Develop a sustainable desert rural house prototype,

in New Valley "Al wadi Al gadid" Governorate in Egypt

Ali Kamal Altawansy[1]

E-mail : dr.aly@hotmail.com

Abstract :

The Egyptian Government give a great attention now to develop the small productive desert rural communities according to our sustainable plan in Egyptian vision 2030, and to fulfill the UN sustainable development goals (SDGs 2030), to save energy, water, and other sustainable criteria. New Valley "Al wadi Al gadid" Governorate constitutes 44% of Egypt area. The research **aims to** identify the basic sustainable design criteria and components of (The Prototype House) which reflect the basic and common needs for these rural small communities and presents desert region criteria that can be generalized to rural desert villages in Egypt and other similar environment, considered the flexibility and possibility of these criteria.

The research adopts the **analytical methodology** based on cultural, economic, geographical, climatic criteria and field survey to fulfill user's requirement, use the local materials, treatments within the basic principles of sustainability, at the lowest possible cost to minimize running cost of these communities.

Keywords: Desert rural house; Sustainable rural communities; Desert Architecture; New Valley.

[1] Associate Professor, Department of Architecture, Faculty of Engineering, October 6 University, 6th of October City, Central Axis, Giza, Egypt.

1. Introduction

Egypt is currently towards to develop the small urban communities and low-income social groups, and has developed several government initiatives, including Haya Karima "It is an Egyptian National Initiative aimed to improve the living conditions and daily life of Egyptian citizens". In line with Egypt's 2030 strategy thus, to fulfill the sustainable cities and communities which is the eleventh goal of SDGs 2030 "UN Sustainable Development goals", Fig.1.

Fig (1): UN SDGs 2030, [1]

The desert rural communities are promising places because of their cultural, social, and spatial components, they've been marginalized areas for a long time. despite the distinguished Architecture and Urban Inheritance.

The New Valley Governorate area is about (440،098km²) 44% of Egypt Area, Fig.2. The population is less than half a million people [2], [3], and it presents one of the unique local desert environments, because of the spread-out oases, springs, and wells of the waters.

Many studies and research have addressed several urban aspects in small rural communities and villages, but the first challenge remains to provide an applicable and flexible criterion for a prototype model, where they are governed by many considerations such as:

a. Different social level and therefore the housing level
b. Its ability to extend vertically and horizontally.
c. Consider the quality, size, distribution, privacy of spaces, social, clan and tribal considerations.
d. The use of local building materials
e. The use of traditional building methods

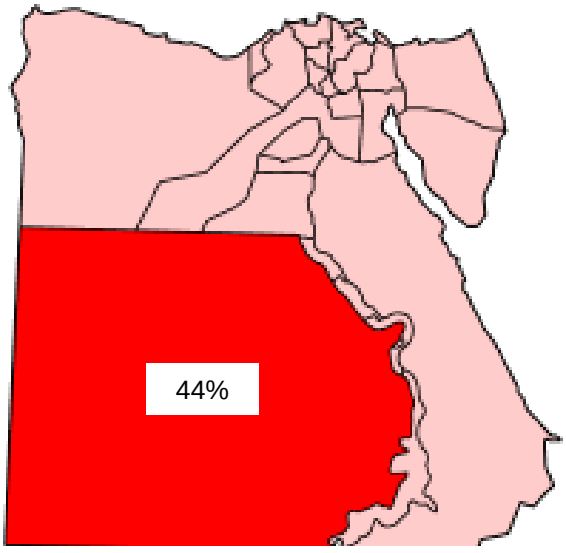


Fig (2): Alwadi Al-Gadid Governorate area 44% of Egypt Area, [3]

There are many previous governmental attempts to provide an appropriate and suitable housing prototype, such as:

- Designed samples by Desert Development Authority
- Paris Village by Hassan Fathy
- Governmental housing

But these attempts were unsuccessful, because it usually gave them our vision, not exactly what they need.

So, the research **aims to;** identify the basic sustainable design criteria and components of (the proposed Prototype House) which reflect the basic and common needs for these rural small communities and considered desert region criteria that can be generalized to rural desert villages in Egypt and other similar environment, considered too the flexibility and possibility to apply. It is absurd to impose one prototype model on them all meets all the requirements of its habitants.

Therefore, there are many other **sub-objectives**:
To target a specific community segment that represents the smallest nucleus in these rural communities.

a. Design flexibility and meaning (acceptable adjustment to suit different needs, possibility of horizontal and vertical expansion). People often tend to be distinct from others.
b. Reduce running cost to the least possible to support this community segment more effectively than reducing the price of electricity and water segments, to rationalize their consumption.
c. Identify the needs of the target communities effectively, not impose rigid designs on them. Through:
    - Monitoring the prevailing housing pattern for these communities.
    - A questionnaire of their needs and a study of their current home style.

The research adopts the analytical **methodology** based on cultural, economic, geographical, climatic criteria and field survey for small rural communities to fulfill user's requirement, use the local materials, treatments within the basic principles of sustainability, at the lowest possible cost to minimize running cost of these communities.

2. Local Design Characteristics and Conditions:

There are many design considerations and determinants that characterize this region and greatly affect the architectural housing design, such as climatic, social, and economic conditions.

2.1. Climate Condition:

The city of Kharga is the capital of The New Valley (Al wadi Al gadid) Governorate, is a hot desert climate region, has a high rate of solar brightness that allow electricity to be generated economically using solar cells, with rare rainfall, Table (1) showing the climatic data of this city.

