P2 Report - January 2019

Passive technology for off-grid safari park

Passive techniques are used to reduce the energy demand of a safari park in Iran

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Building Technology Graduation | TUDelft

Content

1. Introduction

The Simba nature protection and education foundation has asked students from different faculties to work on a safari park in Fars province in Iran.

This graduation research is based on the request from the Simba nature protection and education foundation. The Simba nature protection and education foundation asked for a concept for a safari park in Iran. The safari park should attract tourist to the Fars region and will be built for the local nomads, the Qashqai. The safari park will be an area where animals are kept and have the ability to roam around freely. The safari park should be open for tourist which can observe the wildlife while walking, cycling or driving through the area. The native flora and fauna of Iran should play a big role in the safari park. This means that animals like gazelle, deer, mountain wild goat, ram, ewe and many kinds of birds will be kept in the safari park. The safari park will integrate animal protection and animal breeding in their natural environment. (Zagroz, 2018)

Besides observing the animals the safari park will also offer other kind off activities for the tourists. The tourists can do outdoor activities, like hiking, rock climbing and sports. Excursions are offered from the safari park to nearby historical sites and other interesting places. Besides this the tourist can also work as a volunteer in the safari centre or assist the Qashqai in their daily activities. The tourist can stay in comfortable housing tents. (Figure 1) The safari park will have a restaurant and a shop where the tourist can buy daily necessities and traditional handmade Quashqai products. (Zagroz, 2018)

Figure 1: Tourist accommodation tents
Source: Stichting Simba Nature Protection and Education Foundation, 2018

The safari park will be off-grid . This means that there should be technical solutions for water and electricity. This should be completely supplied by renewable energy sources like air to water technology, solar energy and wind energy. The safari park should be environmental friendly and adjusted to the specific climate of the area, both in summer and winter. (Stichting Simba Nature Protection and Education Foundation, 2018)

2. The Qashqai tribe

Simba is approached by the nomadic Qashqai tribe to help establish the safari park. (Stichting Simba Nature Protection and Education Foundation, 2018)

The Qashqai tribe lives in the Zagros Mountains. They speak Turkish and Shi'i Muslim. The nomads used to travel hundreds of kilometres during spring and autumn. These migrations last up to two or three months. (Beck, 1992)

Figure 2: Qashqai tent
Source: Afshari Hematalikeikhaa & Alinaghizadehb, 2012

- The roof and the trunk is woven out of goat's hair with tight and interwoven strands of thread.
- The ropes are woven out of sheep's wool or goat's hair
- Columns, poles, chains, spikes and pins made of different types of wood
- Bowers made of thin pieces of straw, wood and thread

During these migrations the Qashqai carried al their belongings. They travelled kilometres before setting up a new settlement. Therefore the tents had a few requirements namely they must be light, small and portable. Be warm in winter and cool in summer, be resistant against wind, rain and winter storms, be affordable by all people, and finally be easy to make by the local people themselves. To achieve these requirements natural and light materials are used like goat's hair, sheep's wool, thread, wood and straw. (Figure 2) (Afshari Hematalikeikhaa & Alinaghizadehb, 2012)

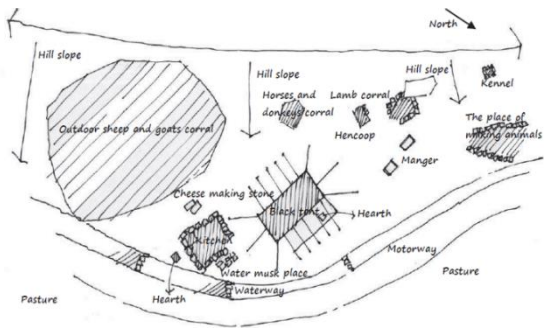


Figure 3: Settlement plan of Qashqai village
Source: Afshari Hematalikeikhaa & Alinaghizadehb, 2012

The tents can be adjusted to the season. During summer one side of the tent is left open. In winter due to heavy rain falls, poles are connected lengthwise to the middle of the tent's roof, supported by columns from below. (Afshari Hematalikeikhaa & Alinaghizadehb, 2012) The Qashqai have a few occupations, namely animal husbandry, handicraft and agriculture. Their settlements are formed around a black tent and have a clear place for the animals. (Figure 3) (Afshari Hematalikeikhaa & Alinaghizadehb, 2012)

In the 1960s and 1970s the regime pressured many Qashqai to settle in villages and towns. (Beck, 1992) Besides the regime also other challenges has forced the Qashqai into settlement. There was too much drought for the Qashqai to find grazing lands for

their flocks. Also when traveling there was not a platform for the Qashqai women to sell their handicraft. Nowadays there are 40,000 Qashqai nomads left, most of which are settled.

