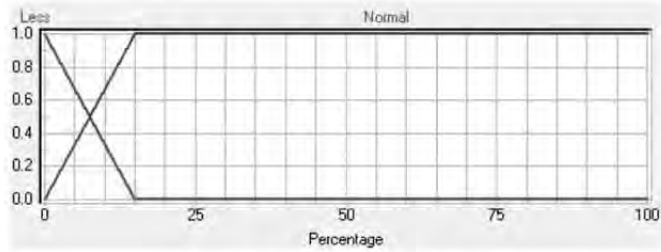


Figure 6: MBF of "Balco_Vis_A_Liv_"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--------------------------|
| Less | linear | (0, 1) (15, 0) (100, 0) |
| Normal | linear | (0, 0) (15, 1) (100, 1) |

Table 15: Definition Points of MBF "Balco_Vis_A_Liv_"

.15 Input Variable "Bath_Vis_A_Liv"

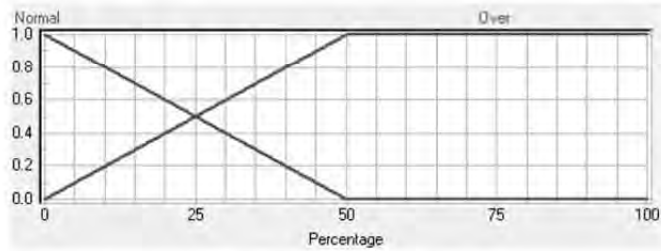


Figure 7: MBF of "Bath_Vis_A_Liv"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--------------------------|
| Normal | linear | (0, 1) (50, 0) (100, 0) |
| Over | linear | (0, 0) (50, 1) (100, 1) |

Table 16: Definition Points of MBF "Bath_Vis_A_Liv"

.16 Input Variable "Bedroom_occ"

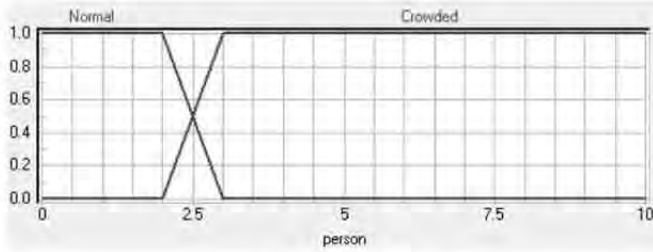


Figure 8: MBF of "Bedroom_occ"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|---------------------------------|
| Normal | linear | (0, 1) (2, 1) (3, 0) (10, 0) |
| Crowded | linear | (0, 0) (2, 0) (3, 1) (10, 1) |

Table 17: Definition Points of MBF "Bedroom_occ"

.17 Input Variable "Cir_inter_Furn"

Intersection of circulation area with the existing furniture

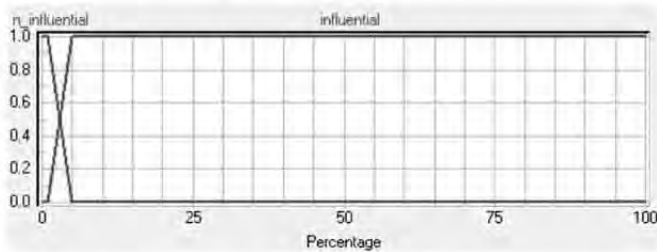


Figure 9: MBF of "Cir_inter_Furn"

| Term Name | Shape/Par. | Definition Points (x, y) |
|---------------|------------|----------------------------------|
| n_influential | linear | (0, 1) (1, 1) (5, 0) (100, 0) |
| influential | linear | (0, 0) (1, 0) (5, 1) (100, 1) |

Table 18: Definition Points of MBF "Cir_inter_Furn"

.18 Input Variable "Dwelling_DF"

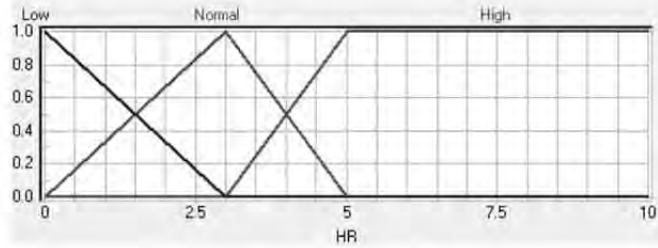


Figure 10: MBF of "Dwelling_DF"

| Term Name | Shape/Par. | Definition Points (x, y) | | |
|-----------|------------|--------------------------|--------|---------|
| Low | linear | (0, 1) | (3, 0) | (10, 0) |
| Normal | linear | (0, 0) | (3, 1) | (5, 0) |
| High | linear | (0, 0) | (3, 0) | (5, 1) |

Table 19: Definition Points of MBF "Dwelling_DF"

.19 Input Variable "Enter_Vis_Area"

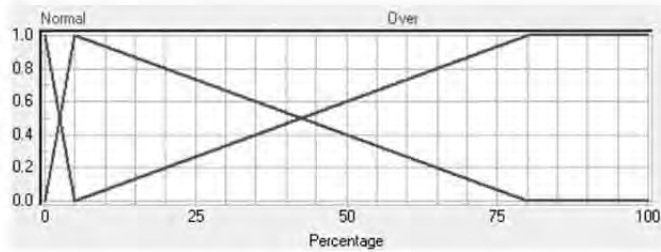


Figure 11: MBF of "Enter_Vis_Area"

| Term Name | Shape/Par. | Definition Points (x, y) | | |
|-----------|------------|--------------------------|--------|---------|
| Normal | linear | (0, 0) | (5, 1) | (80, 0) |
| Over | linear | (0, 1) | (5, 0) | (80, 1) |

Table 20: Definition Points of MBF "Enter_Vis_Area"

.20 Input Variable "Family_Size"

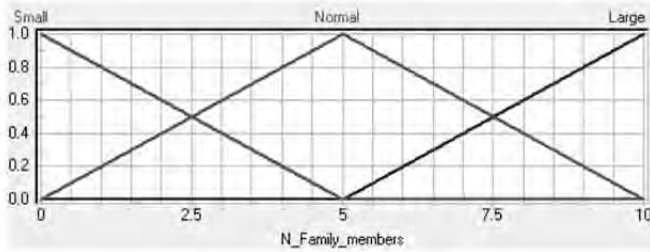


Figure 12: MBF of "Family_Size"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--------------------------|
| Small | linear | (0, 1) (5, 0) (10, 0) |
| Normal | linear | (0, 0) (5, 1) (10, 0) |
| Large | linear | (0, 0) (5, 0) (10, 1) |

Table 21: Definition Points of MBF "Family_Size"

.21 Input Variable "Kitch_Vis_A_Liv"

Determining Kitchen type by determining the visible area of the kitchen from the living room

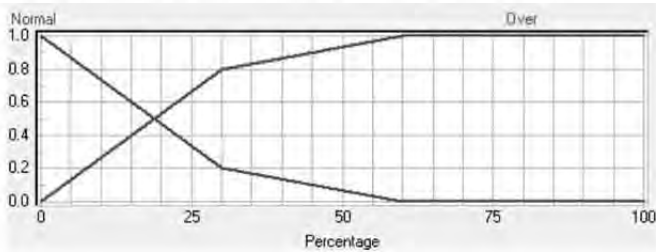


Figure 13: MBF of "Kitch_Vis_A_Liv"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|-----------------------------------|
| Normal | linear | (0, 1) (30, 0.2) (60, 0) (100, 0) |
| Over | linear | (0, 0) (30, 0.8) (60, 1) (100, 1) |

Table 22: Definition Points of MBF "Kitch_Vis_A_Liv"

.22 Input Variable "Kitchen_Vis_A_En"

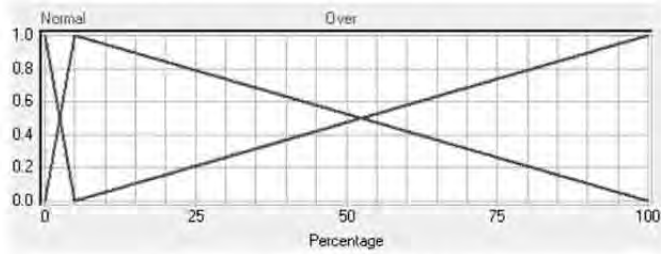


Figure 14: MBF of "Kitchen_Vis_A_En"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--------------------------|
| Normal | linear | (0, 1) (5, 0) (100, 0) |
| Over | linear | (0, 0) (5, 1) (100, 1) |

Table 23: Definition Points of MBF "Kitchen_Vis_A_En"

.23 Input Variable "Living_room_DF"

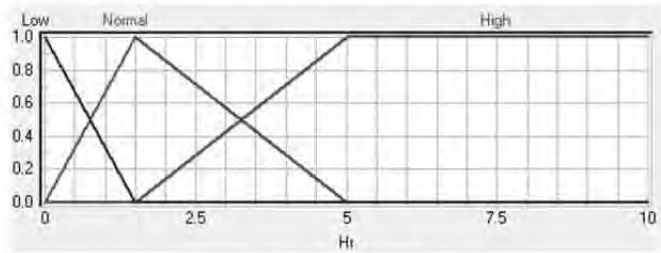


Figure 15: MBF of "Living_room_DF"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--------------------------|
| Low | linear | (0, 1) (1.5, 0) (10, 0) |
| Normal | linear | (0, 0) (1.5, 1) (5, 0) |
| High | linear | (0, 0) (1.5, 0) (5, 1) |

Table 24: Definition Points of MBF "Living_room_DF"

.24 Input Variable "Living_Vis_Area"

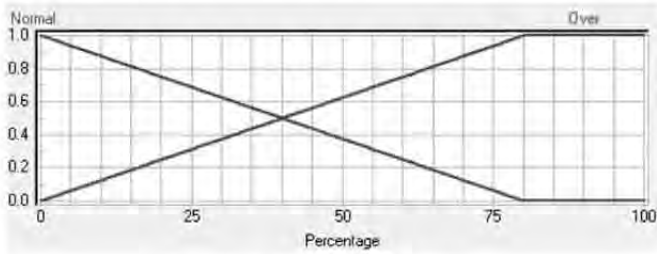


Figure 16: MBF of "Living_Vis_Area"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--------------------------|
| Normal | linear | (0, 1) (80, 0) (100, 0) |
| Over | linear | (0, 0) (80, 1) (100, 1) |

Table 25: Definition Points of MBF "Living_Vis_Area"

.25 Input Variable "M_bed_room_DF"

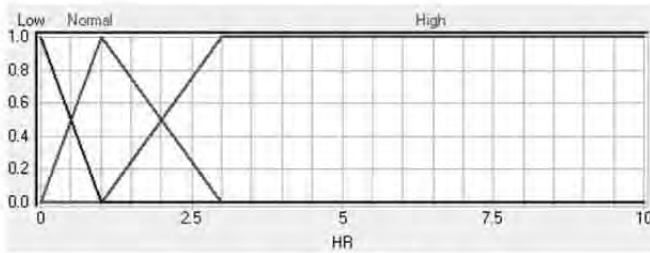


Figure 17: MBF of "M_bed_room_DF"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|------------------------------|
| Low | linear | (0, 1) (1, 0) (10, 0) |
| Normal | linear | (0, 0) (1, 1) (3, 0) |
| High | linear | (0, 0) (1, 0) (3, 1) (10, 1) |

Table 26: Definition Points of MBF "M_bed_room_DF"

.26 Input Variable "MB_Vis_A_Liv_"

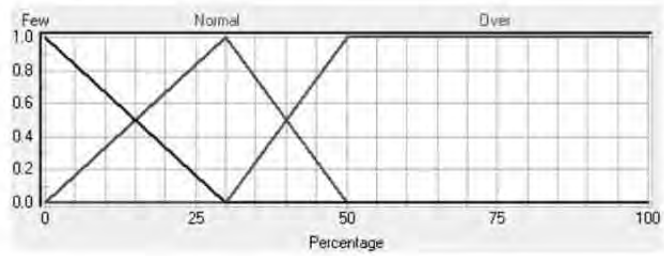


Figure 18: MBF of "MB_Vis_A_Liv_"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|---------------------------------|
| Normal | linear | (0, 0) (30, 1) (50, 0) |
| Few | linear | (0, 1) (30, 0) (100, 0) |
| Over | linear | (0, 0) (30, 0) (50, 1) (100, 1) |

Table 27: Definition Points of MBF "MB_Vis_A_Liv_"

.27 Input Variable "No_of_Bed_Rooms"

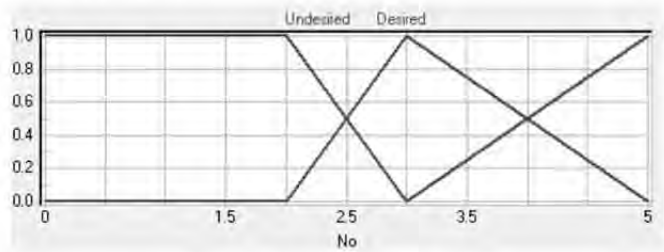


Figure 19: MBF of "No_of_Bed_Rooms"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|-----------------------------|
| Undesired | linear | (0, 1) (2, 1) (5, 0) |
| Desired | linear | (0, 0) (2, 0) (3, 1) (5, 0) |

Table 28: Definition Points of MBF "No_of_Bed_Rooms"

.28 Input Variable "No_of_children"

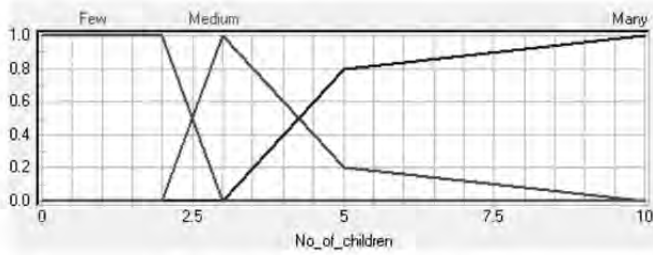


Figure 20: MBF of "No_of_children"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--|
| Few | linear | (0, 1) (2, 1) (3, 0) (10, 0) |
| Medium | linear | (0, 0) (2, 0) (3, 1) (5, 0.2) (10, 0) |
| Many | linear | (0, 0) (3, 0) (5, 0.8) (10, 1) |

Table 29: Definition Points of MBF "No_of_children"

.29 Input Variable "O_bed_rooms_DF_"

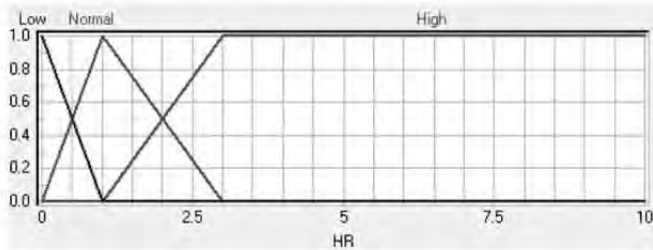


Figure 21: MBF of "O_bed_rooms_DF_"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|---------------------------------|
| Low | linear | (0, 1) (1, 0) (10, 0) |
| Normal | linear | (0, 0) (1, 1) (3, 0) (10, 0) |
| High | linear | (0, 0) (1, 0) (3, 1) (10, 1) |

Table 30: Definition Points of MBF "O_bed_rooms_DF_"

.30 Input Variable "OB_Vis_A_Liv_"

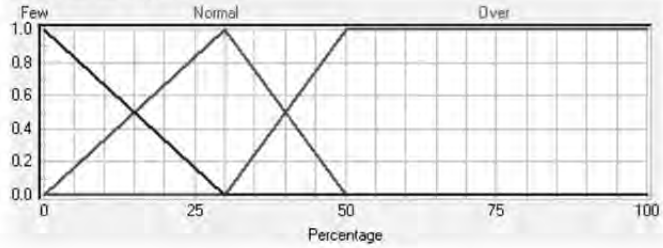


Figure 22: MBF of "OB_Vis_A_Liv_"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|------------------------------------|
| Normal | linear | (0, 0) (30, 1) (50, 0) (100, 0) |
| Few | linear | (0, 1) (30, 0) (100, 0) |
| Over | linear | (0, 0) (30, 0) (50, 1) (100, 1) |

Table 31: Definition Points of MBF "OB_Vis_A_Liv_"

.31 Input Variable "Perc_Balcony"

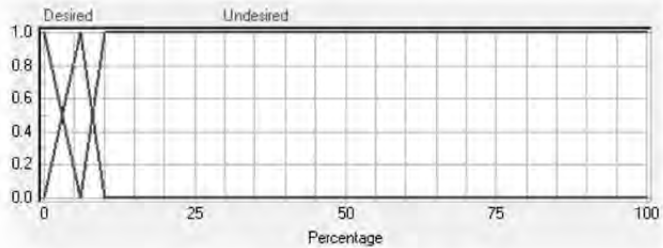


Figure 23: MBF of "Perc_Balcony"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|-----------------------------------|
| Desired | linear | (0, 0) (6, 1) (10, 0) (100, 0) |
| Undesired | linear | (0, 1) (6, 0) (10, 1) (100, 1) |