Table (1): Kharga Climate Data, [4]

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °C (°F)	36.0 (96.8)	42.3 (108.1)	47.5 (117.5)	46.4 (115.5)	49.8 (121.6)	50.3 (122.5)	47.5 (117.5)	46.8 (116.2)	45.4 (113.7)	44.6 (112.3)	39.8 (103.6)	38.7 (101.7)	50.3 (122.5)
Average high °C (°F)	22.1 (71.8)	24.7 (76.5)	28.8 (83.8)	34.5 (94.1)	38.2 (100.8)	40.2 (104.4)	39.9 (103.8)	39.5 (103.1)	37.1 (98.8)	33.9 (93.0)	28.1 (82.6)	23.5 (74.3)	32.5 (90.5)
Daily mean °C (°F)	14.0 (57.2)	16.1 (61.0)	20.4 (68.7)	26.1 (79.0)	30.3 (86.5)	32.6 (90.7)	32.8 (91.0)	32.0 (89.6)	29.0 (84.2)	26.3 (79.3)	20.3 (68.5)	15.5 (59.9)	24.6 (76.3)
Average low °C (°F)	5.6 (42.1)	7.1 (44.8)	11.3 (52.3)	16.7 (62.1)	21.5 (70.7)	24.2 (75.6)	24.4 (75.9)	23.2 (73.8)	22.3 (72.1)	18.5 (65.3)	12.5 (54.5)	7.4 (45.3)	16.2 (61.2)
Record low °C (°F)	0.0 (32.0)	0.2 (32.4)	2.6 (36.7)	6.4 (43.5)	10.6 (51.1)	14.8 (58.6)	16.9 (62.4)	16.9 (62.4)	14.9 (58.8)	9.9 (49.8)	0.8 (33.4)	0.8 (33.4)	0.0 (32.0)
Average precipitation mm (inches)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0.0)	0 (0)	0 (0)	0 (0)	1 (0.0)
Average precipitation days (≥ 1.0 mm)	0	0	0	0	0.1	0	0	0	0	0	0	0	0.1
Average relative humidity (%)	52	45	38	29	27	28	30	31	36	41	47	51	37.9
Mean monthly sunshine hours	287.8	274.4	297.8	307.2	336.8	361.6	359.9	364.9	321.1	313.0	289.7	276.6	3,790.8

The Egyptian Code for Improving Energy Efficiency in Residential Buildings [5], put a specified climate conditions should be considered in sustainable housing design at kharga, as shown in table (2)

Table (2): Housing Design Climate conditions at kharga, [5]

Site			Summer							Winter			
			External Climate Design conditions					Internal Climate Design conditions		External Climate Design conditions		Internal Climate Design conditions	
			Dry Bulb Temp. Values			Wet Bulb Temp. Values							
East Longitude Degree	North Latitude Degree	Height (m)	1 %	2.5 %	5 %	99.6 %	99 %	Internal Design Temp. ˚C	Relative Humidity %	External Temp. ˚C	Relative Humidity %	Internal Design Temp. ˚C	Relative Humidity %
30.5	25.5	78	45	04	38	22	21.8	25	40	14	50	22	40

2.2. Social and Economic Characteristics:

The Village communities in Kharga are characterized by :

- It is isolated communities for a long time, descended from Berbers, Arab Bedouins, Egyptians and Africans, and there is a small percentage of migrant farmers from the Nile Valley, Fig.3.
- They have very low crime rate.
- It suffers from the migration of educated youth to the city seeking a better service and live style.

The social groups in these villages could be divided into three categories, which represent different housing segments as well:

- Farm owners
- Farm workers
- Tenants

Economic activity is based on the cultivation of palms, olives, dates, trade, and industries based on it, in addition to some other simple handicrafts. Tourism activities such as medical tourism with sand and sulfur spring water, oases, and cultural tourism to Pharaonic monuments.

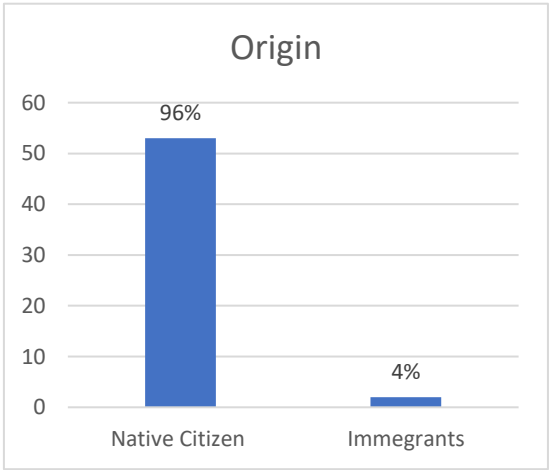


Fig (3): Origins ratios at New Valley small rural communities, field survey, Author, 2022

3. Traditional Cultural House characteristics:

This part explains the basic characteristics and design considerations of the traditional cultural house in the old villages in the oases of the New Valley Governorate, to use it as a guideline design conditions, determinants of the proposed Prototype. The Qasr village in the north of Aldakhla oasis at the New Valley governorate, which is a great monument, preserves many of these traditional buildings in a good condition until now, Fig.4→7.

Fig (4): Qasr Village Great Mosque, Author.

Fig (5): Qasr Village, Entrances, Author.