Figure 4: Qashqai house and qapu
Source: Alinaghizadeha & Afshari Hematalikeikha, 2012

The settlement plan of the Qashqai nomads changed when they became sedentary. In the Qashqai villages there are some important aspects like the main living-room, the qapu, the kitchen, the granary, the sheep's covered corral, the lamb corral, the outdoor corral, the hayloft and the toilet. There is enough room for the animals to stay. The qapu is the outdoor intermediate space where the daily activities from the Qashqai are happening. The intermediate outdoor space is defined by a combination of elements like trees and other natural elements. Nomads are only inside when they are forced to. The houses which the nomads have built have walls made of plaster and stone. (Figure 4)

The ceiling is made of straw and wood. (Alinaghizadeha & Afshari Hematalikeikha, 2012) The Qashqai live outside the most of the time, but their houses do protect them from the winter cold and rain. Natural materials are used for the houses. For the Safari park these materials can also be used.

2.1. Yurt tents

Yurts have been used as a dwelling in Central Asia for at least three thousand years. The yurt is used by nomadic people in Mongol and Turkey. The yurt can now be found from Mongolia and Southern Siberia to Turkey. (Liu, Li, & Ko, 2017)

In the safari park in Iran the tourists can contribute in the daily Qashqai life. The tourists can help with the flocks or with the handicraft. The tourist accommodation therefore can be similar to the tents the nomadic Qashqai lived in to experience the whole Qashqai life. A yurt tent can be a good option for this.

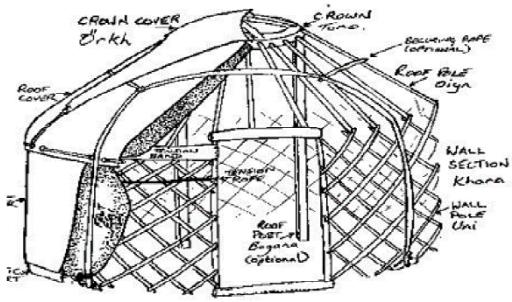


Figure 5: Component parts of the yurt
Source: King, 1997

The yurt is a circular walled framed tent. The roof is supported by a number of wooden ribs. (Figure 5) The yurt is covered with felt made out of sheep fleece. The yurt tent is used in cold, wind, rain and snow in Mongolia for twenty five centuries. To stand the cold winters a wood burning stove is used. The stove is placed in the middle of the tent. The roof

has an opening so that the smoke can leave the tent. In the hot summer the sides of the yurt can be rolled up. In this way a cooling breeze can cool the tent. During the night the sides can be put down. (King, 1997) The yurt is provided with a natural ventilation system. Through the opening in the roof the warm air moves out which maintains the internal comfort.

Down below are some examples for the floorplan of the yurt. (Figure 6) The yurt can be different in size and if wanted a bathroom can be added. The yurt can be used in the safari park in Iran during summer and winter. When desirable the yurt can be removed and placed on another location in the safari park.

