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UTILIZATION OF MONGOLIAN TRADITIONAL GER'S SPATIAL CONFIGURATION IN MODERN HOUSING

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Ariunaa GANBAT

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- All data, information and documents presented in this thesis have been obtained within the scope of academic rules and ethical conduct,
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02/ 07/2019

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(M. Sc. Thesis)

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ABSTRACT

This study investigates the utilization possibilities of architectural characteristics and spatial configuration from Mongolian traditional GER houses for the modern settlements and current housing design. As a method, literature review and on-site investigations of GER houses were conducted. Internal spatial organization and structural features such as portability and easy installation of the houses were obtained as design data acquired from the analysis of traditional GER. Moreover, it was hypothesized that GER has the potentials to provide design inputs for modern housing design. Therefore repeatable 6 polygon plans reflecting the interior organization of GER offered in the original proposal of the thesis. In addition to that, urban residential housing designs were acquired with repetitions of the plans. It has been concluded that traditional GER design concept can contribute not only to the sustainable development for Ulaanbaatar, the capital city of Mongolia, likewise to the development of all other cities in Mongolia, as well as to find an architectural solution to the worldwide need for mass and emergency housing and to development and adaptation of GER to the urban lifestyle. As a result, the design concept of a space that has been formed over the centuries provides data for the design of housing typologies such as mass housing, emergency housing, student dormitory building.

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Key Words	:	Traditional dwelling, Mongolian GER houses, Modern housing, Mass housing, Temporary housing, Emergency housing, Flexible space;
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MOĞOLİSTAN GELENEKSEL GER EVLERİN MEKANSAL KONFIGÜRASYONUNUN MODERN KONUTLARDA KULLANIMI

(Yüksek Lisans Tezi)

Ariunaa GANBAT

GAZİ ÜNİVERSİTESİ

FEN BİLİMLERİ ENSTİTÜSÜ

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ÖZET

Bu çalışmada, Moğolistan geleneksel GER evlerinin mimarı özelliklerinin ve mekan konfigürasyonunun, modern yerleşimlerde ve güncel konutlarda kullanım olanakları incelenmektedir. Metot olarak, GER evleri ile ilgili literatür taraması ve yerinde incelemeler yapılmıştır. Bu analizler ile konutların iç mekan örgütlenmesi ve taşınabilirlik, kolay kurulum gibi strüktürel özellikleri elde edilmiştir. Tezin özgün önerisinde, GER'in iç mekan örgütlenmesini yansıtan 6 adet tekrar edebilen poligon plan önerilmiştir. Buna ek olarak, bu planların tekrar etmesi ile kentsel konut yerleşimler elde edilmiştir. Sonuç olarak, yüzyıllar içinde gelişip bügünkü şeklini alan GER mekan tasarım konsepti, günümüzün konut tipolojileri olan toplu sosyal konutlar, acil durum barınma evleri, öğrenci yurtları tasarımı için veri sağlamaktadır. Geleneksel GER evlerinin sadece Moğolistan'ın başkentinin sürdürülebilir gelişimi için değil, bütün diğer şehirlerinin gelişmesi ve ayrıca dünya çapındaki toplu konut ve acil durum barınma gereksinimine mimari bir çözüm bulabilmek için katkı sağlayabileceği ve GER'in şehir yaşam tarzına göre geliştirebileceği ve uyarlanabileceği sonuçlarına varılmıştır.

Bilim Kodu	:	80107
Anahtar Kelimeler	:	Geleneksel barınakları, Moğolistan GER evleri, Modern konutlar, Toplu konutlar, Geçici iskan, Acil durum barınma, Esnek mekan;
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1. INTRODUCTION

A living environment made by human being has been developing, up to dating, improving or even getting worse in some cases either by sustaining its past tradition and history or removing the existing culture, pursuing “new” style of living environment through the history of architecture and urban planning. In Mongolia, cities generally composed from 2 different types of settlement. As in the case of Ulaanbaatar, the capital city of Mongolia, centrally located duly planned apartment areas are surrounded by “GER district”, semi-formal, spontaneous settlement area which has been developing under the circumstance of rural to capital rapid migration in Mongolia (Figure 1.1.a). “GER settlement” areas which called “GER district”, consists of both self-built detached houses and the Mongolian traditional GER. In GER settlement, household parcels usually consists of one or more detached houses or GERs enclosed by two-meter high wooden fences (Figure 1.1.b). Anderson R. et al. described the GER districts in Ulaanbaatar as “...the site of numerous plans for large scale urban transformation. Ger districts are rapidly growing areas named for the felt tents that are considered their typical housing mode” [1]. Households in the area are not commonly connected to infrastructure such as running water, plumbing and central heating systems.

(a) (b)

Figure 1.1. a. Part of Ulaanbaatar city b. Household parcels

Almost half of 3 million Mongolian population live in Ulaanbaatar. “The population of the ger areas is now estimated to make up about 60 percent of the total population of UB (Ulaanbaatar).… nearly 85 percent of ger residents use wood or coal-burning stoves for heating…” to survive in the world’s coldest capital, Ulaanbaatar with temperatures

frequently drops to -40°C in the winter [2]. Hence the migration and the infrastructural problems related to the "GER settlement" cause environmental degradation, including pollution of air, water, soil and other natural resources. "Air pollution levels of 3,320 μg/m³ (at the area of Baruun 4 zam) were reported - this is 133 times the World Health Organization guideline for the 24-hour mean concentration which is set at 25 $\mu g/m^3$, on January 30, 2018, at 05:00 am" [3]. In the bulletin of the World Health Organization, it "states that 80% of Ulaanbaatar's air pollution in the winter months is caused by households and low pressure boilers burning raw coal in ger districts" [4]. Moreover, increasing number of crime and accidents because of lacking basic urban services, health risks and threats, such as respiratory diseases and hepatitis are the urban problems related with the "GER district". However, Mongolian rural to capital migration is still increasing. Unfortunately, this common problem somehow did not find its solution. The reasons of migration to "GER settlement areas" listed below:

- Loss of livestock herds and animal during severe weather disasters (happened in 1992 and so on...). Generally, herdsmen and those who removed their pastoral production living systems take a huge part in the migration;
- An influence of free market economy followed by the Democratic revolution in Mongolia in 1990;
- Land law (in 2002) permits to possess 0.07 hectare for each citizen;
- Modernization;
- Chasing for better lifestyles. There is lack of social services such as medical, educational etc. in provincial cities of Mongolia
- Pursuing for better jobs and opportunities;
- Parental wishes to move near to children who are studying or working temporarily in the city.

One of the main constituents of this thesis is a Mongolian traditional GER which has been developed for thousands of years. About evolution of GER, Ch. Ariunaa et al. mentioned that "...the current form of ger had taken shape somewhere between 4 to 3 thousand years ago, in the time of the Khunny" [5]. "The inhabitants of the yurts (from the Turkic languages) are nomad people (primarily herdsmen) from Central Asia. As they need to move with their herds from pasture to pasture almost all year around, they developed a typology of house that permits them easy assembling, disassembling and transporting" [6].

“Yurt (or GER in Mongolian) has a large tradition. Mongolian yurt, for example, developed from 5th to 19th century”, said Oliver, P. [7]. GER, refers “home” in Mongolian, is a Mongolian traditional housing which originally has portable, easy to build up and build down function derived from nomadic lifestyle of nomads in wide steppes of the country (Figure 1.2). It is a circular tent-like dwelling, consisting from cylindrical enclosed area with circular cross section and a cone-like roofing as structure. Roofing has 64-192 poles or rafters (named “uni” in Mongolian) depending on capacity or size of a GER, which connect lattice wall sections (“khana”) and roof-ring (“toono”) together, and it enables the load of the GER to be landed through the pillars (“bagana”) located in the center. Number of latticed wall sections indicate the size of the GER and there are different types with 4-12 pieces of “khana”. The most common used one is GER with 5 “khana”s. Skin or felt envelope which is loaded on poles and lattice wall under canvas is an insulation material of the traditional GER (Figure 1.3).

Figure 1.2. GER in the steppe

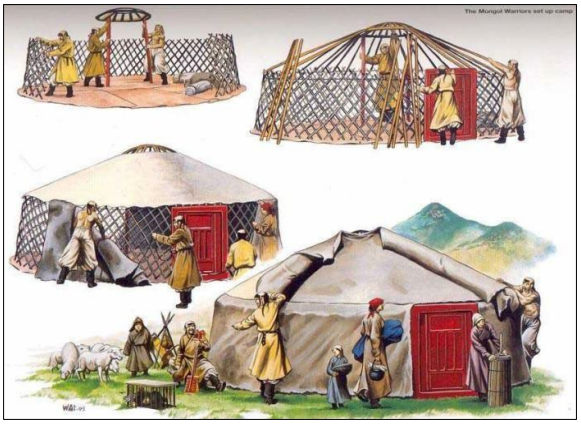


Figure 1.3. Mongol empires setting up camp

“The traditional ger are sustainable structures very well adapted for a nomadic society but, when they are located in high-density, unplanned, informal settlements they create many issues. These informal urban areas lack sanitation, adequate vehicular access and other basic services” said Caldieron, J. M. [8].

This thesis will be investigating a suitability of GER settlement in the capital city, where GER itself is originally harmonious with Mongolian nomadic lifestyle in its vast steppe. Moreover, the main and most important characteristic of Mongolian GER is the breathable, natural insulation material for the shell, and its air circulating. Could GER remain this characteristic and other advantages in a urban city or could it have the most developed version in its evolution in 21st century? The problem possibly gets some theoretical answer in our study. The architectural issue of this portable dwelling still remains as one of the challenges to be addressed for researchers. Today, because of poor urban planning policy, Ulaanbaatar appears to be air polluted, untidy, condensed, disorganized and stuck in its traffic. GERs in the settlement areas of Ulaanbaatar are struggling to fit into a base surrounded by four sacred mountains instead of moving across potential land of Mongolia like they used to. This study introduces the knowledge and description of GER as Mongolian architectural heritage and favourable symbol of the nation’s tradition, not GER as tent and “GER settlement area” as slum or informal settlement type.

The aim of this study is to provide design data with the existing internal ergonomic and modular design of GER for the modern building types such as mass housing, student dormitory, emergency housing which constitutes an issue in the capital of Mongolia and concurrent world-wide architectural tendency. In other words, the objective of the study is to provide beneficial usages of traditional design concepts and spatial configuration of Mongolian GER and its utilization for modern housing typologies.

Architectural design layouts of the modern building types such as mass housing and emergency housing are predicted as results of the study. Therefore we propose that the modular features of GER can be deformed and modeled into above mentioned housing designs. Internal spatial design, features and functional parts comprised and compactly organised in GER housing must be taken and reflected in designing of modern housing. Functions such as heating, cooking, dining, living and sleeping except of wet areas occurs only in GER space which is original and different from other accommodations. It has

considered that this feature of traditional GER has potential to provide design data and parameters for modern housing typologies.

The main question in the study:
How can we learn from the spatial utilization of GER internal organisation to develop new housing typology of urban areas and sustainable cities in Mongolia?
The sub-question of the research:
Could GER remain its characteristic and other advantages in its current state in GER settlement areas in Ulaanbaatar city or could it have the most developed version in its evolution in 21st century?

Mongolian traditional GER and GER settlement areas in Ulaanbaatar, the capital city of Mongolia, investigated in the scope of this study.

First, literature review has been conducted on GER and modern housing design. Afterwards, analysis in 3 main category such as function and structure of GER, urban community of GER settlement areas are being studied in order to obtain design ideas and use its data for further modern housing design. Furthermore, GER module will be developed into modern housing design that allows to horizontally and vertically extend the dwelling like honeycomb. The idea helps to reduce urban sprawl in GER settlement area and to balance density in the area. Made attempts to deform circular shape of GER into polygon shapes i.e hexagon etc... to adjust the spatial configuration of traditional GER into modern design from the space saving and economical view, keeping at the same time, main advanteges of GER housing.

2. GENERAL INFORMATION ABOUT MONGOLIA

2.1. Geographics and Demographics

Mongolia is a landlocked country covering areas in northeast and central Asia. In its history, the region has been ruled by several nomadic tribes and empires, one of which is Chinggis Khan-founder of the Mongol Empire. In 2019, population of the country is estimated to be 3,238,479 people, while this number been expected to reach around 3.5 million by 2030. As stated in the data from World Factbook CIA [9], population of Mongolia has exceeded 3.1 million. Report by the National Statistical Department of Mongolia [10] reveals that in 2019, the population has reached 3.17 million, which puts the country at 137th in the world in rating of most populous country. Also, Mongolia is at 19th in the world by the area of territory being 1,566 million square kilometers, and due to its population, it is viewed as most sparsely inhabited country. Almost 45% of the nation's population live in Ulaanbaatar the capital city. Being nested by nearly 1.34 million residents, Ulaanbaatar arises as most dense-inhabited city.

2.2. Settlements and Cities in Mongolia

The need for transition to a higher economic possibility by the 1990s and a sequentially harsh weather conditions in winters, called zud, have forced many low-income families to leave their home town or countryside heading to the capital city, Ulaanbaatar. Migration of people from the rural area to the capital city resulted in increasing GER districts in suburban areas of the city. The city grew in its population rapidly, in 18 years from the late of 1980s until 2007, the number of residents increased from around 600,000 people to over 1.03 million, which was accounting for nearly 39 percent of the country’s population [2].

Table 2.1. Structure of Governing Units in Ulaanbaatar by JICA, 2008 [2]

Government	Division	Quantity	Approx. population	Responsibility
Capital (Ulaanbaatar)	City	1	1,025,174	Budget allocation, services, maintenance
Duureg	District	9	113,908	Infrastructure, tax collection, services
Khoroo	Sub-district	132	7,766	Registration, census, voting, community outreach
Kheseg	Micro-disctict	8-13 per khoroo	597–970	Registration, community outreach

There are a substantial contamination concerns associated with Ger areas in Ulaanbaatar. Most of the residents burn wood, animal manure, fossil fuels or tire in typical stoves to generate heat for their household application releasing a high quantity of air pollutants such as carbon dioxide and fly ash. As reported by Caldieron [8], among the sources of heat generation, 87% and 69% are from coal and wood, respectively, and electricity comprises only 21%. (Table 2.2)

Table 2.2. Various sources for heat generation [8]

Sources for heating	Percentage
Coal	87
Electricity	21
Wood	69
Other	2
Gas/Petrol	1

Table 2.3. Population growth of Mongolia by year [11]

Year	Population	Male, %	Female, %	Density, per km^2
2019	3,166,244	49.42	50.58	2.02
2018	3,121,772	49.44	50.56	2.00
2017	3,075,647	49.47	50.53	1.97
2016	3,027,398	49.49	50.51	1.94
2015	2,976,877	49.51	50.49	1.90
2010	2,712,650	49.62	50.38	1.73
2005	2,526,446	49.75	50.25	1.62
2000	2,397,436	49.87	50.13	1.53
1995	2,298,039	49.54	50.46	1.47
1990	2,184,145	49.37	50.63	1.40

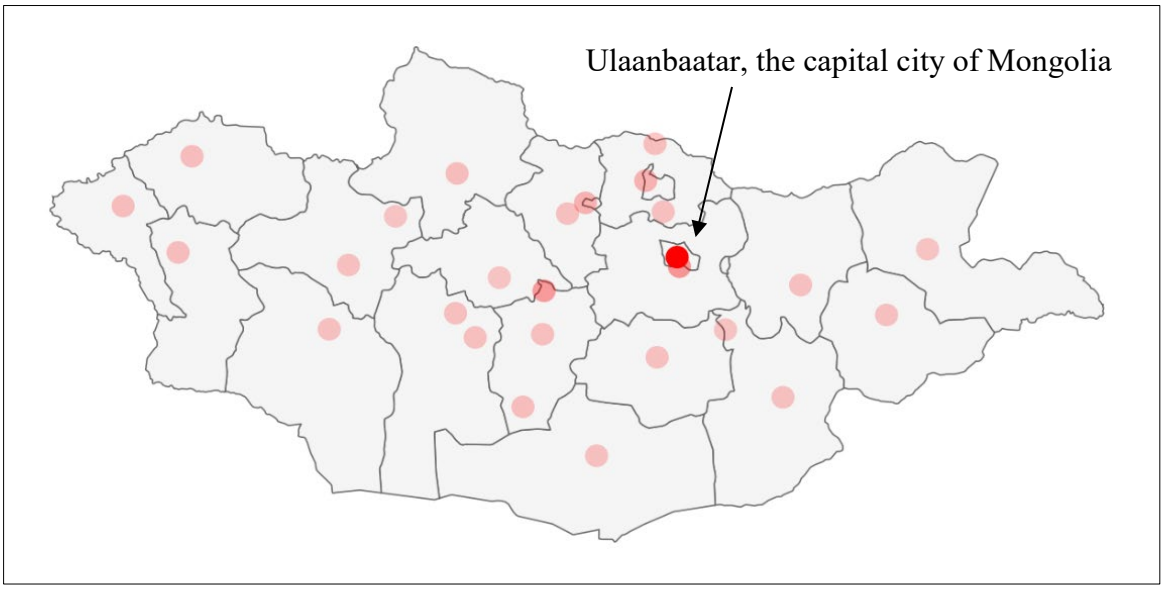
Table 2.4. Most populated 10 cities in Mongolia [11]

Name	Population
Ulan Bator	844,818
Erdenet	79, 647
Darhan	74,300
Khovd	30,500
Ulgii	28,400
Ulaangom	28,085
Hovd	27,924
Murun	27,690
Bayanhongor	26,252
Arvaikheer	25,622

Table 2.5. Livestock of Mongolia by 2018 [10]

Livestock	2018
Horse	3,940,090
Cow	4,380,880
Goat	27,124,700
Camel	459,700
Sheep	30,554,800
Total	66,460,180

Map 2.1. Mongolian population density in cities [11]

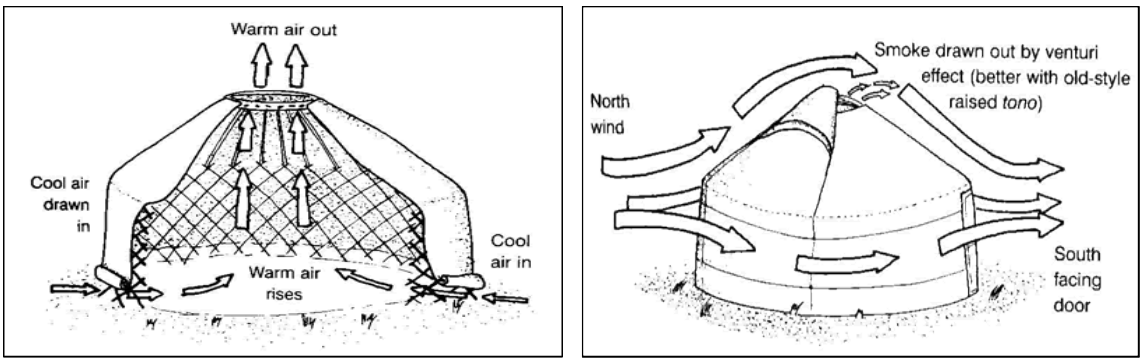


3. TRADITIONAL TYPE OF MONGOLIAN HOUSE : “GER”

3.1. Architectural Characteristics

Original characteristic of GER is its environmentally friendliness. This housing type does not form crowded residential area in one place and does not cause waste landfills being ecologically clean and keeping nature balance due to its portability four times in a year (every four season). Most of the researchers see GER as a dwelling suitable for nomadic lifestyles and see it reached its most developed mode. In contrary, research investigations show GER has its potential for today’s architectural tendency which follows modular, temporary, urgent, flexible and reactive features of housing typology for necessity of rapid changing world and its inhabitants. Moreover, it has green architecture features such as natural shell materials, unique air circulating and natural ventilating, closest to open air condition in summer time. As Katarina Mrkonjic mentioned in the article titled “Autonomous Lightweight Houses: Learning from Yurts”, “...in the case on a house of a single space with a central opening in the roof, the warm air moves upwards and goes out through the hole, maintaining the internal comfort. Circular shape of a GER is aerodynamic and offers less resistance to wind, compared to the rectangular houses of the same volume. This is of major importance in the harsh climates of Central Asia” [6]. “Toono”, central skylighting structure has opening function for the chimney of a stove. It may be covered or uncovered by piece of felt which called “Urkh”, depending on weather conditions and time of a day.

Besides the roof ring, a circular plan shape of the GER itself creates air circulation movement which prevent unwanted heat losses.