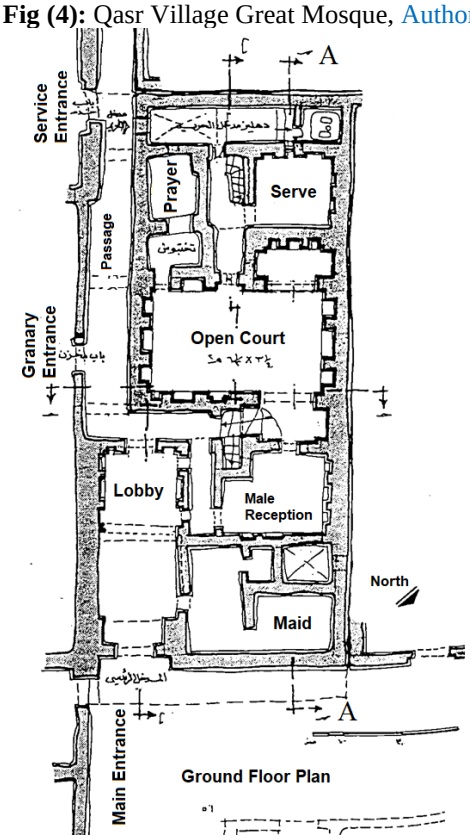


Fig (6): House Ground Floor Plan, [6]

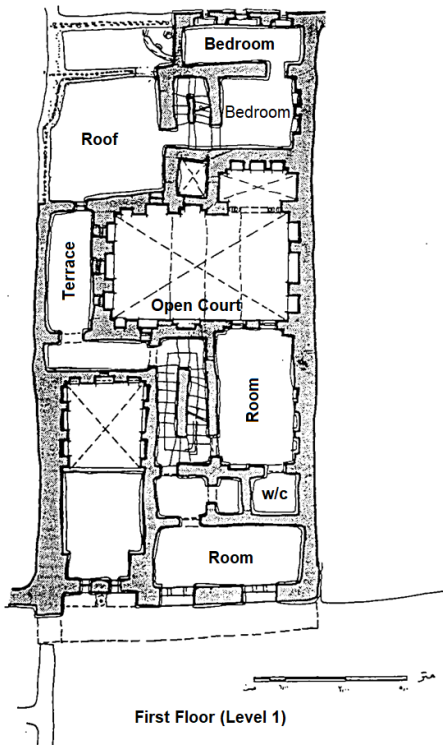


Fig (7): House First Floor Plan, [6]

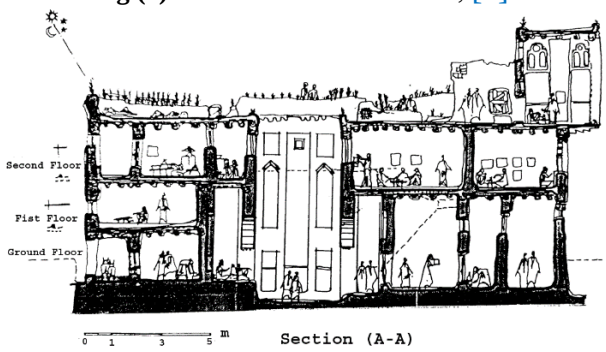


Fig (8): Vertical Cross Section, [6]

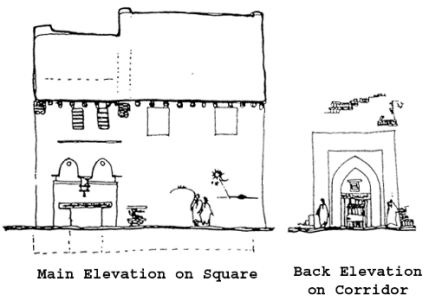


Fig (9): Elevations, [6]

The characteristics of the traditional housing can be defined in the following points,[6],[7]:

a. Design characteristics:

- Houses are grouped together (in compact form)
- Mostly, the house consists of two or three floors.
- The openings are oriented mostly to the north direction.
- The house's main entrance is indirect for more privacy.
- Often in large houses there are several entrances (male, female, and service entrances).
- Houses entrances are not facing each other to respect neighbors' privacy.
- Low entrance height, about 160 cm as a kind of respect, Fig.5
- Squared and small openings have raised seats on the ground floor to achieve visual and sound privacy.
- The roof parapet height level is also about 2m to achieve privacy and visual isolation.

b. The house common components:

- Male reception (called Marbuaa in the local accent)
- Female reception
- Bedrooms and maid rooms in large homes
- Granary
- Courtyard
- Cattle or poultry barn

c. Construction system and materials:

- Construction system of load-bearing walls with a thickness of about 50 cm, sloped from bottom to top.
- Foundations of limestone or sand
- The walls are made of stone or mud bricks, which are still used until now, Fig.10.
- The roofs are flat in the most, made of olive wood, palm trunks, leaf, reeds, and clay.
- The plastering of the walls is made of clay, and white lime is sometimes used in paint.

4. Existing Housing patterns:

Vernacular house's design is common in the governorate, but it doesn't meet many of architectural design norms, codes and standards, Fig.10.