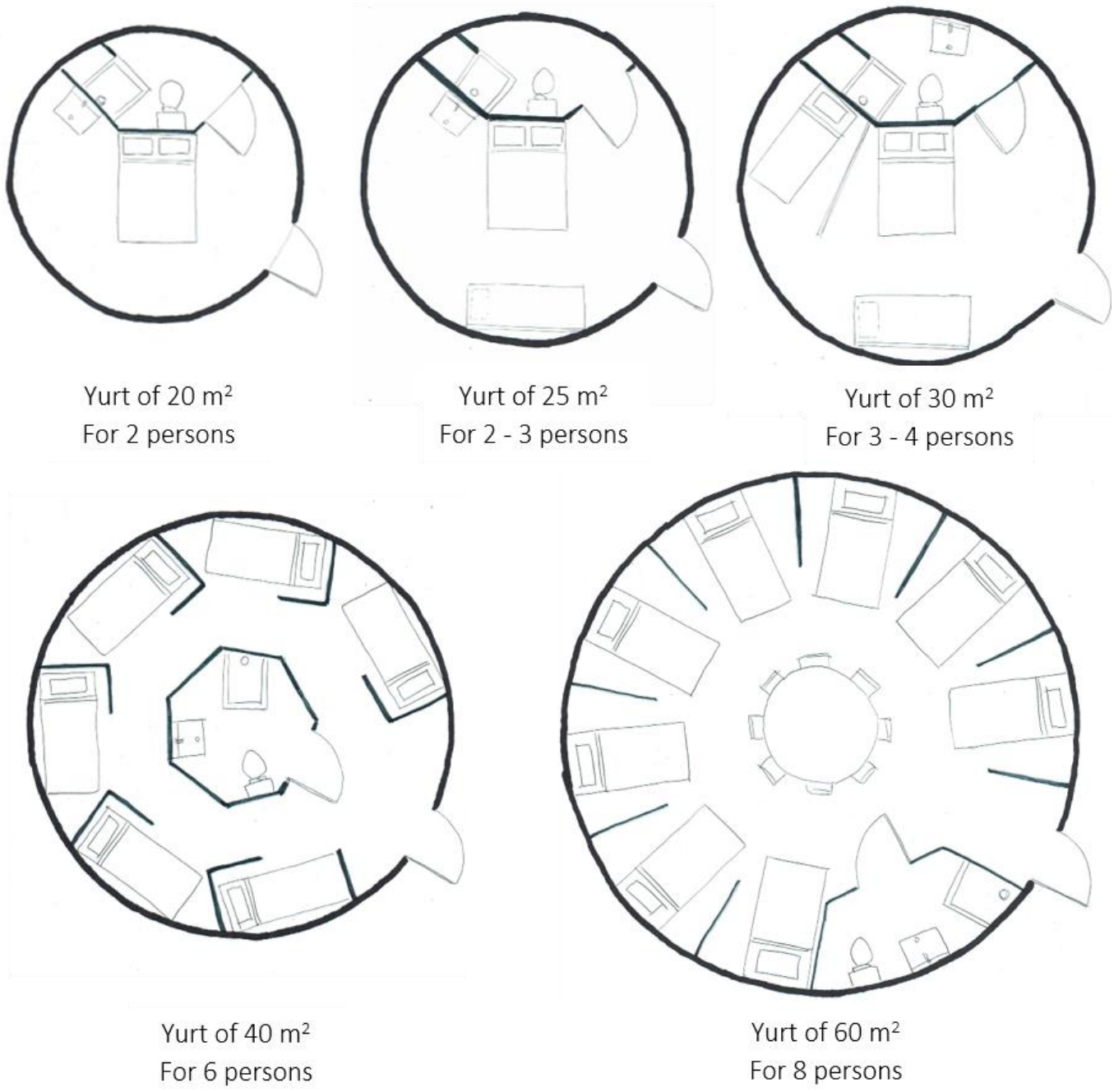


Figure 6: Floorplan of the yurt
Source: Author

3. Climate Iran

Iran is a multi-climate country. This means that in the country there are multiple different climate zones.

- Mild and wet on the coast of the Caspian Sea
- Continental and arid in the plateau
- Cold in high mountains
- Desert and hot on the southern coast and in the southeast

Iran is overall an arid country. However, in the west and the north the rains are a bit more abundant than in the east and the south. The only rainy area is the Caspian Sea coast.

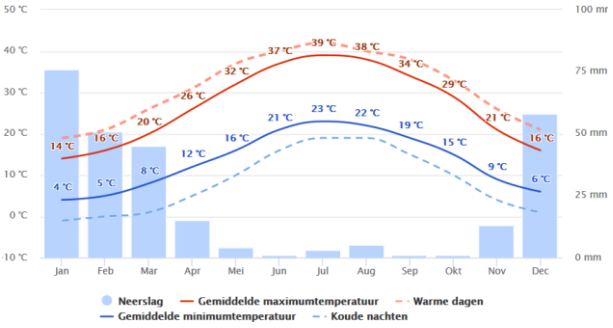


Figure 7: Temperature and rain Fīrūzābād
Source: https://www.meteoblue.com, 2018

The Safari park will be built in Fars, Iran. The location is close to Fīrūzābād. For the climate data Fīrūzābād is used. In Fīrūzābād, the summers are long, sweltering, arid, and clear and the winters are cold and mostly clear. Over the course of the year, the temperature typically varies from 1°C to 38°C and is rarely below -3°C or above 41°C.

