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STAND-ALONE EDUCATIONAL CENTER

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The world is suffering from the worse refugee crises since World War II as Syria alone has 7.6 million. Out of which 85,000 people (December 2015) are living at Al Zaatari camp located in Jordan near to Jerusalem. A need to design and build a sustainable self-sufficient educational center for the school children was felt. A district wise study and site analysis was performed using geographical information and climate analysis computer tool, Climate Consultant 6.0 to figure out important factors like quantity of ground water, rainfall intensity, solar radiation and sun path at the site. Integrating different sustainable active and passive strategies for energy generation developed building plan. The model was simulated using annual whole building energy modeling software (Safeira â„¢), Photovoltaics can produce 50% of the required energy, natural ventilation and geothermal heat pump can reduce the annual energy consumption by 9.28% and 2% respectively, if used in months in which they are more useful whereas the remaining energy can be covered by wind turbines. With skylights, enough daylight was provided (unlit areas were reduced to 10%) and providing natural ventilation as well. It was concluded that a Stand-Alone refugee center for Syrian refugees at Al Zatari camp is possible and could well be constructed if proper support from international community is provided.

Keywords: Energy efficient building, Sustainable, Refugee, Resilient, Simulation.

1 INTRODUCTION

According to the UNHCR refugee agency report of June 2015 the world is suffering from the worst refugee crises since World War II, as Syria alone has 7.6 million, of which 85,000 refugees, as of December 2015, are living at the Al Zaatari camp located in Jordan near to Jerusalem (UNHCR, 2015). Education is one of the many problems the refugees are facing. The aim of this paper is to solve the main problems of the student community in the camp, which are preventing them from attending schools, by designing a stand-alone sustainable education building. The background, current situation and site analysis are the major steps to be done in order to satisfy the refugee's needs.

2 OVERVIEW OF THE CAMP AND SITE CONDITIONS

2.1 Background

Zaatari camp was opened in 2012 to host Syrian refugees escaping from the war in Syria, Lived Projects (2015). Alongside many other problems, getting education is as an important issue to consider for children at the camp, as there are many students who stopped going to schools from last three to five years.

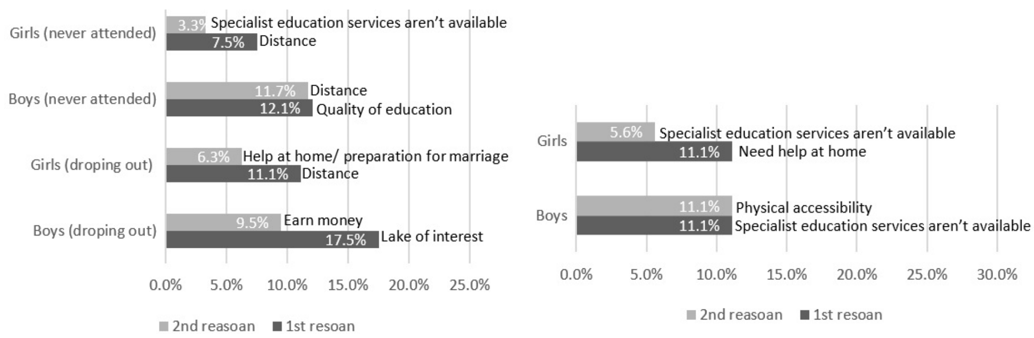

Figure 1. Reasons for dropping out from school or not continuing education at Zataari camp.

2.2 Site Analysis

The project location is in Al Zaatari camp which is 10 km far from Al-Mafraq city in Northern West Jordan with an area of 33 km^2. The camp is near King Hussein and Zarka airports which will allow building material exporting to the camp easily. Also, the camp is near to Al-Albayt and the Hashemite Universities (Ledwith and Smith 2014). The camp area has three main entrances and is divided into twelve districts shown in Figure 2. Paved roads in addition to some internal paved roads to ease the accessibility in the camp separate districts.