Table 32: Definition Points of MBF "Perc_Balcony"

.32 Input Variable "Perc_F_M"

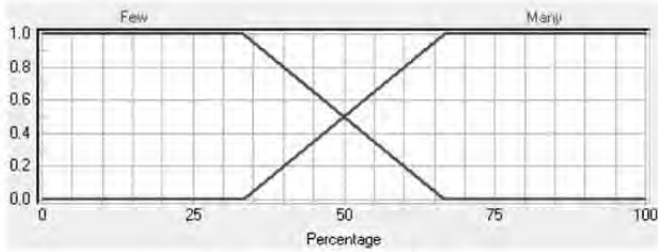


Figure 24: MBF of "Perc_F_M"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|---|
| Few | linear | (0, 1) (33.334, 1) (66.666, 0) |
| Many | linear | (0, 0) (33.334, 0) (66.666, 1) (100, 1) |

Table 33: Definition Points of MBF "Perc_F_M"

.33 Input Variable "Perc_Lobbies"

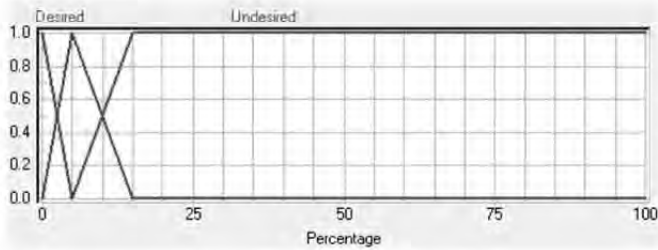


Figure 25: MBF of "Perc_Lobbies"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--------------------------------|
| Desired | linear | (0, 0) (5, 1) (15, 0) |
| Undesired | linear | (0, 1) (5, 0) (15, 1) (100, 1) |

Table 34: Definition Points of MBF "Perc_Lobbies"

.34 Input Variable "Perc_Storage"

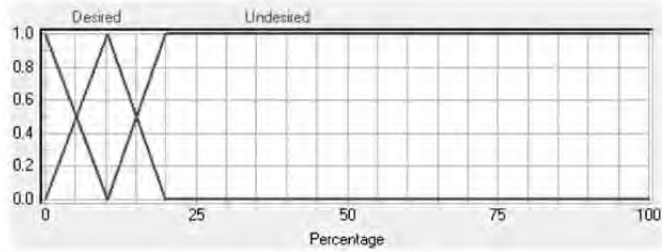


Figure 26: MBF of "Perc_Storage"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--------------------------------------|
| Desired | linear | (0, 1) (10.4, 1) (20, 0) (100, 0) |
| Undesired | linear | (0, 0) (10.4, 0) (20, 1) (100, 1) |

Table 35: Definition Points of MBF "Perc_Storage"

.35 Input Variable "Persons_Room"

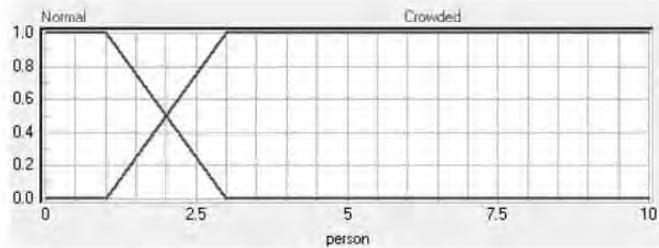


Figure 27: MBF of "Persons_Room"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|---------------------------------|
| Normal | linear | (0, 1) (1, 1) (3, 0) (10, 0) |
| Crowded | linear | (0, 0) (1, 0) (3, 1) (10, 1) |

Table 36: Definition Points of MBF "Persons_Room"

.36 Input Variable "Tot_Circul_area"

Percentage of the total used area for circulation

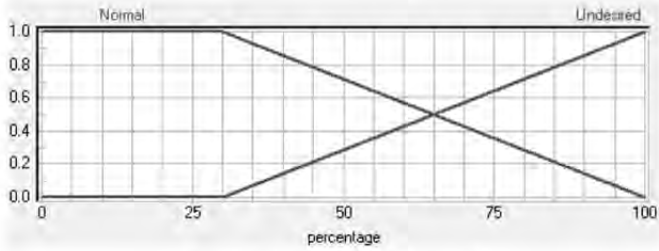


Figure 28: MBF of "Tot_Circul_area"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--------------------------|
| Normal | linear | (0, 1) (30, 1) (100, 0) |
| Undesired | linear | (0, 0) (30, 0) (100, 1) |

Table 37: Definition Points of MBF "Tot_Circul_area"

.37 Input Variable "Tot_Occ_area_EF"

Percentage of the total occupied area with elevated furniture

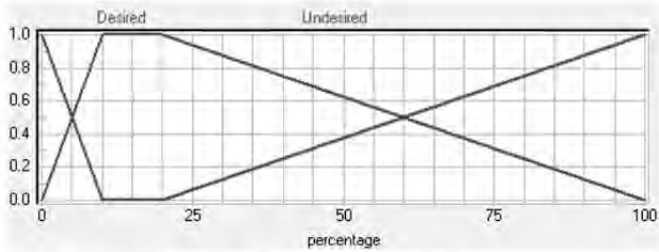


Figure 29: MBF of "Tot_Occ_area_EF"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--------------------------|
| Desired | linear | (0, 0) (10, 1) (20, 1) |
| Undesired | linear | (0, 1) (10, 0) (20, 0) |

Table 38: Definition Points of MBF "Tot_Occ_area_EF"

.38 Input Variable "Tot_Occ_area_fur"

Percentage of the total occupied area with fixed furniture

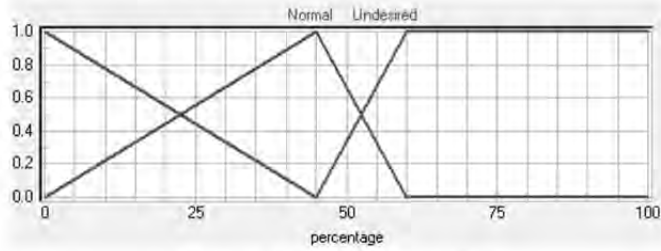


Figure 30: MBF of "Tot_Occ_area_fur"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|------------------------------------|
| Normal | linear | (0, 0) (45, 1) (60, 0) (100, 0) |
| Undesired | linear | (0, 1) (45, 0) (60, 1) (100, 1) |

Table 39: Definition Points of MBF "Tot_Occ_area_fur"

.39 Input Variable "Tot_Occ_area_str"

Percentage of the total occupied area used for storage

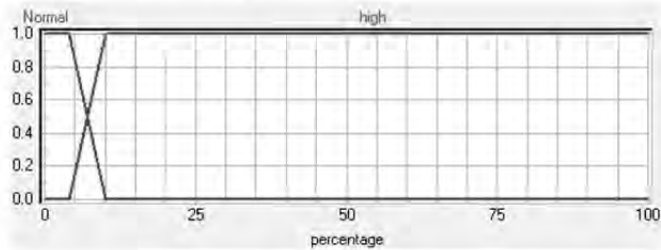


Figure 31: MBF of "Tot_Occ_area_str"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|-----------------------------------|
| Normal | linear | (0, 1) (4, 1) (10, 0) (100, 0) |
| high | linear | (0, 0) (4, 0) (10, 1) (100, 1) |

Table 40: Definition Points of MBF "Tot_Occ_area_str"

.40 Input Variable "Tot_Occ_area_TF"

Percentage of the total occupied area with temporary furniture

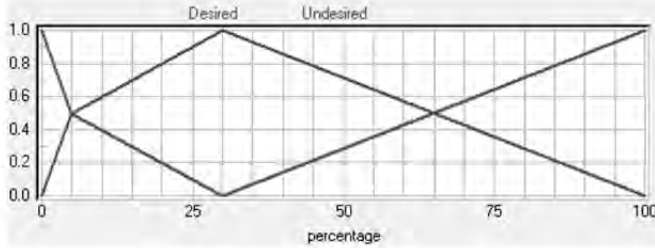


Figure 32: MBF of "Tot_Occ_area_TF"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|----------------------------------|
| Desired | linear | (0, 0) (5, 0.5) (30, 1) (100, 0) |
| Undesired | linear | (0, 1) (5, 0.5) (30, 0) (100, 1) |

Table 41: Definition Points of MBF "Tot_Occ_area_TF"

.41 Input Variable "Tot_Used_area"

Percentage of the total usable area

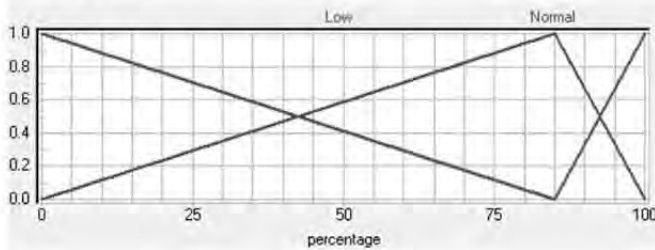


Figure 33: MBF of "Tot_Used_area"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--------------------------|
| Low | linear | (0, 1) (85, 0) (100, 1) |
| Normal | linear | (0, 0) (85, 1) (100, 0) |

Table 42: Definition Points of MBF "Tot_Used_area"

.42 Input Variable "Total_Area"

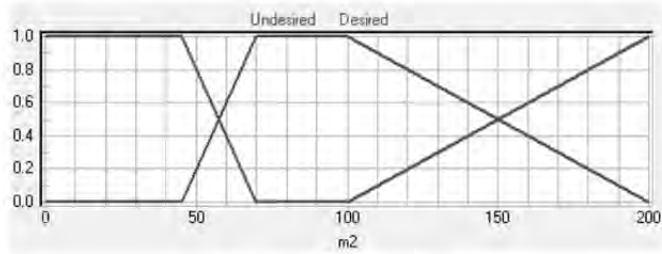


Figure 34: MBF of "Total_Area"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--|
| Undesired | linear | (0, 1) (45, 1) (70, 0) |
| Desired | linear | (0, 0) (45, 0) (70, 1) (100, 1) (200, 0) |

Table 43: Definition Points of MBF "Total_Area"

.43 Input Variable "Used_empty_area"

Percentage of the total used empty (unoccupied) area

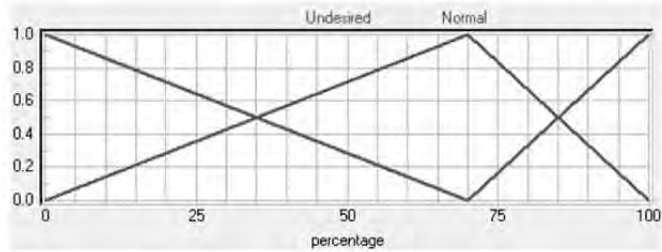


Figure 35: MBF of "Used_empty_area"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--------------------------|
| Undesired | linear | (0, 1) (70, 0) (100, 1) |
| Normal | linear | (0, 0) (70, 1) (100, 0) |

Table 44: Definition Points of MBF "Used_empty_area"

.44 Input Variable "Vis_Area_Liv"

Determining all visible area of the dwelling from the center of the living room

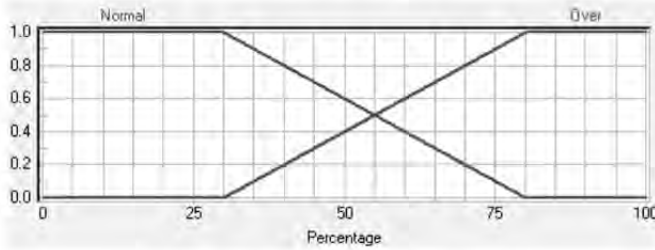


Figure 36: MBF of "Vis_Area_Liv"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|------------------------------------|
| Normal | linear | (0, 1) (30, 1) (80, 0) (100, 0) |
| Over | linear | (0, 0) (30, 0) (80, 1) (100, 1) |

Table 45: Definition Points of MBF "Vis_Area_Liv"

.45 Input Variable "Woking_at_home"

| Term Name |
|-----------|
| 000 yes |
| 001 no |

Table 46: Term Names of "Woking_at_home"

.46 Output Variable "Crowding_indicat"

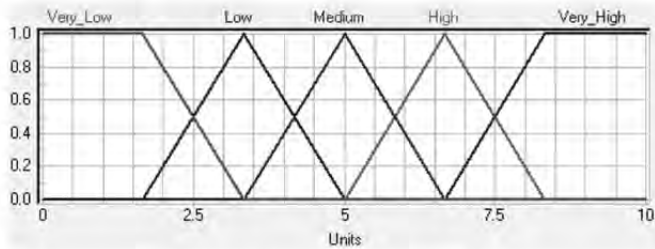


Figure 37: MBF of "Crowding_indicat"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--|
| Very_Low | linear | (0, 1) (10, 0) (1.6666, 1) (3.3334, 0) |
| Low | linear | (0, 0) (5, 0) (1.6666, 0) (3.3334, 1) (10, 0) |
| Medium | linear | (0, 0) (6.6666, 0) (3.3334, 0) (5, 1) (10, 0) |
| High | linear | (0, 0) (8.3332, 0) (5, 0) (6.6666, 1) (10, 0) |
| Very_High | linear | (0, 0) (10, 1) (6.6666, 0) (8.3332, 1) |

Table 47: Definition Points of MBF "Crowding_indicat"

.47 Output Variable "D_Dwelling_Accep"

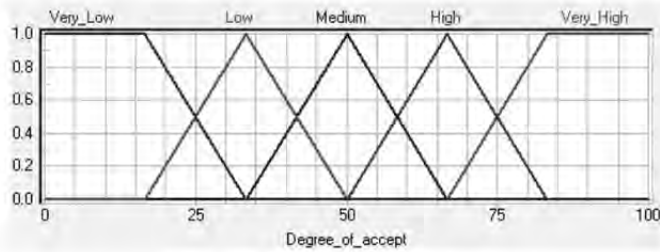


Figure 38: MBF of "D_Dwelling_Accep"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--|
| Very_Low | linear | (0, 1) (100, 0) (16.666, 1) (33.332, 0) |
| Low | linear | (0, 0) (50, 0) (16.666, 0) (33.332, 1) (100, 0) |
| Medium | linear | (0, 0) (66.666, 0) (33.332, 0) (50, 1) (100, 0) |
| High | linear | (0, 0) (83.332, 0) (50, 0) (66.666, 1) (100, 0) |
| Very_High | linear | (0, 0) (100, 1) (66.666, 0) (83.332, 1) |

Table 48: Definition Points of MBF "D_Dwelling_Accep"

.48 Output Variable "Error_Factor"

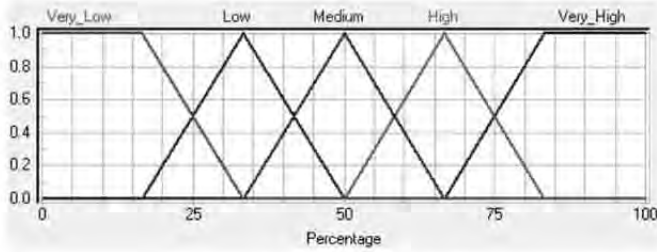


Figure 39: MBF of "Error_Factor"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--------------------------------|
| Very_Low | linear | (0, 1) (16.666, 1) (33.332, 0) |
| Low | linear | (0, 0) (16.666, 0) (33.332, 1) |
| Medium | linear | (0, 0) (33.332, 0) (50, 1) |
| High | linear | (0, 0) (50, 0) (66.666, 1) |
| Very_High | linear | (0, 0) (66.666, 0) (83.332, 1) |

Table 49: Defintion Points of MBF "Error_Factor"

.49 Output Variable "F_Efficiency"

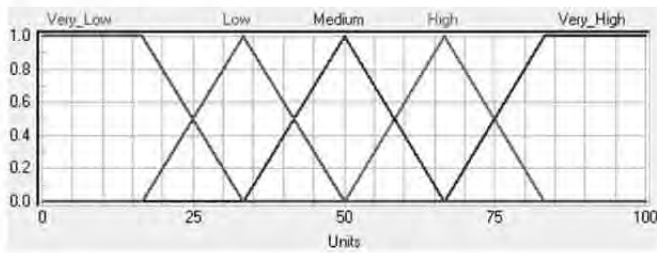


Figure 40: MBF of "F_Efficiency"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--------------------------------|
| Very_Low | linear | (0, 1) (16.666, 1) (33.332, 0) |
| Low | linear | (0, 0) (16.666, 0) (33.332, 1) |
| Medium | linear | (0, 0) (33.332, 0) (50, 1) |
| High | linear | (0, 0) (50, 0) (66.666, 1) |
| Very_High | linear | (0, 0) (66.666, 0) (83.332, 1) |