There are many governmental housing projects too in the New Valley Governorate, suitable for residents of cities and large residential communities, It is vertical buildings consist of ground floor and three to five typical floors, have one entrance, with areas range about 70 to 100m², targeting The middle and low-income immigrants users, it doesn't not suitable for villages and small rural communities and doesn't meet their needs such as; privacy, suitable area or required spaces for their activities. Fig. 11,12,13

A- Bearing walls of mud bricks & palm trunks & Leaf

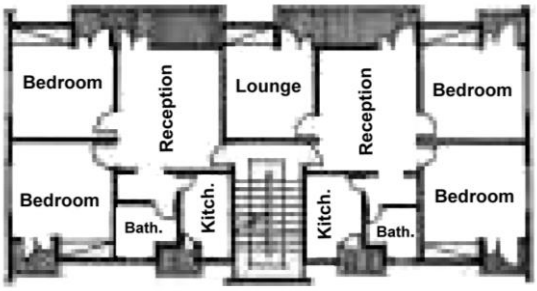
B- Bearing walls of stone & reinforced concrete ceiling

C- Skeleton structure of reinforced concrete

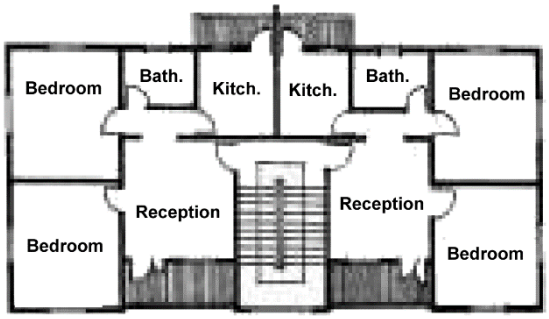
Fig (10): Eastern suburbs of Kharga "Sharq Albalad", Author.

Fig (11): Governorate old Housing at Al Zohur District, Al khargah, Author, 2022.

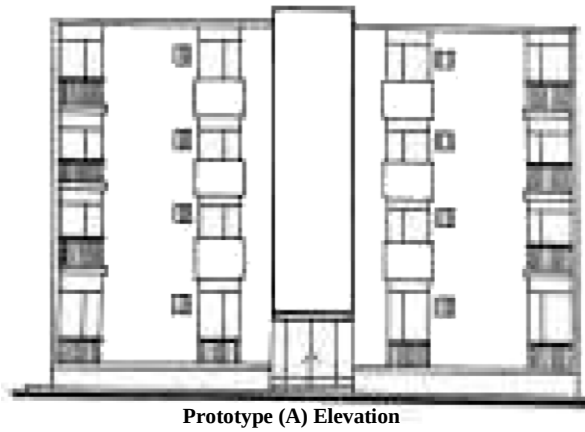
Fig (12): Dorrat Alwady Governorate recent Housing Project in 2022 at Al khargah (Qasr), Author, 2022.



Prototype (A) Plan



Prototype (B) Plan



Prototype (A) Elevation

Prototype (B) Elevation

Fig (13): Governorate old Housing prototypes (Plans & elevations) at, Al khargah, [8]

There are many attempts to revival the traditional heritage architecture, such as:

- Paris village of Hassan Fathi, which is located to the south of the Kharga Oasis, Fig,14,15,16, where he succeeded to design buildings achieved 15℃ difference between outdoor and indoor of buildings, using vaults, domes, and local building materials, he provided people with their needs such as: good isolated underground granary, poultry and cattle barns, bedrooms, shaded passages…etc. Unfortunately, this project was discontinued for unknown reason,
- There is another model prepared by Desert Reconstruction Organization in Siwa Oasis of a similar nature, but it's flawed by the inability to expand vertically, small rooms and it didn't fulfil other segments requirements in the community. Fig.13.
- Haya Karima It is an Egyptian National initiative that aims to improve the villages socially, economically, and urbanely to improve the quality of life of the people in their villages, it targets the poor families in the rural communities, concentrated on utilities network and public services, not on the house design,[18].

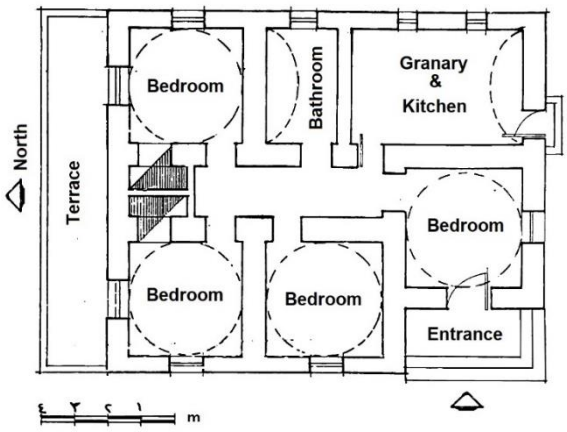


Fig (13): Model of a residential rural house for the Desert Reconstruction Organization in Siwa Oasis, [7]

Fig (14): Paris Heritage Village by Hassan Fathi at, Al khargah, [9]