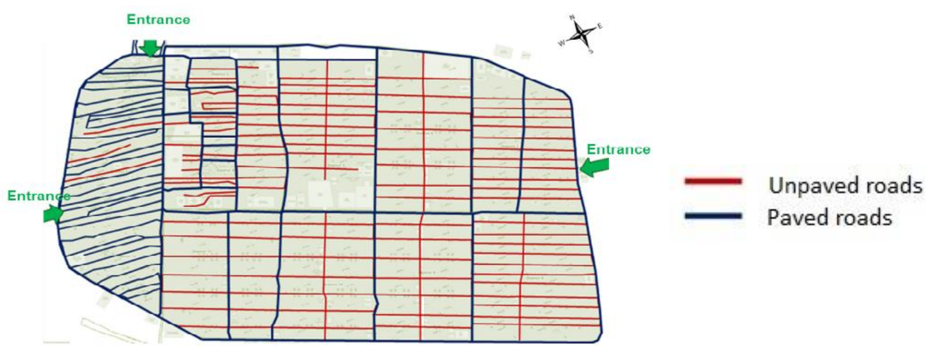

Figure 2. Map of Zatari camp showing division of districts, main entrances, paved and unpaved roads (Ledwith and Smith 2014).

2.2.1 Services

There are three operating schools in the camp, three distribution centers. In addition, there are two field hospitals and nine primary health care centers. There are twenty community based centers provide psychosocial support services and seven playgrounds and sports courts for children activities (UNHCR 2015).

2.2.2 Demography

The camp population was around two hundred thousand in July 2012, but since July 2014, it has been ninety thousand and is steady (Ledwith and Smith 2014).

2.2.3 Climate

Jordan has two different climates cold and moderate. The cold period has temperature below 20C it's from January to March and from November to December. Moderate months are between April to October with temperatures above 21^{0}C (ARFFI 2015).

Table 1. Temperature chart of Jordan weather (ARFFI 2015).

Month	Sun hours/Day	Humidity (%)	Max. Temp (C)	Min.Temp (C)
January	5	74	10	2
February	6	72	12	4
March	7	63	16	6
Arpil	9	52	22	10
May	10	43	26	12
June	12	46	28	17
July	13	44	31	18
August	13	55	31	19
September	10	59	10	18
October	8	59	26	14
November	7	61	18	10
December	5	73	14	6

2.2.4 Energy and water

The Camp has three boreholes and the water is distributed in the camp via a network of 65 trucks. For the wastewater in the camp it is treated by a wastewater treatment plant and transported via sewage trucks. Daily 750 m^3 of solid waste is collected and transferred to external garbage facilities. Energy system is provided to operate the services and caravans. All districts have electricity but there is a time limit daily service provision from 7 PM to 5 AM to manage operational costs. Storm water runoff and reported flooding in November 2015 (UNHCR 2014).

2.2.5 Soil and vegetation

According to Jordan climate, it's possible to grow citrus, apple, grape, olive and almonds. Rain-fed wheat is grown in limited areas near the borders (of Syria). Barley is grown in a few depressions and in valleys. This is one of the first regions in Jordan to develop borehole irrigation (Lucke *et al.* 2013).

3 LOCATION OF PROJECT SITE

A District-wise student population study was done to analyze the percentage of students attending schools with respect to the distance they walk. It was found that that the education center needs to be accessible for the upper right corner students, therefore three different locations were suggested for the education center in District 6, 7, and 8 as shown in Figure 3.

Alternative 1 Alternative 2 Alternative 3

Figure 3. Location of different site alternatives.

The Alternatives were compared with respect to the services in the specific district and it was found that Alternative 3 is the best option for locating the education center.

4 DESIGN DEVELOPMENT

Jordanian ministry restrictions were considered during design development. The standards were followed according to Neufert *et al.* (2000). The zoning of the plan Design is shown in Figure 4. According to the needs of an education center, architectural program was set to have ten classes (70 m^2 each), a computer lab (60 m^2), library (60 m^2), multi-purpose hall (100 m^2), two workshops (30 –35 m^2 each), administration office (20 –25 m^2), clinic (20 m^2), psychologist (m^2), food services (20 m^2) and outdoor area (500 m^2).