Table 50: Definition Points of MBF "F_Efficiency"

.50 Output Variable "Life_style_ind"

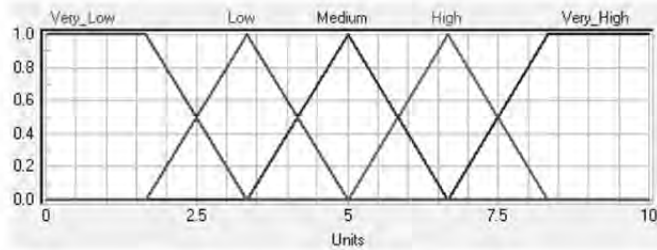


Figure 41: MBF of "Life_style_ind"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|---|
| Very_Low | linear | (0, 1) (10, 0) |
| Low | linear | (0, 0) (1.6666, 0) (3.3334, 1) (5, 0) (10, 0) |
| Medium | linear | (0, 0) (3.3334, 0) (5, 1) (6.6666, 0) (10, 0) |
| High | linear | (0, 0) (5, 0) (6.6666, 1) (8.3332, 0) (10, 0) |
| Very_High | linear | (0, 0) (6.6666, 0) (8.3332, 1) (10, 1) |

Table 51: Definition Points of MBF "Life_style_ind"

.51 Output Variable "Spatial_Accep"

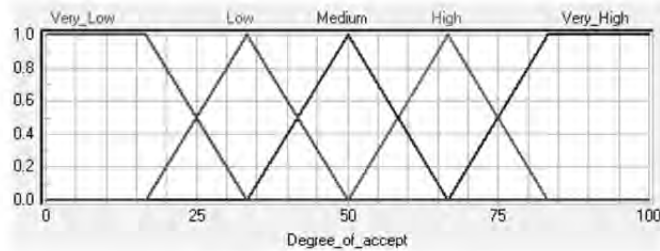


Figure 42: MBF of "Spatial_Accep"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|---|
| Very_Low | linear | (0, 1) (100, 0) |
| Low | linear | (0, 0) (16.666, 0) (33.332, 1) (50, 0) (100, 0) |
| Medium | linear | (0, 0) (33.332, 0) (50, 1) (66.666, 0) (100, 0) |
| High | linear | (0, 0) (50, 0) (66.666, 1) (83.332, 0) (100, 0) |

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--|
| Very_High | linear | (0, 0) (66.666, 0) (83.332, 1) (100, 1) |

Table 52: Definition Points of MBF "Spatial_Accep"

.52 Output Variable "Spatial_Accep_en"

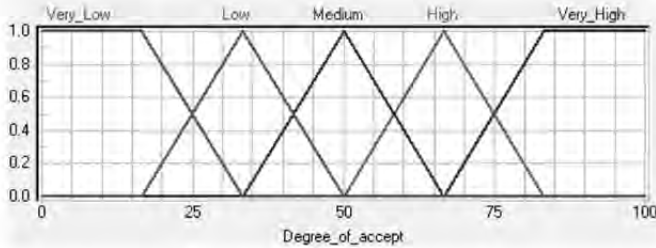


Figure 43: MBF of "Spatial_Accep_en"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--|
| Very_Low | linear | (0, 1) (16.666, 1) (33.332, 0) (100, 0) |
| Low | linear | (0, 0) (16.666, 0) (33.332, 1) (50, 0) (100, 0) |
| Medium | linear | (0, 0) (33.332, 0) (50, 1) (66.666, 0) (100, 0) |
| High | linear | (0, 0) (50, 0) (66.666, 1) (83.332, 0) (100, 0) |
| Very_High | linear | (0, 0) (66.666, 0) (83.332, 1) (100, 1) |

Table 53: Definition Points of MBF "Spatial_Accep_en"

.53 Output Variable "Spatial_Accep_Li"

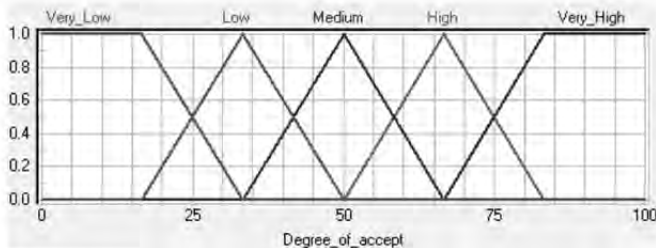


Figure 44: MBF of "Spatial_Accep_Li"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--|
| Very_Low | linear | (0, 1) (100, 0) |
| Low | linear | (0, 0) (50, 0) (16.666, 1) (33.332, 1) |
| Medium | linear | (0, 0) (66.666, 0) (33.332, 1) (100, 1) |
| High | linear | (0, 0) (83.332, 0) (50, 1) (100, 1) |
| Very_High | linear | (0, 0) (100, 1) (66.666, 0) (83.332, 0) |

Table 54: Definition Points of MBF "Spatial_Accep_Li"

.54 Output Variable "T_Group_Accept"

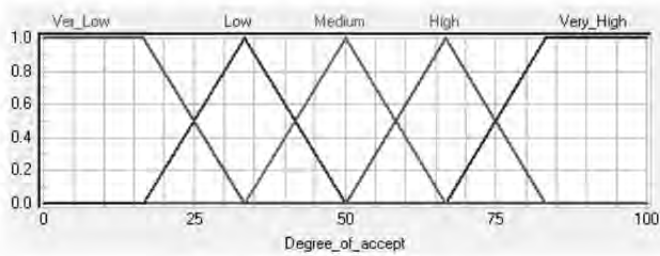


Figure 45: MBF of "T_Group_Accept"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--|
| Ver_Low | linear | (0, 1) (100, 0) |
| Low | linear | (0, 0) (50, 0) (16.666, 1) (33.332, 1) |
| Medium | linear | (0, 0) (66.666, 0) (33.332, 1) (100, 1) |
| High | linear | (0, 0) (83.332, 0) (50, 1) (100, 1) |
| Very_High | linear | (0, 0) (100, 1) (66.666, 0) (83.332, 0) |

Table 55: Definition Points of MBF "T_Group_Accept"

.55 Output Variable "Use_Accep"

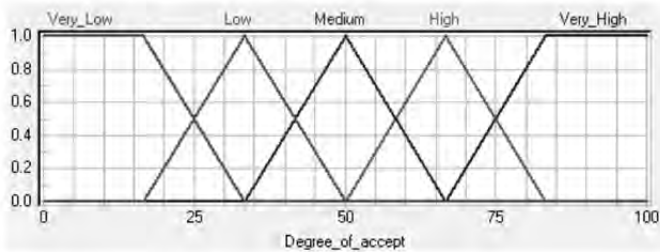


Figure 46: MBF of "Use_Accep"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--|
| Very_Low | linear | (0, 1) (100, 0) |
| Low | linear | (0, 0) (50, 0) (16.666, 1) (33.332, 1) |
| Medium | linear | (0, 0) (66.666, 0) (33.332, 1) (100, 1) |
| High | linear | (0, 0) (83.332, 0) (50, 1) (66.666, 1) |
| Very_High | linear | (0, 0) (100, 1) (66.666, 0) (83.332, 0) |

Table 56: Definition Points of MBF "Use_Accep"

.56 Output Variable "Use_Factor_"

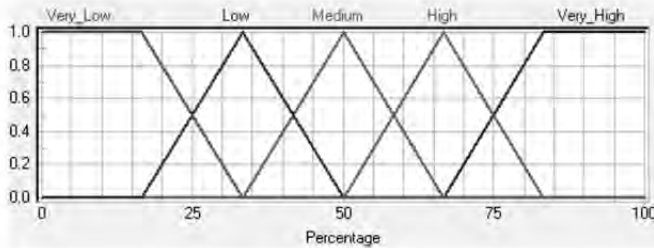


Figure 47: MBF of "Use_Factor_"

| Term Name | Shape/Par. | Definition Points (x, y) |
|-----------|------------|--|
| Very_Low | linear | (0, 1) (100, 0) |
| Low | linear | (0, 0) (50, 0) (16.666, 1) (33.332, 1) |
| Medium | linear | (0, 0) (66.666, 0) (33.332, 1) (100, 1) |
| High | linear | (0, 0) (83.332, 0) (50, 1) (66.666, 1) |
| Very_High | linear | (0, 0) (100, 1) (66.666, 0) (83.332, 0) |

Table 57: Definition Points of MBF "Use_Factor_"

.4 Rule Blocks

The rule blocks contain the control strategy of a fuzzy logic system. Each rule block confines all rules for the same context. A context is defined by the same input and output variables of the rules.

The rules' 'if' part describes the situation, for which the rules are designed. The 'then' part describes the response of the fuzzy system in this situation. The degree of support (DoS) is used to weigh each rule according to its importance.

The processing of the rules starts with calculating the 'if' part. The operator type of the rule block determines which method is used. The operator types MIN-MAX, MIN-AVG and GAMMA are available. The characteristic of each operator type is influenced by an additional parameter.

For example:

- MIN-MAX, parameter value 0 = Minimum Operator (MIN)
- MIN-MAX, parameter value 1 = Maximum Operator (MAX)
- GAMMA, parameter value 0 = Product Operator (PROD)

The minimum operator is a generalization of the Boolean 'and'; the maximum operator is a generalization of the Boolean 'or'.

The fuzzy composition eventually combines the different rules to one conclusion. If the BSUM method is used all firing rules are evaluated, if the MAX method is used only the dominant rules are evaluated.

.1 Rule Block "RB1_Family_Check"

| | |
|---------------------|--------|
| Parameter | |
| Aggregation: | MINMAX |
| Parameter: | 0,00 |
| Result Aggregation: | BSUM |
| Number of Inputs: | 4 |
| Number of Outputs: | 1 |
| Number of Rules: | 16 |

| IF | | | | THEN | |
|-------------|----------------|----------|----------------|------|----------------|
| Family Size | No of children | Perc F_M | Woking at home | DoS | T Group Accept |
| Small | Few | Few | yes | 1.00 | High |
| Small | Few | Few | no | 1.00 | Very High |
| Small | Few | Many | yes | 1.00 | Medium |
| Small | Few | Many | no | 1.00 | Very High |
| Normal | Few | Few | yes | 1.00 | Medium |
| Normal | Few | Few | no | 1.00 | Very High |
| Normal | Few | Many | yes | 1.00 | Medium |
| Normal | Few | Many | no | 1.00 | High |
| Normal | Medium | Few | yes | 1.00 | Medium |
| Normal | Medium | Few | no | 1.00 | High |
| Normal | Medium | Many | yes | 1.00 | Low |
| Normal | Medium | Many | no | 1.00 | Medium |
| Large | Many | Few | yes | 1.00 | Ver Low |
| Large | Many | Few | no | 1.00 | Low |
| Large | Many | Many | yes | 1.00 | Ver Low |
| Large | Many | Many | no | 1.00 | Low |

Table 58: Rules of the Rule Block "RB1_Family_Check"

2 Rule Block "RB2_D_dwelling_check"

Parameter

Aggregation: MINMAX
 Parameter: 0.00
 Result Aggregation: BSUM
 Number of Inputs: 7
 Number of Outputs: 1
 Number of Rules: 128

| IF | | | | | | | THEN | |
|------------------|----------------|-----------------|---------------|---------------|---------------|------------|------|------------------|
| Area_living room | Area_Servic es | No_of_Bed Rooms | Perc_Balco ny | Perc_Lobbi es | Perc_Stora ge | Total_Area | DoS | D_Dwelling Accep |
| Undesired | Undesired | Undesired | Desired | Desired | Desired | Undesired | 1.00 | Very High |
| Undesired | Undesired | Undesired | Desired | Desired | Desired | Desired | 1.00 | Low |
| Undesired | Undesired | Undesired | Desired | Desired | Undesired | Undesired | 1.00 | Very Low |
| Undesired | Undesired | Undesired | Desired | Desired | Undesired | Desired | 1.00 | Low |
| Undesired | Undesired | Undesired | Desired | Undesired | Desired | Undesired | 1.00 | Very Low |
| Undesired | Undesired | Undesired | Desired | Undesired | Desired | Desired | 1.00 | Low |
| Undesired | Undesired | Undesired | Desired | Undesired | Undesired | Undesired | 1.00 | Very Low |
| Undesired | Undesired | Undesired | Undesired | Desired | Desired | Undesired | 1.00 | Very Low |
| Undesired | Undesired | Undesired | Undesired | Desired | Desired | Desired | 1.00 | Low |
| Undesired | Undesired | Undesired | Undesired | Desired | Undesired | Undesired | 1.00 | Very Low |
| Undesired | Undesired | Undesired | Undesired | Desired | Undesired | Desired | 1.00 | Low |
| Undesired | Undesired | Undesired | Undesired | Desired | Desired | Undesired | 1.00 | Very Low |
| Undesired | Undesired | Undesired | Undesired | Desired | Desired | Desired | 1.00 | Low |
| Undesired | Undesired | Undesired | Undesired | Undesired | Desired | Undesired | 1.00 | Very Low |
| Undesired | Undesired | Undesired | Undesired | Undesired | Desired | Desired | 1.00 | Low |
| Undesired | Undesired | Desired | Desired | Desired | Desired | Undesired | 1.00 | Low |
| Undesired | Undesired | Desired | Desired | Desired | Desired | Desired | 1.00 | High |
| Undesired | Undesired | Desired | Desired | Desired | Undesired | Undesired | 1.00 | Low |
| Undesired | Undesired | Desired | Desired | Desired | Undesired | Desired | 1.00 | Medium |
| Undesired | Undesired | Desired | Desired | Undesired | Desired | Undesired | 1.00 | Low |
| Undesired | Undesired | Desired | Desired | Undesired | Desired | Desired | 1.00 | Medium |
| Undesired | Undesired | Desired | Desired | Undesired | Undesired | Undesired | 1.00 | Low |
| Undesired | Undesired | Desired | Desired | Undesired | Desired | Undesired | 1.00 | Medium |
| Undesired | Undesired | Desired | Desired | Undesired | Desired | Desired | 1.00 | Low |
| Undesired | Undesired | Desired | Desired | Undesired | Undesired | Undesired | 1.00 | Medium |
| Undesired | Undesired | Desired | Desired | Undesired | Desired | Undesired | 1.00 | Low |
| Undesired | Undesired | Desired | Desired | Undesired | Desired | Desired | 1.00 | Medium |
| Undesired | Undesired | Desired | Desired | Undesired | Undesired | Undesired | 1.00 | Very Low |
| Undesired | Undesired | Desired | Desired | Undesired | Undesired | Desired | 1.00 | Medium |
| Undesired | Desired | Undesired | Desired | Desired | Desired | Undesired | 1.00 | Low |
| Undesired | Desired | Undesired | Desired | Desired | Desired | Desired | 1.00 | Medium |
| Undesired | Desired | Undesired | Desired | Desired | Undesired | Undesired | 1.00 | Low |
| Undesired | Desired | Undesired | Desired | Desired | Undesired | Desired | 1.00 | Medium |
| Undesired | Desired | Undesired | Desired | Desired | Desired | Undesired | 1.00 | Low |
| Undesired | Desired | Undesired | Desired | Desired | Desired | Desired | 1.00 | Medium |
| Undesired | Desired | Undesired | Desired | Desired | Undesired | Undesired | 1.00 | Very Low |
| Undesired | Desired | Undesired | Desired | Desired | Undesired | Desired | 1.00 | Low |
| Undesired | Desired | Undesired | Desired | Desired | Undesired | Undesired | 1.00 | Very Low |
| Undesired | Desired | Undesired | Desired | Desired | Desired | Desired | 1.00 | Medium |
| Undesired | Desired | Undesired | Desired | Desired | Undesired | Undesired | 1.00 | Very Low |
| Undesired | Desired | Undesired | Desired | Desired | Undesired | Desired | 1.00 | Medium |
| Undesired | Desired | Undesired | Desired | Desired | Desired | Undesired | 1.00 | Very Low |
| Undesired | Desired | Undesired | Desired | Desired | Desired | Desired | 1.00 | Medium |

| IF | | | | | | | THEN | |
|---------|---------|-----------|-----------|-----------|-----------|-----------|------|-----------|
| Desired | Desired | Undesired | Undesired | Desired | Undesired | Desired | 1.00 | Medium |
| Desired | Desired | Undesired | Undesired | Undesired | Desired | Undesired | 1.00 | Low |
| Desired | Desired | Undesired | Undesired | Undesired | Desired | Desired | 1.00 | Medium |
| Desired | Desired | Undesired | Undesired | Undesired | Undesired | Undesired | 1.00 | Low |
| Desired | Desired | Undesired | Undesired | Undesired | Undesired | Desired | 1.00 | Medium |
| Desired | Desired | Desired | Desired | Desired | Desired | Undesired | 1.00 | Medium |
| Desired | Desired | Desired | Desired | Desired | Desired | Desired | 1.00 | Very High |
| Desired | Desired | Desired | Desired | Desired | Undesired | Undesired | 1.00 | Medium |
| Desired | Desired | Desired | Desired | Desired | Undesired | Desired | 1.00 | Very High |
| Desired | Desired | Desired | Desired | Desired | Undesired | Undesired | 1.00 | Medium |
| Desired | Desired | Desired | Desired | Undesired | Desired | Undesired | 1.00 | Medium |
| Desired | Desired | Desired | Desired | Undesired | Undesired | Desired | 1.00 | Very High |
| Desired | Desired | Desired | Desired | Undesired | Undesired | Undesired | 1.00 | Medium |
| Desired | Desired | Desired | Desired | Undesired | Undesired | Desired | 1.00 | High |
| Desired | Desired | Desired | Undesired | Desired | Desired | Undesired | 1.00 | Medium |
| Desired | Desired | Desired | Undesired | Desired | Desired | Desired | 1.00 | Very High |
| Desired | Desired | Desired | Undesired | Desired | Undesired | Undesired | 1.00 | Medium |
| Desired | Desired | Desired | Undesired | Undesired | Desired | Undesired | 1.00 | High |
| Desired | Desired | Desired | Undesired | Undesired | Desired | Desired | 1.00 | Very High |
| Desired | Desired | Desired | Undesired | Undesired | Undesired | Undesired | 1.00 | Medium |
| Desired | Desired | Desired | Undesired | Undesired | Undesired | Desired | 1.00 | High |