In figure 7 the monthly amount of rain is shown. The rainy period of the year lasts for 5.1 months. The most rain falls during the 31 days centered around January 18. The rainless period of the year lasts for 6.9 months. The least rain falls around September 19. (Figure 4)

(https://weatherspark.com, 2018)

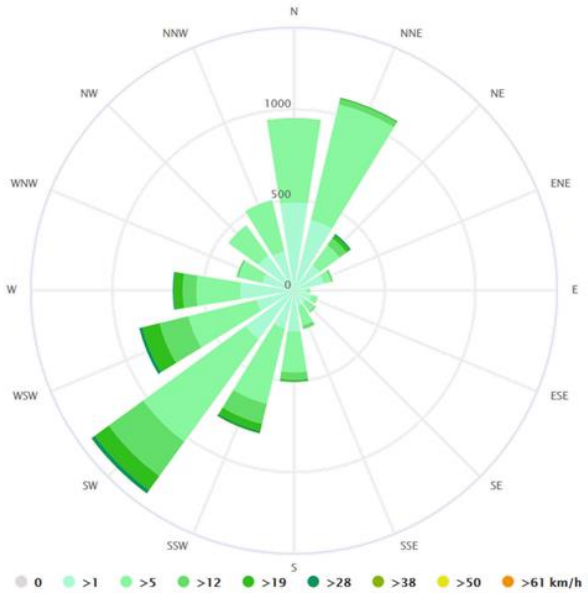


Figure 8: Wind direction Fīrūzābād
Source: https://www.meteoblue.com, 2018

A building built in this climate should be able to stand the high temperatures which can be up to 40 °C. This means that a lot of cooling is needed in the summer. However, in the winter it can be freezing which means that a heating system will also be needed in this building.

The wind speed in Iran varies from 5 km/h to 28 km/h. (Figure 8) The predominant wind direction comes from the southwest. However the wind direction from the north northeast is also very common.

The wind direction can be used in a building for passive cooling.

For more information about the climate in Fīrūzābād see appendix 1.

4. Research existing safari parks

To get a better idea of what the safari park should look like 6 different parks from all over the world are examined. The parks are examined on some different aspects, like size, facilities, tourist housing and how the animals live in the parks.

4.1. Governors' Camp (Kenya)

Governors' Camp is located nearby the Mara River in Kenya. The camp is the first permanent tented camp in Masai Mara National Reserve. Animals roam around freely troughs the Masai Mara National Reserve. The camp consist of 37 tents lined along the riverbank. Some tents have a few over the river while others have a few across the sweeping plains. The tents are luxurious. They are big, bright and allow lots of natural light. All tents have an en-suite bathroom, a private veranda and electricity for charging camera's and phones. The camp has a mess tent with bar and deck overlooking the Mara River, dining tent, souvenir shop, reception and spa tent. (https://www.governorscamp.com/stay/governors-camp/, 2018)

Figure 9: Tents Governors' Camp
Source: https://www.governorscamp.com, 2018

4.2. Safari Yurt Camp (Uzbekistan)

The safari yurt camp is located 60 kilometres from Nurata, Uzbekistan. The camp is close by the sandy Kyzyl Kum Desert and Lake Aydarkul. The camp has 20 yurt tents in a quiet area. The direct surrounding of the camp has not more to offer than some small bushes. The camp is used as a base to explore the surroundings by a camel ride or by car. The tents are equipped with good mattresses and clean sheets with blankets. There are tents for two people and bigger tents for up to 5 people. There is a separate building with toilets, sinks and showers. A nicely decorated brick building is used as a restaurant where the breakfast and dinner is served. (http://uzbek-travel.com/hotels/safari_yurt_camp/#information, 2018)

Figure 10: Yurt tent camp
Source: http://uzbek-travel.com/hotels/safari_yurt_camp