(a) (b)

Figure 3.1. a. Natural ventilation of a GER b. Door of a Mongolian GER faces south in accordance with the wind direction

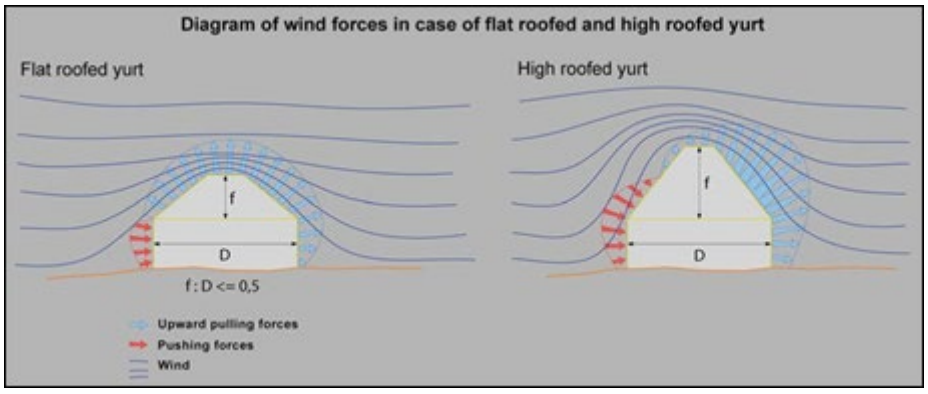


Figure 3.2. The roof of a traditional Mongolian GER is lower comparing than the other yurts around the world [18]

The cooling and ventilation system of GER has several functions such as:

- production of suction by creation of air flow from openings to roof ring,
- maximizing the aerodynamics of the house,
- minimizing the drag to prevent heat loss,
- vent design in a way to be lifted in case of tornado to prevent explode of GER.

On top of that, “in most cases the doors face south, southeast or southwest, though in the case of mountain slopes they always face downwards in order to avoid the direct impact of the wind coming down the mountain” [6]. “They also pay attention not to offend the spirits of the wind, the earth and the sky. Regarded as the warrant of their ancestors’ cultural traditions, nomadic people remain faithful to their heritage and respect their surrounding

environment" [16]. Mongolians were able to determine the time with an accuracy up to five minutes by looking at sunlight reflection on interior and exterior parts of the GER. Mauvieux B. et al. described this feature of GER: "An open circular hole named the ''toon'' can be found at the centre of the roof. On sunny days, a ray of sunshine revolves around its inner wall. Depending on the season, the light first appears between 5:40 am and 7:40 am and moves around the different inner walls (khana)" [16]. Moreover, at noon the sun falls in the center of GER – "khoimor" which is the sacred and honorable place for Mongolians. Table 3.1 shows daily activities of nomadic people in relation with time, or in other words by sunlight reflective points in GER at periods of the day.

Table 3.1. Daily activities due to zodiac time [14]

Time	Zodiac name of the time	Sun shining positions in a GER interior at the time	Activities
04:00-06:00 am	From the tiger until the rabbit	At the roof ring	dairying/milking the cows and other livestock
06:00-08:00 am	From the rabbit until the dragon	At the end of the rafters	
08:00-10:00 am	From the dragon until the snake	At the head of the lattice wall and then reaches middle of it	To pasture the livestock, forenoon
10:00 am-12:00 pm	From the snake until the horse	From the pillow on the bed in west to the 'khoimori'	noon
12:00-14:00 pm	From the horse until the sheep	From the 'khoimori' to the foot of the bed in the east	To water the livestock
14:00-16:00 pm	From the sheep until the monkey	At the cupboard	Flock of sheep and cow returns back from the pasture
16:00-18:00	From the monkey until the rooster	Sun reaches the roof from the end of the rafters / sunset	End of milking livestock

3.2. Structure and Materials

In the case of yurts the structure consists of walls and roof. There are no foundations, a fact that minimizes the environmental impact - once the dwelling is removed nothing is left at the site. The yurt is covered with felt that is additionally pressed by the ropes and textile stripes. Felt is produced by rubbing and squeezing the moist wool together. The felt covers walls, roof and a hole in the roof. The materials are chosen due to their availability, lightness and suitability for transportation. Upon their disposal they disintegrate and convert to compost, entering into the natural material cycles [6].

Mongolian GER is easy to build up or down according to their nomadic lifestyle and structure consists of the following parts:

“Shal” (floor)

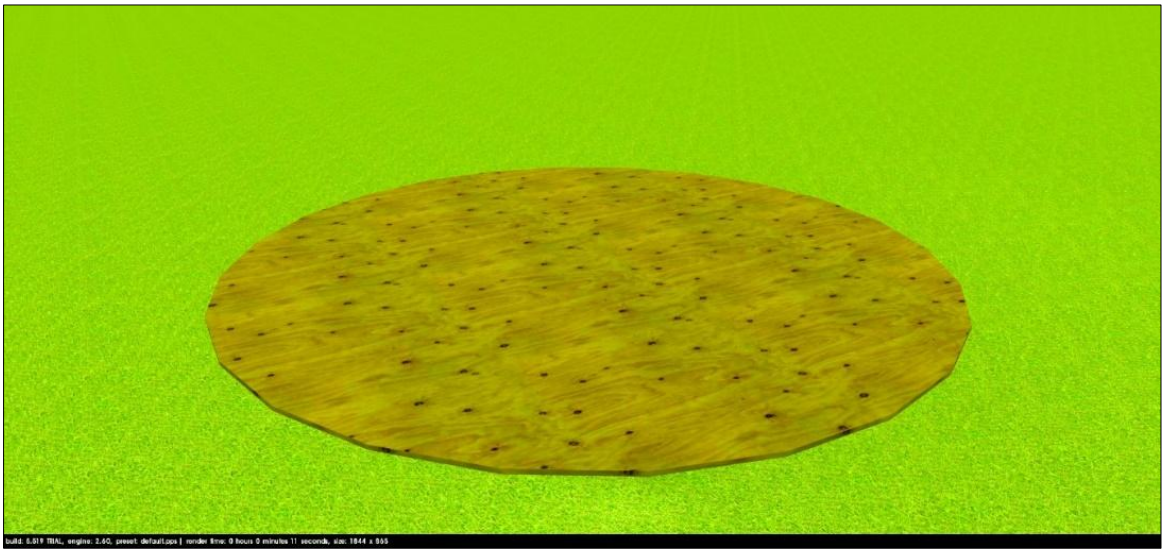


Figure 3.3. Structure of floor

Its structure divides into several pieces according to the easy transportable characteristic (Picture 3.4). Floor area nearly same with area of a GER depends on the number of wall sections or size of a GER (Table 3.3).

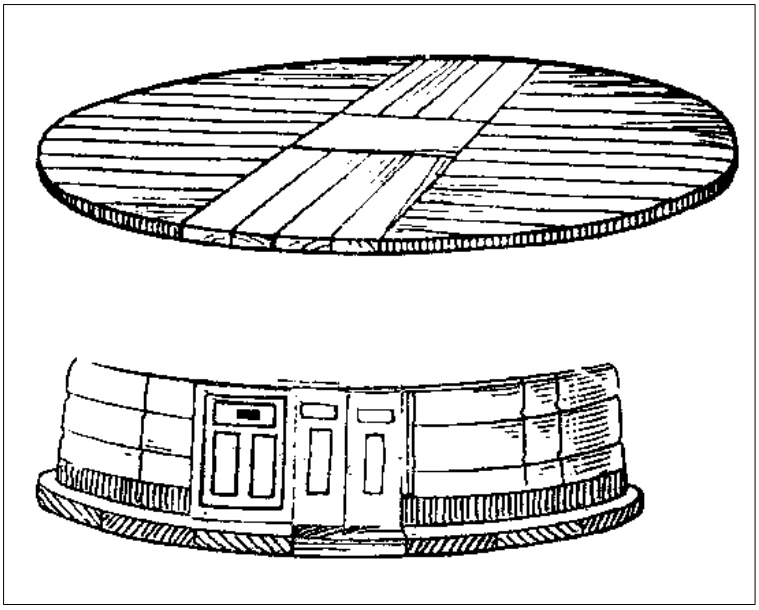


Figure 3.4. Floor detachment drawing

Table 3.2. Mongol GER types and its dimensions [5]

№	Number of lattice wall sections	Number of poles	Diameter of the toono /м/	Diameter of Ger /м/	Pillar height /м/	Area of Ger /м2/	Volume of Ger /м3/
1	4	64	1.22	4.9	1.95	18.9	42.7
2	5	81	1.54	6.1	2.5	29.3	86.8
3	6	96	1.82	7.3	2.94	42.0	144.4
4	7	111	2.12	8.5	3.42	57.0	227.5
5	8	128	2.40	9.6	3.88	72.6	331.5
6	9	141	2.56	10.2	4.14	79.0	383.4
7	10	160	3.08	12.3	4.97	119.0	689.0
8	11	173	3.28	13.1	5.3	135.0	829.0
9	12	192	3.64	14.5	5.9	165.0	1132.0

“Khana” (Lattice walls)

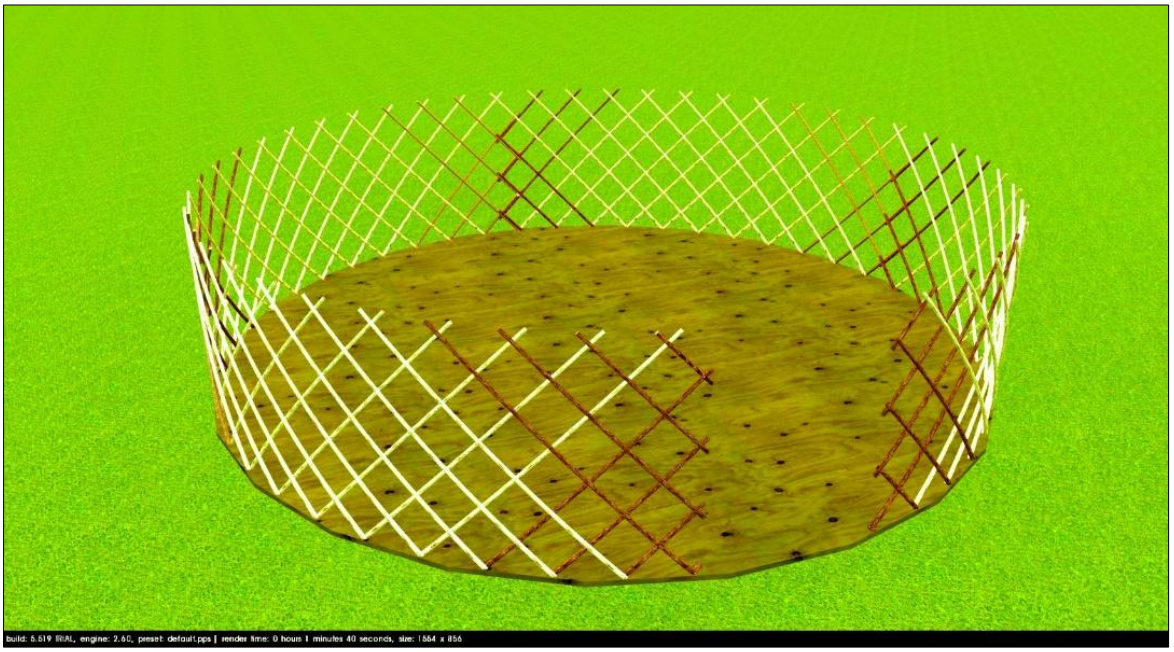


Figure 3.5. Structure of lattice walls

GER’s circular wall is divided into 4 to 12 sections depending on its size and capacity. Each section is a flexible lattice work. The lattice wall sections of the GER is foldable. During movement it is being squeezed to transport safely on the back of the horse or camel in the past (Figure 3.6.a,b). Each section of a “khana” is joined together with straps handmade leather or animal fur (Figure 3.6.c). The lattice wall is also classified as “Baga khana” or “Ikh khana” according to its number of heads in each wall sections where poles (“uni”) are laid on. “Baga khana” or “Ikh khana” lattice wall sections receive either 13 or 15 poles respectively [9]. “A standard size yurt has five khanas with a diameter of 5.80m, a maximum height of 2.30m and a minimum one of 1.50m, a surface area of 25–28m2, and can accommodate a family of 3–4 members” [12].

(a) (b) (c)

Figure 3.6. a. Structure of foldable wall section b. Unfolding wall sections
c. Wall sections jointed together with strap

"Bagana" (Pillars)

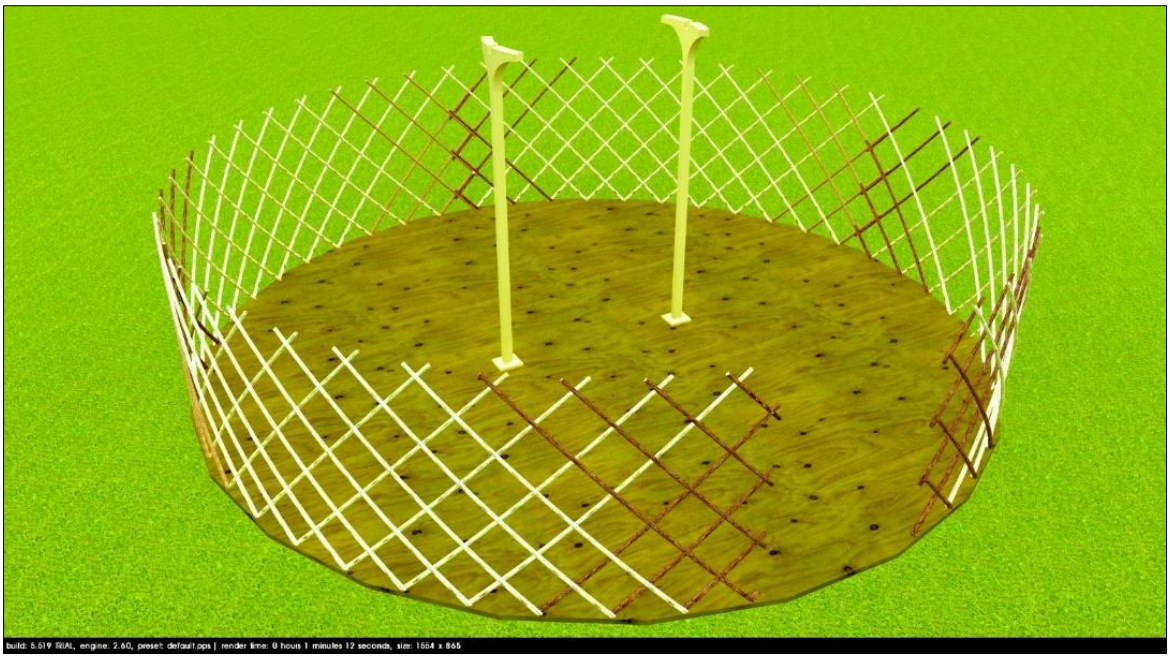


Figure 3.7. Structure of pillars

There are 2 or 4 pillars in GER. The most common 5 walls section GER has 2 pillars supporting the roof ring. It traditionally symbolizes equal balance of wife and husband of the family.

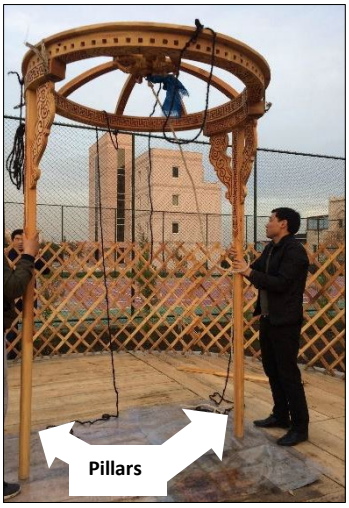


Figure 3.8. Structure of pillars

"Toono" (Roof ring)

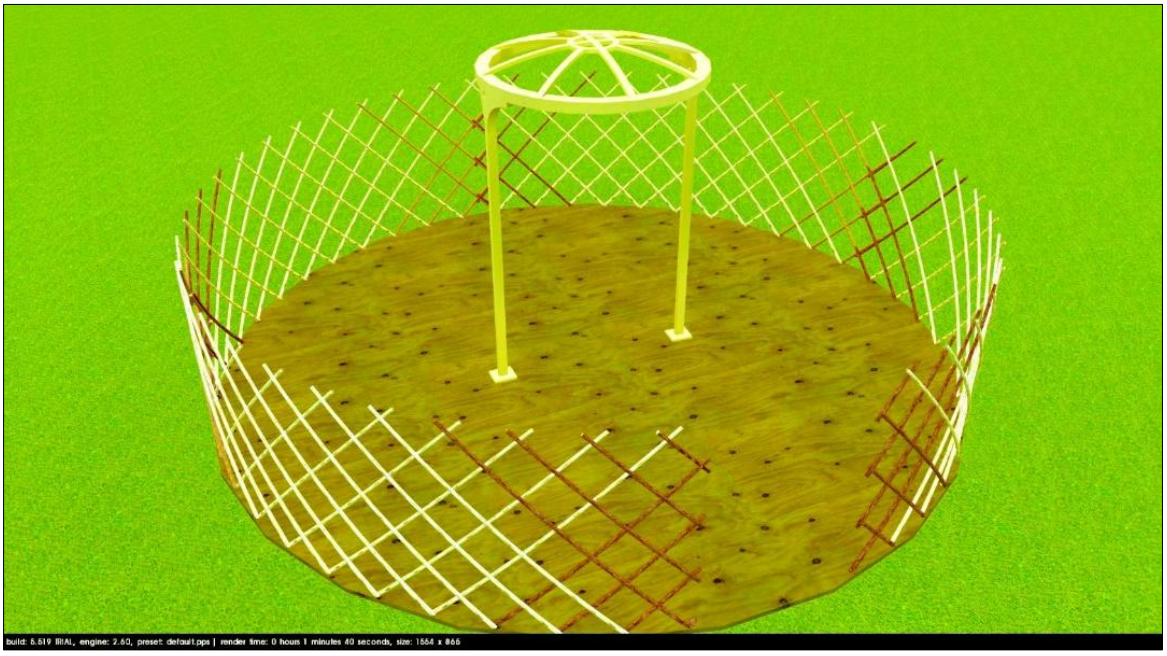
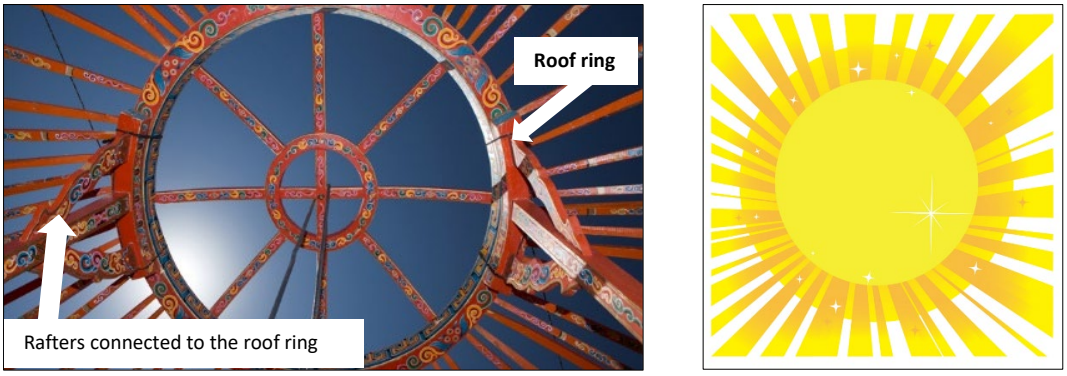


Figure 3.9. Structure of roofring

This is the top part of the GER which allows chimney to discharge the smoke and to let the sunlight into the interior. "Toono" has a structure which symbolizes sun and surrounded by roof poles as its sun rays (Figure 3.10.b). Moreover it laid on centrical pillars below it.