Table 59: Rules of the Rule Block "RB2_D_dwelling_check"

.3 Rule Block "RB3_Spatial_check"

Parameter

Aggregation: MINMAX
 Parameter: 0,00
 Result Aggregation: BSUM
 Number of Inputs: 2
 Number of Outputs: 1
 Number of Rules: 25

| IF | | THEN | |
|------------------|------------------|------|---------------|
| Spatial Accep en | Spatial Accep Li | DoS | Spatial Accep |
| Very Low | Very Low | 1.00 | Very Low |
| Very Low | Low | 1.00 | Very Low |
| Very Low | Medium | 1.00 | Low |
| Very Low | High | 1.00 | Low |
| Very Low | Very High | 1.00 | Medium |
| Low | Very Low | 1.00 | Very Low |
| Low | Low | 1.00 | Low |
| Low | Medium | 1.00 | Low |
| Low | High | 1.00 | Medium |
| Low | Very High | 1.00 | High |
| Medium | Very Low | 1.00 | Low |
| Medium | Low | 1.00 | Low |
| Medium | Medium | 1.00 | Medium |
| Medium | High | 1.00 | High |
| Medium | Very High | 1.00 | High |
| High | Very Low | 1.00 | Low |
| High | Low | 1.00 | Medium |
| High | Medium | 1.00 | High |
| High | High | 1.00 | High |
| High | Very High | 1.00 | Very High |
| Very High | Very Low | 1.00 | Medium |

| IF | | THEN | |
|-----------|-----------|------|-----------|
| Very High | Low | 1.00 | High |
| Very High | Medium | 1.00 | High |
| Very High | High | 1.00 | Very High |
| Very High | Very High | 1.00 | Very High |

Table 60: Rules of the Rule Block "RB3_Spatial_check"

4 Rule Block "RB3_Vis_En"

Parameter
 Aggregation: MINMAX
 Parameter: 0.00
 Result Aggregation: BSUM
 Number of Inputs: 3
 Number of Outputs: 1
 Number of Rules: 8

| IF | | | THEN | |
|----------------|------------------|-----------------|------|------------------|
| Enter_Vis_Area | Kitchen_Vis_A_En | Living_Vis_Area | DoS | Spatial_Accep_en |
| Normal | Normal | Normal | 1.00 | Very High |
| Normal | Normal | Over | 1.00 | Medium |
| Normal | Over | Normal | 1.00 | High |
| Normal | Over | Over | 1.00 | Medium |
| Over | Normal | Normal | 1.00 | Medium |
| Over | Normal | Over | 1.00 | Low |
| Over | Over | Normal | 1.00 | Medium |
| Over | Over | Over | 1.00 | Very Low |

Table 61: Rules of the Rule Block "RB3_Vis_En"

5 Rule Block "RB3_Vis_Liv"

Parameter
 Aggregation: MINMAX
 Parameter: 0.00
 Result Aggregation: BSUM
 Number of Inputs: 6
 Number of Outputs: 1
 Number of Rules: 144

| IF | | | | | | THEN | |
|-----------------|----------------|-----------------|--------------|--------------|--------------|------|-------------------|
| Balco_Vis_A_Liv | Bath_Vis_A_Liv | Kitch_Vis_A_Liv | MB_Vis_A_Liv | OB_Vis_A_Liv | Vis_Area_Liv | DoS | Spatial_Accep_Liv |
| Less | Normal | Normal | Normal | Normal | Normal | 1.00 | High |
| Less | Normal | Normal | Normal | Normal | Over | 1.00 | High |
| Less | Normal | Normal | Normal | Few | Normal | 1.00 | High |
| Less | Normal | Normal | Normal | Few | Over | 1.00 | Medium |
| Less | Normal | Normal | Normal | Over | Normal | 1.00 | High |
| Less | Normal | Normal | Normal | Over | Over | 1.00 | Medium |
| Less | Normal | Normal | Few | Normal | Normal | 1.00 | High |
| Less | Normal | Normal | Few | Normal | Over | 1.00 | Medium |
| Less | Normal | Normal | Few | Few | Normal | 1.00 | High |
| Less | Normal | Normal | Few | Few | Over | 1.00 | Medium |
| Less | Normal | Normal | Few | Over | Normal | 1.00 | Medium |

| IF | | | | | | THEN | |
|------|--------|--------|--------|--------|--------|------|----------|
| Less | Normal | Normal | Few | Over | Over | 1.00 | Medium |
| Less | Normal | Normal | Over | Normal | Normal | 1.00 | High |
| Less | Normal | Normal | Over | Normal | Over | 1.00 | Medium |
| Less | Normal | Normal | Over | Few | Normal | 1.00 | Medium |
| Less | Normal | Normal | Over | Few | Over | 1.00 | Medium |
| Less | Normal | Normal | Over | Over | Normal | 1.00 | Medium |
| Less | Normal | Normal | Over | Over | Over | 1.00 | Medium |
| Less | Normal | Over | Normal | Normal | Normal | 1.00 | Medium |
| Less | Normal | Over | Normal | Normal | Over | 1.00 | Medium |
| Less | Normal | Over | Normal | Few | Normal | 1.00 | Medium |
| Less | Normal | Over | Normal | Few | Over | 1.00 | Medium |
| Less | Normal | Over | Normal | Over | Normal | 1.00 | Medium |
| Less | Normal | Over | Normal | Over | Over | 1.00 | Medium |
| Less | Normal | Over | Few | Normal | Normal | 1.00 | Medium |
| Less | Normal | Over | Few | Normal | Over | 1.00 | Medium |
| Less | Normal | Over | Few | Few | Normal | 1.00 | Medium |
| Less | Normal | Over | Few | Few | Over | 1.00 | Medium |
| Less | Normal | Over | Few | Over | Normal | 1.00 | Medium |
| Less | Normal | Over | Few | Over | Over | 1.00 | Low |
| Less | Normal | Over | Over | Normal | Normal | 1.00 | Medium |
| Less | Normal | Over | Over | Normal | Over | 1.00 | Medium |
| Less | Normal | Over | Over | Few | Normal | 1.00 | Medium |
| Less | Normal | Over | Over | Few | Over | 1.00 | Low |
| Less | Normal | Over | Over | Over | Normal | 1.00 | Medium |
| Less | Normal | Over | Over | Over | Over | 1.00 | Low |
| Less | Over | Normal | Normal | Normal | Normal | 1.00 | Medium |
| Less | Over | Normal | Normal | Normal | Over | 1.00 | Medium |
| Less | Over | Normal | Normal | Few | Normal | 1.00 | Medium |
| Less | Over | Normal | Normal | Few | Over | 1.00 | Medium |
| Less | Over | Normal | Normal | Over | Normal | 1.00 | Medium |
| Less | Over | Normal | Normal | Over | Over | 1.00 | Medium |
| Less | Over | Normal | Few | Normal | Normal | 1.00 | Medium |
| Less | Over | Normal | Few | Normal | Over | 1.00 | Medium |
| Less | Over | Normal | Few | Few | Normal | 1.00 | Medium |
| Less | Over | Normal | Few | Few | Over | 1.00 | Medium |
| Less | Over | Normal | Few | Over | Normal | 1.00 | Medium |
| Less | Over | Normal | Few | Over | Over | 1.00 | Low |
| Less | Over | Normal | Over | Normal | Normal | 1.00 | Medium |
| Less | Over | Normal | Over | Normal | Over | 1.00 | Medium |
| Less | Over | Normal | Over | Few | Normal | 1.00 | Medium |
| Less | Over | Normal | Over | Few | Over | 1.00 | Low |
| Less | Over | Normal | Over | Over | Normal | 1.00 | Medium |
| Less | Over | Normal | Over | Over | Over | 1.00 | Low |
| Less | Over | Over | Normal | Normal | Normal | 1.00 | Medium |
| Less | Over | Over | Normal | Normal | Over | 1.00 | Medium |
| Less | Over | Over | Normal | Few | Normal | 1.00 | Medium |
| Less | Over | Over | Normal | Few | Over | 1.00 | Low |
| Less | Over | Over | Normal | Over | Normal | 1.00 | Low |
| Less | Over | Over | Normal | Over | Over | 1.00 | Low |
| Less | Over | Over | Few | Normal | Normal | 1.00 | Medium |
| Less | Over | Over | Few | Normal | Over | 1.00 | Low |
| Less | Over | Over | Few | Few | Normal | 1.00 | Low |
| Less | Over | Over | Few | Few | Over | 1.00 | Low |
| Less | Over | Over | Few | Over | Normal | 1.00 | Low |
| Less | Over | Over | Few | Over | Over | 1.00 | Low |
| Less | Over | Over | Over | Normal | Normal | 1.00 | Low |
| Less | Over | Over | Over | Normal | Over | 1.00 | Low |
| Less | Over | Over | Over | Few | Normal | 1.00 | Low |
| Less | Over | Over | Over | Few | Over | 1.00 | Low |
| Less | Over | Over | Over | Over | Normal | 1.00 | Low |
| Less | Over | Over | Over | Over | Over | 1.00 | Very Low |

| IF | | | | | | THEN | |
|--------|------|------|------|--------|--------|------|--------|
| Normal | Over | Over | Few | Normal | Over | 1.00 | Medium |
| Normal | Over | Over | Few | Few | Normal | 1.00 | Medium |
| Normal | Over | Over | Few | Few | Over | 1.00 | Low |
| Normal | Over | Over | Few | Over | Normal | 1.00 | Medium |
| Normal | Over | Over | Few | Over | Over | 1.00 | Low |
| Normal | Over | Over | Over | Normal | Normal | 1.00 | Medium |
| Normal | Over | Over | Over | Normal | Over | 1.00 | Low |
| Normal | Over | Over | Over | Few | Normal | 1.00 | Medium |
| Normal | Over | Over | Over | Few | Over | 1.00 | Low |
| Normal | Over | Over | Over | Over | Normal | 1.00 | Low |
| Normal | Over | Over | Over | Over | Over | 1.00 | Low |

Table 62: Rules of the Rule Block "RB3_Vis_Liv"

6 Rule Block "RB4_Use_Check"

Parameter

Aggregation: MINMAX
 Parameter: 0.00
 Result Aggregation: BSUM
 Number of Inputs: 8
 Number of Outputs: 1
 Number of Rules: 256

| IF | | | | | | | | THEN | |
|---------------------|---------------------|---------------------|----------------------|----------------------|---------------------|-------------------|---------------------|------|----------------|
| Activ_sha r_area | Tot_Circu l_area | Tot_Occ_a rea EF | Tot_Occ_a rea fur | Tot_Occ_a rea str | Tot_Occ_a rea TF | Tot_Used _area | Used_emp ty_area | DoS | Use_Facto r |
| Undesired | Undesired | Undesired | Undesired | Normal | Undesired | Low | Undesired | 1.00 | Medium |
| Undesired | Undesired | Undesired | Undesired | Normal | Undesired | Low | Normal | 1.00 | Medium |
| Undesired | Undesired | Undesired | Undesired | Normal | Undesired | Normal | Undesired | 1.00 | Medium |
| Undesired | Undesired | Undesired | Undesired | Normal | Undesired | Normal | Normal | 1.00 | High |
| Undesired | Undesired | Undesired | Undesired | Normal | Desired | Low | Undesired | 1.00 | Medium |
| Undesired | Undesired | Undesired | Undesired | Normal | Desired | Low | Normal | 1.00 | High |
| Undesired | Undesired | Undesired | Undesired | Normal | Desired | Normal | Undesired | 1.00 | High |
| Undesired | Undesired | Undesired | Undesired | Normal | Desired | Normal | Normal | 1.00 | High |
| Undesired | Undesired | Undesired | Undesired | high | Undesired | Low | Undesired | 1.00 | Low |
| Undesired | Undesired | Undesired | Undesired | high | Undesired | Low | Normal | 1.00 | Medium |
| Undesired | Undesired | Undesired | Undesired | high | Undesired | Normal | Undesired | 1.00 | Medium |
| Undesired | Undesired | Undesired | Undesired | high | Undesired | Normal | Normal | 1.00 | High |
| Undesired | Undesired | Undesired | Undesired | high | Undesired | Low | Undesired | 1.00 | Medium |
| Undesired | Undesired | Undesired | Undesired | high | Desired | Low | Undesired | 1.00 | Medium |
| Undesired | Undesired | Undesired | Undesired | high | Desired | Low | Normal | 1.00 | Medium |
| Undesired | Undesired | Undesired | Undesired | high | Desired | Normal | Undesired | 1.00 | Medium |
| Undesired | Undesired | Undesired | Undesired | high | Desired | Normal | Normal | 1.00 | High |
| Undesired | Undesired | Undesired | Normal | Normal | Undesired | Low | Undesired | 1.00 | Low |
| Undesired | Undesired | Undesired | Normal | Normal | Undesired | Low | Normal | 1.00 | Medium |
| Undesired | Undesired | Undesired | Normal | Normal | Undesired | Normal | Undesired | 1.00 | Medium |
| Undesired | Undesired | Undesired | Normal | Normal | Undesired | Normal | Normal | 1.00 | Medium |
| Undesired | Undesired | Undesired | Normal | Normal | Desired | Low | Undesired | 1.00 | Low |
| Undesired | Undesired | Undesired | Normal | Normal | Desired | Low | Normal | 1.00 | Medium |
| Undesired | Undesired | Undesired | Normal | Normal | Desired | Normal | Undesired | 1.00 | Medium |
| Undesired | Undesired | Undesired | Normal | Normal | Desired | Normal | Normal | 1.00 | High |
| Undesired | Undesired | Undesired | Normal | high | Undesired | Low | Undesired | 1.00 | Low |
| Undesired | Undesired | Undesired | Normal | high | Undesired | Low | Normal | 1.00 | Low |
| Undesired | Undesired | Undesired | Normal | high | Undesired | Normal | Undesired | 1.00 | Low |
| Undesired | Undesired | Undesired | Normal | high | Undesired | Normal | Normal | 1.00 | Medium |
| Undesired | Undesired | Undesired | Normal | high | Desired | Low | Undesired | 1.00 | Low |
| Undesired | Undesired | Undesired | Normal | high | Desired | Low | Normal | 1.00 | Medium |