4.3. Beekse Bergen (Netherlands)

Safari park Beekse Bergen is the largest wildlife zoo of the Benelux region and provides a home to approximately 1,250 animals from over 150 species, varying from small mammals to large birds. In the Beekse Bergen there are some different ways to stay overnight. You can choose to stay in the safari resort, the holiday resort or to go camping. These different accommodations offer different luxuriousness. In the safari resort you can sleep nearby the animals. You can choose between a safari tent, a lodge or a treehouse. In the holiday resort you stay in a bungalow in a more bushy environment. Safari park the Beekse Bergen offers more than 400 accommodations different in size and type. From regular cabins to treehouses. From 15 - 150 m2. The small houses do not have a bathroom. Larger houses have a bathroom and a kitchen. The safari park is very big and offers a lot off facilities. The park has multiple restaurants and places to eat. There is a swimming pool, a bowling place and multiple playground equipment for the kids. There is also an animation team and a small market. (https://www.beeksebergen.nl/overnachten, 2018)

Figure 11: Lodges with view on the animals
Source: https://www.beeksebergen.nl, 2018

4.4. San Diego Zoo Safari Park (California)

The San Diego Zoo Safari Park is an 730 ha zoo located in the San Pasqual Valley. The park houses over 2600 animals from 300 species. The park is in a semi-arid environment. You can spend your night in the park when you book a roar and snore safari. When you book this overnight safari you will get camp activities, an after-hours look at the wild life of the animals, guided walks, a campfire program, dinner, an evening snack, and breakfast the following morning. You can choose between three different types of tents, namely the classic tent which is 3 x 4 meters and for up to 5 persons. The tent has a traditional vinyl-covered tent floor and sleeping bag pads. The vista tent, which is 3 x 4 meters and for up to 6 persons. The tent has a traditional vinyl-covered tent

floor, two chairs and to sets of bunk beds and two single beds. These tents have a view looking out over the animals. Or the premium tent which is 3,5 x 5 meters. This is the most luxurious tent and has electrical outlets, nightstand/storage, queen bed, plus two cots, bed linens and pillows and a wooden floors with area rug. The safari park has different facilities, like restaurants, toilets, an amphitheatre and play grounds for the kids. (https://www.sdzsafaripark.org/safari/roar-snore-safari, 2018)

Figure 12: Safari Park
Source: https://hope-amundson.com/projects/san-diego-zoo-safari-park-lion-camp/

4.5. Taronga Western Plains Zoo Dubbo (Australia)

Taronga Western Plains Zoo is a large zoo near Dubbo. When you want to sleep in this zoo you can choose between different accommodations. The Zoofari Lodge is a luxurious lodge with a view overlooking the animals. The lodge has a private en-suite, a mini-bar, a fridge and a shaded veranda. The Billabong Camp offers 3x3 meter tents where two people can sleep. The Savannah cabins are self-contained and offer a place for up to six people. The cabin has two bedrooms and two bathrooms, a kitchen and an outdoor area. The Safari park has some facilities like a restaurant, swimming pool, library and they offer car and bike rental. (https://taronga.org.au/dubbo-zoo/accommodation, 2018)

Figure 13: Zoofari Lodge
Source: https://taronga.org.au/dubbo-zoo

4.6. Giraffe Lodge (United Kingdom)

The Giraffe lodge is located in a wildlife park in Port Lympne, Kent. Port Lympne is home to over 700 animals and 88 species, including tigers, lions, leopards, gorillas, bears, giraffes and the UK's biggest herd of black rhinos. The focus of Port Lympne is on conservation and breeding animals to release into the wild. It's run as a charity and most animals are in open enclosures rather than cages so it doesn't feel too zoo-like. You can stay overnight in this wildlife park nearby the animals. There is a luxurious hotel and wooden camping pods. The tents are in two rows and built of canvas

with a wooden base and a balcony. You can watch the animals right from your room. Some of the tents have an en-suite bathroom while others have a shared bathroom block. The tents have their own boiler. Next to the row of tents there is the Laapa. This is the camp's communal lounge and dining room. When the place is fully booked 18 people can stay in the tents. (https://www.ontheluce.com/uk-safari-port-lympne-giraffe-lodge/, 2018)

Figure 14: Giraffe Lodge
Source: https://www.ontheluce.com/uk-safari-port-lympne-giraffe-lodge/

4.7. Overview facilities safari parks

Down below is an overview of the different facilities that the examined safari parks have.