(a) (b)

Figure 3.10. a. Structure of a roof ring surrounded by rafters b. Symbol of a "toono"

"Uni" (Rafters)

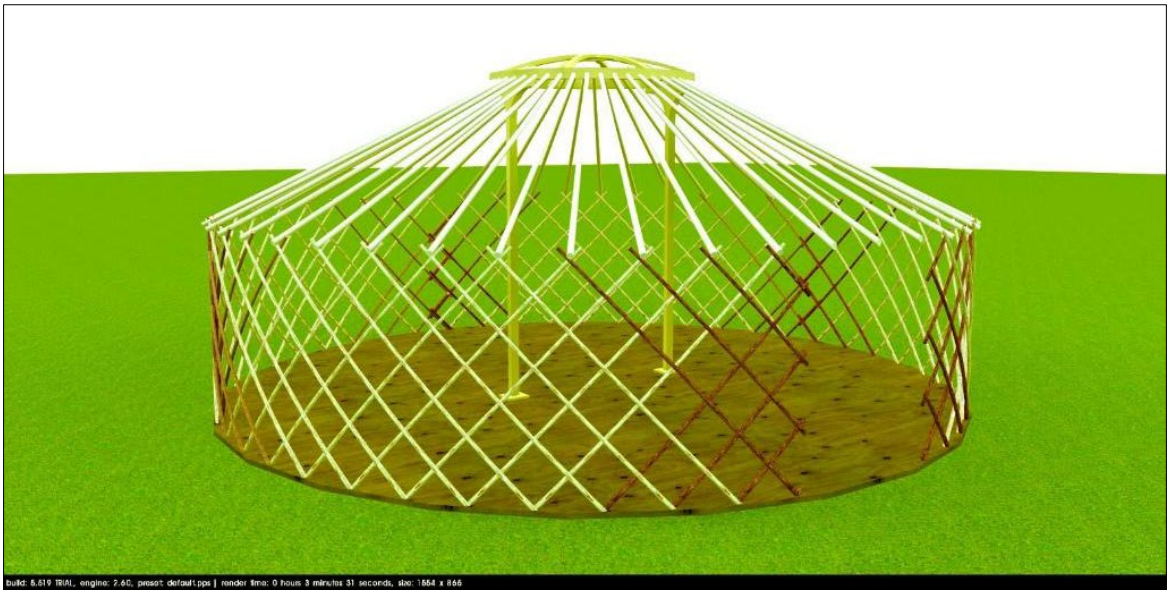


Figure 3.11. Structure of rafters

This is the part connects roof ring with the lattice walls sections (Figure 3.11). Number of rafters determined depending on the number of wall sections and its size. For example, 5 wall section GER which is a common among folk, there are 81 rafter pieces.

Figure 3.12. Structure of rafters

"Khaalga" (Door)

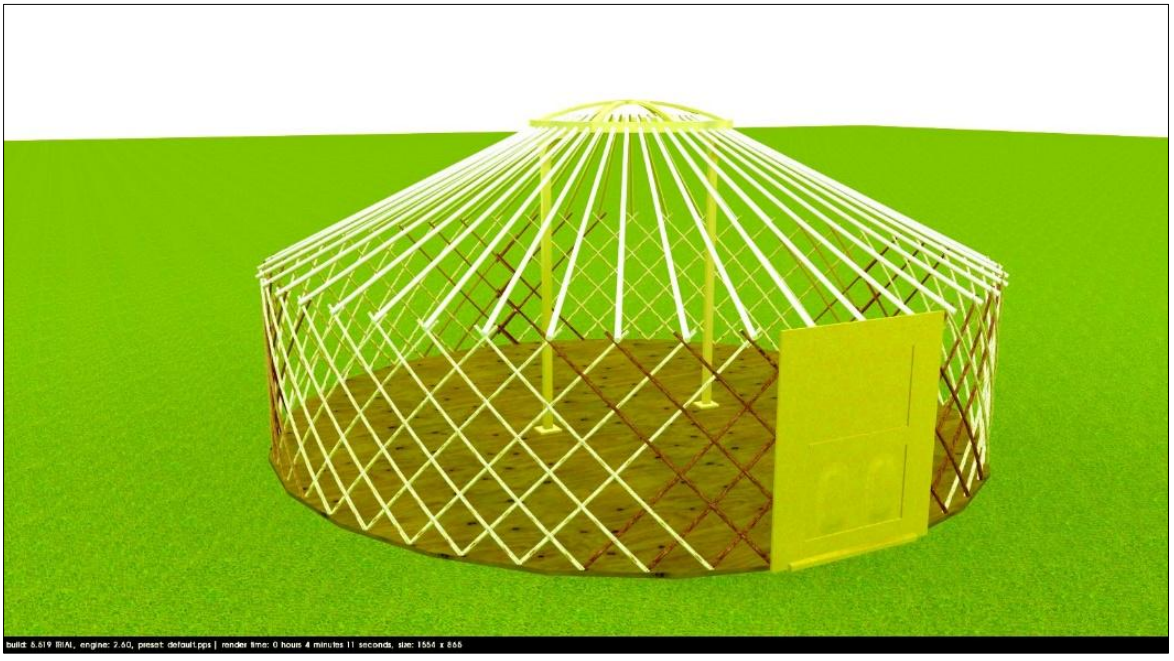


Figure 3.13. Structure of door

Mongolian GER door traditionally directs to the south. It receives 6 rafters on it (Figure 3.13).

(a)

(b)

Figure 3.14. a. Door of a GER b. Rafters laid on door of a GER

"Deever" (Roof covering)

Figure 3.15. Roof covering of GER

After building up the GER structure, the felt is put above the rafters like shown in the figure 3.15.

Figure 3.16. Roof covering

“Tuurga” (Wall cover)

It is made with felt and it covers the wall.

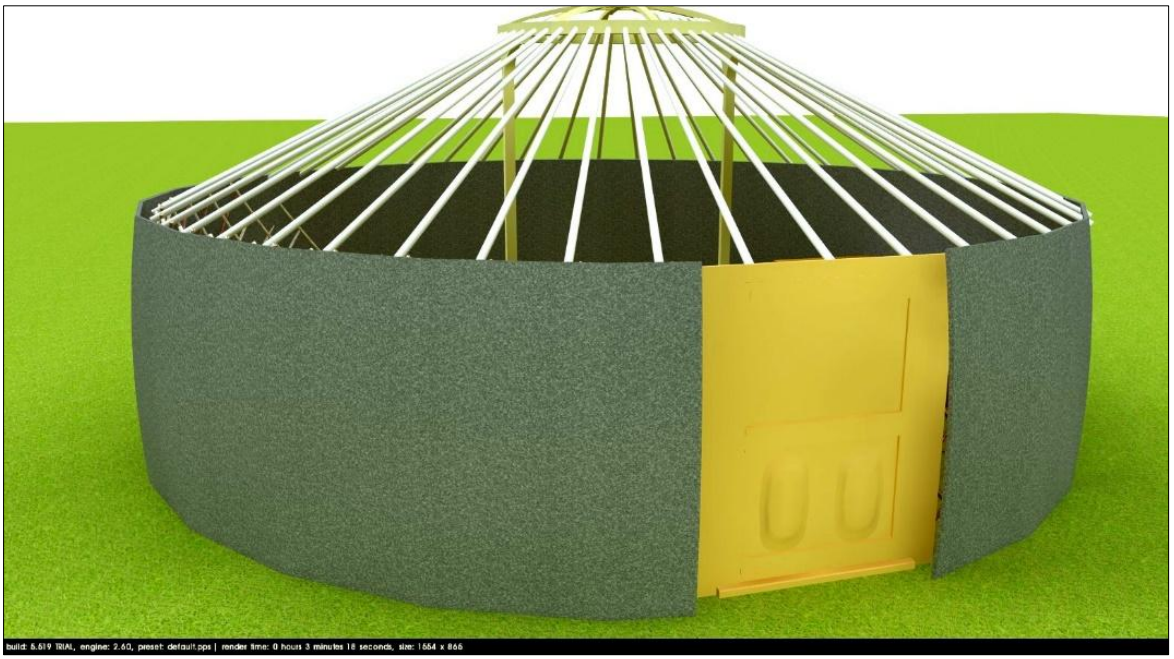


Figure 3.17. Wall cover of GER

“Burees” (outer cover of GER)

This is the part where covers the whole ger and is usually made of canvas or water resistant materials. (Figure 3.18.b)

(a) (b) (c)

Figure 3.18. a. Wall cover b. Outer cover, Figure 3.18.(c) Assembled GER

“Urkh” (Felt cover for roof ring)

This is the sheet covering the roof ring and function as shelter during rainfall and other natural conditions (Figure 3.19).

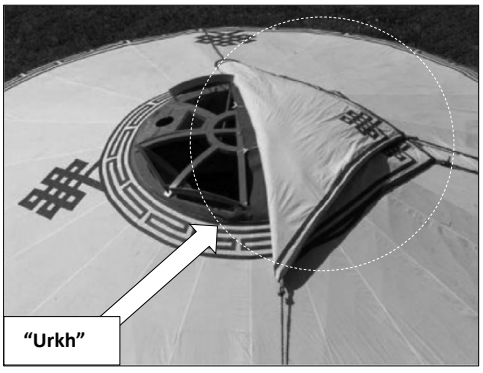


Figure 3.19. Foldable felt covering for roof ring [16].

Figure 3.20. Assembled GER

3.3. Internal Organization and Furnishing (Purpose and Function):

Mongolian GER is structurally round and the shape formed over thousands of years as a result of the nomad's necessity caused from easily portable moving and quick assembling - disassembling their home in a relatively short time interval (at least 4 times a year). Internal space and location of furnishing in GER have deep meanings according to the national culture and belief, as well as presenting mobile, reduced, compacted interior space at the same time. Mongolians emphasizes circle as a cosmic and universal shape.

An entrance or door of Mongolian GER faces to the South. In their book "GER: Historical outline of the Housing", Maidar D. and Darisuren L. mention that "...west side of GER belongs to men or leader of the family and women resides in east side…" [14]. William B. Dinsmoor III points out that "the house owner's bed, the hearth, and the altar of the house, god are all in the back part of the house. The conclusion he reaches is that the rear of the house is more honorable than the front" [15]. Mongols divided GER into 12 parts and named them after 12 zodiac animals as follows mice, cow, tiger, rabbit, dragon, snake, horse, sheep, monkey, rooster, dog and pig. (Figure 3.21)

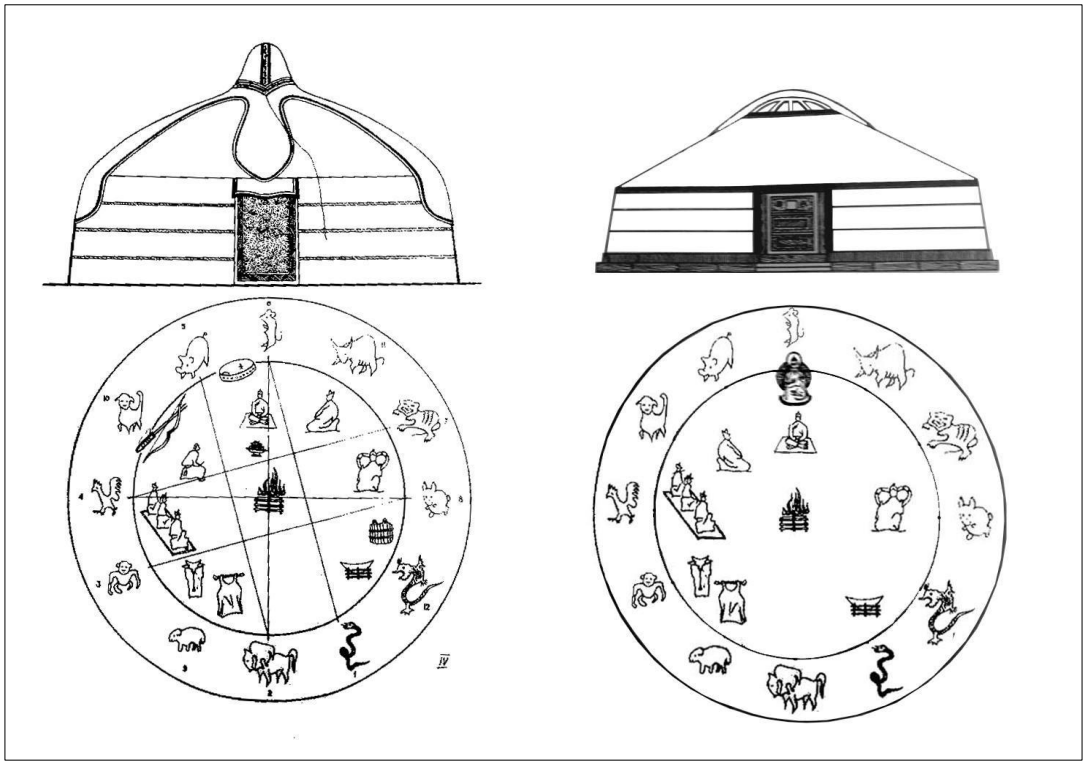


Figure 3.21. Diagram shows how zodiac animals symbolically take part in internal space inside GER [14]

Table 3.3. Names and Descriptions for GER parts [14]

Icon of the animals	Zodiac naming for parts of the GER	Part of the GER	Reference of the meaning
	The horse, the snake	Entry part	According to the fact that the arriving vehicle of the nomadic tribe people was the horse
 	The monkey, the rooster	Part belongs to the man	Based on the ideology that men are those who are ambitious, enthusiastic and courageous
	The pig, the mice	Khoimor (north and sacred part)	Due to the tradition considering that the mice is the symbol of wealth and cleverness
 	The tiger, the rabbit	Part belongs to the woman	This part is named so because of the perception that the women are like a rabbit chased and hunted by a tiger, based on their natural characters such as modest, humble, quiet and easily frightened...
	The sheep	Part for lamb and goat lings (to shelter them in a harsh spring conditions when they newly born)	In accordance of the nomadic lifestyle
	The dog	Place for tools of hunting	Traditional perception believes in that the successful hunting is a luck of a man

Table 3.3. (continue) Names and Descriptions for GER parts [14]

Icon of the animals	Zodiac naming for parts of the GER	Part of the GER	Reference of the meaning
	The cow	Place for needle and thread of woman in the home	The luck of a woman is relevant with the needle and thread, milk, dairy and milk products
	The dragon	Place for cooking pot and water	According to habits of Mongolians

According to the above mentioned symbolic beliefs, Mongolians used the only internal space as below:

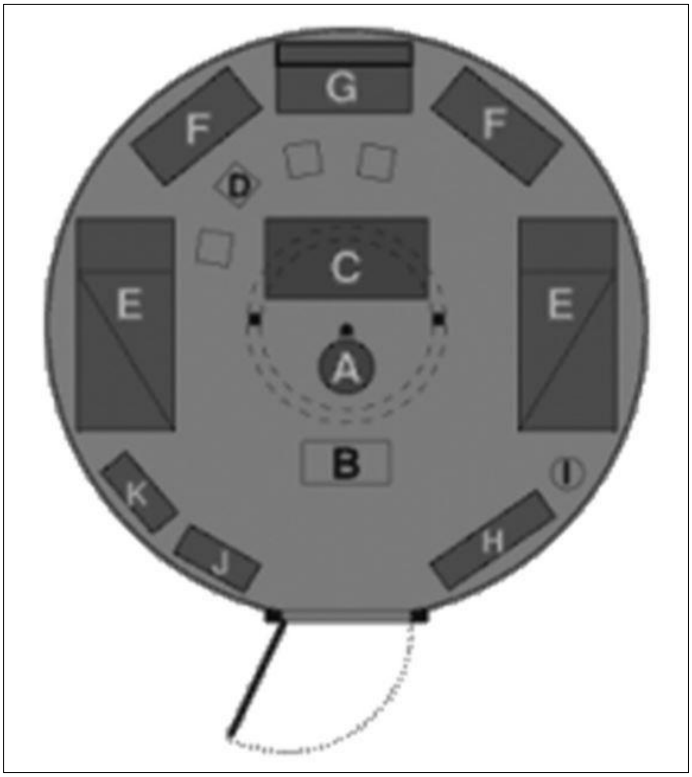


Figure 3.22. Spatial organization of a yurt A. wood stove or dried yak dung B. reserve wood C. low table to eat D. low stools E. beds for sleeping and sitting F. pitches for clothing G. hoimor (altar, statues and family photos) H. location for kitchen equipment I. water tank J. equipment for the production of dairy products K. Saddles [16]

“The khoimor, the most honorable place in the yurt (the place for shrines, altars, photos of ancestors, sacred objects and other religious articles of faith), is located behind the fire on the north side of the yurt” [16]. Mongolians welcome the most honored guests to sit in the “khoimor”.

Figure 3.23. Isometric drawing of traditional Mongolian GER interior

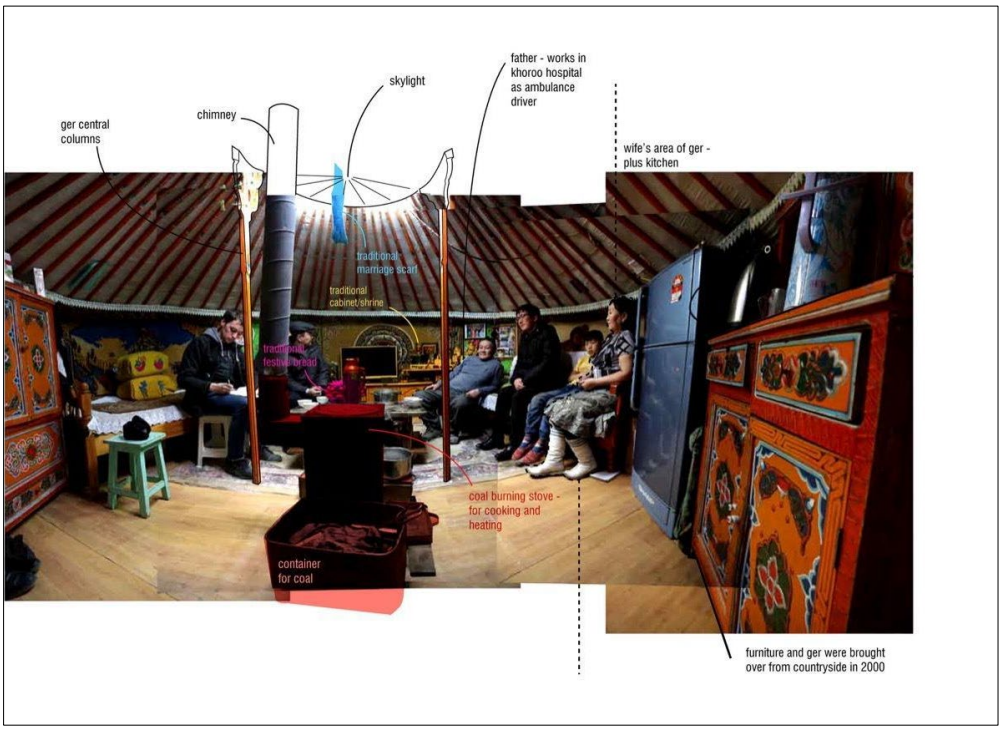
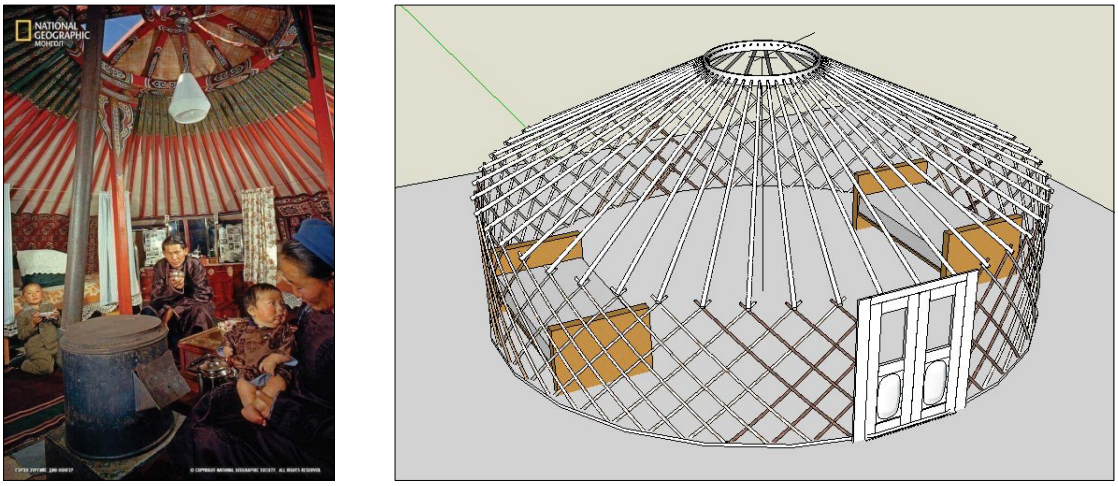


Figure 3.24. Interior of GER, Chingeltei district in Ulaanbaatar, Mongolia [17]

3.3.1. Sleeping and living

Sleeping area generally refers to single size or king size beds in GER due to its compact interior. Used the curtains closed to make privacy corner for the family members during night time. (Figure 3.25.a). The beds used open to interior space, as living space during the day. Guests are welcomed to sit on the bed as if its sofa.