| IF | | | | | | | | THEN | |
|--------|--------|-----------|-----------|--------|-----------|--------|-----------|------|----------|
| Normal | Normal | Undesired | Normal | Normal | Desired | Low | Normal | 1.00 | Medium |
| Normal | Normal | Undesired | Normal | Normal | Desired | Normal | Undesired | 1.00 | Medium |
| Normal | Normal | Undesired | Normal | Normal | Desired | Normal | Normal | 1.00 | Medium |
| Normal | Normal | Undesired | Normal | high | Undesired | Low | Undesired | 1.00 | Very Low |
| Normal | Normal | Undesired | Normal | high | Undesired | Low | Normal | 1.00 | Low |
| Normal | Normal | Undesired | Normal | high | Undesired | Normal | Undesired | 1.00 | Low |
| Normal | Normal | Undesired | Normal | high | Undesired | Normal | Normal | 1.00 | Medium |
| Normal | Normal | Undesired | Normal | high | Desired | Low | Undesired | 1.00 | Low |
| Normal | Normal | Undesired | Normal | high | Desired | Low | Normal | 1.00 | Low |
| Normal | Normal | Undesired | Normal | high | Desired | Normal | Undesired | 1.00 | Low |
| Normal | Normal | Undesired | Normal | high | Desired | Normal | Normal | 1.00 | Medium |
| Normal | Normal | Desired | Undesired | Normal | Undesired | Low | Undesired | 1.00 | Medium |
| Normal | Normal | Desired | Undesired | Normal | Undesired | Low | Normal | 1.00 | Medium |
| Normal | Normal | Desired | Undesired | Normal | Undesired | Normal | Undesired | 1.00 | Medium |
| Normal | Normal | Desired | Undesired | Normal | Undesired | Normal | Normal | 1.00 | High |
| Normal | Normal | Desired | Undesired | Normal | Desired | Low | Undesired | 1.00 | Medium |
| Normal | Normal | Desired | Undesired | Normal | Desired | Low | Normal | 1.00 | High |
| Normal | Normal | Desired | Undesired | Normal | Desired | Normal | Undesired | 1.00 | High |
| Normal | Normal | Desired | Undesired | Normal | Desired | Normal | Normal | 1.00 | High |
| Normal | Normal | Desired | Undesired | high | Undesired | Low | Undesired | 1.00 | Low |
| Normal | Normal | Desired | Undesired | high | Undesired | Low | Normal | 1.00 | Medium |
| Normal | Normal | Desired | Undesired | high | Undesired | Normal | Undesired | 1.00 | Medium |
| Normal | Normal | Desired | Undesired | high | Undesired | Normal | Normal | 1.00 | High |
| Normal | Normal | Desired | Undesired | high | Desired | Low | Undesired | 1.00 | Medium |
| Normal | Normal | Desired | Undesired | high | Desired | Low | Normal | 1.00 | Medium |
| Normal | Normal | Desired | Undesired | high | Desired | Normal | Undesired | 1.00 | Medium |
| Normal | Normal | Desired | Undesired | high | Desired | Normal | Normal | 1.00 | High |
| Normal | Normal | Desired | Normal | Normal | Undesired | Low | Undesired | 1.00 | Low |
| Normal | Normal | Desired | Normal | Normal | Undesired | Low | Normal | 1.00 | Medium |
| Normal | Normal | Desired | Normal | Normal | Undesired | Normal | Undesired | 1.00 | Medium |
| Normal | Normal | Desired | Normal | Normal | Undesired | Normal | Normal | 1.00 | Medium |
| Normal | Normal | Desired | Normal | Normal | Desired | Low | Undesired | 1.00 | Low |
| Normal | Normal | Desired | Normal | Normal | Desired | Low | Normal | 1.00 | Medium |
| Normal | Normal | Desired | Normal | Normal | Desired | Normal | Undesired | 1.00 | Medium |
| Normal | Normal | Desired | Normal | Normal | Desired | Normal | Normal | 1.00 | High |
| Normal | Normal | Desired | Normal | high | Undesired | Low | Undesired | 1.00 | Low |
| Normal | Normal | Desired | Normal | high | Undesired | Low | Normal | 1.00 | Low |
| Normal | Normal | Desired | Normal | high | Undesired | Normal | Undesired | 1.00 | Low |
| Normal | Normal | Desired | Normal | high | Undesired | Normal | Normal | 1.00 | Medium |
| Normal | Normal | Desired | Normal | high | Desired | Low | Undesired | 1.00 | Low |
| Normal | Normal | Desired | Normal | high | Desired | Low | Normal | 1.00 | Medium |
| Normal | Normal | Desired | Normal | high | Desired | Normal | Undesired | 1.00 | Medium |
| Normal | Normal | Desired | Normal | high | Desired | Normal | Normal | 1.00 | Medium |

Table 63: Rules of the Rule Block "RB4_Use_Check"

.7 Rule Block "RB5_Error_Check"

| | |
|---------------------|--------|
| Parameter | |
| Aggregation: | MINMAX |
| Parameter: | 0.00 |
| Result Aggregation: | BSUM |
| Number of Inputs: | 2 |
| Number of Outputs: | 1 |
| Number of Rules: | 4 |

| IF | | THEN | |
|------------------|----------------|------|--------------|
| Activ inter Furn | Cir inter Furn | DoS | Error Factor |
| n influential | n influential | 1.00 | Very High |
| n influential | influential | 1.00 | Medium |
| influential | n influential | 1.00 | Medium |
| influential | influential | 1.00 | Very Low |

Table 64: Rules of the Rule Block "RB5_Error_Check"

.8 Rule Block "RB6_Life_style_check"

| | |
|---------------------|--------|
| Parameter | |
| Aggregation: | MINMAX |
| Parameter: | 0.00 |
| Result Aggregation: | BSUM |
| Number of Inputs: | 4 |
| Number of Outputs: | 1 |
| Number of Rules: | 81 |

| IF | | | | THEN | |
|-------------|----------------|---------------|----------------|------|----------------|
| Dwelling DF | Living room DF | M bed room DF | O bed rooms DF | DoS | Life style ind |
| Normal | Normal | Normal | Normal | 1.00 | Very Low |
| Normal | Normal | Normal | Low | 1.00 | Low |
| Normal | Normal | Normal | High | 1.00 | Low |
| Normal | Normal | Low | Normal | 1.00 | Low |
| Normal | Normal | Low | Low | 1.00 | Low |
| Normal | Normal | Low | High | 1.00 | Low |
| Normal | Normal | High | Normal | 1.00 | Low |
| Normal | Normal | High | Low | 1.00 | Low |
| Normal | Normal | High | High | 1.00 | Medium |
| Normal | Low | Normal | Normal | 1.00 | Low |
| Normal | Low | Normal | Low | 1.00 | Low |
| Normal | Low | Normal | High | 1.00 | Low |
| Normal | Low | Low | Normal | 1.00 | Low |
| Normal | Low | Low | Low | 1.00 | Low |
| Normal | Low | Low | High | 1.00 | Medium |
| Normal | Low | High | Normal | 1.00 | Low |
| Normal | Low | High | Low | 1.00 | Medium |
| Normal | Low | High | High | 1.00 | Medium |
| Normal | Low | High | High | 1.00 | Medium |
| Normal | High | Normal | Normal | 1.00 | Low |
| Normal | High | Normal | Low | 1.00 | Low |
| Normal | High | Normal | High | 1.00 | Medium |
| Normal | High | Low | Normal | 1.00 | Low |
| Normal | High | Low | Low | 1.00 | Medium |
| Normal | High | Low | High | 1.00 | Medium |
| Normal | High | High | Normal | 1.00 | Medium |
| Normal | High | High | Low | 1.00 | Medium |
| Normal | High | High | High | 1.00 | Medium |
| Low | Normal | Normal | Normal | 1.00 | Low |
| Low | Normal | Normal | Low | 1.00 | Low |
| Low | Normal | Normal | High | 1.00 | Medium |
| Low | Normal | Low | Normal | 1.00 | Low |
| Low | Normal | Low | Low | 1.00 | Medium |
| Low | Normal | Low | High | 1.00 | Medium |
| Low | Normal | High | Normal | 1.00 | Medium |
| Low | Normal | High | Low | 1.00 | Medium |
| Low | Normal | High | High | 1.00 | Medium |
| Low | Low | Normal | Normal | 1.00 | Low |

| IF | | | | THEN | |
|------|--------|--------|--------|------|-----------|
| Low | Low | Normal | Low | 1.00 | Medium |
| Low | Low | Normal | High | 1.00 | Medium |
| Low | Low | Low | Normal | 1.00 | Medium |
| Low | Low | Low | Low | 1.00 | Medium |
| Low | Low | Low | High | 1.00 | Medium |
| Low | Low | High | Normal | 1.00 | Medium |
| Low | Low | High | Low | 1.00 | Medium |
| Low | Low | High | High | 1.00 | High |
| Low | High | Normal | Normal | 1.00 | Medium |
| Low | High | Normal | Low | 1.00 | Medium |
| Low | High | Normal | High | 1.00 | Medium |
| Low | High | Low | Normal | 1.00 | Medium |
| Low | High | Low | Low | 1.00 | Medium |
| Low | High | Low | High | 1.00 | High |
| Low | High | High | Normal | 1.00 | Medium |
| Low | High | High | Low | 1.00 | High |
| Low | High | High | High | 1.00 | High |
| High | Normal | Normal | Normal | 1.00 | Medium |
| High | Normal | Normal | Low | 1.00 | Medium |
| High | Normal | Normal | High | 1.00 | Medium |
| High | Normal | Low | Normal | 1.00 | Medium |
| High | Normal | Low | Low | 1.00 | Medium |
| High | Normal | Low | High | 1.00 | High |
| High | Normal | High | Normal | 1.00 | Medium |
| High | Normal | High | Low | 1.00 | High |
| High | Normal | High | High | 1.00 | High |
| High | Low | Normal | Normal | 1.00 | Medium |
| High | Low | Normal | Low | 1.00 | Medium |
| High | Low | Normal | High | 1.00 | High |
| High | Low | Low | Normal | 1.00 | Medium |
| High | Low | Low | Low | 1.00 | High |
| High | Low | Low | High | 1.00 | High |
| High | Low | High | Normal | 1.00 | High |
| High | Low | High | Low | 1.00 | High |
| High | Low | High | High | 1.00 | High |
| High | High | Normal | Normal | 1.00 | Medium |
| High | High | Normal | Low | 1.00 | High |
| High | High | Normal | High | 1.00 | High |
| High | High | Low | Normal | 1.00 | High |
| High | High | Low | Low | 1.00 | High |
| High | High | Low | High | 1.00 | High |
| High | High | High | Normal | 1.00 | High |
| High | High | High | Low | 1.00 | High |
| High | High | High | High | 1.00 | Very High |

Table 65: Rules of the Rule Block "RB6_Life_style_check"

9 Rule Block "RB7_Use_Check"

Parameter
 Aggregation: MINMAX
 Parameter: 0.00
 Result Aggregation: BSUM
 Number of Inputs: 2
 Number of Outputs: 1
 Number of Rules: 25

| IF | | THEN | |
|--------------|------------|------|-----------|
| Error Factor | Use Factor | DoS | Use Accep |
| Very Low | Very Low | 1.00 | Very Low |

| IF | | THEN | |
|-----------|-----------|------|-----------|
| Very Low | Low | 1.00 | Low |
| Very Low | Medium | 1.00 | Low |
| Very Low | High | 1.00 | Medium |
| Very Low | Very High | 1.00 | High |
| Low | Very Low | 1.00 | Very Low |
| Low | Low | 1.00 | Low |
| Low | Medium | 1.00 | Medium |
| Low | High | 1.00 | Medium |
| Low | Very High | 1.00 | High |
| Medium | Very Low | 1.00 | Low |
| Medium | Low | 1.00 | Low |
| Medium | Medium | 1.00 | Medium |
| Medium | High | 1.00 | High |
| Medium | Very High | 1.00 | High |
| High | Very Low | 1.00 | Low |
| High | Low | 1.00 | Medium |
| High | Medium | 1.00 | Medium |
| High | High | 1.00 | High |
| High | Very High | 1.00 | Very High |
| Very High | Very Low | 1.00 | Low |
| Very High | Low | 1.00 | Medium |
| Very High | Medium | 1.00 | High |
| Very High | High | 1.00 | High |
| Very High | Very High | 1.00 | Very High |

Table 66: Rules of the Rule Block "RB7_Use_Check"

.10 Rule Block "RB8_Efficiency_check"

Rule of Efficiency

Parameter

Aggregation: MINMAX
 Parameter: 0.00
 Result Aggregation: BSUM
 Number of Inputs: 4
 Number of Outputs: 1
 Number of Rules: 625

| IF | | | | THEN | |
|------------------|---------------|---------------|-----------|------|--------------|
| D Dwelling Accep | Spatial Accep | T Group Accep | Use Accep | DoS | F Efficiency |
| Very Low | Very Low | Ver Low | Very Low | 1.00 | Very Low |
| Very Low | Very Low | Ver Low | Low | 1.00 | Very Low |
| Very Low | Very Low | Ver Low | Medium | 1.00 | Very Low |
| Very Low | Very Low | Ver Low | High | 1.00 | Low |
| Very Low | Very Low | Ver Low | Very High | 1.00 | Low |
| Very Low | Very Low | Low | Very Low | 1.00 | Very Low |
| Very Low | Very Low | Low | Low | 1.00 | Very Low |
| Very Low | Very Low | Low | Medium | 1.00 | Low |
| Very Low | Very Low | Low | High | 1.00 | Low |
| Very Low | Very Low | Low | Very High | 1.00 | Low |
| Very Low | Very Low | Medium | Very Low | 1.00 | Very Low |
| Very Low | Very Low | Medium | Low | 1.00 | Low |
| Very Low | Very Low | Medium | Medium | 1.00 | Low |
| Very Low | Very Low | Medium | High | 1.00 | Low |
| Very Low | Very Low | Medium | Very High | 1.00 | Medium |
| Very Low | Very Low | High | Very Low | 1.00 | Low |
| Very Low | Very Low | High | Low | 1.00 | Low |
| Very Low | Very Low | High | Medium | 1.00 | Low |
| Very Low | Very Low | High | High | 1.00 | Medium |
| Very Low | Very Low | High | Very High | 1.00 | Medium |

| | | | | | |
|----------|----------|-----------|-----------|------|----------|
| Very Low | Very Low | Very High | Very Low | 1.00 | Low |
| Very Low | Very Low | Very High | Low | 1.00 | Low |
| Very Low | Very Low | Very High | Medium | 1.00 | Medium |
| Very Low | Very Low | Very High | High | 1.00 | Medium |
| Very Low | Very Low | Very High | Very High | 1.00 | Medium |
| Very Low | Low | Ver Low | Very Low | 1.00 | Very Low |
| Very Low | Low | Ver Low | Low | 1.00 | Very Low |
| Very Low | Low | Ver Low | Medium | 1.00 | Low |
| Very Low | Low | Ver Low | High | 1.00 | Low |
| Very Low | Low | Ver Low | Very High | 1.00 | Low |
| Very Low | Low | Low | Very Low | 1.00 | Very Low |
| Very Low | Low | Low | Low | 1.00 | Low |
| Very Low | Low | Low | Medium | 1.00 | Low |
| Very Low | Low | Low | High | 1.00 | Low |
| Very Low | Low | Low | Very High | 1.00 | Medium |
| Very Low | Low | Medium | Very Low | 1.00 | Low |
| Very Low | Low | Medium | Low | 1.00 | Low |
| Very Low | Low | Medium | Medium | 1.00 | Low |
| Very Low | Low | Medium | High | 1.00 | Medium |
| Very Low | Low | Medium | Very High | 1.00 | Medium |
| Very Low | Low | High | Very Low | 1.00 | Low |
| Very Low | Low | High | Low | 1.00 | Low |
| Very Low | Low | High | Medium | 1.00 | Medium |
| Very Low | Low | High | High | 1.00 | Medium |
| Very Low | Low | High | Very High | 1.00 | Medium |
| Very Low | Low | Very High | Very Low | 1.00 | Low |
| Very Low | Low | Very High | Low | 1.00 | Medium |
| Very Low | Low | Very High | Medium | 1.00 | Medium |
| Very Low | Low | Very High | High | 1.00 | Medium |
| Very Low | Low | Very High | Very High | 1.00 | Medium |
| Very Low | Medium | Ver Low | Very Low | 1.00 | Very Low |
| Very Low | Medium | Ver Low | Low | 1.00 | Very Low |
| Very Low | Medium | Ver Low | Medium | 1.00 | Low |
| Very Low | Medium | Ver Low | Hjgh | 1.00 | Low |
| Very Low | Medium | Ver Low | Very High | 1.00 | Low |
| Very Low | Medium | Low | Very Low | 1.00 | Very Low |
| Very Low | Medium | Low | Low | 1.00 | Low |
| Very Low | Medium | Low | Medium | 1.00 | Low |
| Very Low | Medium | Low | High | 1.00 | Low |
| Very Low | Medium | Low | Very High | 1.00 | Medium |
| Very Low | Medium | Medium | Very Low | 1.00 | Low |
| Very Low | Medium | Medium | Low | 1.00 | Low |
| Very Low | Medium | Medium | Medium | 1.00 | Low |
| Very Low | Medium | Medium | High | 1.00 | Medium |
| Very Low | Medium | Medium | Very High | 1.00 | Medium |
| Very Low | Medium | High | Very Low | 1.00 | Low |
| Very Low | Medium | High | Low | 1.00 | Low |
| Very Low | Medium | High | Medium | 1.00 | Medium |
| Very Low | Medium | High | High | 1.00 | Medium |
| Very Low | Medium | High | Very High | 1.00 | Medium |
| Very Low | Medium | Very High | Very Low | 1.00 | Low |
| Very Low | Medium | Very High | Low | 1.00 | Medium |
| Very Low | Medium | Very High | Medium | 1.00 | Medium |
| Very Low | Medium | Very High | Hjgh | 1.00 | Medium |
| Very Low | Medium | Very High | Very High | 1.00 | High |
| Very Low | High | Ver Low | Very Low | 1.00 | Very Low |
| Very Low | High | Ver Low | Low | 1.00 | Low |
| Very Low | High | Ver Low | Medium | 1.00 | Low |
| Very Low | High | Ver Low | Hjgh | 1.00 | Low |
| Very Low | High | Ver Low | Very High | 1.00 | Medium |
| Very Low | High | Low | Very Low | 1.00 | Low |
| Very Low | High | Low | Low | 1.00 | Low |