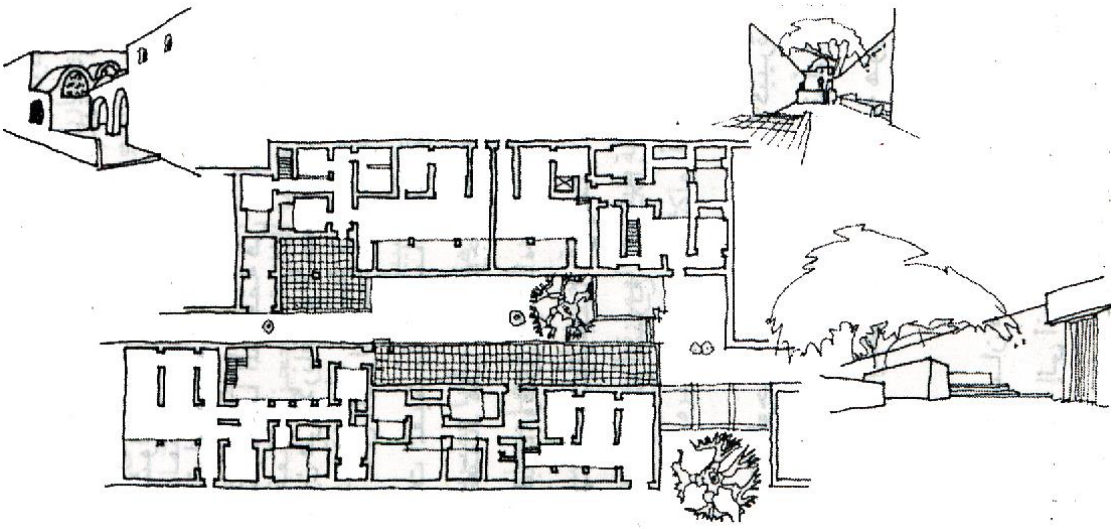


Fig (15): Rural houses plan in Paris Heritage Village by Hassan Fathi at, Al khargah, [9]

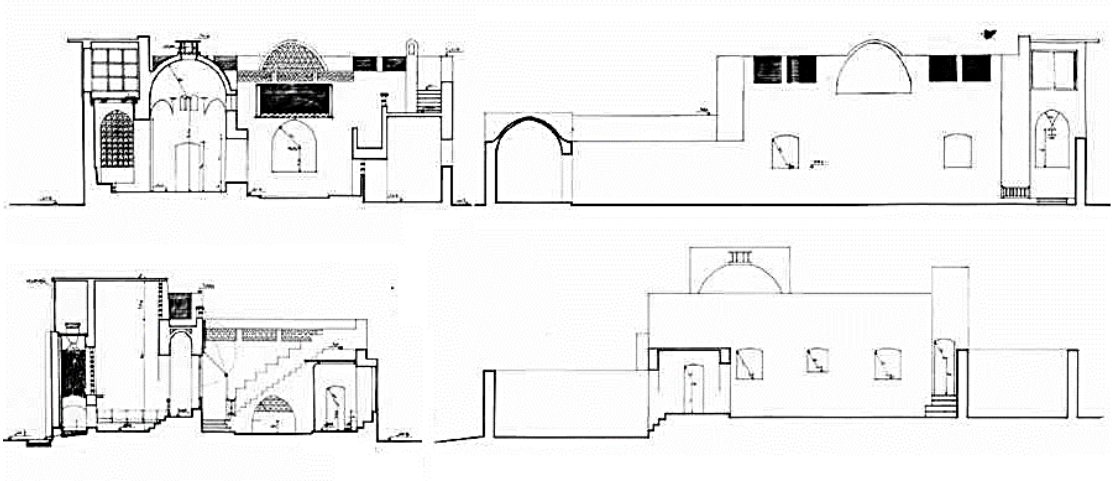


Fig (16): Rural houses vertical cross sections & elevations in Paris Paris Heritage Village by Hassan Fathi at, Al khargah, [9]

5. Recommended basic sustainable design criteria:

This part of the research proposes recommendations for designing a prototype house in the New Valley Governorate, as it does not restrict the architect in a specific form or style, but present recommendations and design determinants to be considered during the architectural design process. It does not deal with the planning and urban design aspects, which can be addressed in another research. These recommendations cover four main aspects:

- Firstly: The common design required components should exist in the prototype house.
- Secondly: Architectural design determinants and conditions
- Third: Structural considerations
- Fourth: General recommendations

The research adopted the analytical approach to reach these recommendations, through a field survey for many small rural villages and remote communities in the Western Desert of Egypt. The survey covered 10 communities and 55 houses, to detect the actual needs of these communities. According to the minimum design requirements, security, safety requirements, and sustainability standards stipulated by the relevant engineering laws and codes, such as:

1. Egyptian Construction Law No. (119) of 2008,[11]
2. House and residential community Code,[12]
3. The Egyptian Code for Improving Energy Efficiency in Residential Buildings,[5]
4. Green Pyramids Rating System,[13]
5. Egyptian code for Masonry work in buildings,[14]
6. Egyptian code for Design and construction of concrete constructions,[15]
7. Egyptian soil construction rammed earth units code,[16],[17]

5.1. Recommended house design components

The following chart, Fig.17, explain the result of field survey and importance of the common functions (uses) of the rural house plan design in the selected samples which are as follows:

- There are spaces **must** exist such as: (bedrooms, kitchen, and bathroom)
- There are spaces **should** exist such as: (Granary, Poultry Barn and Cattle Barn which could be available in various positions in the house)
- There are spaces **Maybe** exist such as: (The additional w/c and Reception which is called “Marbuaa” in the local accent).

So, the Architect proposed design alternatives should reflect this result.