(a) (b)

Figure 3.25. a. Curtains hanged from the roof rafters through the front of the bed in GER
b. Bed location and orientation inside the GER

3.3.2. Kitchen and Food Preparation

Food preparation process is held on the multi-purpose lower table in the “khoimor” of GER. After preparation, cooking process is held on the centrally located stove. Kitchenwares are kept at cupboards next to door as shown in the figure 3.26. Traditional cupboard called “ergeneg”.

Figure 3.26. Food preparation process in the GER

3.3.3. Hosting Guests

Most honored guests are invited to the depth or more northern side of the GER. Guests can have a seat eather on the stool, bed or on the floor as like in figures 3.27 a and b.

(a)

(b)

Figure 3.27. a,b. Hosting guests in the GER

3.3.4. Wet Areas

Hand washing or daily cleaning sink types are shown in the figure 3.28. Other activities such as taking shower are held in public bathing centers according to fact that GER area household do not have private bathing facilities.

(a)

(b)

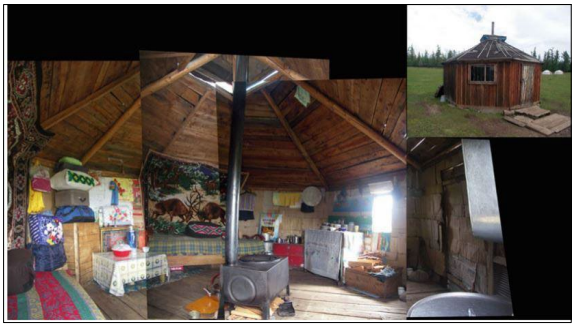
Figure 3.28. a,b. Wet area activities in the GER

4. DESIGN PROPOSALS: UTILIZATION OF MONGOLIAN TRADITIONAL GER'S SPATIAL CONFIGURATION IN MODERN HOUSING

Original GER dwellings have all required housing functions in it except from wet areas including bath, sink and toilet and in minimum floor area as presented in the 3rd chapter.
In addition to that, constructional characteristics are being suitable for transformable and demountable prefabricated housing which is commonly used as structure type for temporary or short term stay. We are raising the idea to adapt and use the modernized functional data of "GER" in housing types for housing the victims during or after natural disasters (which are earthquake, flood, fire etc.…), refugees, homeless and low-income people, young couples and families as well as for students (dormitory).

4.1. Design Proposals for Polygon Plans Inspired by GER

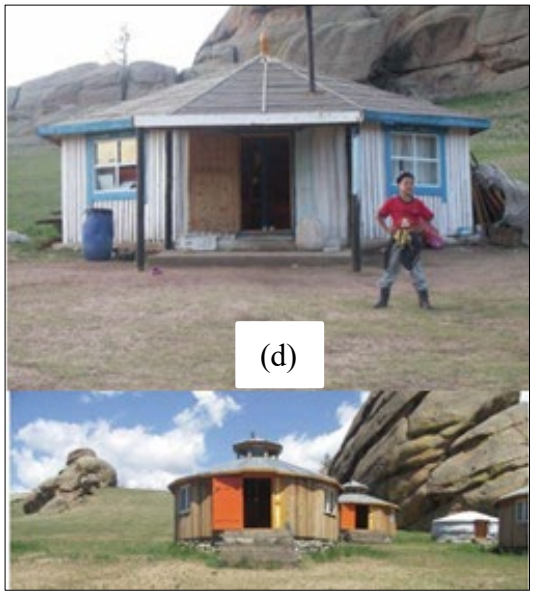
Modern houses inspired by and resembled GER can be designed in different shapes. It can be planned and designed from the original circular plan of GER into modern houses with a floor plan shape such as square, hexagonal, octagonal etc.… The circular plan can also be used unless it is not suitable to connect to each other in areas with weather conditions as like as in Mongolia. Moreover, the most important design phase is to choose an appropriate plan type of house within its suitable connection to each household units. For example, it is hypothesized that circular plans have priorities to be used for singular houses but not in vertically and horizontally developed planning. In contrary, other shapes for the plan can easily articulate to each other in order to obtain mass housing composition. Nowadays, many wooden houses are built in the form of closely related to GER shape and have the similar inner planning and organisation.



(a)

(b)

(c)



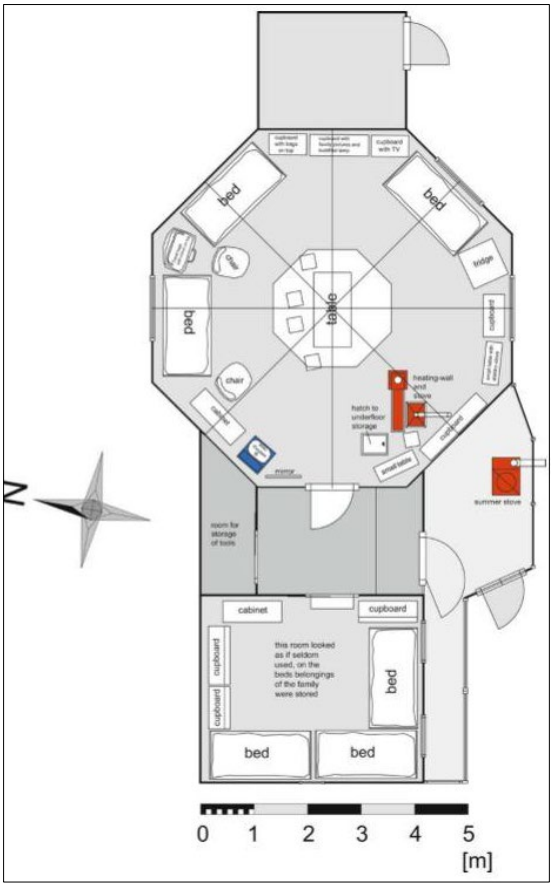
(e)

Figure 4.1. a,b,c,d,e. Wooden house resembling GER, Terelj National Park, Mongolia [18]

Figure 4.1.c shows the internal panorama of a wooden house resembling GER. In this house even a roof wheel has been used.

(a)

(b)



(c)

Figure 4.2. a. Octagonal house in Ulaanbaatar b. Stove with heated wall inside the octagonal house c. Ground plan of the octagonal house [18]

The wall ensures that heat is radiated slowly to the surrounding room area in winter.

Figure 4.3. Rectangular anteroom attached to a GER-like hall of Gandan Monastery, Ulaanbaatar [18]

“Constant features of urban living are sheds and auxiliary buildings. Some of them are built on runners to be movable within the plot boundaries. In some cases these sheds are also used as entrance buildings for yurts and houses as a kind of anteroom. This seems to be quite an old invention, as yurt-like halls of monasteries also frequently show these features.” [18]

Viewing and browsing all these observations we are stating that GER housing can serve convenient as an architectural module for derivation of modular housing because its design and form allow us to solve some architectural deformations. It is practically proven that ergonomical utilization of GER internal organisations can make a place in any of these forms. The study shows that GER is the ideal version and architectural module for either high-rise apartments or horizontal developed settlements. GER’s dome shape is deformeable into polygon shapes i.e cube hexagonal and octagonal cylinders. Therefore inspired by observing the existing wooden houses shown above, a design form of GER and its modular feature is favorable and promising for further developing and extending not only horizontally but vertically like honeycomb.

The National Development Corporation of Mongolia reported that the 160.000 households in a capital of Mongolia are living in apartments while 217.000 out of Ulaanbaatar’s total around 380.000 households are living in GER areas by March 2018”. Moreover, they mentioned that 5822 household apartments were not being sold in their report [19]. Kamata, T. et al. concluded in their conference report of “Enhancing Policies and Practices for Ger Area Development in Ulaanbaatar” that the conversion of GER settlement areas

into apartment complexes has not progressed as fast as the Government had envisaged which is the unfortunately visible result of the today's UB development. They started mentioning its first reason, is that residents cannot afford the cost of the existent apartments while putting the reasons one by one. "The lack of mortgage finance also makes buying large assets (such as apartments) difficult for many people. A third reason is that the absence of a functioning real estate market—including proper methods for determining prices for private land transactions—has impeded the development of new housing" [2]. Moreover, Kamata, T. et al. categorized the GER settlement areas into 3 different zones which are the City Center GER area, Mid-tier GER and Fringe GER area. Moreover, they define differences of 3 different residential area as shown below:

In the City Center Ger, a majority of people (59 percent) still live in GERs. This is due to the fact that the area is still being expanded with people settling in the hilly side of the district. In Bayankhoshuu, the Mid-tier Ger, more than 70 percent of households live in detached houses, consistent with the fact that this GER area was established a relatively long time ago. "In the Fringe Ger, more than one-half the residences are living in GER because this is a newly-established and still-growing area. The average size of land plots in the three areas is less than the 700 m2 size of a 'hashaa' - a fence, which individual households are entitled to by law" [2].

Original GER houses have all necessary housing functions except only wet area in it and in minimum floor area as presented in the 3rd chapter. In addition to that, constructional characteristics are being suitable for transformable and demountable prefabricated housing which is commonly used structure type for temporary or short term stay. The modernized functional data of GER can be used in housing types for disaster (which are earthquake, flood, fire etc.…) victims, refugees, migrants, homeless and low-income people, young couples and families as well as students (dormitory). The expression "5 ханатай гэр" in Mongolian means "GER with 5 walls (khana)" is a commonly used phrase which reveals the capacity or the size of a GER determined by its number of the wall sections. The GER's wall structure has 4 to 12 separate lattice sections and the GERs with 5 wall sections are being generally used. The analysis concludes in the idea that this characteristic is compatible to maintain in the new designs.

Circular shape of GER was deformed into polygon shapes to design residential area which can be derived from a single GER module to possible extended dwellings. By turning a plan of GER with 4 “khana” into quadratic, 5 “khana” into pentagonal, 6 “khana” into hexagonal and a plan of the GER with 8 “khana” into octagonal plan, GER could be the first module to be extended after short time stay of nomad’s arrival into the city. This way, sprawl of the GER settlement area will be composed and furthermore standard amount of density which is the most basic approach to be connected to the urban infrastructure.

Potentionally extendable and modular characteristics of the right geometrical shapes appear as the main reasons in choosing them for proposal planning. Moreover, the shapes has the centric focused and same origin like the circle version. It should be stated that other geometrical shapes such as rectangular, L-shaped and ellipse are not able to meet the need for compact and extendable planning which was included in the objectives of the study.

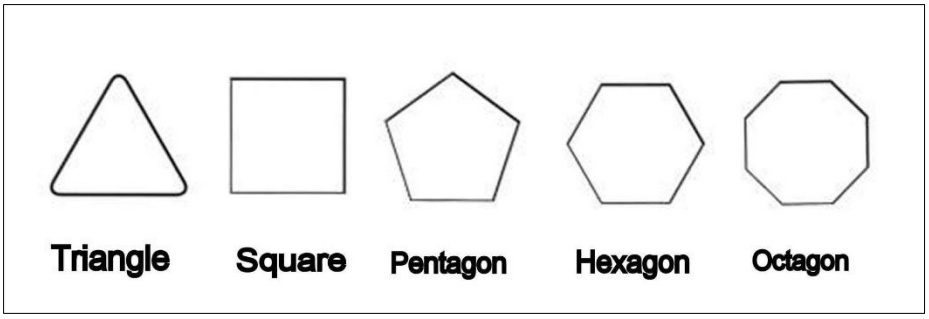


Figure 4.4. Plan shapes of modular housing units

GER’s architectural characteristics were considered and reflected in the proposals within 3 main categories and its sub points as shown below:

1. Compact inner orginisation as main designing and planning characteristic:
- Kitchen wares designed in the center of the units which was directly adapted from conventional arrangement of GER.
- Eastern and northern location of beds kept in GER’s traditional position with the head facing to the South, NOT to the North.
- Design methods of flexible planning were applied such as folding, sliding and rotating walls and doors to remain GER’s open space and to keep traditional aura in a single “cosmic” space.

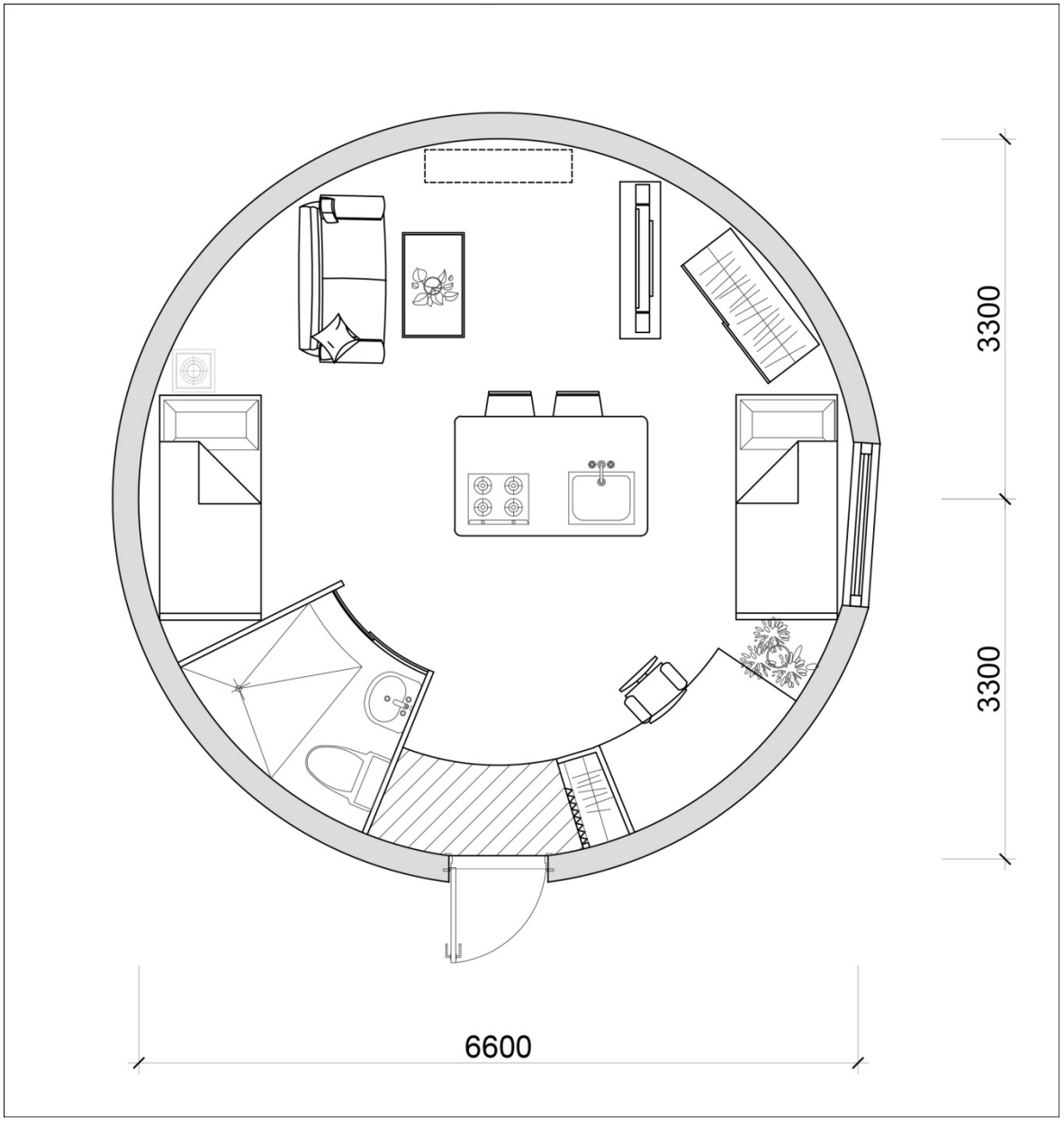
2. Portable and quick assembled-disassembled features remained as structural characteristics.
3. Proposed new designs hypothesized to be made from conventional natural materials as traditional GER, except for felt in case of humid weather conditions.

In addition, the number of wall sections are referred the number of sides in polygon shapes in suggested plans. Most commonly used GER with 5 wall sections was taken as the simulation and prototype for the proposed plans. The floor area of 5 “khana” GER is 29.3 square meters [5]. Total sizes of area in all polygon shapes are mainly proposed to cover around 30 m2 in order to accomodate compact furniture and squeeze all functions in minimal space. Each proposal plan designed in 2 alternatives: plan including wet area and excluding wet area. In plan samples, wet areas can be placed either in or out of the housing units. If the wet areas are placed outside the house, the neighbours can share the wet area, depending on the housing type.

Modern houses inspired by GER designed in different plan shapes by redesigning the original circular plan of GER into modern houses with a polygon shapes such as square, hexagon, octagon. The circular plan is useful for detached or individual housing typology in weather conditions different from Mongolian, in other words, it is suitable for mild weather condition. Moreover, the most important design phase is choosing appropriate plan type of house within its suitability of a connecting and joining to each household units. For example, it is hypothesized that circular plan can be used for stand-alone houses but not in vertical and horizontal developed planning. In opposite, the plans except for circular shape can easily be extended in order to obtain mass housing composition.

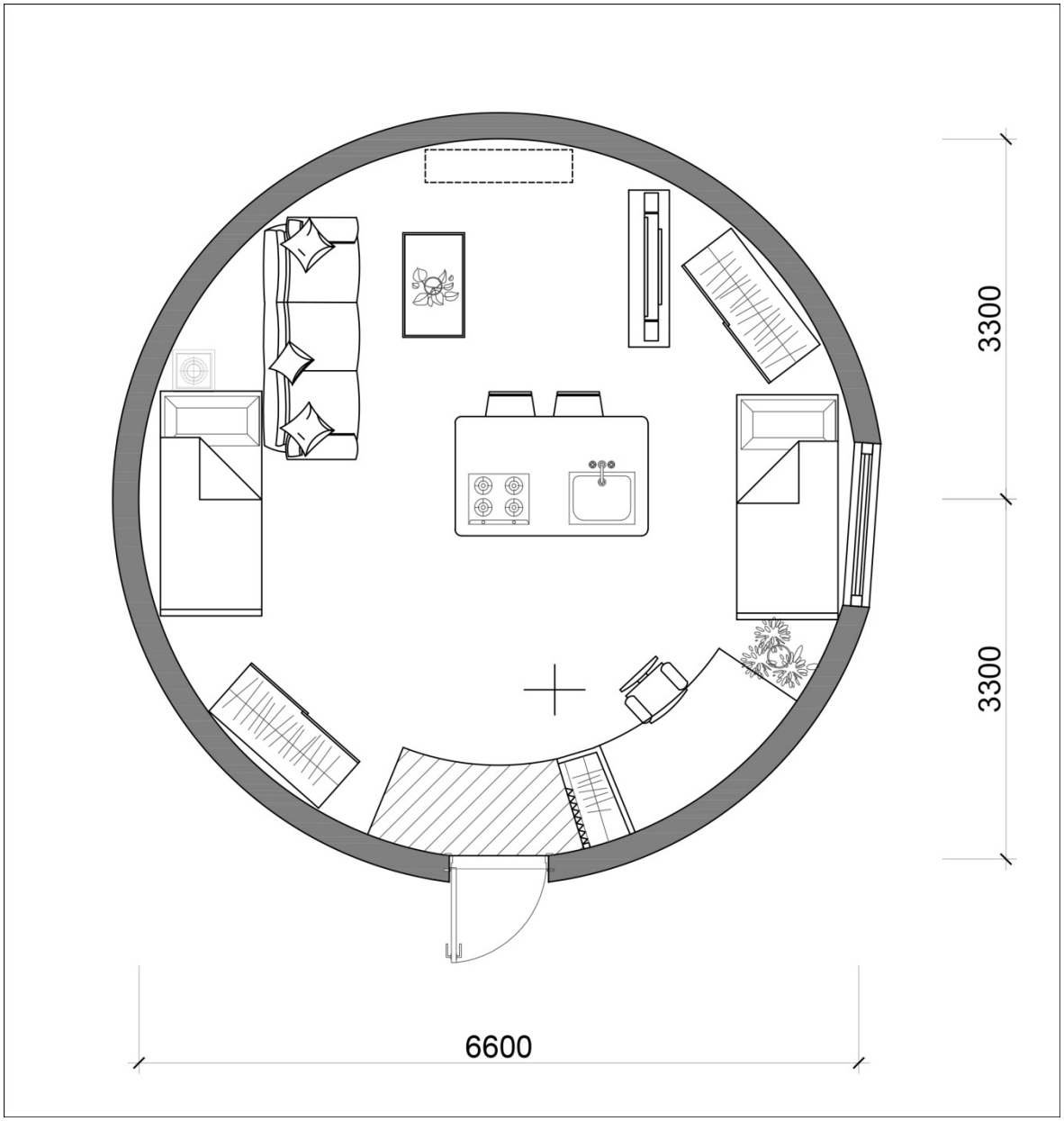
4.1.1. Proposal for circular plan

The radius of the circle is 3.3 meters and the area of the plan is 34 square meters. We propose to accommodate 3-4 people.