| | | | | | |
|----------|-----------|-----------|-----------|------|----------|
| Very Low | High | Low | Medium | 1.00 | Low |
| Very Low | High | Low | High | 1.00 | Medium |
| Very Low | High | Low | Very High | 1.00 | Medium |
| Very Low | High | Medium | Very Low | 1.00 | Low |
| Very Low | High | Medium | Low | 1.00 | Low |
| Very Low | High | Medium | Medium | 1.00 | Medium |
| Very Low | High | Medium | High | 1.00 | Medium |
| Very Low | High | Medium | Very High | 1.00 | Medium |
| Very Low | High | High | Very Low | 1.00 | Low |
| Very Low | High | High | Low | 1.00 | Medium |
| Very Low | High | High | Medium | 1.00 | Medium |
| Very Low | High | High | High | 1.00 | Medium |
| Very Low | High | High | Very High | 1.00 | Medium |
| Very Low | High | Very High | Very Low | 1.00 | Medium |
| Very Low | High | Very High | Low | 1.00 | Medium |
| Very Low | High | Very High | Medium | 1.00 | Medium |
| Very Low | High | Very High | High | 1.00 | Medium |
| Very Low | High | Very High | Very High | 1.00 | High |
| Very Low | Very High | Ver Low | Very Low | 1.00 | Very Low |
| Very Low | Very High | Ver Low | Low | 1.00 | Low |
| Very Low | Very High | Ver Low | Medium | 1.00 | Low |
| Very Low | Very High | Ver Low | High | 1.00 | Low |
| Very Low | Very High | Ver Low | Very High | 1.00 | Medium |
| Very Low | Very High | Low | Very Low | 1.00 | Low |
| Very Low | Very High | Low | Low | 1.00 | Low |
| Very Low | Very High | Low | Medium | 1.00 | Low |
| Very Low | Very High | Low | High | 1.00 | Medium |
| Very Low | Very High | Low | Very High | 1.00 | Medium |
| Very Low | Very High | Medium | Very Low | 1.00 | Low |
| Very Low | Very High | Medium | Low | 1.00 | Low |
| Very Low | Very High | Medium | Medium | 1.00 | Medium |
| Very Low | Very High | Medium | High | 1.00 | Medium |
| Very Low | Very High | Medium | Very High | 1.00 | Medium |
| Very Low | Very High | High | Very Low | 1.00 | Low |
| Very Low | Very High | High | Low | 1.00 | Medium |
| Very Low | Very High | High | Medium | 1.00 | Medium |
| Very Low | Very High | High | High | 1.00 | High |
| Very Low | Very High | Very High | Very Low | 1.00 | Medium |
| Very Low | Very High | Very High | Low | 1.00 | Medium |
| Very Low | Very High | Very High | Medium | 1.00 | Medium |
| Very Low | Very High | Very High | High | 1.00 | High |
| Very Low | Very High | Very High | Very High | 1.00 | High |
| Low | Very Low | Ver Low | Very Low | 1.00 | Very Low |
| Low | Very Low | Ver Low | Low | 1.00 | Very Low |
| Low | Very Low | Ver Low | Medium | 1.00 | Low |
| Low | Very Low | Ver Low | High | 1.00 | Low |
| Low | Very Low | Ver Low | Very High | 1.00 | Low |
| Low | Very Low | Low | Very Low | 1.00 | Very Low |
| Low | Very Low | Low | Low | 1.00 | Low |
| Low | Very Low | Low | Medium | 1.00 | Low |
| Low | Very Low | Low | High | 1.00 | Low |
| Low | Very Low | Low | Very High | 1.00 | Medium |
| Low | Very Low | Medium | Very Low | 1.00 | Low |
| Low | Very Low | Medium | Low | 1.00 | Low |
| Low | Very Low | Medium | Medium | 1.00 | Low |
| Low | Very Low | Medium | High | 1.00 | Medium |
| Low | Very Low | Medium | Very High | 1.00 | Medium |
| Low | Very Low | High | Very Low | 1.00 | Low |
| Low | Very Low | High | Low | 1.00 | Low |
| Low | Very Low | High | Medium | 1.00 | Medium |
| Low | Very Low | High | High | 1.00 | Medium |

| | | | | | |
|-----|----------|-----------|-----------|------|----------|
| Low | Very Low | High | Very High | 1.00 | Medium |
| Low | Very Low | Very High | Very Low | 1.00 | Low |
| Low | Very Low | Very High | Low | 1.00 | Medium |
| Low | Very Low | Very High | Medium | 1.00 | Medium |
| Low | Very Low | Very High | High | 1.00 | Medium |
| Low | Very Low | Very High | Very High | 1.00 | High |
| Low | Low | Ver Low | Very Low | 1.00 | Very Low |
| Low | Low | Ver Low | Low | 1.00 | Low |
| Low | Low | Ver Low | Medium | 1.00 | Low |
| Low | Low | Ver Low | High | 1.00 | Low |
| Low | Low | Ver Low | Very High | 1.00 | Medium |
| Low | Low | Low | Very Low | 1.00 | Low |
| Low | Low | Low | Low | 1.00 | Low |
| Low | Low | Low | Medium | 1.00 | Low |
| Low | Low | Low | High | 1.00 | Medium |
| Low | Low | Low | Very High | 1.00 | Medium |
| Low | Low | Medium | Very Low | 1.00 | Low |
| Low | Low | Medium | Low | 1.00 | Low |
| Low | Low | Medium | Medium | 1.00 | Medium |
| Low | Low | Medium | High | 1.00 | Medium |
| Low | Low | Medium | Very High | 1.00 | Medium |
| Low | Low | High | Very Low | 1.00 | Low |
| Low | Low | High | Low | 1.00 | Medium |
| Low | Low | High | Medium | 1.00 | Medium |
| Low | Low | High | High | 1.00 | Medium |
| Low | Low | High | Very High | 1.00 | Medium |
| Low | Low | Very High | Very Low | 1.00 | Medium |
| Low | Low | Very High | Low | 1.00 | Medium |
| Low | Low | Very High | Medium | 1.00 | Medium |
| Low | Low | Very High | High | 1.00 | Medium |
| Low | Low | Very High | Very High | 1.00 | High |
| Low | Medium | Ver Low | Very Low | 1.00 | Very Low |
| Low | Medium | Ver Low | Low | 1.00 | Low |
| Low | Medium | Ver Low | Medium | 1.00 | Low |
| Low | Medium | Ver Low | High | 1.00 | Low |
| Low | Medium | Ver Low | Very High | 1.00 | Medium |
| Low | Medium | Low | Very Low | 1.00 | Low |
| Low | Medium | Low | Low | 1.00 | Low |
| Low | Medium | Low | Medium | 1.00 | Low |
| Low | Medium | Low | High | 1.00 | Medium |
| Low | Medium | Low | Very High | 1.00 | Medium |
| Low | Medium | Medium | Very Low | 1.00 | Low |
| Low | Medium | Medium | Low | 1.00 | Low |
| Low | Medium | Medium | Medium | 1.00 | Medium |
| Low | Medium | Medium | High | 1.00 | Medium |
| Low | Medium | Medium | Very High | 1.00 | Medium |
| Low | Medium | High | Very Low | 1.00 | Low |
| Low | Medium | High | Low | 1.00 | Medium |
| Low | Medium | High | Medium | 1.00 | Medium |
| Low | Medium | High | High | 1.00 | Medium |
| Low | Medium | High | Very High | 1.00 | High |
| Low | Medium | Very High | Very Low | 1.00 | Medium |
| Low | Medium | Very High | Low | 1.00 | Medium |
| Low | Medium | Very High | Medium | 1.00 | Medium |
| Low | Medium | Very High | High | 1.00 | High |
| Low | Medium | Very High | Very High | 1.00 | High |
| Low | High | Ver Low | Very Low | 1.00 | Low |
| Low | High | Ver Low | Low | 1.00 | Low |
| Low | High | Ver Low | Medium | 1.00 | Low |
| Low | High | Ver Low | High | 1.00 | Medium |
| Low | High | Ver Low | Very High | 1.00 | Medium |
| Low | High | Low | Very Low | 1.00 | Low |

| | | | | | |
|--------|-----------|-----------|-----------|------|----------|
| Low | High | Low | Low | 1.00 | Low |
| Low | High | Low | Medium | 1.00 | Medium |
| Low | High | Low | High | 1.00 | Medium |
| Low | High | Low | Very High | 1.00 | Medium |
| Low | High | Medium | Very Low | 1.00 | Low |
| Low | High | Medium | Low | 1.00 | Medium |
| Low | High | Medium | Medium | 1.00 | Medium |
| Low | High | Medium | High | 1.00 | Medium |
| Low | High | Medium | Very High | 1.00 | Medium |
| Low | High | High | Very Low | 1.00 | Medium |
| Low | High | High | Low | 1.00 | Medium |
| Low | High | High | Medium | 1.00 | Medium |
| Low | High | High | High | 1.00 | Medium |
| Low | High | High | Very High | 1.00 | High |
| Low | High | Very High | Very Low | 1.00 | Medium |
| Low | High | Very High | Low | 1.00 | Medium |
| Low | High | Very High | Medium | 1.00 | Medium |
| Low | High | Very High | High | 1.00 | High |
| Low | High | Very High | Very High | 1.00 | High |
| Low | Very High | Ver Low | Very Low | 1.00 | Low |
| Low | Very High | Ver Low | Low | 1.00 | Low |
| Low | Very High | Ver Low | Medium | 1.00 | Low |
| Low | Very High | Ver Low | High | 1.00 | Medium |
| Low | Very High | Ver Low | Very High | 1.00 | Medium |
| Low | Very High | Low | Very Low | 1.00 | Low |
| Low | Very High | Low | Low | 1.00 | Low |
| Low | Very High | Low | Medium | 1.00 | Medium |
| Low | Very High | Low | High | 1.00 | Medium |
| Low | Very High | Low | Very High | 1.00 | Medium |
| Low | Very High | Medium | Very Low | 1.00 | Low |
| Low | Very High | Medium | Low | 1.00 | Medium |
| Low | Very High | Medium | Medium | 1.00 | Medium |
| Low | Very High | Medium | High | 1.00 | Medium |
| Low | Very High | Medium | Very High | 1.00 | High |
| Low | Very High | High | Very Low | 1.00 | Medium |
| Low | Very High | High | Low | 1.00 | Medium |
| Low | Very High | High | Medium | 1.00 | Medium |
| Low | Very High | High | High | 1.00 | High |
| Low | Very High | High | Very High | 1.00 | High |
| Low | Very High | Very High | Very Low | 1.00 | Medium |
| Low | Very High | Very High | Low | 1.00 | Medium |
| Low | Very High | Very High | Medium | 1.00 | High |
| Low | Very High | Very High | High | 1.00 | High |
| Low | Very High | Very High | Very High | 1.00 | High |
| Medium | Very Low | Ver Low | Very Low | 1.00 | Very Low |
| Medium | Very Low | Ver Low | Low | 1.00 | Low |
| Medium | Very Low | Ver Low | Medium | 1.00 | Low |
| Medium | Very Low | Ver Low | High | 1.00 | Low |
| Medium | Very Low | Ver Low | Very High | 1.00 | Medium |
| Medium | Very Low | Low | Very Low | 1.00 | Low |
| Medium | Very Low | Low | Low | 1.00 | Low |
| Medium | Very Low | Low | Medium | 1.00 | Low |
| Medium | Very Low | Low | High | 1.00 | Medium |
| Medium | Very Low | Low | Very High | 1.00 | Medium |
| Medium | Very Low | Medium | Very Low | 1.00 | Low |
| Medium | Very Low | Medium | Low | 1.00 | Low |
| Medium | Very Low | Medium | Medium | 1.00 | Medium |
| Medium | Very Low | Medium | High | 1.00 | Medium |
| Medium | Very Low | Medium | Very High | 1.00 | Medium |
| Medium | Very Low | High | Very Low | 1.00 | Low |
| Medium | Very Low | High | Low | 1.00 | Medium |
| Medium | Very Low | High | Medium | 1.00 | Medium |

| | | | | | |
|--------|----------|-----------|-----------|------|--------|
| Medium | Very Low | High | High | 1.00 | Medium |
| Medium | Very Low | High | Very High | 1.00 | High |
| Medium | Very Low | Very High | Very Low | 1.00 | Medium |
| Medium | Very Low | Very High | Low | 1.00 | Medium |
| Medium | Very Low | Very High | Medium | 1.00 | Medium |
| Medium | Very Low | Very High | High | 1.00 | High |
| Medium | Very Low | Very High | Very High | 1.00 | High |
| Medium | Low | Ver Low | Very Low | 1.00 | Low |
| Medium | Low | Ver Low | Low | 1.00 | Low |
| Medium | Low | Ver Low | Medium | 1.00 | Low |
| Medium | Low | Ver Low | High | 1.00 | Medium |
| Medium | Low | Ver Low | Very High | 1.00 | Medium |
| Medium | Low | Low | Very Low | 1.00 | Low |
| Medium | Low | Low | Low | 1.00 | Low |
| Medium | Low | Low | Medium | 1.00 | Medium |
| Medium | Low | Low | High | 1.00 | Medium |
| Medium | Low | Low | Very High | 1.00 | Medium |
| Medium | Low | Medium | Very Low | 1.00 | Low |
| Medium | Low | Medium | Low | 1.00 | Medium |
| Medium | Low | Medium | Medium | 1.00 | Medium |
| Medium | Low | Medium | High | 1.00 | Medium |
| Medium | Low | Medium | Very High | 1.00 | Medium |
| Medium | Low | High | Very Low | 1.00 | Medium |
| Medium | Low | High | Low | 1.00 | Medium |
| Medium | Low | High | Medium | 1.00 | Medium |
| Medium | Low | High | High | 1.00 | Medium |
| Medium | Low | High | Very High | 1.00 | High |
| Medium | Low | Very High | Very Low | 1.00 | Medium |
| Medium | Low | Very High | Low | 1.00 | Medium |
| Medium | Low | Very High | Medium | 1.00 | Medium |
| Medium | Low | Very High | High | 1.00 | High |
| Medium | Low | Very High | Very High | 1.00 | High |
| Medium | Medium | Ver Low | Very Low | 1.00 | Low |
| Medium | Medium | Ver Low | Low | 1.00 | Low |
| Medium | Medium | Ver Low | Medium | 1.00 | Low |
| Medium | Medium | Ver Low | High | 1.00 | Medium |
| Medium | Medium | Ver Low | Very High | 1.00 | Medium |
| Medium | Medium | Low | Very Low | 1.00 | Low |
| Medium | Medium | Low | Low | 1.00 | Low |
| Medium | Medium | Low | Medium | 1.00 | Medium |
| Medium | Medium | Low | High | 1.00 | Medium |
| Medium | Medium | Low | Very High | 1.00 | Medium |
| Medium | Medium | Medium | Very Low | 1.00 | Low |
| Medium | Medium | Medium | Low | 1.00 | Medium |
| Medium | Medium | Medium | Medium | 1.00 | Medium |
| Medium | Medium | Medium | High | 1.00 | Medium |
| Medium | Medium | Medium | Very High | 1.00 | High |
| Medium | Medium | High | Very Low | 1.00 | Medium |
| Medium | Medium | High | Low | 1.00 | Medium |
| Medium | Medium | High | Medium | 1.00 | Medium |
| Medium | Medium | High | High | 1.00 | High |
| Medium | Medium | High | Very High | 1.00 | High |
| Medium | Medium | Very High | Very Low | 1.00 | Medium |
| Medium | Medium | Very High | Low | 1.00 | Medium |
| Medium | Medium | Very High | Medium | 1.00 | High |
| Medium | Medium | Very High | High | 1.00 | High |
| Medium | Medium | Very High | Very High | 1.00 | High |
| Medium | High | Ver Low | Very Low | 1.00 | Low |
| Medium | High | Ver Low | Low | 1.00 | Low |
| Medium | High | Ver Low | Medium | 1.00 | Medium |
| Medium | High | Ver Low | High | 1.00 | Medium |
| Medium | High | Ver Low | Very High | 1.00 | Medium |