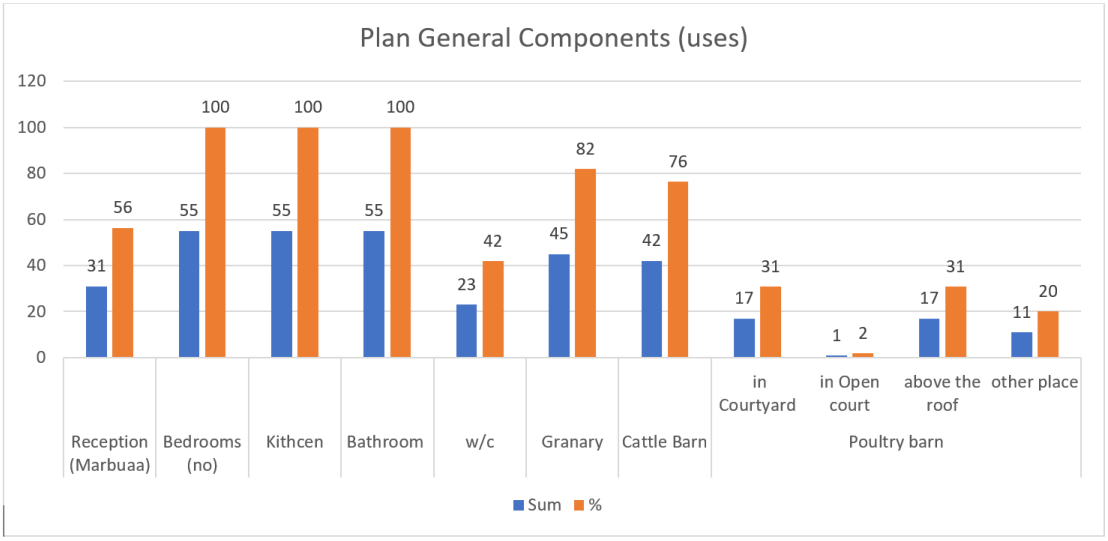


Fig (17): House plan general and common components, field survey, Author.

5.2. Design conditions.

One of the most important results of the field survey is most of the surveyed vernacular samples didn't achieve the minimum standard requirements, (minimum area, minimum dimension, minimum height, and other mentioned requirements in the Egyptian housing code and building construction law No. (119/2008), Tables, [4], [5].

Table (3): Minimum home space's net dimensions and area, [11],[12]

The use	Minimum distance (m)	Minimum Area (m2)	Minimum Height (m)
Residential Room	2.70	7.50	2.70
Living	2.70	10	2.70
Kitchen	1.50	3	2.30
Bathroom	1.00	2.40	2.30
w/c	0.80	1.50	2.30
corridors	1.00	1.50 (& should not exceed 20% of total house area	2.30
Entrance lobby	1.40	2.00	2.30
Terrace (or Balcony)	0.8	1.20-3.00m2 according to total house area Less than 5% ground floor area (in typical floors)	2.30
Service open court	2.50 (or according to building code)	7.50m2 for height ≤ 10m 10m2 for height ≤ 20m 12.50m2 for height ≤ 30m +2.5m2 for every 10m additional height	---
Residential open court	3.00 (or according to building code)	9m2 or (1/4h)2 which one is bigger	---

Table (4): Other public building element's standards, [11],[12]

House Elements	standards
Horizontal Corridors min. width	1.2m for ≤ two units +0.05m for every additional unit, not exceed 1.8m
Building Stair's standards	Flayer min. width (Main stairs) ≤ 1.10m for ≤ 4 units Flayer min. width (Main stairs) ≥ 1.20m for ≥ four units Flayer min. Clear Height ≥ 2.10m Landing ≥ flayer width Maximum flayer stairs ≤ 14 stairs 32cm ≥ Tread (Main stairs) ≥ 27cm

	17cm ≥ Riser (Main stairs) ≥ 15cm
Building entrance	Min. lobby height ≥ 2.50m Min. door width ≥ 1.40m Min. door Height ≥ 2.20m
Parking (parking code) Car Parking Place: (≈ 2.2→2.5w × 4.7→5L)	1 Parking place for (70m2 ≤ unit's net area ≤120m2) 2 Parking place for (120m2 < unit's net area ≤ 200m2) 3 Parking place for (unit's net area > 200m2) 0.5 Parking place for (unit's net area > 70m2)

5.3. Construction conditions

There are many construction conditions, [14], should be considered in:

- The architectural design processes.
- Building construction process

The New Valley Governorate is in the first seismic zone, Figure 18, which is the least exposed region to earthquakes in Egypt. It includes the western and eastern deserts of Egypt as well, it has the minimum safety requirements, which give architect more flexibility in design and construction process.