(a)

Figure 4.5. a. Optimal design for the circular plan with wet area b. Optimal design for the circular plan without wet area (prepared by author)



(b)

Figure 4.5. (continue) a. Optimal design for the circular plan with wet area b. Optimal design for the circular plan without wet area (prepared by author)

Proposed composition of modular units /circle/

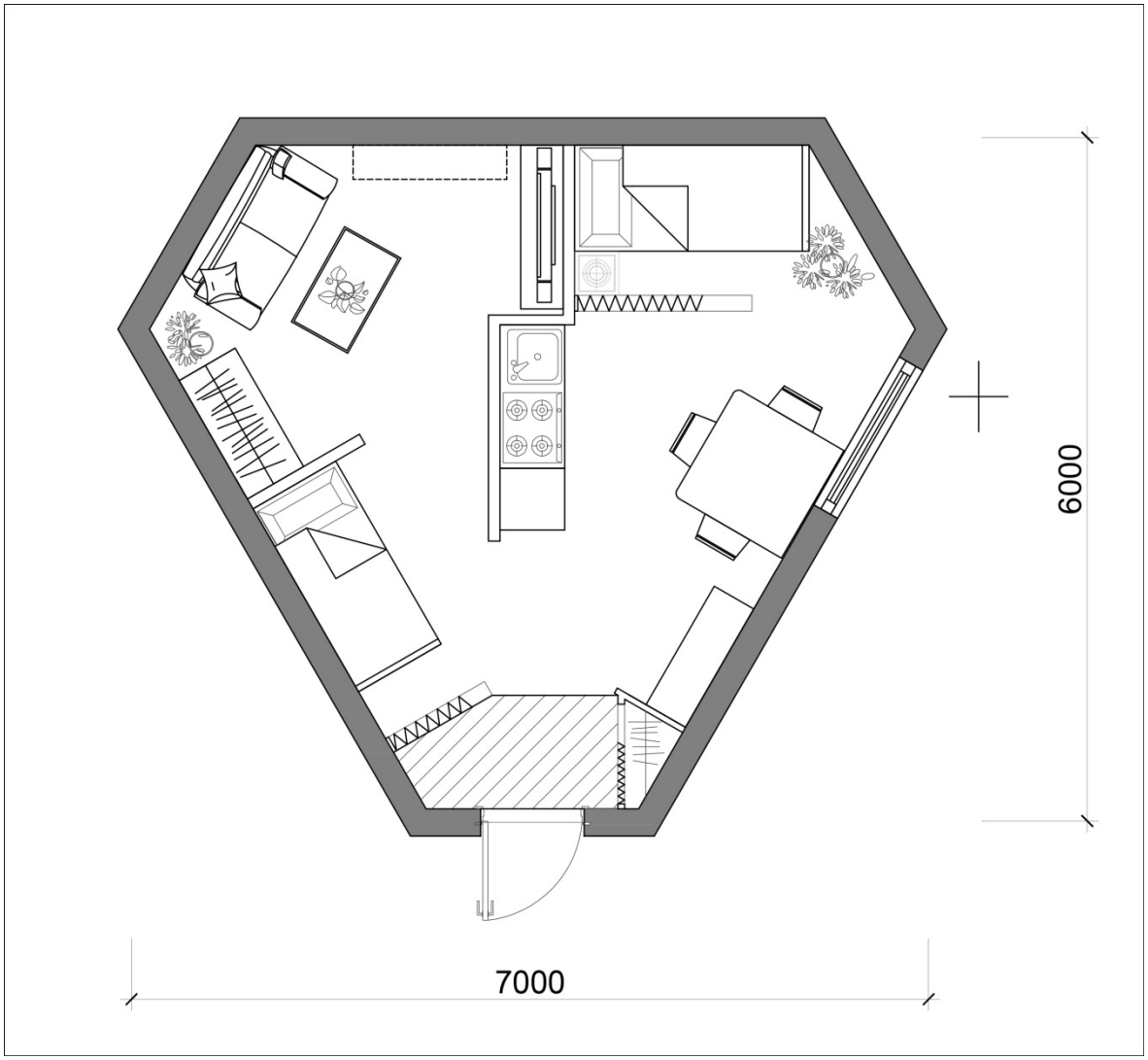
This type of planning is not considered suitable for mass composition of the housing. In contrary it is considered compatible for individual or singular housing.

4.1.2. Proposal for triangular plan

The triangular shape is 6 meters high and 7 meters wide. The area of the plan is 27 square meters.

(a)

Figure 4.6. a. Optimal design for the triangular plan with wet area b. Optimal design for the triangular plan without wet area (prepared by author)



(b)

Figure 4.6. (continue) a. Optimal design for the triangular plan with wet area b. Optimal design for the triangular plan without wet area (prepared by author)

Proposed composition of modular units /triangular/

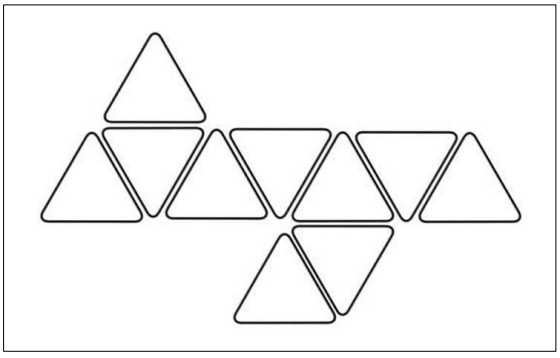
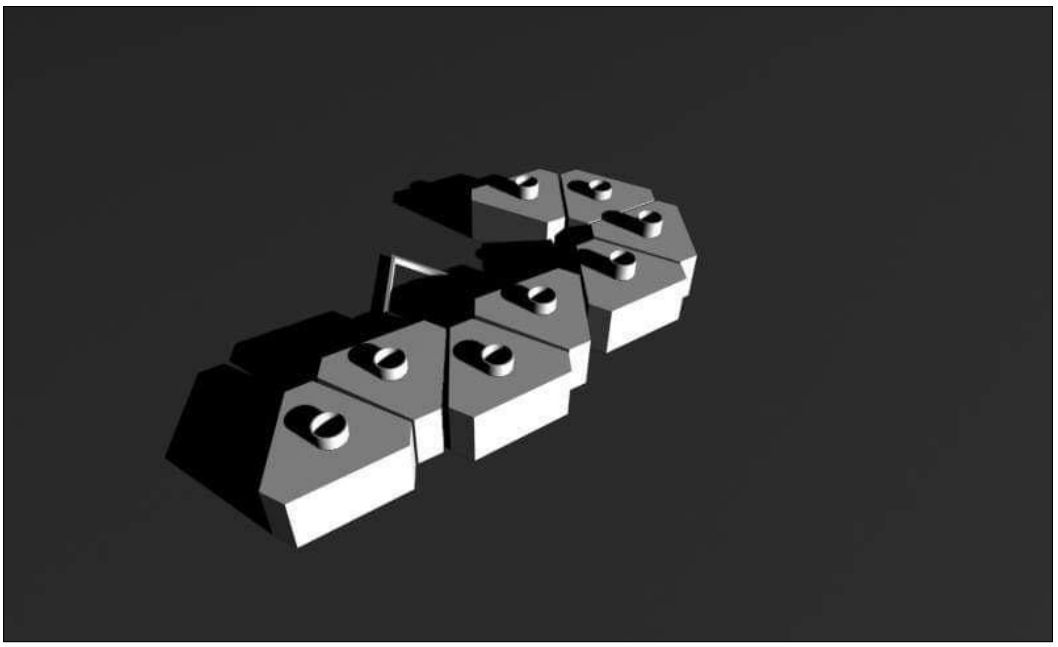
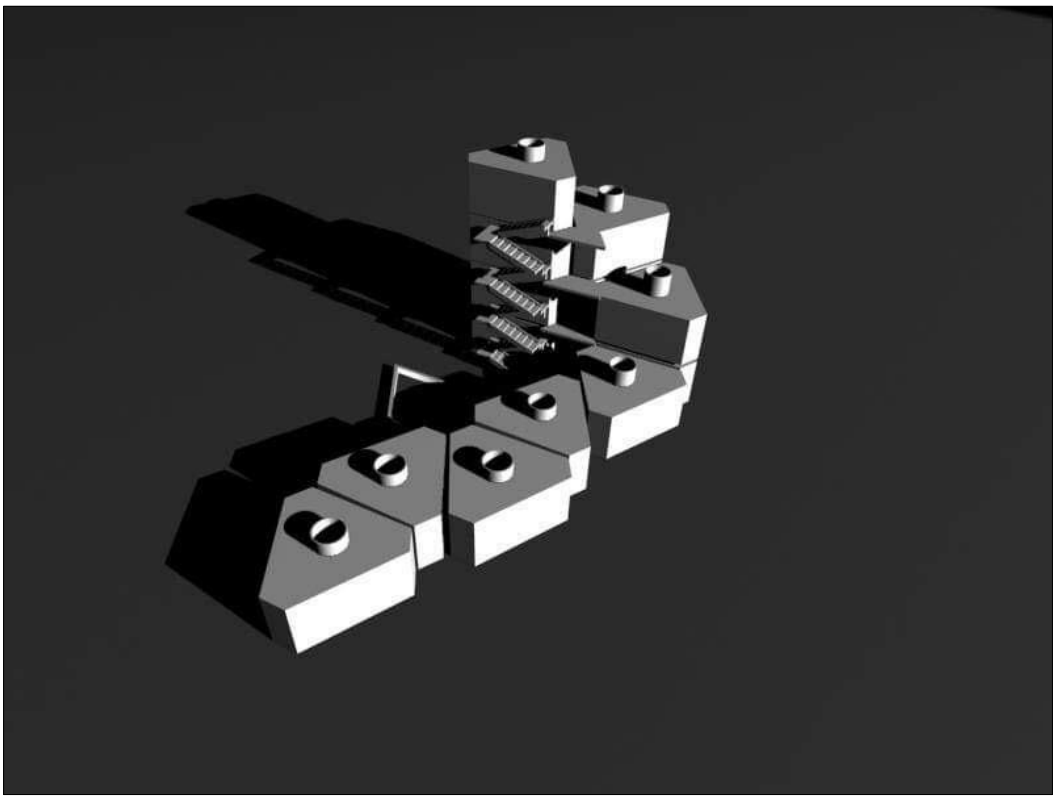


Figure 4.7. 60 degree grid pattern and composition of triangular plan



(a)

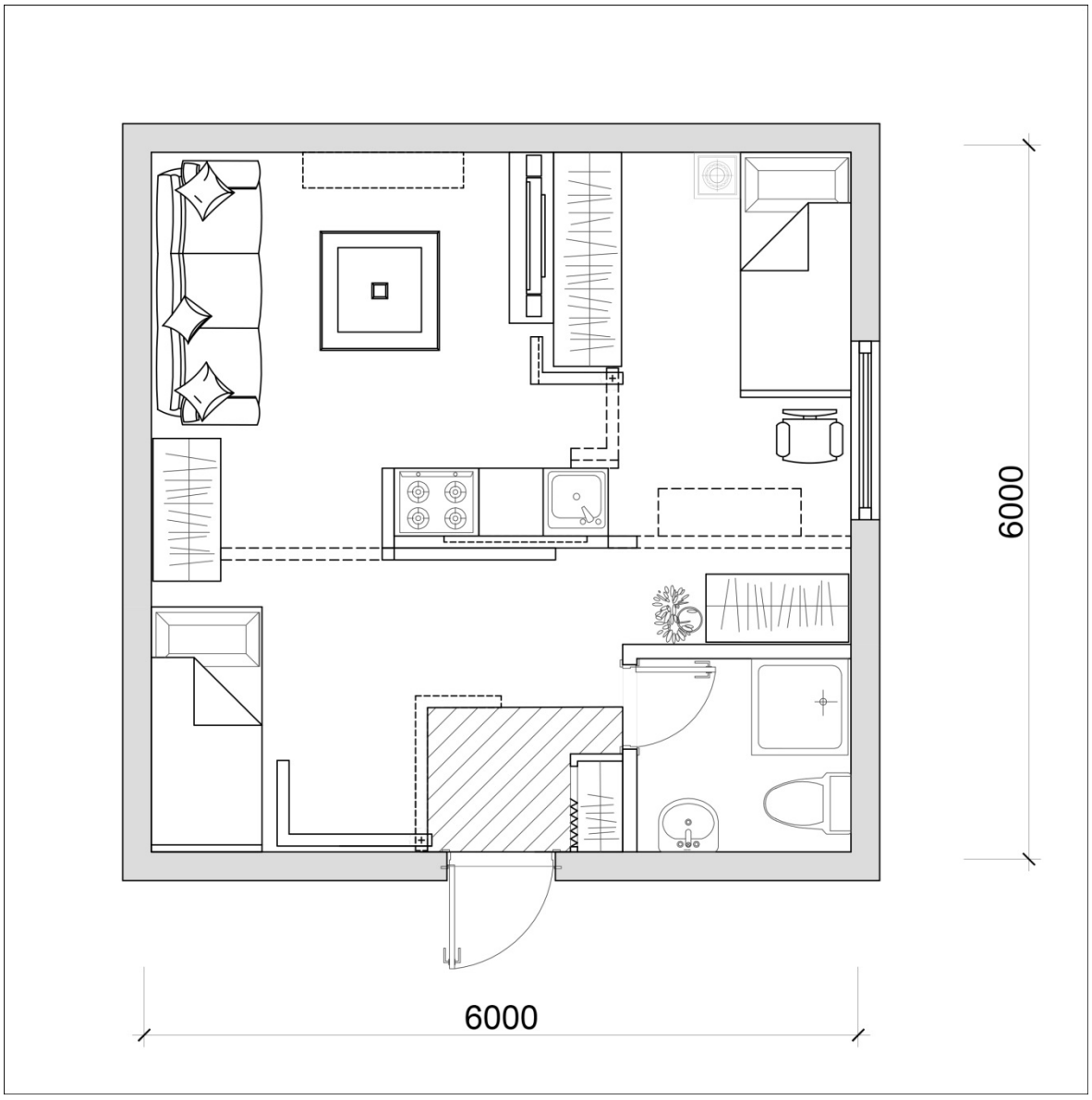


(b)

Figure 4.8. a. Optimal proposal for the single storey composition of triangular units
b. Optimal proposal for the multi storey composition of triangular units
(prepared by author)

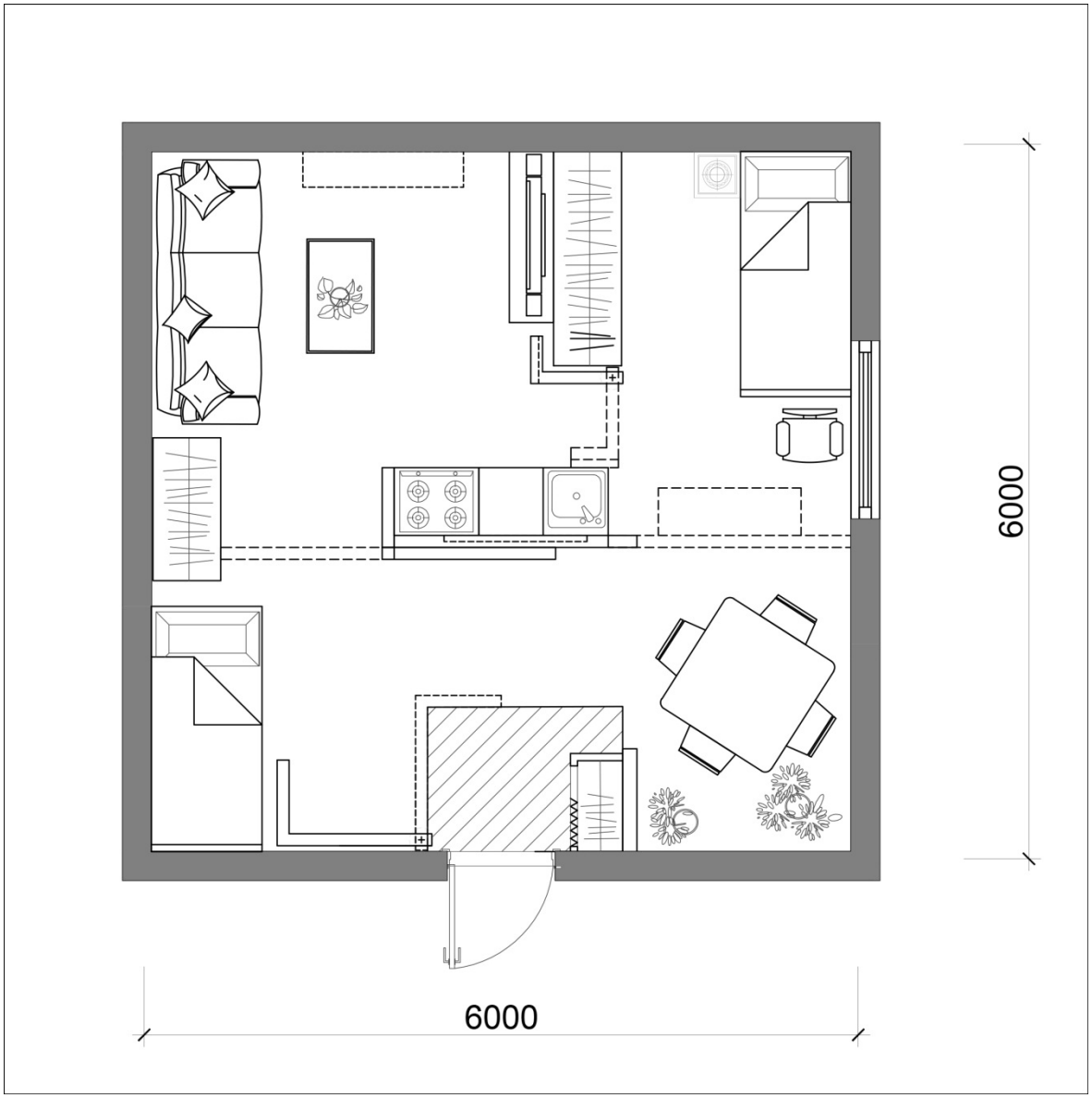
4.1.3. Proposal for square plan

The area of 6x6 square is 36 square meters.