| | | | | | |
|--------|-----------|-----------|-----------|------|-----------|
| Medium | High | Low | Very Low | 1.00 | Low |
| Medium | High | Low | Low | 1.00 | Medium |
| Medium | High | Low | Medium | 1.00 | Medium |
| Medium | High | Low | High | 1.00 | Medium |
| Medium | High | Low | Very High | 1.00 | Medium |
| Medium | High | Medium | Very Low | 1.00 | Medium |
| Medium | High | Medium | Low | 1.00 | Medium |
| Medium | High | Medium | Medium | 1.00 | Medium |
| Medium | High | Medium | High | 1.00 | Medium |
| Medium | High | Medium | Very High | 1.00 | High |
| Medium | High | High | Very Low | 1.00 | Medium |
| Medium | High | High | Low | 1.00 | Medium |
| Medium | High | High | Medium | 1.00 | Medium |
| Medium | High | High | High | 1.00 | High |
| Medium | High | High | Very High | 1.00 | High |
| Medium | High | Very High | Very Low | 1.00 | Medium |
| Medium | High | Very High | Low | 1.00 | Medium |
| Medium | High | Very High | Medium | 1.00 | High |
| Medium | High | Very High | High | 1.00 | High |
| Medium | High | Very High | Very High | 1.00 | High |
| Medium | Very High | Ver Low | Very Low | 1.00 | Low |
| Medium | Very High | Ver Low | Low | 1.00 | Low |
| Medium | Very High | Ver Low | Medium | 1.00 | Medium |
| Medium | Very High | Ver Low | High | 1.00 | Medium |
| Medium | Very High | Ver Low | Very High | 1.00 | Medium |
| Medium | Very High | Low | Very Low | 1.00 | Low |
| Medium | Very High | Low | Low | 1.00 | Medium |
| Medium | Very High | Low | Medium | 1.00 | Medium |
| Medium | Very High | Low | High | 1.00 | Medium |
| Medium | Very High | Low | Very High | 1.00 | High |
| Medium | Very High | Medium | Very Low | 1.00 | Medium |
| Medium | Very High | Medium | Low | 1.00 | Medium |
| Medium | Very High | Medium | Medium | 1.00 | Medium |
| Medium | Very High | Medium | High | 1.00 | High |
| Medium | Very High | Medium | Very High | 1.00 | High |
| Medium | Very High | High | Very Low | 1.00 | Medium |
| Medium | Very High | High | Low | 1.00 | Medium |
| Medium | Very High | High | Medium | 1.00 | High |
| Medium | Very High | High | High | 1.00 | High |
| Medium | Very High | High | Very High | 1.00 | High |
| Medium | Very High | Very High | Very Low | 1.00 | Medium |
| Medium | Very High | Very High | Low | 1.00 | High |
| Medium | Very High | Very High | Medium | 1.00 | High |
| Medium | Very High | Very High | High | 1.00 | High |
| Medium | Very High | Very High | Very High | 1.00 | Very High |
| High | Very Low | Ver Low | Very Low | 1.00 | Low |
| High | Very Low | Ver Low | Low | 1.00 | Low |
| High | Very Low | Ver Low | Medium | 1.00 | Low |
| High | Very Low | Ver Low | High | 1.00 | Medium |
| High | Very Low | Ver Low | Very High | 1.00 | Medium |
| High | Very Low | Low | Very Low | 1.00 | Low |
| High | Very Low | Low | Low | 1.00 | Low |
| High | Very Low | Low | Medium | 1.00 | Medium |
| High | Very Low | Low | High | 1.00 | Medium |
| High | Very Low | Low | Very High | 1.00 | Medium |
| High | Very Low | Medium | Very Low | 1.00 | Low |
| High | Very Low | Medium | Low | 1.00 | Medium |
| High | Very Low | Medium | Medium | 1.00 | Medium |
| High | Very Low | Medium | High | 1.00 | Medium |
| High | Very Low | Medium | Very High | 1.00 | High |
| High | Very Low | High | Very Low | 1.00 | Medium |
| High | Very Low | High | Low | 1.00 | Medium |

| | | | | | |
|------|----------|-----------|-----------|------|-----------|
| High | Very Low | High | Medium | 1.00 | Medium |
| High | Very Low | High | High | 1.00 | High |
| High | Very Low | High | Very High | 1.00 | High |
| High | Very Low | Very High | Very Low | 1.00 | Medium |
| High | Very Low | Very High | Low | 1.00 | Medium |
| High | Very Low | Very High | Medium | 1.00 | High |
| High | Very Low | Very High | High | 1.00 | High |
| High | Very Low | Very High | Very High | 1.00 | High |
| High | Low | Ver Low | Very Low | 1.00 | Low |
| High | Low | Ver Low | Low | 1.00 | Low |
| High | Low | Ver Low | Medium | 1.00 | Medium |
| High | Low | Ver Low | High | 1.00 | Medium |
| High | Low | Ver Low | Very High | 1.00 | Medium |
| High | Low | Low | Very Low | 1.00 | Low |
| High | Low | Low | Low | 1.00 | Medium |
| High | Low | Low | Medium | 1.00 | Medium |
| High | Low | Low | High | 1.00 | Medium |
| High | Low | Low | Very High | 1.00 | Medium |
| High | Low | Medium | Very Low | 1.00 | Medium |
| High | Low | Medium | Low | 1.00 | Medium |
| High | Low | Medium | Medium | 1.00 | Medium |
| High | Low | Medium | High | 1.00 | Medium |
| High | Low | Medium | Very High | 1.00 | High |
| High | Low | High | Very Low | 1.00 | Medium |
| High | Low | High | Low | 1.00 | Medium |
| High | Low | High | Medium | 1.00 | Medium |
| High | Low | High | High | 1.00 | High |
| High | Low | High | Very High | 1.00 | High |
| High | Low | Very High | Very Low | 1.00 | Medium |
| High | Low | Very High | Low | 1.00 | Medium |
| High | Low | Very High | Medium | 1.00 | High |
| High | Low | Very High | High | 1.00 | High |
| High | Low | Very High | Very High | 1.00 | High |
| High | Medium | Ver Low | Very Low | 1.00 | Low |
| High | Medium | Ver Low | Low | 1.00 | Low |
| High | Medium | Ver Low | Medium | 1.00 | Medium |
| High | Medium | Ver Low | High | 1.00 | Medium |
| High | Medium | Ver Low | Very High | 1.00 | Medium |
| High | Medium | Low | Very Low | 1.00 | Low |
| High | Medium | Low | Low | 1.00 | Medium |
| High | Medium | Low | Medium | 1.00 | Medium |
| High | Medium | Low | High | 1.00 | Medium |
| High | Medium | Low | Very High | 1.00 | High |
| High | Medium | Medium | Very Low | 1.00 | Medium |
| High | Medium | Medium | Low | 1.00 | Medium |
| High | Medium | Medium | Medium | 1.00 | Medium |
| High | Medium | Medium | High | 1.00 | High |
| High | Medium | Medium | Very High | 1.00 | High |
| High | Medium | High | Very Low | 1.00 | Medium |
| High | Medium | High | Low | 1.00 | Medium |
| High | Medium | High | Medium | 1.00 | High |
| High | Medium | High | High | 1.00 | High |
| High | Medium | High | Very High | 1.00 | High |
| High | Medium | Very High | Very Low | 1.00 | Medium |
| High | Medium | Very High | Low | 1.00 | High |
| High | Medium | Very High | Medium | 1.00 | High |
| High | Medium | Very High | High | 1.00 | High |
| High | Medium | Very High | Very High | 1.00 | Very High |
| High | High | Ver Low | Very Low | 1.00 | Low |
| High | High | Ver Low | Low | 1.00 | Medium |
| High | High | Ver Low | Medium | 1.00 | Medium |
| High | High | Ver Low | High | 1.00 | Medium |

| | | | | | |
|-----------|-----------|-----------|-----------|------|-----------|
| High | High | Ver Low | Very High | 1.00 | Medium |
| High | High | Low | Very Low | 1.00 | Medium |
| High | High | Low | Low | 1.00 | Medium |
| High | High | Low | Medium | 1.00 | Medium |
| High | High | Low | High | 1.00 | Medium |
| High | High | Low | Very High | 1.00 | High |
| High | High | Medium | Very Low | 1.00 | Medium |
| High | High | Medium | Low | 1.00 | Medium |
| High | High | Medium | Medium | 1.00 | Medium |
| High | High | Medium | High | 1.00 | High |
| High | High | Medium | Very High | 1.00 | High |
| High | High | High | Very Low | 1.00 | Medium |
| High | High | High | Low | 1.00 | Medium |
| High | High | High | Medium | 1.00 | High |
| High | High | High | High | 1.00 | High |
| High | High | High | Very High | 1.00 | High |
| High | High | Very High | Very Low | 1.00 | Medium |
| High | High | Very High | Low | 1.00 | High |
| High | High | Very High | Medium | 1.00 | High |
| High | High | Very High | High | 1.00 | High |
| High | High | Very High | Very High | 1.00 | Very High |
| High | Very High | Ver Low | Very Low | 1.00 | Low |
| High | Very High | Ver Low | Low | 1.00 | Medium |
| High | Very High | Ver Low | Medium | 1.00 | Medium |
| High | Very High | Ver Low | High | 1.00 | Medium |
| High | Very High | Ver Low | Very High | 1.00 | High |
| High | Very High | Low | Very Low | 1.00 | Medium |
| High | Very High | Low | Low | 1.00 | Medium |
| High | Very High | Low | Medium | 1.00 | Medium |
| High | Very High | Low | High | 1.00 | High |
| High | Very High | Low | Very High | 1.00 | High |
| High | Very High | Medium | Very Low | 1.00 | Medium |
| High | Very High | Medium | Low | 1.00 | Medium |
| High | Very High | Medium | Medium | 1.00 | High |
| High | Very High | Medium | High | 1.00 | High |
| High | Very High | Medium | Very High | 1.00 | High |
| High | Very High | High | Very Low | 1.00 | Medium |
| High | Very High | High | Low | 1.00 | High |
| High | Very High | High | Medium | 1.00 | High |
| High | Very High | High | High | 1.00 | High |
| High | Very High | High | Very High | 1.00 | Very High |
| High | Very High | Very High | Very Low | 1.00 | High |
| High | Very High | Very High | Low | 1.00 | High |
| High | Very High | Very High | Medium | 1.00 | High |
| High | Very High | Very High | High | 1.00 | Very High |
| High | Very High | Very High | Very High | 1.00 | Very High |
| Very High | Very Low | Ver Low | Very Low | 1.00 | Low |
| Very High | Very Low | Ver Low | Low | 1.00 | Low |
| Very High | Very Low | Ver Low | Medium | 1.00 | Medium |
| Very High | Very Low | Ver Low | High | 1.00 | Medium |
| Very High | Very Low | Ver Low | Very High | 1.00 | Medium |
| Very High | Very Low | Low | Very Low | 1.00 | Low |
| Very High | Very Low | Low | Low | 1.00 | Medium |
| Very High | Very Low | Low | Medium | 1.00 | Medium |
| Very High | Very Low | Low | High | 1.00 | Medium |
| Very High | Very Low | Low | Very High | 1.00 | High |
| Very High | Very Low | Medium | Very Low | 1.00 | Medium |
| Very High | Very Low | Medium | Low | 1.00 | Medium |
| Very High | Very Low | Medium | Medium | 1.00 | Medium |
| Very High | Very Low | Medium | High | 1.00 | High |
| Very High | Very Low | Medium | Very High | 1.00 | High |
| Very High | Very Low | High | Very Low | 1.00 | Medium |

| | | | | | |
|-----------|----------|-----------|-----------|------|-----------|
| Very High | Very Low | High | Low | 1.00 | Medium |
| Very High | Very Low | High | Medium | 1.00 | High |
| Very High | Very Low | High | High | 1.00 | High |
| Very High | Very Low | High | Very High | 1.00 | High |
| Very High | Very Low | Very High | Very Low | 1.00 | Medium |
| Very High | Very Low | Very High | Low | 1.00 | High |
| Very High | Very Low | Very High | Medium | 1.00 | High |
| Very High | Very Low | Very High | High | 1.00 | High |
| Very High | Very Low | Very High | Very High | 1.00 | Very High |
| Very High | Low | Ver Low | Very Low | 1.00 | Low |
| Very High | Low | Ver Low | Low | 1.00 | Medium |
| Very High | Low | Ver Low | Medium | 1.00 | Medium |
| Very High | Low | Ver Low | High | 1.00 | Medium |
| Very High | Low | Ver Low | Very High | 1.00 | Medium |
| Very High | Low | Low | Very Low | 1.00 | Medium |
| Very High | Low | Low | Low | 1.00 | Medium |
| Very High | Low | Low | Medium | 1.00 | Medium |
| Very High | Low | Low | High | 1.00 | Medium |
| Very High | Low | Low | Very High | 1.00 | High |
| Very High | Low | Medium | Very Low | 1.00 | Medium |
| Very High | Low | Medium | Low | 1.00 | Medium |
| Very High | Low | Medium | Medium | 1.00 | Medium |
| Very High | Low | Medium | High | 1.00 | High |
| Very High | Low | Medium | Very High | 1.00 | High |
| Very High | Low | High | Very Low | 1.00 | Medium |
| Very High | Low | High | Low | 1.00 | Medium |
| Very High | Low | High | Medium | 1.00 | High |
| Very High | Low | High | High | 1.00 | High |
| Very High | Low | High | Very High | 1.00 | High |
| Very High | Low | Very High | Very Low | 1.00 | Medium |
| Very High | Low | Very High | Low | 1.00 | High |
| Very High | Low | Very High | Medium | 1.00 | High |
| Very High | Low | Very High | High | 1.00 | High |
| Very High | Low | Very High | Very High | 1.00 | Very High |
| Very High | Medium | Ver Low | Very Low | 1.00 | Low |
| Very High | Medium | Ver Low | Low | 1.00 | Medium |
| Very High | Medium | Ver Low | Medium | 1.00 | Medium |
| Very High | Medium | Ver Low | High | 1.00 | Medium |
| Very High | Medium | Ver Low | Very High | 1.00 | High |
| Very High | Medium | Low | Very Low | 1.00 | Medium |
| Very High | Medium | Low | Low | 1.00 | Medium |
| Very High | Medium | Low | Medium | 1.00 | Medium |
| Very High | Medium | Low | High | 1.00 | High |
| Very High | Medium | Low | Very High | 1.00 | High |
| Very High | Medium | Medium | Very Low | 1.00 | Medium |
| Very High | Medium | Medium | Low | 1.00 | Medium |
| Very High | Medium | Medium | Medium | 1.00 | Medium |
| Very High | Medium | Medium | High | 1.00 | High |
| Very High | Medium | Medium | Very High | 1.00 | High |
| Very High | Medium | High | Very Low | 1.00 | Medium |
| Very High | Medium | High | Low | 1.00 | High |
| Very High | Medium | High | Medium | 1.00 | High |
| Very High | Medium | High | High | 1.00 | High |
| Very High | Medium | High | Very High | 1.00 | Very High |
| Very High | Medium | Very High | Very Low | 1.00 | High |
| Very High | Medium | Very High | Low | 1.00 | High |
| Very High | Medium | Very High | Medium | 1.00 | High |
| Very High | Medium | Very High | High | 1.00 | Very High |
| Very High | Medium | Very High | Very High | 1.00 | Very High |
| Very High | High | Ver Low | Very Low | 1.00 | Medium |
| Very High | High | Ver Low | Low | 1.00 | Medium |
| Very High | High | Ver Low | Medium | 1.00 | Medium |

| | | | | | |
|-----------|-----------|-----------|-----------|------|-----------|
| Very High | High | Ver Low | High | 1.00 | Medium |
| Very High | High | Ver Low | Very High | 1.00 | High |
| Very High | High | Low | Very Low | 1.00 | Medium |
| Very High | High | Low | Low | 1.00 | Medium |
| Very High | High | Low | Medium | 1.00 | Medium |
| Very High | High | Low | High | 1.00 | High |
| Very High | High | Low | Very High | 1.00 | High |
| Very High | High | Medium | Very Low | 1.00 | Medium |
| Very High | High | Medium | Low | 1.00 | Medium |
| Very High | High | Medium | Medium | 1.00 | High |
| Very High | High | Medium | High | 1.00 | High |
| Very High | High | Medium | Very High | 1.00 | High |
| Very High | High | High | Very Low | 1.00 | Medium |
| Very High | High | High | Low | 1.00 | High |
| Very High | High | High | Medium | 1.00 | High |
| Very High | High | High | High | 1.00 | High |
| Very High | High | High | Very High | 1.00 | Very High |
| Very High | High | Very High | Very Low | 1.00 | High |
| Very High | High | Very High | Low | 1.00 | High |
| Very High | High | Very High | Medium | 1.00 | High |
| Very High | High | Very High | High | 1.00 | Very High |
| Very High | High | Very High | Very High | 1.00 | Very High |
| Very High | Very High | Ver Low | Very Low | 1.00 | Medium |
| Very High | Very High | Ver Low | Low | 1.00 | Medium |
| Very High | Very High | Ver Low | Medium | 1.00 | Medium |
| Very High | Very High | Ver Low | High | 1.00 | High |
| Very High | Very High | Ver Low | Very High | 1.00 | High |
| Very High | Very High | Low | Very Low | 1.00 | Medium |
| Very High | Very High | Low | Low | 1.00 | Medium |
| Very High | Very High | Low | Medium | 1.00 | High |
| Very High | Very High | Low | High | 1.00 | High |
| Very High | Very High | Low | Very High | 1.00 | High |
| Very High | Very High | Medium | Very Low | 1.00 | Medium |
| Very High | Very High | Medium | Low | 1.00 | High |
| Very High | Very High | Medium | Medium | 1.00 | High |
| Very High | Very High | Medium | High | 1.00 | High |
| Very High | Very High | Medium | Very High | 1.00 | Very High |
| Very High | Very High | High | Very Low | 1.00 | High |
| Very High | Very High | High | Low | 1.00 | High |
| Very High | Very High | High | Medium | 1.00 | High |
| Very High | Very High | High | High | 1.00 | Very High |
| Very High | Very High | High | Very High | 1.00 | Very High |
| Very High | Very High | Very High | Very Low | 1.00 | High |
| Very High | Very High | Very High | Low | 1.00 | High |
| Very High | Very High | Very High | Medium | 1.00 | Very High |
| Very High | Very High | Very High | High | 1.00 | Very High |
| Very High | Very High | Very High | Very High | 1.00 | Very High |