	Governors' Camp	Safari Yurt camp	Safari park Beekse Bergen	San Diego Zoo Safari Park	Taronga Western Plains Zoo Dubbo	Giraffe Lodge
Accommodations < 25		20				9
Accommodations 25 - 50	37			46	?	
Accommodations > 50			425			
Caged animals						
Different type accommodations						
Restaurant						
Souvenir Shop						
Spa / swimming pool						
Play ground						
View on animals from bedroom						
Private bathroom						

Available	
Might be available depended in type of accommodation	

From the overview it becomes clear what facilities most safari parks offer. Most of the examined parks have between 25 - 50 accommodations which differ in type. This difference in type of accommodation can also be used in the safari park in Iran. It can be attractive for some people to have a luxurious room with a private bathroom, while others want a cheap option and do not mind a shared bathroom. This difference can also be in the experience of the Qashqai life. Yurt tents can be used to give the tourist a back to basic feeling. However small houses can also be used to create a more luxurious feeling.

All parks offer a restaurant. The bigger safari parks do offer more than one restaurant. This can also be a small kiosk besides one bigger restaurant. Most of the park have a first aid spot and a souvenir shop or a small store for daily necessaries.

Some of the parks offer a spa or a swimming pool. The safari park in Iran will be off-grid which makes a swimming pool difficult because it needs a lot of water. Also the safari park will not be that big so a swimming pool is not desirable in Iran.

A view on the animals from the bedroom is offered in some parks only in some accommodations. This can also be done in Iran. By offering a view on the animals the accommodation will be more attractive.

From the research to the different safari parks a lot is learned on how the safari park in Iran can be. Different types of accommodations can be used and a restaurant, a shop and playground for the children should be a part of the safari park.

4.8. Requirements of Simba NGO

In the table down below an overview is given for the facilities needed in the safari park. This is a list of all the requirements from the Simba NGO combined with information learned from the other safari parks that are examined. This list will be used for the first design of the safari park.

Parking area	600 m^2
Safari tents for tourist	15 tents: 5 tents for 2 persons = 20 m^2 4 tents for 3 persons = 25 m^2 2 tents for 4 persons = 30 m^2 2 tents for 6 persons = 40 m^2 2 tents for 8 persons = 60 m^2 When fully booked 58 people will stay in the safari park *Different types of accommodations can be used when examined*
Housing for staff	3 persons which will stay in the safari centre all the time Small house of around 50 m^2
Housing for students	Can stay in the same accommodations as the tourist
Restaurant + Kitchen	Should be available for 60 people. 100 m^2
Playing area older kids	Ping Pong table = 2,74 x 1,52 m Small field for playing sports = 18 x 9 m
Playing area for young kids	150 m^2
Meeting place making campfire	20 m^2
Temporary take in for wounded animals	150 m^2
Dog training	10 - 20 dogs = 100 m^2
Animals in fences	*Some of the animals that live in Iran and can be caged in the safari park are: leopards, bears, hyenas, wild boars, ibex, gazelles, Eurasian lynx, mouflons, jackals, wild asses, wolves, panthers, falcons, eagles, storks, pheasants, partridges* Cages in Beekse Bergen are around 25000 – 30000 m^2 Cages in Artis are < 10000 m^2 The cage size depends on the amount of animals in the cage but to create the feeling of a safari park and the animals roaming around the cages should be big enough.
Artificial lake	3000 m^2
Workshop space Area for weaving	10 m^2 per workstation
Souvenir and handicraft Shops	35 m^2
Back of house	14% of overall lodge area

5. First design safari park

In the first design for the safari park (Figure 16) the requirement from the Simba NGO are combined with the results of the examined safari parks. The design is made with some big cages for the animals. These cages must be big enough for the animals to roam around. The entrance of the park is nearby the parking lot and has the reception and shop and restaurant all combined in one building. There are play area's both for the younger and the older kids. The safari tents have a few on the animals. There also is an artificial lake which will attract wild animals. The lake has some distance from the park because the animals should feel save when coming to this lake. With this first design in mind further research will b

Figure 15: View from the yurt to the animal cage
Source: Author

Figure 16: First design safari park
Source: Author

6. Passive design techniques from vernacular architecture

The vernacular architecture can be used to get more insight in the techniques used for decades. Before the fridge was invented an ice-house or yack-chal was used to keep ice cool from winter to summer. Other solutions like the windcatcher or a courtyard are still used in Iran to cool the houses.

6.1. Yakh-chal (Ice house)

Ice houses were used to store ice throughout the year, it is an earlier version of the refrigerator. The designs involve underground chambers and the buildings are close by winter ice sources like freshwater lakes. During the winter ice and snow is taken into the ice house and packed with insulation like straw or sawdust. The ice remains frozen for several months.