(a)

Figure 4.9. a. Optimal design for the square plan with wet area b. Optimal design for the square plan without wet area (prepared by author)



(b)

Figure 4.9. (continue) a. Optimal design for the square plan with wet area b. Optimal design for the square plan without wet area (prepared by author)

Proposed composition of modular units /square/

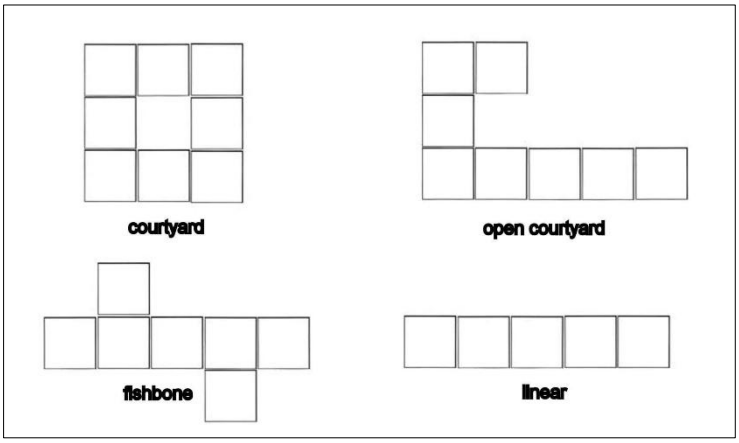


Figure 4.10. 90 degree grid pattern and composition of square plan

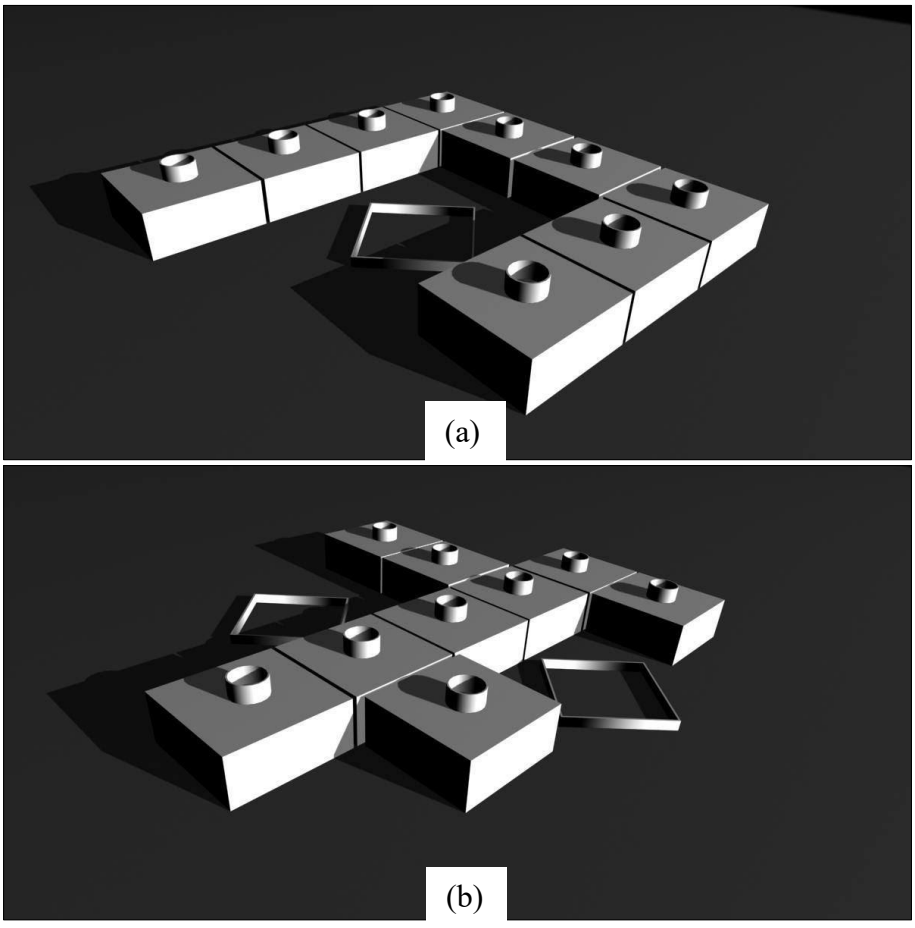
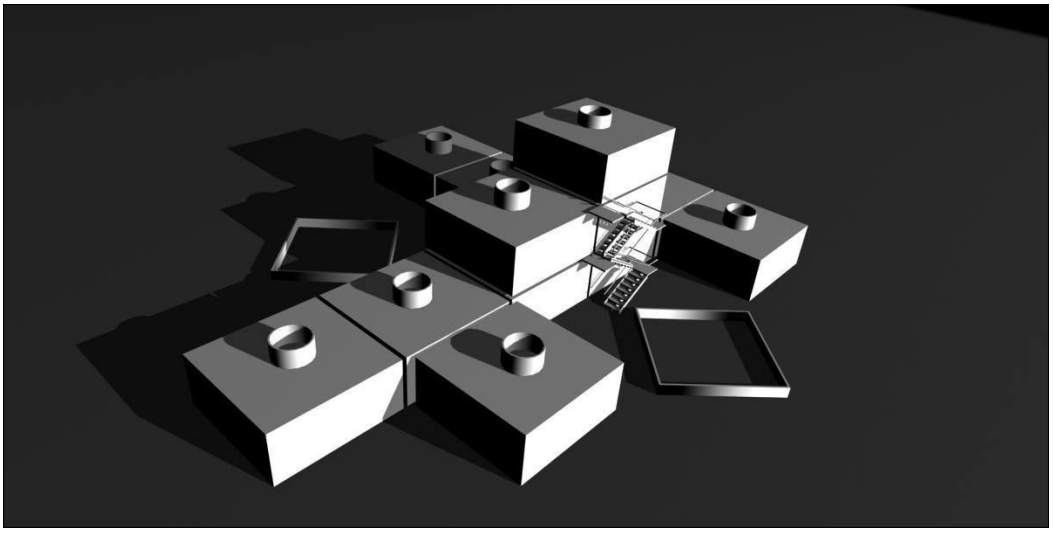


Figure 4.11. a,b. Optimal proposal for the single storey composition of square units c. Optimal proposal for the multi storey composition of square units (prepared by author)

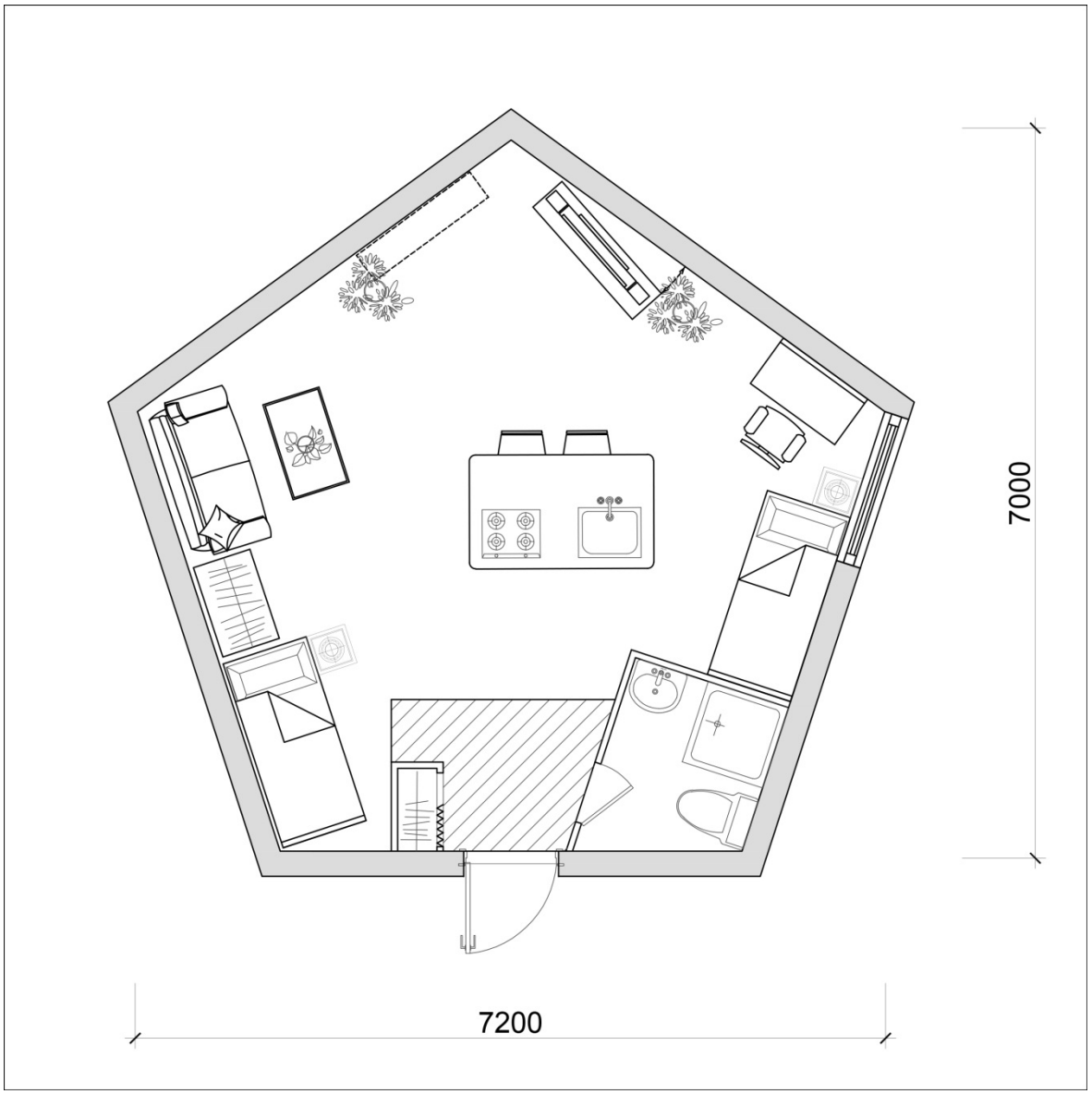


(c)

Figure 4.11. (continue) a,b. Optimal proposal for the single storey composition of square units c. Optimal proposal for the multi storey composition of square units (prepared by author)

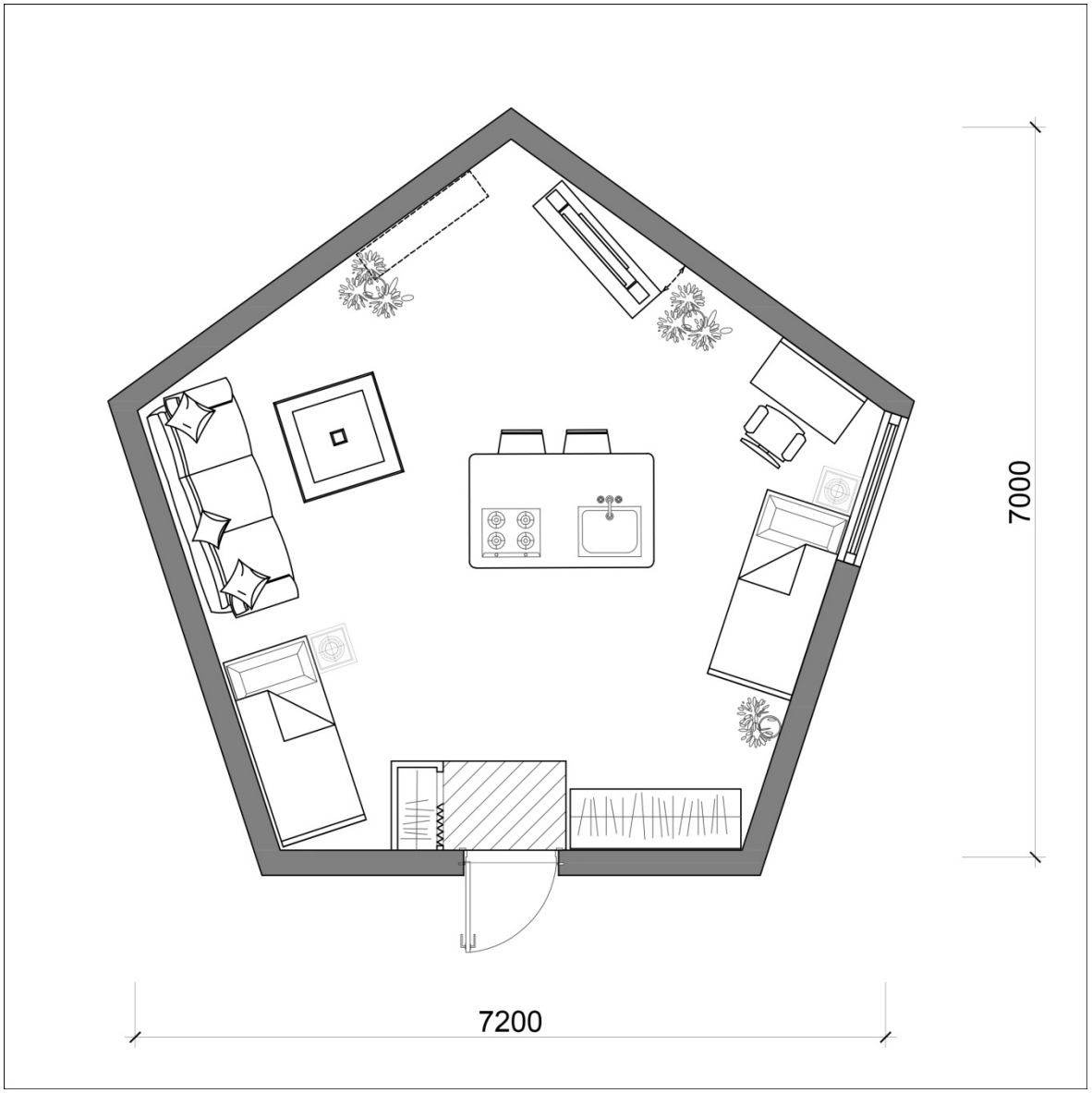
4.1.4. Proposal for pentagonal plan

The height and width of the pentagonal plan is 7 meters and 7.2 meters respectively. The area of the pentagonal plan is 34 square meters.



(a)

Figure 4.12. a. Optimal design for the pentagonal plan with wet area b. Optimal design for the pentagonal plan without wet area (prepared by author)



(b)

Figure 4.12. (continue) a. Optimal design for the pentagonal plan with wet area b. Optimal design for the pentagonal plan without wet area (prepared by author)

Proposed composition of modular units /pentagonal/

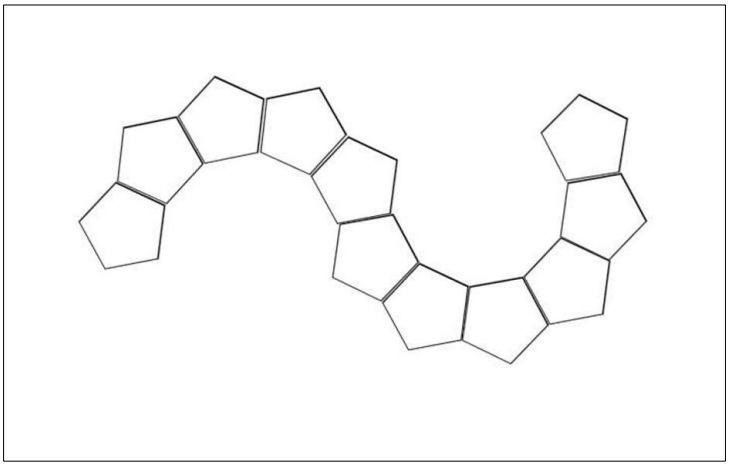
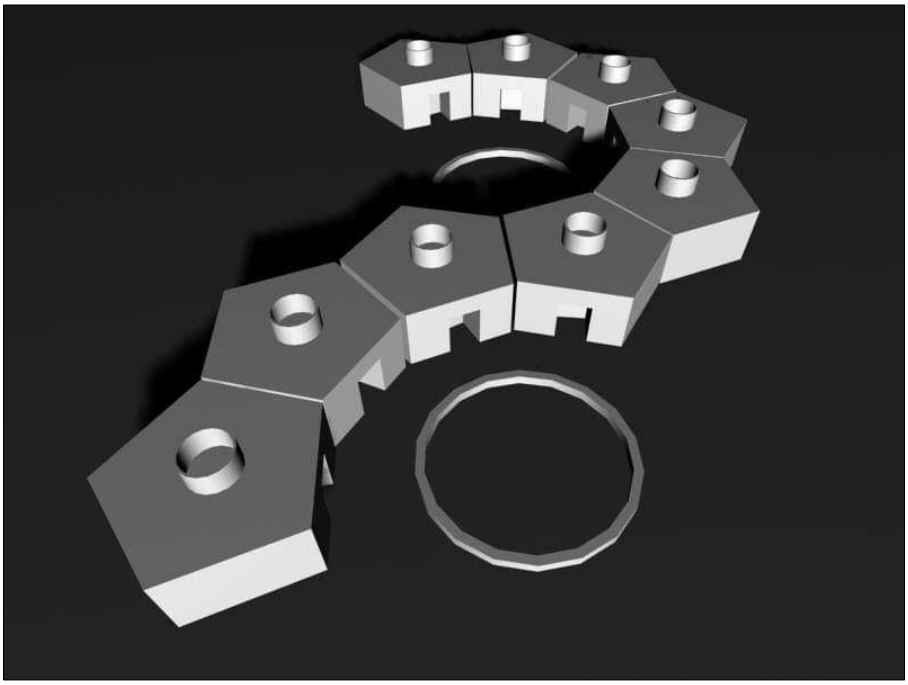
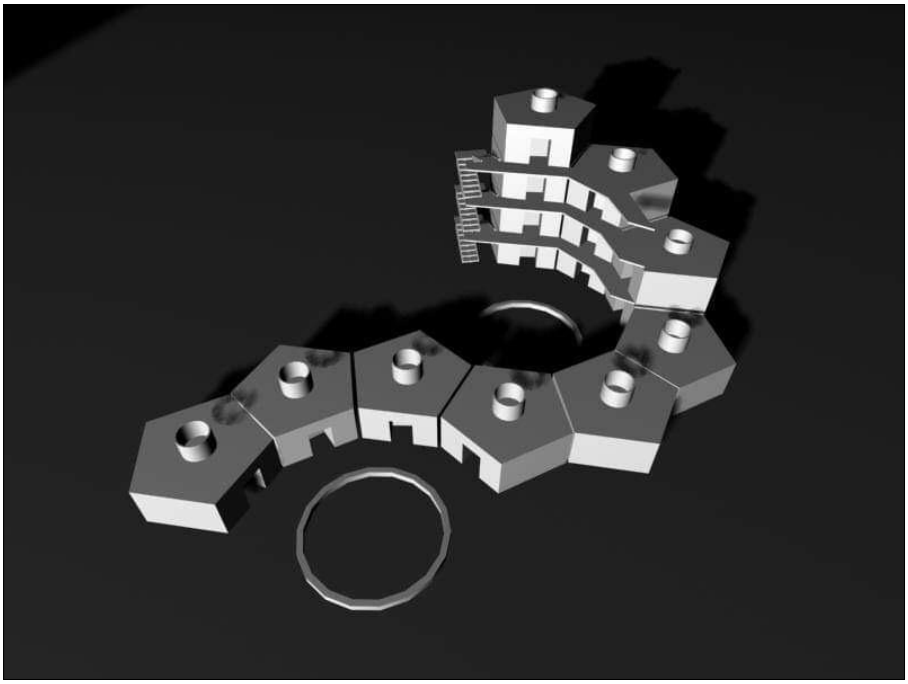


Figure 4.13. Composition of pentagonal plan.



(a)

Figure 4.14. a. Optimal proposal for the single storey composition of pentagonal units b. Optimal proposal for the multi storey composition of pentagonal units (prepared by author)

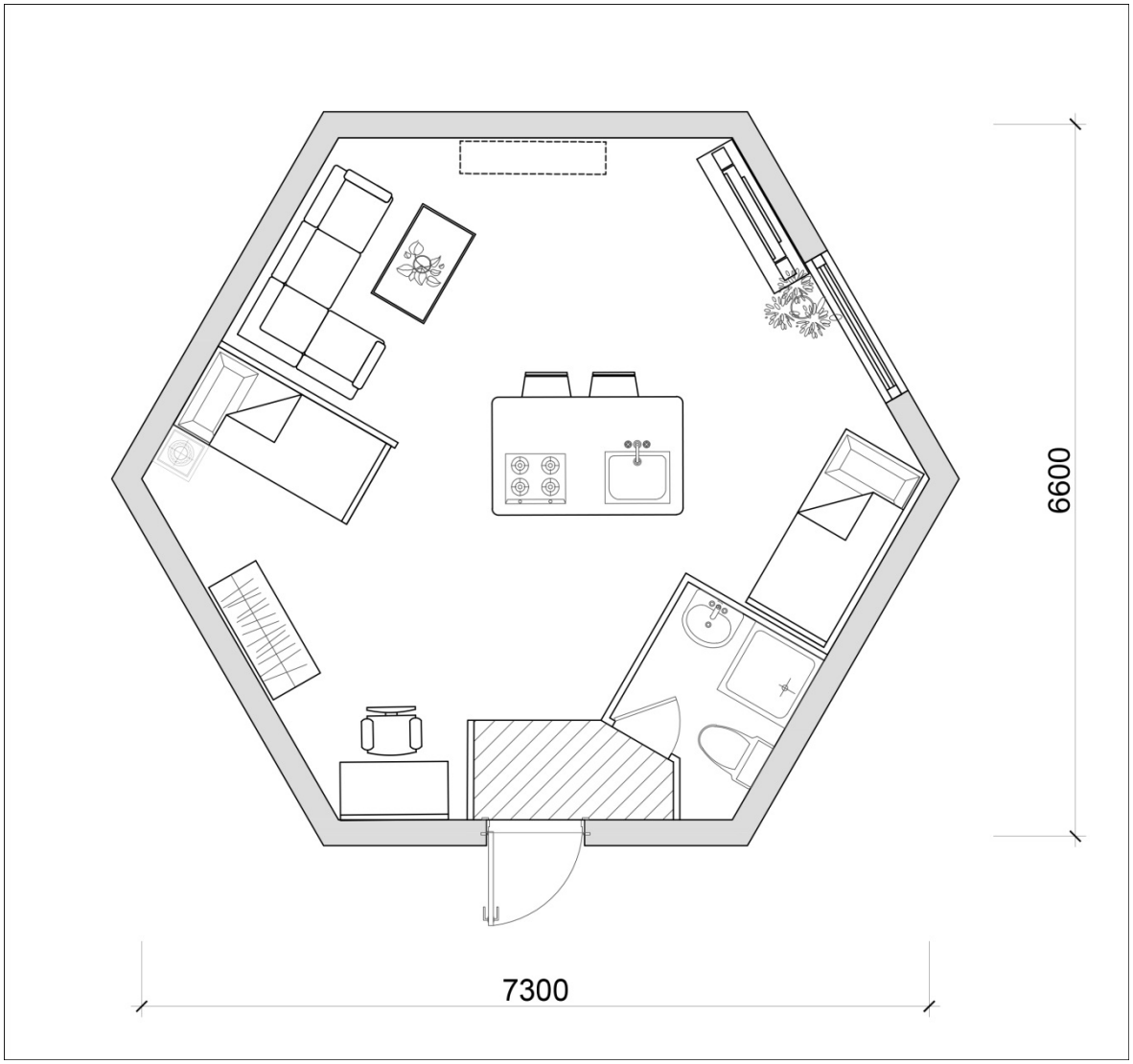


(b)