Table 67: Rules of the Rule Block "RBS_Efficiency_check"

.11 Rule Block "RB9_Crowding_check"

Parameter

| | |
|---------------------|--------|
| Aggregation: | MINMAX |
| Parameter: | 0,00 |
| Result Aggregation: | BSUM |
| Number of Inputs: | 2 |
| Number of Outputs: | 1 |
| Number of Rules: | 4 |

| IF | | THEN | |
|-------------|--------------|------|------------------|
| Bedroom occ | Persons Room | DoS | Crowding indicat |
| Normal | Normal | 1.00 | Very Low |
| Normal | Crowded | 1.00 | High |
| Crowded | Normal | 1.00 | Low |
| Crowded | Crowded | 1.00 | Very High |

Table 68: Rules of the Rule Block "RB9_Crowding_check"

ARABIC SUMMARY

كثيراً ما نرى تغييراً في سياسة الإسكان بمصر بهدف تلبية احتياج الشرائح الاجتماعية المختلفة للمسكن الملائم ولكن نرى خللاً واضحاً في هذه المشروعات التي تم تنفيذها برغم من الإعلان عن أهدافها وتحديدها للشرائح السكانية المستهدفة منها فهناك العديد من السلبيات التي يمكن ملاحظتها في تلك المشروعات منها ما يتعلق بإدارة تلك المشروعات وكيفية اختيار الشرائح السكانية المستهدفة ومنها ما يتعلق بصياغة الفراغات الخاصة بالوحدات السكنية والتصميم المعماري لتلك الوحدات.

ولذلك نجد أن مشكلة الإسكان بمصر تتفاقم بشكل ملحوظ هذا بالرغم من توافر الكثير من مشروعات الإسكان المختلفة وتوافر أعداد كبيرة من الوحدات السكنية ولكنها في الأغلب تكون قاصرة على بعض شرائح المجتمع وتكون صعبة المنال للفئات المحدودة الدخل منها ، مما جعل من الضروري إعادة دراسة المسكن الاقتصادي من جميع جوانبه التصميمية والفراغية حتى يناسب تلك الشرائح.

وبالنظر إلى مفهوم الإسكان الاقتصادي بمصر نجده دائماً مرتبطاً بالفئة المستخدمة لهذا المسكن بما يميزها من سمات، على النقيض نجد في المجتمعات الأكثر تطوراً ونمواً، المسكن الاقتصادي فيها يرتبط بحجم هذا المسكن باختلاف الفئات المستخدمة له ويراعي في الأساس جميع الاحتياجات الإنسانية مع تحديد حجم الأسرة المستخدمة لهذا المسكن ويعرف هذا المسكن بالمسكن الميسر ونجد أيضاً أن هناك معايير تحكم تصميم هذا المسكن بحيث تضمن توفير جودة الحياة) لمستخدمي هذا المسكن.

ويتناول البحث دراسة المسكن من الناحية الفراغية والوظيفية بغرض معرفة إمكانية تقليل مساحة المسكن بصفة عامة بما لا يحدث خللاً في المردود النفسي و الحسي والوظيفي مع إعادة تصور النواحي الوظيفية للمسكن عن طريق دراسة النطاق الحيوي لتأدية وظيفة الفراغ الواحد ومدى إمكانية تقليل مساحة هذا الفراغ بما لا يخل بتأدية الوظيفة ولا يؤثر سلباً على النواحي الإدراكية للسكان .

المشكلة البحثية:

عند الحديث عن خفض تكلفة إنشاء المسكن نلاحظ أن جميع الحلول تسير في اتجاه واحد وهو تقليل مساحة الوحدة السكنية واستخدام مواد إنشاء منخفضة التكاليف ولكنها تغفل في أغلب الأحيان الجانب الفراغي للمسكن ولا تقوم بدراسة العلاقة بين المسكن ومستخدميه من حيث الجوانب الوظيفية والإدراكية والحسية مما يجعل من الضروري إعادة دراسة المسكن من تلك الجوانب.

الهدف من البحث:

يهدف البحث إلى عمل نظام خبرة باستخدام الحاسب الآلي يقوم بتقييم فراغات المسكن الاقتصادي ومدى إمكانية تقليل التكلفة العامة لتنفيذ المسكن عن طريق إعادة صياغة الإطار التشكيلي الحاكم لمفردات المسكن و تقريرها في سياق لا يخل بالنواحي الوظيفية والإدراكية المتعلقة بأسلوب معيشة الساكنين و في هذا الإطار يسعى البحث إلى التعبير عن جميع العناصر الوظيفية المؤثرة في تصميم المسكن إلى قيم رقمية يمكن ترجمتها بعد ذلك إلى قيم اقتصادية واضحة مما ينتج في النهاية مسكن مناسب يحقق الوظيفة المطلوبة منه بنجاح ولا يخل بالنواحي الوظيفية والإدراكية.

- ولكي يتحقق هذا الهدف لابد من تحقيق عدة أهداف مرحلية كالتالي:
- دراسة أسلوب معيشة محدودي الدخل في مصر وذلك بهدف استقراء الخصائص الاجتماعية والثقافية لهم والتعرف على احتياجاتهم الفراغية ومتطلباتهم ورغباتهم لمسكن المستقبل.
- دراسة وتحديد نقاط التلاقي والخلاف بين الرؤية التصميمية للمصمم المعماري للمسكن وطريقة معيشة المستخدمين ورغباتهم واحتياجاتهم طبقاً لخصائصهم الاجتماعية والثقافية.
- تحليل الأداء الوظيفي داخل فراغات مسكن ذوي الدخل المنخفضة معتمداً على أسلوب معيشة المستخدمين.
- استنتاج معايير لتقييم فراغات ومفردات مسكن ذوي الدخل المنخفضة معتمداً على الخصائص الاجتماعية والثقافية لهم.
- تصميم نظام خبرة لتقييم الاداء الوظيفي والفراغي داخل فراغات مسكن ذوي الدخل المنخفضة.

الفرضية البحثية:

يعتمد البحث على فرضية بحثية مفادها أنه هناك خلل في فهم طبيعة فراغات ومفردات مسكن ذوي الدخل المنخفضة والتي تم تطبيقها في مشروعات الإسكان السابقة وأن هناك مدخل آخر أكثر تأثيراً في ضبط وتقليل تكلفة مسكن ذوي الدخل المنخفضة معتمداً على أسلوب معيشة السكان وخصائصهم الاجتماعية والثقافية.

منهجية البحث:

ينقسم البحث في مجمله إلى ثلاث أجزاء ، الجزء الأول ويستخدم فيه المنهج التحليلي بهدف استقراء أسلوب معيشة الفئات محدودة الدخل في القاهرة بالإضافة إلى رصد أسلوب تفكير المصمم والمستخدم ويستخدم في هذا الجزء دراسات الحالة والاستبيانات ، والجزء الثاني يهدف إلى تحليل المسكن وظيفياً وفراغياً معتمداً على أسلوب معيشة الساكنين، أما الجزء الثالث فيمثل الجانب التطبيقي ويستخدم فيه المنهج التجريبي باستخدام الحاسب الآلي بهدف الوصول إلى نظام تقييم لمفردات المسكن الاقتصادي معتمداً على أسلوب معيشة الفئة المستهدفة من السكان.

هيكل البحث:

ينقسم البحث إلى ثلاث أبواب رئيسية وكل باب يحتوي على فصلين ويمكن إيجاز الأهداف المرجوة من كل فصل والنتائج التي تم التوصل إليها كالتالي:

الباب الأول :

ويتناول الباب الأول دراسة مفهوم مسكن ذوي الدخل المنخفضة في مصر والتعريف بتلك الفئة وخصائصها الاجتماعية والثقافية وأيضاً يتناول المفهوم الغربي والعالمي للمسكن الاقتصادي والأفكار التصميمية المنفذة عالمياً وينقسم ذلك الباب إلى فصلين رئيسيين:

الفصل الأول: يهدف ذلك الفصل إلى دراسة وتحليل الخصائص الاجتماعية والثقافية لفئة محدودي الدخل بمصر واستقراء كيفية تعايش تلك الفئات مع المسكن موضعاً أهم المتطلبات والاحتياجات الخاصة بهم والتي يرغبون في توافرها بمسكن المستقبل وأهم المشكلات والعقبات التي يواجهونها في المسكن الحالي وكيفية التغلب على تلك العقبات.

الفصل الثاني: يتناول الفصل الثاني مناقشة الاختلاف بين الفكر التصميمي للمسكن بين المصمم له والمستخدم لهذا المسكن وذلك بهدف تحديد الخلل في تلك العلاقة كما يتناول هذا الفصل الأفكار التصميمية المختلفة والمعايير المستخدمة عالمياً في توفير المساكن الاقتصادية .

الباب الثاني :

ويتناول الباب الثاني دراسة مسكن محدودي الدخل وظيفياً وفراغياً وكيفية تعايش المستخدمين في مفردات المسكن ومدى استغلالهم للمتاح من مساحة المسكن وينقسم ذلك الباب إلى فصلين رئيسيين:

الفصل الثالث: يتناول هذا الفصل التحليل الوظيفي لمسكن ذوي الدخل المنخفضة في مصر وكيفية تعايشهم مع مفردات المسكن وذلك طبقاً للخصائص الثقافية والاجتماعية للفئة المستخدمة وذلك بهدف تحديد الاحتياجات الوظيفية الأساسية لهم حتى يتم مراعاة تلك الاحتياجات في مسكن المستقبل.

الفصل الرابع: يتناول هذا الفصل مناقشة الفراغ الاجتماعي ودراسة المسكن فراغياً طبقاً لإدراك مستخدميه كما يعرض هذا الباب النظريات المختلفة في تحليل الفراغات المعمارية والتي يعتمد بعض منها على السلوك الانساني داخل تلك الفراغات والبعض الآخر على إدراك الفراغ والعلاقات بين الفراغات .

الباب الثالث :

يعرض الباب الثالث نتيجة البحث وفيه يتم تصميم النظام الحاسوبي (الرقمي) لتقييم فراغات مسكن ذوي الدخل المنخفضة في مصر معتمداً على الخصائص الاجتماعية والثقافية لمستخدمي هذا المسكن وينقسم ذلك الباب إلى فصلين رئيسيين:

الفصل الخامس: يهدف ذلك الفصل إلى دراسة وتحليل المعايير التصميمية والتي سيتم تغذيتها بنظام الخبرة المقترح والتي عن طريقها سيتم تقييم فراغات المساكن الجديدة والمصممة لتلك الفئة معتمداً على أربعة مصادر رئيسية للتقييم : أسلوب معيشة فئة محدودي الدخل ورغباتهم واحتياجاتهم – الأكواد التصميمية لمساكن محدودي الدخل – الأمثلة الناجحة عالمياً – أفكار واستراتيجيات توفير المساحة في المسكن.

الفصل السادس: وفيه يتم تصميم نظام الخبرة لتقييم فراغات ومفردات مسكن ذوي الدخل المنخفضة في مصر باستخدام نظام حسابي يعتمد على المبدأ الضبابي والذي يستخدم للتعبير عن البيانات الإنسانية والتي لا يمكن ترجمتها باستخدام النظم الحسابية التقليدية.

وقد انتهت الرسالة في نهايتها إلى تصميم نظام خبرة مبتكر باستخدام الحاسب الآلي استهدف تقييم مفردات مسكن ذوي الدخل المنخفضة وظيفياً وفراغياً معتمداً في تقييمه على الخصائص الاجتماعية والثقافية للفئة المستخدمة بالإضافة إلى تقرير مجموعة من النتائج و التوصيات المرتبطة بمفردات مسكن ذوي الدخل المنخفضة ومدى تأثير الهيكل الفراغي والوظيفي للمسكن بالتغيرات الثقافية والاجتماعية للفئة المستخدمة.

إقرار

هذا البحث مقدم إلى جامعة عين شمس للحصول على درجة الدكتوراه في الهندسة ، تم إنجاز هذا البحث بقسم الهندسة المعمارية ، بكلية الهندسة - جامعة عين شمس من عام 2007 إلى 2011. هذا ولم يتم تقديم أي جزء من هذا البحث لنيل أي مؤهل أو درجة علمية لأي معهد علمي آخر.

و هذا إقرار مني بذلك ،،،

التوقيع :

الاسم : أيمن محمد عاصم أحمد

التاريخ : / / 2011

البنية الوظيفية للشكل كمدخل اقتصادي لصياغة مفردات مسكن ذوي الدخل المنخفضة

رسالة مقدمة من:

المهندس / أيمن محمد عاصم أحمد إسماعيل
ماجستير الهندسة المعمارية 2007 – جامعة عين شمس
للحصول على درجة دكتوراه الفلسفة في الهندسة المعمارية

تاريخ البحث : / / 2011

لجنة الحكم

التوقيع

أ.د. روبرت هيويت (محكماً)

أستاذ التخطيط العمراني وتنسيق المواقع – كلية العمارة
جامعة كليسون – الولايات المتحدة الأمريكية

التوقيع

أ.د. محمد عبد الباقي إبراهيم (محكماً)

أستاذ التخطيط العمراني – كلية الهندسة - جامعة عين شمس

التوقيع

أ.د. محمد أيمن عاشور (مشرفاً)

أستاذ العمارة والتخطيط العمراني – كلية الهندسة-جامعة عين شمس

التوقيع

أ.د. محمد إبراهيم جبر (مشرفاً)

أستاذ نظريات العمارة – كلية الهندسة - جامعة عين شمس

أجيزت الرسالة بتاريخ:

.....

موافقة مجلس الجامعة

.....

التاريخ: / /

الدراسات العليا

ختم الإجازة

موافقة مجلس الكلية

.....



جامعة عين شمس
كلية الهندسة
قسم الهندسة المعمارية

البنية الوظيفية للشكل كمدخل اقتصادي لصياغة مفردات مسكن ذوي الدخل المنخفضة

إعداد

مهندس / أيمن محمد عاصم أحمد إسماعيل
مدرس مساعد بقسم الهندسة المعمارية
كلية الهندسة – جامعة عين شمس

رسالة مقدمة كجزء من المتطلبات للحصول على درجة دكتوراه الفلسفة في الهندسة المعمارية

أستاذ دكتور / محمد إبراهيم جبر
أستاذ العمارة بكلية الهندسة
جامعة عين شمس

أستاذ دكتور / محمد أيمن عاشور
أستاذ العمارة بكلية الهندسة
جامعة عين شمس

كلية الهندسة
جامعة عين شمس
2011