However this will not work in Iran because there are not so much freshwater lakes and snow is only available in the mountains. Also the sun during the day in winter can still be very hot. Therefore a channel is made alongside the ice-house with a high wall alongside in which water is collected during the day in winter which will freeze during the night. (Kazemi & Shirvani, 2011) The tall wall shadow on the ground and creates freezing conditions. During night with a clear sky the ground temperature drops quickly. When the earth was already cooler due to shadow the temperature drops more quickly and reaches freezing points. (Figure 17) (Zandieh, Khaleghi, & Rahgoshay, 2012)

This is done for a few days and the ice that is collected will be insulated in the ice-house. In this way the snow does not have to come from the mountains. (Kazemi & Shirvani, 2011)

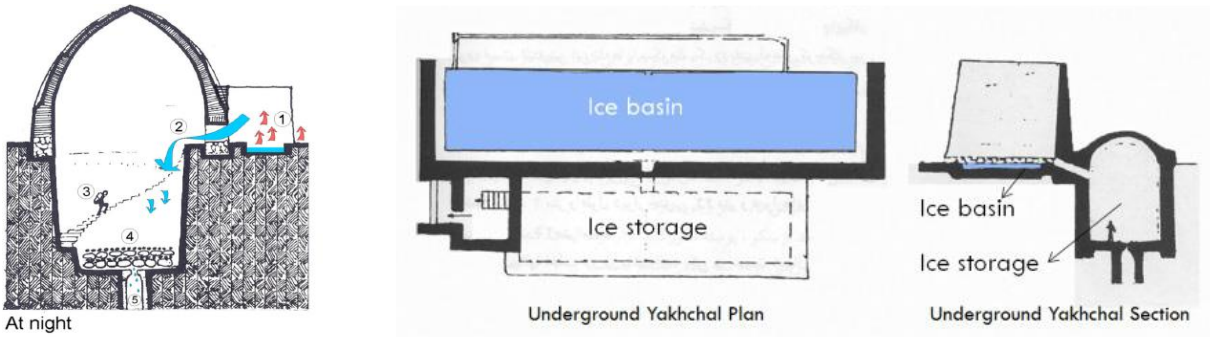


Figure 17: Yakh-chal system
Source: Kazemi & Shirvani, 2011

To prevent the solar heat from entering the ice-house, a substantial dome is required. On top of the dome, a large hole let out the warm air while allowing the cool air to penetrate the storage area from the bottom. Such a shape is the ideal form for an ice-house. The building material of the ice-house is Sarooj (traditional water-resistant mortar). The walls are 2 meters thick at the base. (Zandieh, Khaleghi, & Rahgoshay, 2012)

The structure of the ice-house can be used as a base point for the buildings in the safari park. The domed roof will keep the building cooler and the thick walls will keep the heat during the day and give it back into the building during the night.

6.2. Windcatcher

One of the signature elements in the traditional courtyard houses in Iran is the badgir, or windcatcher. The function of the windcatcher is to cool the house and create natural ventilation.

At the top of the structure from the open side of the windcatcher, blowing air is captured and funnelled to the bottom of the shaft where a small pool filled with water in the basement maintains the airflow. (Mollayousef, 2018) Through the wind tower, the air current first passes over a stone pond and fountain after entering a building, thereby bringing humidity to the other spaces in the building. (Ahmadkhani Maleki, 2011b) During the summer time, the basement was used as a place to escape from the hot summer days. (Figure 18)

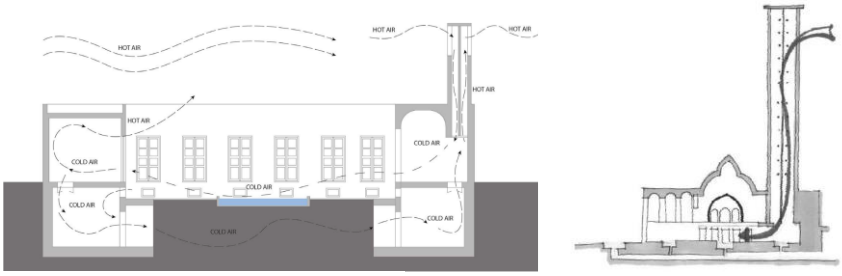


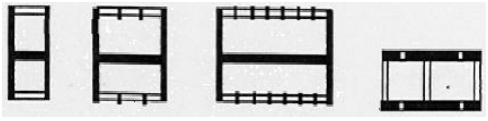
Figure 19: Windcatcher schematic
Source: Mollayousef, 2018