Figure 4.14. (continue) a. Optimal proposal for the single storey composition of pentagonal units b. Optimal proposal for the multi storey composition of pentagonal units (prepared by author)

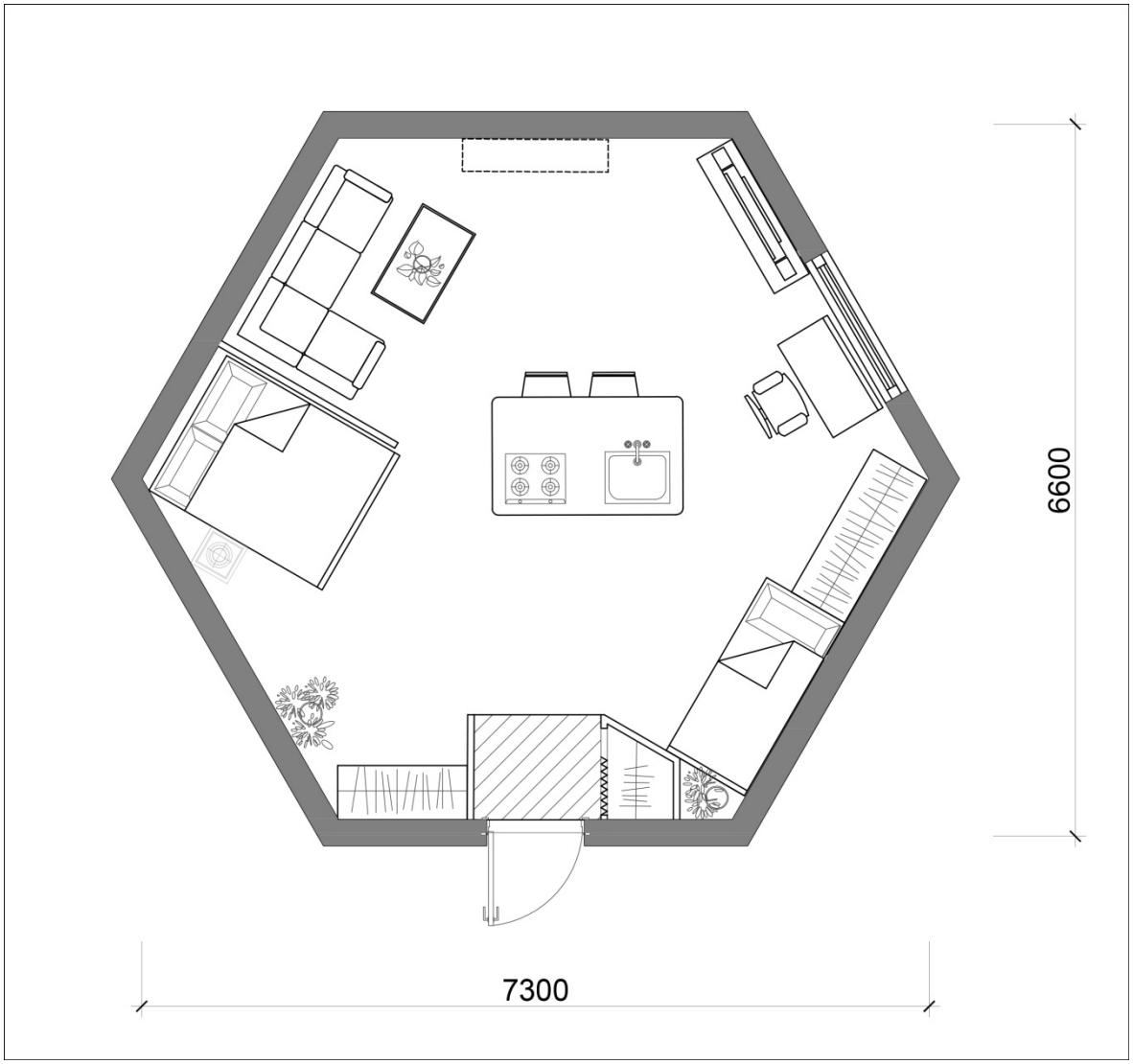
4.1.5. Proposal for hexagonal plan

The hexagonal plan was proposed to have 34 square meters area with the height of 6.6 meters and width of 7.3 meters.



(a)

Figure 4.15. a. Optimal design for the hexagonal plan with wet area b. Optimal design for the hexagonal plan without wet area (prepared by author)



(b)

Figure 4.15. (continue) a. Optimal design for the hexagonal plan with wet area b. Optimal design for the hexagonal plan without wet area (prepared by author)

Proposed composition of modular units /hexagonal/

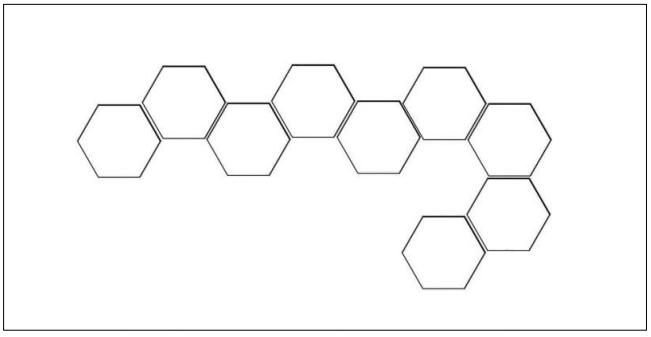
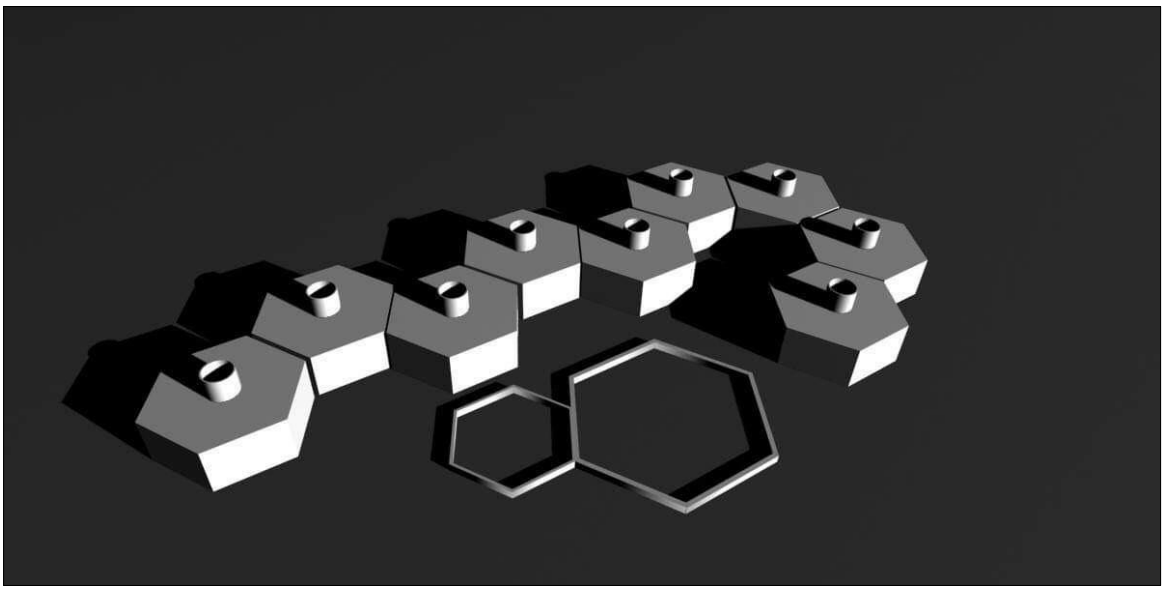
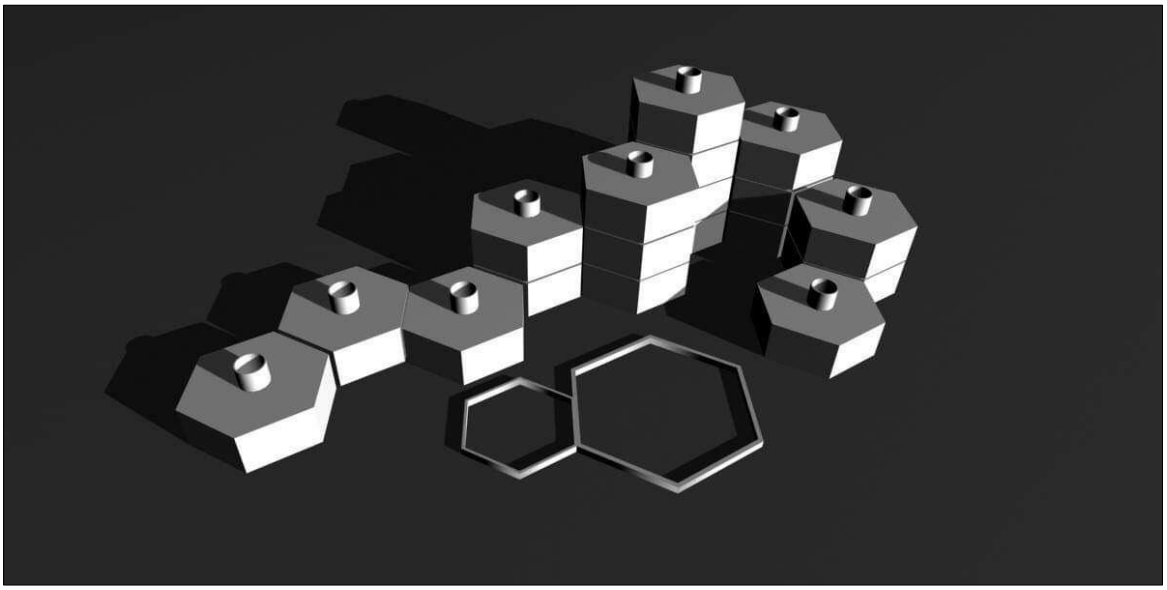


Figure 4.16. 60 degree grid pattern and composition of hexagonal plan



(a)

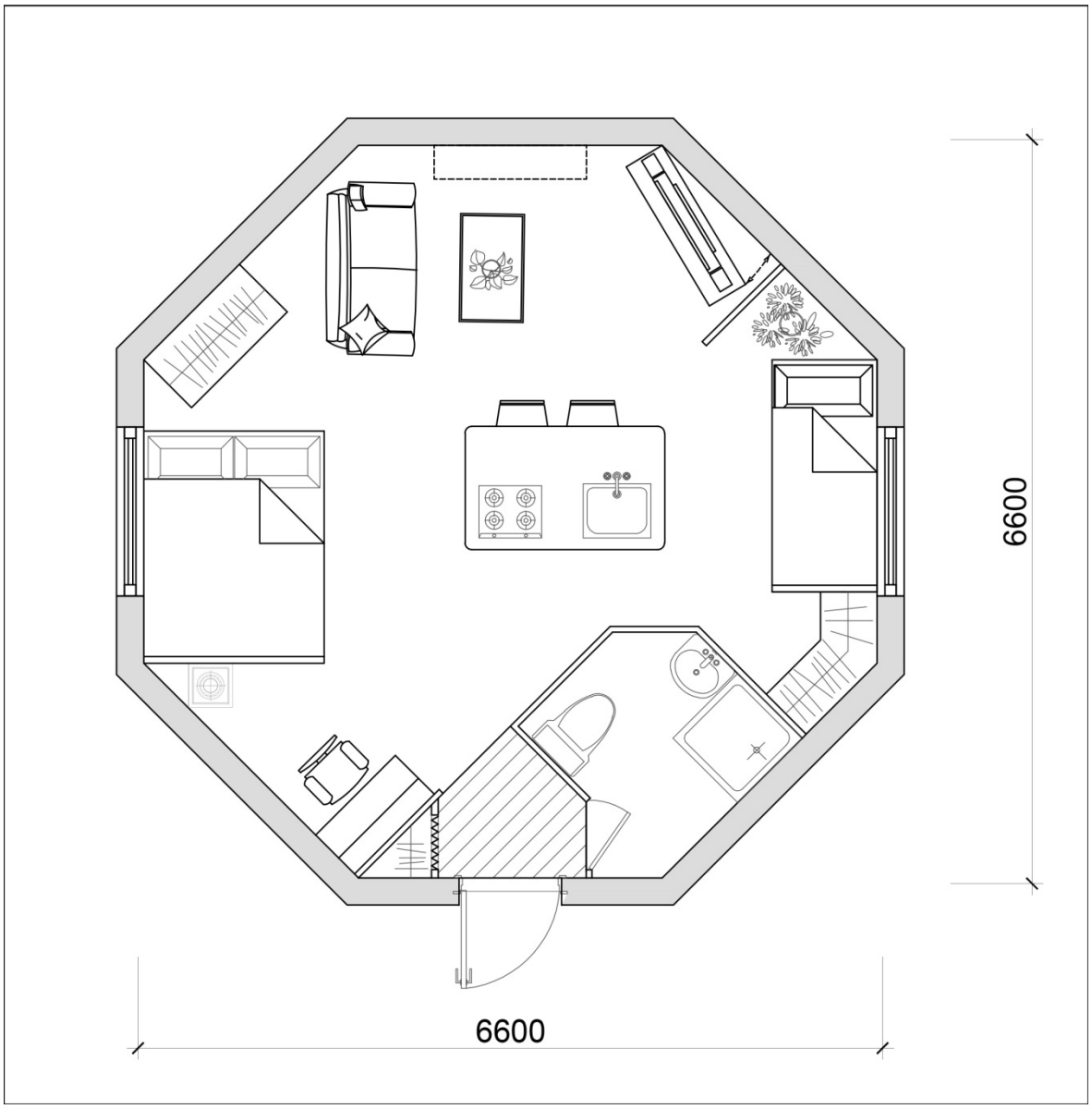


(b)

Figure 4.17. a. Optimal proposal for the single storey composition of hexagonal units b. Optimal proposal for the multi storey composition of hexagonal units (prepared by author)

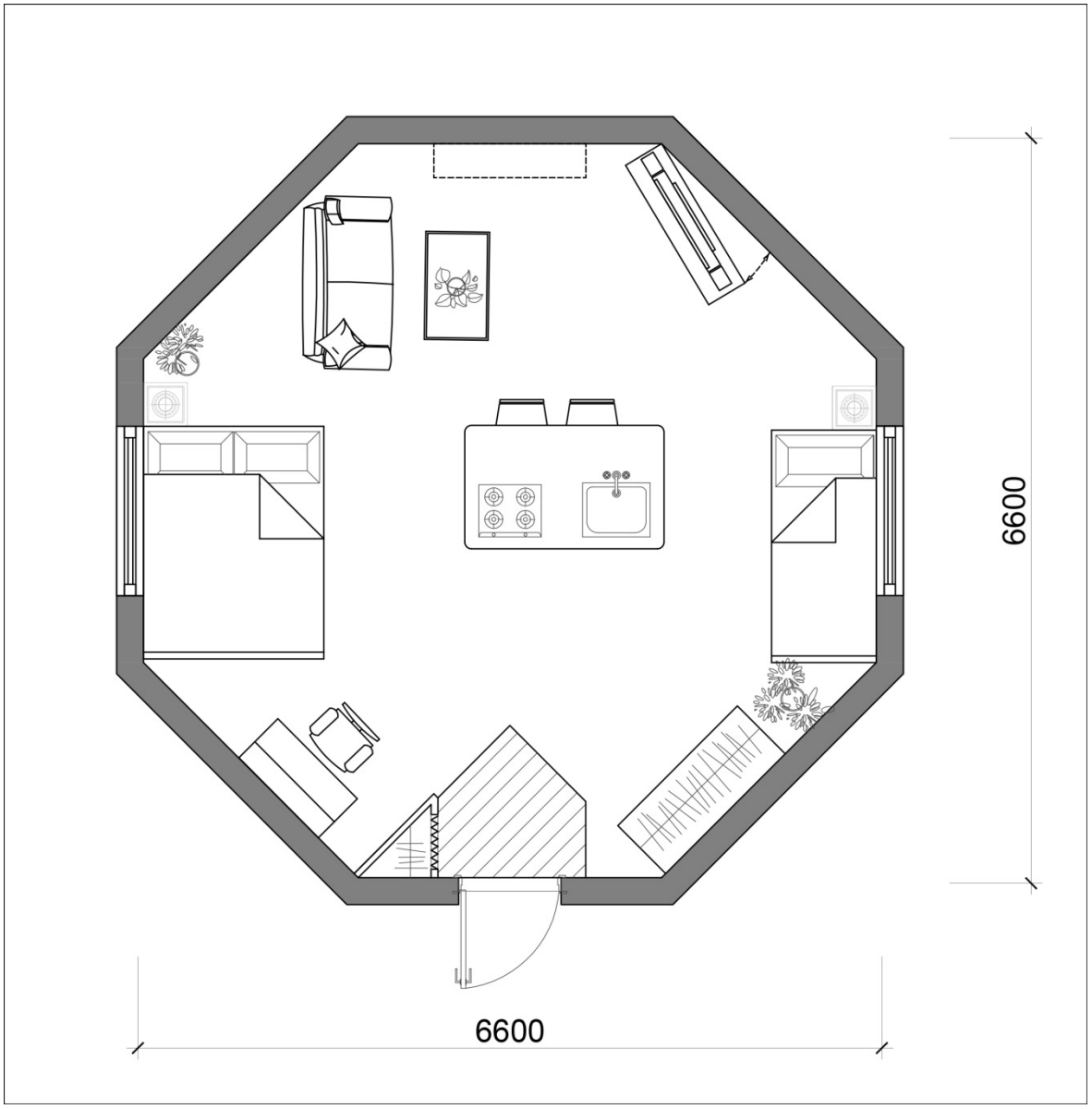
4.1.6. Proposal for octagonal plan

The area of the 6.6 x 6.6 octagonal plan is 35 square meters.