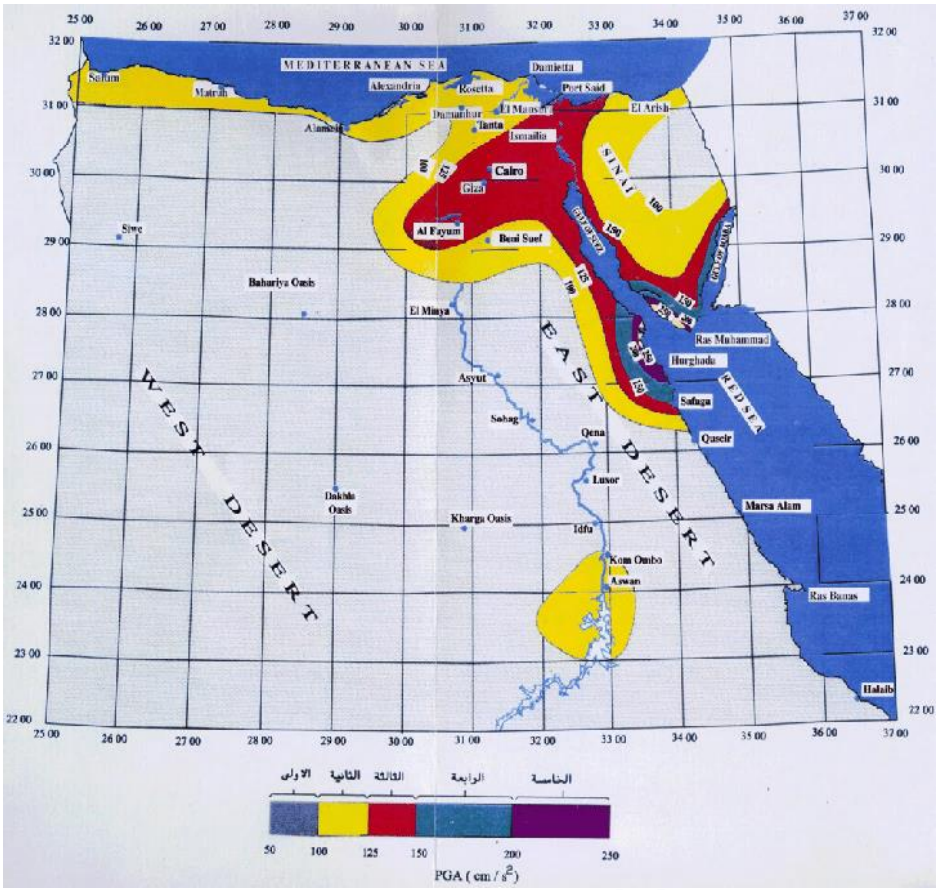


Fig (18): Seismic map of Egypt, [15]

5.3.1. The Architectural design processes considerations for bearing walls, [14]

- design regular spaces as possible.
- distribute loads regularly and use ground or basement floor directly for high loads such as granary.
- The number of floors should not exceed two floors, including the basement with bearing wall construction system with minimum thickness 25cm for clay and concrete bricks, 40cm with rubble stone. And one floor only when using adobe walls with minimum thickness 40cm.
- avoid using more than one structural system.

- Floor height must be less than 3m.
- The maximum distance between the axes does not exceed 5 m.
- Building ratio (height: minimum building width) not more than (1:2.5)
- Building ratio (width: length) does not exceed (1:4) and use construction joints if increased.
- Non-load-bearing internal partitions must not be more than 4m in length or height.

5.3.2. Building Construction process considerations for bearing walls, [14]

- Making prominent shoulders (protective bumpers) for building corners
- Use 50cm length metal connectors every five courses and to reinforce the building corners and load-bearing walls, especially mud bricks (not obligatory for this seismic zone), Figure 19.
- Do not load newly built walls until they are completely dry.
- It is preferable to make wood shavings for openings (doors or windows) to avoid cracking.

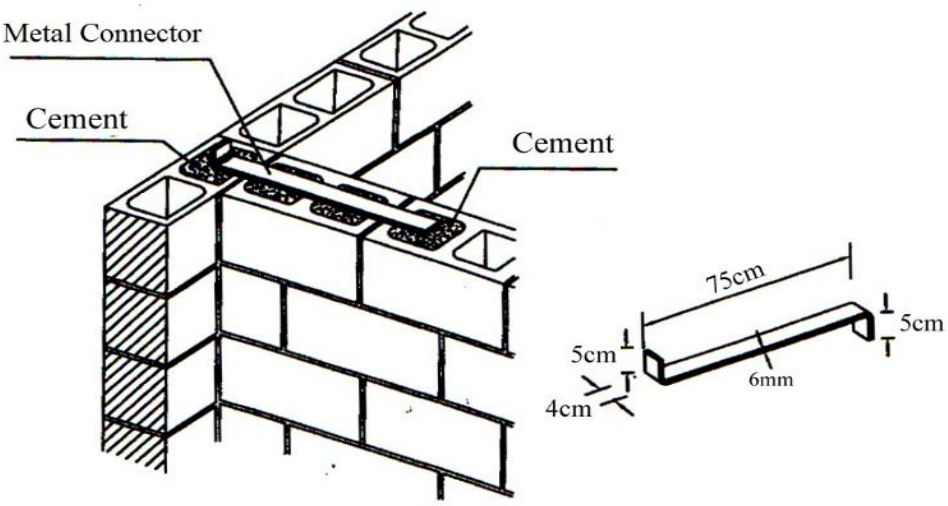


Fig (19): Masonry Construction recommendations, [14]

5.3.3. General Recommendations

- Localities and city organs can provide citizen (habitants) with sustainable house design alternatives (Architectural, Structural, Plumbing, Electrical...etc.) that consider the different social level as well as the size of the family and so on.
- Submit a flexible licensing (Permit) mechanism for buildings in these rural communities.
- Increase awareness of sustainability and its impact on the environment, economy, and public health in these communities.

6. Conclusion:

The search concludes the following points:

- The architect cannot impose a unified prototype model for everyone in these communities, this destroys innovation and creativity, but he can apply it through specified conditions, determinants, design elements and considerations. So, the research presents it to achieve Sustainable house prototype for small rural communities in the New Valley Governorate in Egypt, and to minimize running cost in these communities.

- Any design proposal should reflect the inhabitant's actual needs, not just the architect's vision, as well as flexibility, feasibility of implementation, and the possibility of horizontal and vertical extend. The research addressed this goal through field survey.
- Sustainable design laws and standards should be activated and applied.
- These urban communities possess many of the ingredients for success that qualify them to adopt a sustainable urban pattern (such as: solar energy, water, crops, and local building construction materials...etc.).