Three types of wind catchers are found in traditional houses: one sided, four sided, or eight sided. (Figure 19) The type of wind catcher used in a specific area is dependent on airflow and air direction. The combination of wind catchers with courtyards and domes produces far more effective ventilation. Used in unison, these elements create better airflow and heat management. (Mollayousef, 2018) The long sides of wind towers are oriented towards the desired wind direction. When the wind comes from more directions a four directional orientation is used in order to use all of the desirable winds. (Ahmadkhani Maleki, 2011b)

Wind towers in hot dry climates are built either of mud brick or more commonly of baked brick covered with mud plaster. Mud brick (adobe) passes heat at long time, because soil has got uncompressed volume and mud makes from water and soil. Wind towers in hot humid climates are covered with (gach) plaster and (sarooj) this type of covering resists moisture. (Ahmadkhani Maleki, 2011b)

One direction wind tower

Two direction wind tower



Four direction wind tower

Eight direction wind tower

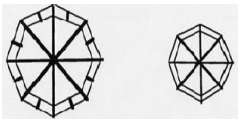


Figure 19: Windcatcher types
Source: Ahmadkhani Maleki, 2011b

The construction materials used for wind towers depend on climate. The choice of materials is made to ensure that the wind tower operates effectively as a passive cooling system.
A wind-catcher in order from down to upward is formed of following parts: chimney, stalk, catgut and chain, shelf. (Ahmadkhani Maleki, 2011b)

- Chimney
  The chimney part of the wind-catcher is usually an incomplete pyramid form. The different proportions of upper part of the wind-catcher are arranged with this part.
- Stalk
  That part of the wind-catcher which is located between shelf and the room is called the "stalk"; the higher is the wind-catcher the higher is its stalk too. The height of the wind-catcher is for taking suitable wind which blows in heights
- Catgut and Chain
  The catgut and chain is located between the stalk and the shelf. This element would be made and the shelf, this element would be made in different shapes.
- Shelf
  The head of the wind-catcher is the shelf which includes the blades, the channel of air passing. Shelves are usually front open or front closed. And this feature would be changed according to the wind blast, on the other hand two shelves would be usually considered for each ways of air channel towards the room

Even though wind catchers were a very important element in the Persian house only a small percentage of houses used wind catchers. The more restricted use of wind catchers is due in large part to cost and difficulty of construction. (Mollayousef, 2018)

6.3. Courtyard

Figure 20: Courtyard with trees and pond
Source: Ahmadkhani Maleki, 2011b

The courtyard is one of the most important elements in Persian architecture. In the courtyard there is fresh air mixed with the scent of flowers that adorn the space. The courtyard has a small pool and trees which create shade and help keep the place cool. (Mollayousef, 2018) The different kinds of flowers and trees and the pond increase the relative humidity of the air in the courtyard. (Ahmadkhani Maleki, 2011b) The courtyard is a smart mechanism for maintaining privacy in an outdoor setting that household members and guests can enjoy. The garden in the courtyard located around the pool was a symbol of paradise in the Persian architecture. (Mollayousef, 2018)

The courtyard can be used on ground level but it can also be placed below the ground. The courtyard is than called a Godal Baghcheh. When a building is constructed without any excavation, the contact surface of it with earth would be equal to its area but once the excavation is done the contact size would be increased. In hot and dry regions to decrease the heat exchange of the building with outside air and to provide low-expense and natural cooling and heating, the buildings are constructed in a pile of soil as much as possible. (Ahmadkhani Maleki, 2011b)

6.4. Material

Figure 17: Mud buildings Iran
Source: Ahmadkhani Maleki, 2011

The materials used in hot and dry regions are: mud, mudbrick, stone, brick, mortar, lime and wood. For the choice of the material the thermo-physical specifications are most important. These materials have thermal resistance, high heat capacity and they absorb the sun radiation. The many pores which are in these materials are filled with air which make them work similar to thermal insulator. (Ahmadkhani Maleki, 2011a)

Adobe is another commonly used material. Adobe is a natural building material typically made from sand, clay, water, and a fibrous or organic material and is shaped using molding techniques and dried in the sun. (Mollayousef, 2018)

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