(a)

Figure 4.18. a. Optimal design for the octagonal plan with wet area b. Optimal design for the octagonal plan without wet area (prepared by author)



(b)

Figure 4.18. (continue) a. Optimal design for the octagonal plan with wet area b. Optimal design for the octagonal plan without wet area (prepared by author)

Proposed composition of modular units /octagonal/

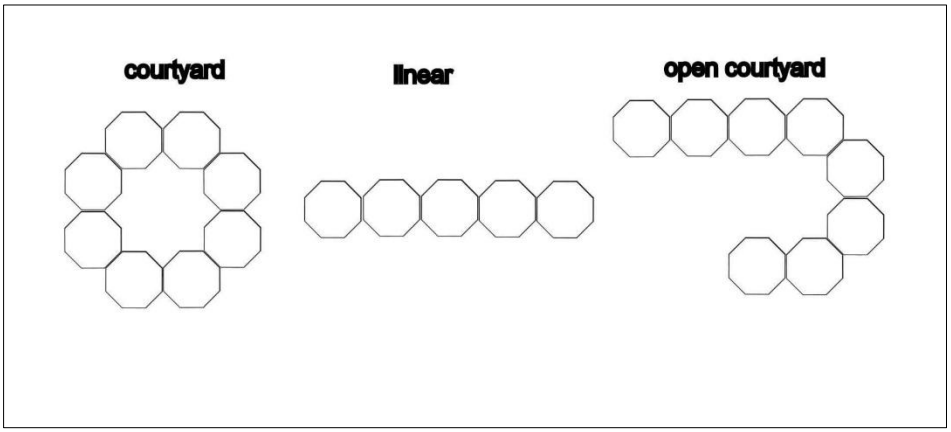
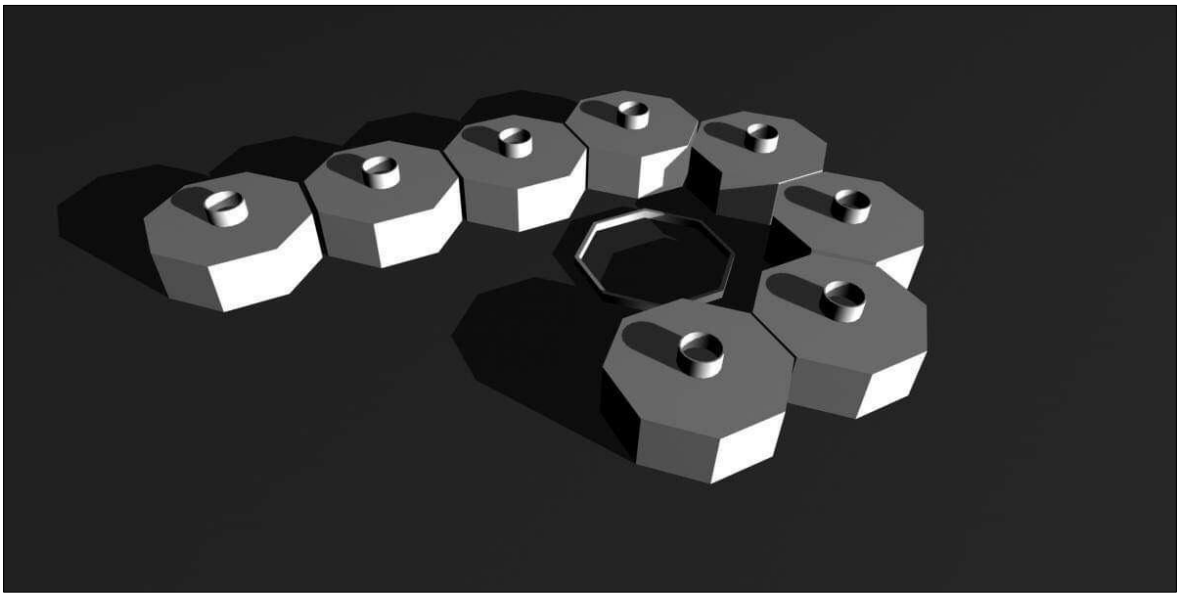
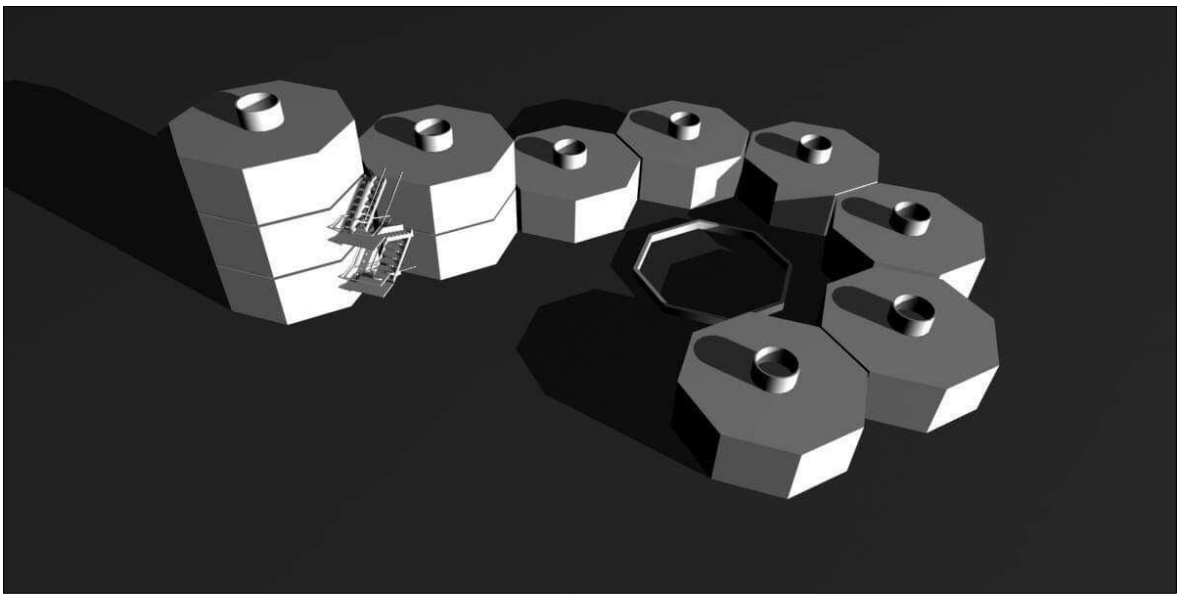


Figure 4.19. 90 and 45 degree grid pattern and composition of octagonal plan



(a)

Figure 4.20. a. Optimal proposal for the single storey composition of octagonal units b. Optimal proposal for the multi storey composition of octagonal units (prepared by author)



(b)

Figure 4.20. (continue) a. Optimal proposal for the single storey composition of octagonal units b. Optimal proposal for the multi storey composition of octagonal units (prepared by author)

4.2. Demountable Structures (Portable)

4.2.1. Case studies

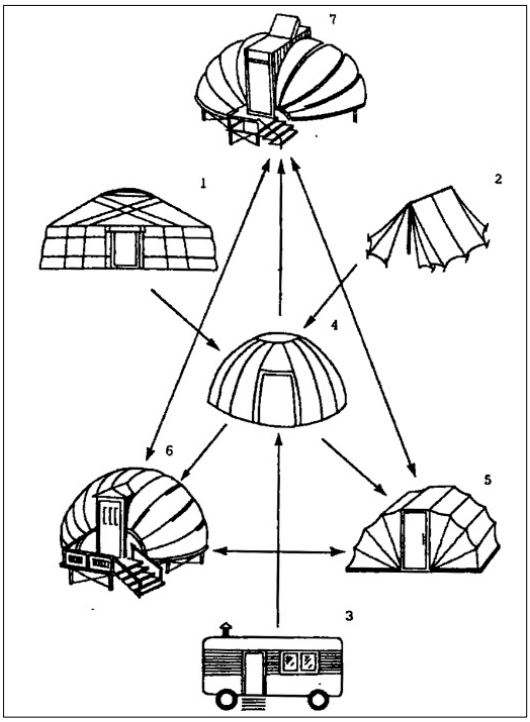


Figure 4.21. Modern portable dwelling types 1-GER 2-Tent 3-Trailer dwelling 4-Tent-Russian Federation 5-Demountable dwelling 6-Semisphere foldable dwelling (Project by Daajav Banzragch) 7-Box dwelling heats with solar energy [20]

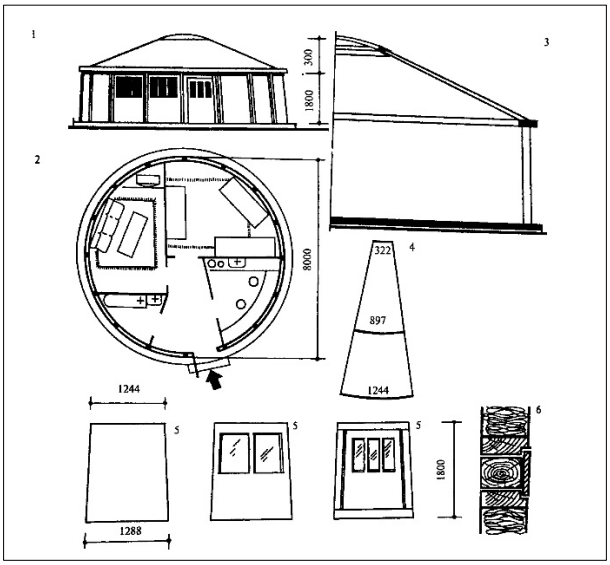


Figure 4.22. Modern portable dwelling (prefabricated wooden panels) 1-Elevation 2-Plan 3-Cross section 4-Roofing panel section 5-Wall panel section 6-Detachment of wall panel to the column [20]

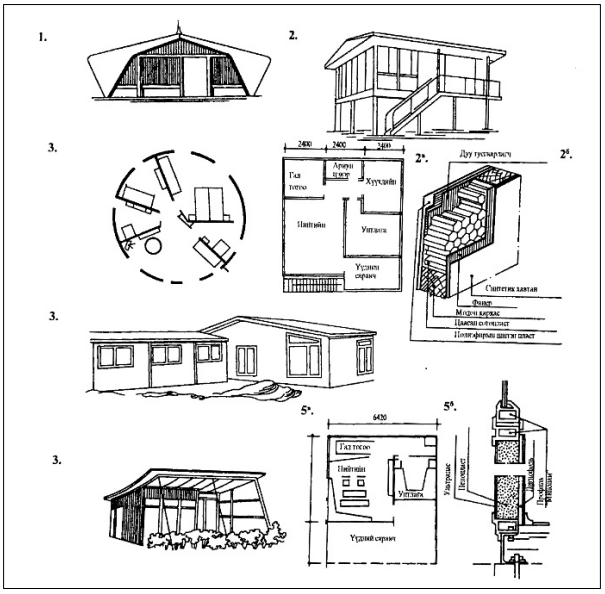


Figure 4.23. International case studies of prefabricated and portable dwelling 1-Germany 2-Italy 3-Italy 4-England 5-Germany a. Plan b. Cross section of wall [20]

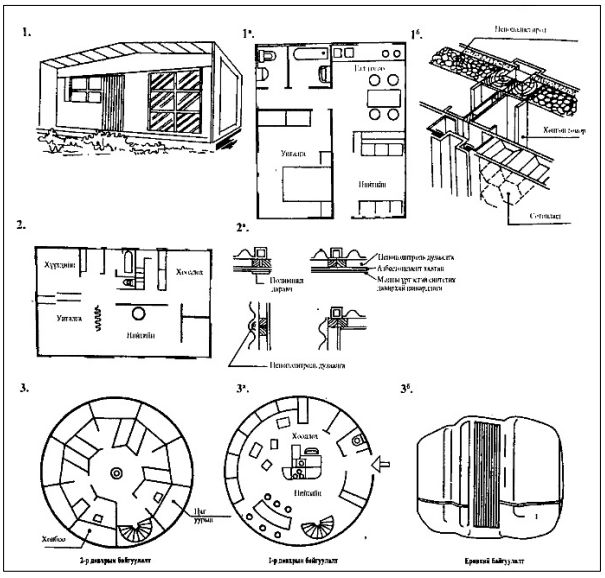


Figure 4.24. International prefabricated and portable dwellings 1-Housing in Osaka, Japan a. Plan b. Section 2-Housing in Poland a. Section of wall fixing b. Second floor plan of an expedition house in France a. First floor plan [20]

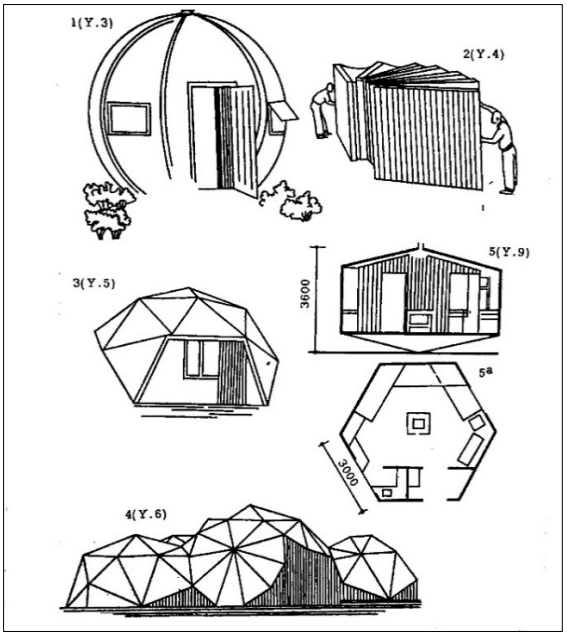


Figure 4.25. Prefabricated and portable housings in abroad 1-Spheric house (Germany) 2-Accordionic dwelling (USA) 3-Camping house (England) 4-Dome range dwelling (England) 5-Prefabricated housing (Russian Federation) a. Plan [20]

4.2.2. Proposal for structure

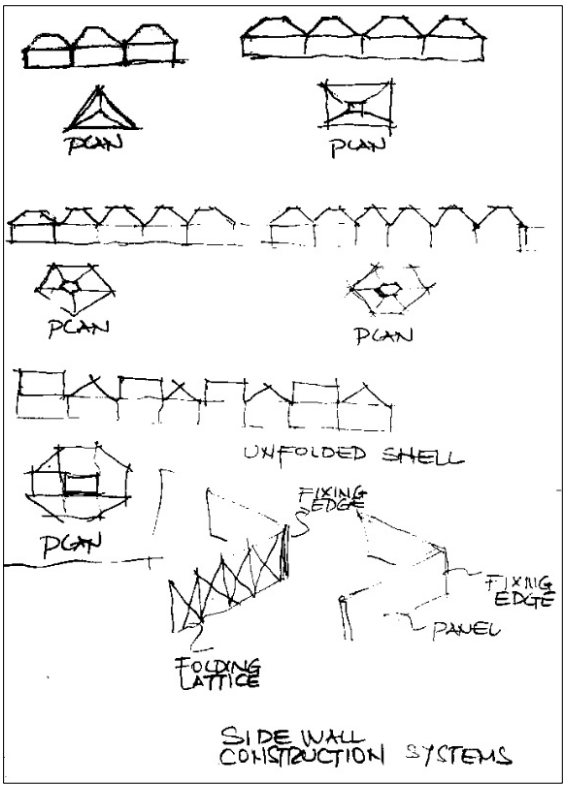


Figure 4.26. Proposed demountable structure for the new design (prepared by author)

We propose all metal lattices, prefabricated wooden panels and insulation layers as demountable and transportable in accordance with GER's features.
For exterior walls alternatives:

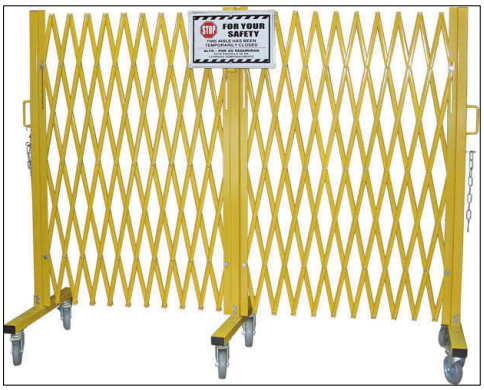
1. Metal lattice + outer shell (leather, textile or wooden board)
2. Only sandwich (insulated multi layer) board panels
3. Folding panels

For the roof structure, timber or metal trusses covered by fabric types are proposed.
For slabs in multi storey types, timber or metal beams covered by wooden board panels are proposed.

(a)

(b)

(c)



(d)

(e)

Figure 4.27. a,b,c,d,e,. Foldable steel structure

4.2.3. Proposal for shell

Second proposal of the wall can be prefabricated wooden panels. For multi storeys, metal beams or truss can be used as floor structure.

(a)

(b)

(c)

(d)

Figure 4.28. a,b,c,d. Prefabricated panels

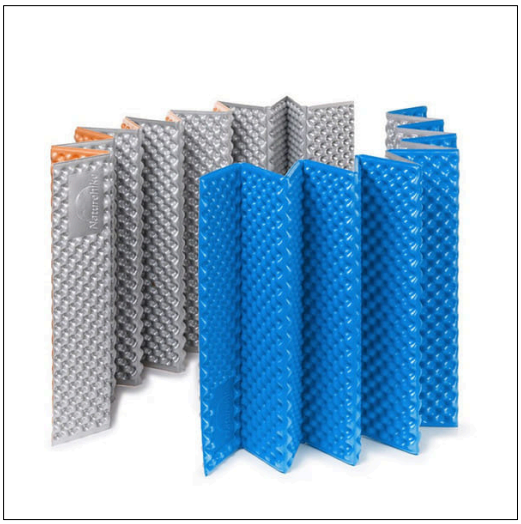
Proposed pre manufactured panels fix each other by hinge and screws as shown in the figure 4.29.

(a) (b)

Figure 4.29. a,b. Hinge connection of panels

4.2.3. Proposal for insulation

Foldable and insulated panels shown in the figure 4.30 can be used for outer wall instead of lattice or board panels.



(a) (b)

Figure 4.30. a,b. Foldable insulation material

5. CONCLUSION AND FURTHER RESEARCH SUGGESTIONS

GER house, commonly used dwelling in Mongolia for thousands of years, have the following architectural characteristics:

Having consisted of structural parts - timber lattice wall sections, timber roof beams and textiles such as leather, felt or canvas used for the purpose of outer shell, GER is mobile and demountable. Mongolians carry the parts of GER in vehicles, on back of horses or camels and then reattach the parts in order to establish their houses after their moving from pasture to pasture. These important features define original GER as convenient and practical dwelling in rural areas, not in a urban space, specially in the capital city.

Next main characteristic of GER is to contain all housing functions in it. Living, resting, sleeping, hosting guests, preparing food, cooking, dining, washing the dishes, doing laundry, entertaining and working functions are being held in a single space. GER is unique and enviromentally friendly dwelling and its ventilation is completely natural through the “hayaavch”-outer skirt and the “toono”-roof hole. The analysis on these characteristics brought up to the idea that it is compatible to maintain in the new designs and became the foremost reasons of our pursue to deform or adapt the GER in modern living space. Meanwhile traditional Mongolian GER is seen as it reached its highest point of evolution, it can find its optimal usefulness in the 21st century and rearranged into a contemporary housing with appropriate architectural suggestions.

In the thesis, all mentioned characteristics of GER are taken and duely transferred into the proposed type of mass and emergency housing. Conducting analysis and weighing advantages and disadvantages of GER, we are concluding that these easily assembled and portable characteristics should be used for emergency housings for rural to capital migrants, earthquake, storm, tsunami victims, social housing for single living people or small families, student (dormitory buildings) and even for migrants.

Deformation and adjustments were suggested based on the analysis of the functional, structural and urban community study of GER. GER’s internal function and space configuration adjusted into and planned in 6 various geometrical shapes, namely, circle,

triangle, square, pentagon, octagon and hexagon. Each plan was designed in two alternatives (including wet area and excluding wet area) with the future consideration of mass housing and GER area features. We hypothesize that prefabricated structure is suitable for the further mass production of the design presented, according to the same mobile structure of GER. The study suggests that the housing can accommodate not only Mongolian migrants from rural to capital, but also natural disaster victims since rapid supply of housing in these situations became a worldwide architectural issue.

Moreover, we are suggesting that units of geometrical plans can be multiplied and connected with each other in order to obtain housing clusters (community/neighbourhood settlements). During the study the author came to the conclusion that the utilization of GER's spatial configuration into modern housing is promising and has potential perspectives to provide new design hints and guidance in developing new settlement concepts. Attempts made to fit the GER internal orginisation into 6 different plan shapes, gave the opportunity to find out and emphasize the triangular plan as the most compitable shape among all proposed plan shapes. Having 27 square meters plan area, it is the most compact and the closest option to GER architectural charcteristics. The furniture design in interior of GER inspired housing and material study will possibly be developed in the further stage of the research. The study puts forward its new design ideas on the development of GER which have theoretical and practical merits for architects, students for their further findings on GER in Mongolia and around the world.

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APPENDICES

APPENDIX - 1. Definition of the drawings in fourth chapter

Definition of the drawing

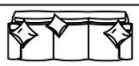
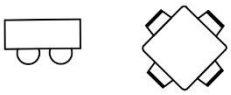
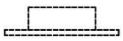
Drawing	Definition
	Altar /where family photos and religious items found/
	Sofa
	Television
	Low table /for eating/
	Coffee table
	Bed
	Chair for /working and studying/
	Wardrobe
	Kitchen
	Eating tables
	Bathroom
	Sliding wall with the height of 1.5 metre
	Foldable working desk /collapsible from the sliding wall/
	Rotating wall with the /for flexible interior/
	Folding wall
	Window
	Extruded entrance
	Flowers

Figure 1.1. Definition of the layout plans (prepared by author)

CURRICULUM VITAE

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Education

Degree	School/ Program	Graduation Date
MSc	Gazi University / Architecture	ongoing
Undergraduate	Mongolian Uvinersity of Science and Technology / Architecture	2015
High School	School #1, Ulaanbaatar	2010

Professional Experience

Year	Place of Work	Position
2014	Bayars Construction Co., LTD / Ulaanbaatar, Mongolia	General Manager
2017	Hungarian Contemporary Architecture Center / Budapest, Hungary	Researcher
2018	Bilişim Private High School / Ankara, Turkey	Teacher

Foreign Language

English, Turkish, Russian

Publications

1. Ganbat, A., Yıldırım, M. T. and Dayandorj A. (In press). Utilization of Mongolian GER's Spatial Configuration in Modern Housing. *Gazi University Journal of Science Part B: Art Humanities Design and Planning.*

Hobbies

Fencing, snowboarding, reading books

GAZİ GELECEKTİR...