7. References:

1. https://www.un.org
2. Central Agency for Public Mobilization and Statistics, **Statistical Yearbook – Population**, Cairo, Egypt, Jan 2021
3. www.newvalley.gov.eg
4. https://www.noaa.gov/ "National Oceanic and Atmospheric Administration", Washington, DC, USA.
5. HBRC "Housing and Building National Research Center" (2006), The Egyptian Code for Improving **Energy Efficiency in Buildings, Part I: Residential Buildings** Code No. (306/1), Ministry of Housing, Utilities and New Urban Communities, Egypt.

٦. علي لبيب محمد، (١٩٨٧)، **تأصيل القيم المعمارية الإسلامية في عمارة الصحراء بمصر**، رسالة ماجستير، كلية الهندسة، جامعة عين شمس، القاهرة، ١٩٨٧.

٧. النحاس، أسامة، (١٩٨٧) **عمارة الصحراء**، مكتبة الأنجلو المصرية، القاهرة، ١٩٨٧.

٨. عبد المطلب محمد علي، (٢٠٠٩)، **تأثير الظروف المناخية على تشكيل عمارة جنوب الوادي بمصر** "مدينة الخارجة بالوادي الجديد بالصحراء الغربية كمثال"، مجلة العلوم والتكنولوجيا، المجلد (١٤) العدد (١)، اليمن.

٩. محمد عبد العال إبراهيم، (١٩٨٦)، **العمارة العربية** (١): العمارة والعمران في الوطن العربي، دار الراتب الجامعية، أكتوبر، الطبعة الثالثة، بيروت، لبنان.

10. https://www.hayakarima.com/ accessed, 10-Apr.-2022.
11. Egyptian Construction Law No. (119) of 2008 and its executive regulations, Cairo, Egypt.
12. HBRC "Housing and Building National Research Center" (2009), **House and residential community** Code No. (602), Ministry of Housing, Utilities and New Urban Communities, Egypt.
13. HBRC "Housing and Building National Research Center" (2019), Green Pyramids Rating System – **GPRS** for New Building and Major Renovation, Ministry of Housing, Utilities and Urban Communities, Egypt.
14. HBRC "Housing and Building National Research Center" (2009), Egyptian code for **Masonry work in buildings**, ECP (204-2005), Ministry of Housing, Utilities and Urban Communities, Egypt.
15. HBRC "Housing and Building National Research Center" (2018), Egyptian code for **Design and construction of concrete constructions**, ECP (203-2018), Ministry of Housing, Utilities and Urban Communities, Egypt.

١٦. أيمن ملوك، (٢٠٢١)، **البناء بمادة تربة الأرض**، الجزء الأول، في العالم القديم، الناشر مكتبة الأنجلو المصرية، القاهرة، مصر، ٢٠٢١.

17. HBRC "Housing and Building National Research Center" (2017), Egyptian soil construction code, part 1: construction with **rammed earth** units, Ministry of Housing, Utilities and Urban Communities, Egypt.
18. Fatma Gamal, Mohamed Hagag, Ahmed Elkholy, (2019), Principals and criteria for environmental planning for sustainable urban communities in desert pattern in Egyptian oasis, Egyptian society of engineers' journal, volume 58, No. 3 2019

Arabic Abstract

تطوير نموذج نمطي لمنزل صحراوي ريفي مستدام بمحافظة الوادي الجديد

علي كمال الطوانسي[2]
dr.aly@hotmail.com

ملخص البحث باللغة العربية:

تولي الدولة اهتماما كبيرا لتعمير المناطق الصحراوية باستخدام أساليب مستدامة سواء لتوفير الطاقة و المياه، واستخدام مواد من البيئات المحلية، وغيرها من مبادئ الاستدامة، كذلك تسعى للاهتمام بالقرى الريفية والصحراوية (التجمعات الصغيرة المنتجة عموما)، وتعد أحد أهم محاور التنمية في خطة مصر للتنمية المستدامة ٢٠٣٠، و تعد محافظة الوادي الجديد أكبر المحافظات في مصر حيث تمثل نحو ٤٤٪ من مساحة مصر، يهدف البحث لتحديد المقومات التصميمية والمكونات الأساسية (لنموذج سكني نمطي) الأكثر احتياجا وشيوعا للبيت الريفي في هذه المجتمعات الصغيرة وباعتبارها إقليما صحراويا ذو طبيعة خاصة يمكن تعميمه على القرى الريفية الصحراوية في مصر والمناطق ذات الطبيعة المشابهة، وبحيث يتميز بالمرونة إمكانية التوسع الرأسي والأفقي، وتعديل نمط وشكل الواجهات، وغيرها من الأهداف الفرعية.

، ويعتمد البحث المنهج التحليلي استنادا لدراسات واستقصاءات اجتماعية واقتصادية ومعمارية، وتوظيف الخامات المتاحة في البيئات المحلية وعمل معالجات لكل العناصر المعمارية والإنشائية والبيئيـــة التي تتناسب مع عادات ومتطلبات المجتمع الريفي المحلي وفي إطار المبادئ الأساسية للاستدامة، وبأقل تكلفة ممكنة.

الكلمات الدالة:

عمارة الصحراء، العمارة المستدامة، الوادي الجديد، المنازل الريفية

٢ أستاذ مشارك، قسم الهندسة المعمارية، كلية الهندسة، جامعة ٦ أكتوبر، القاهرة، مصر