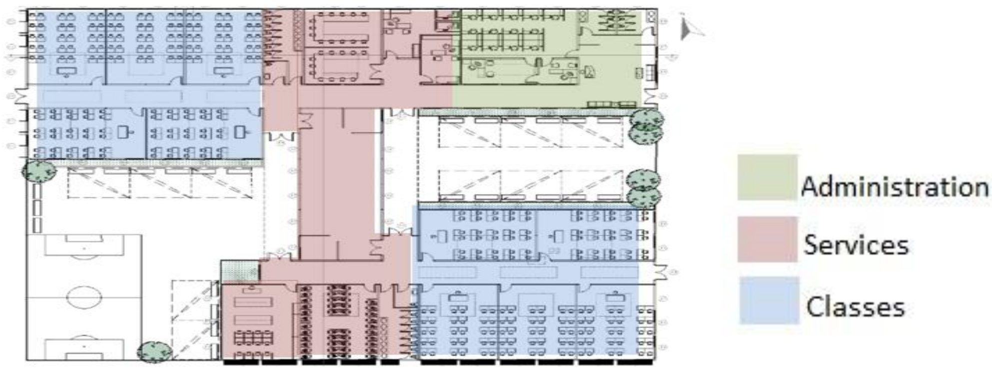

Figure 4. Zoning of the Education center.

The education center was oriented to north since it gave the least energy consumption, but according to the site study it had to be oriented 18^o to the west. Roof monitors were added to get enough natural lighting which will leave only 10% of the building underlit and to catch wind for cross ventilation which will be shown in the integrated systems part. The natural lighting analysis, is shown in Figure 5, was done by Sefaira software.

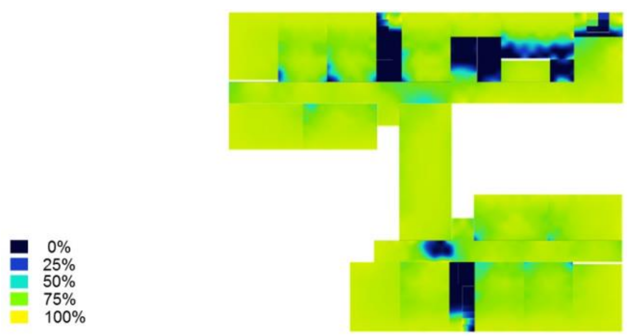

Figure 5. Natural lighting analysis of the Education center (Sefaira 2016).

5 SYSTEMS

5.1 Structure and Construction Systems

Steel Structure, with beams depth calculated as 65cm using the Span Range graph for Structure elements. The column size was estimated to be 6"x6" square steel section using the Steel

Column. Prefab system was found to be the most suitable option out of the three. The roof panels selected to be OPTIM-R from Kingspans Company with 21 cm insulation and the glass panels were selected to be EMIR-GL-020 from Emirates glass company with 1.3 U-value and 0.27 Solar Heat Gain Coefficient. The building dimensions were fixed to suit the prefabricated system external and internal panels.

5.2 Integrated Systems

Wind scoop was integrated in building design at it is an architectural device used for many centuries to create natural ventilation in buildings. Using Climate Consultant, it was found that the natural ventilation strategy is suitable between May to October with temperature (21-27^{0}C). The need to increase the area of opening and directing it to the Northwest is recommended, so that the opening will have positive pressure and it will start to collect the cold air (wind scoop) (Alshaali 2013). For heating, a geothermal heat pump was the suitable option available option according to the camp conditions. From sun shading, through Climate Consultant, it was found that altitude angle should be 68° and horizontal shading depth as 0.6m for the window overhang devices, which will help in reducing heat gains. The total photovoltaics energy production was found to be 65,036 kwh/year which makes 15.17% of the total energy of the building. The basic water needs of the building in refugee camps were studied (UNHCR 2014): the building requires about 29,760 L per month. In the first three months of a year, enough water could be collected for the entire year. One drawback is that the cistern size would be about 280 m^3. Total number of tanks requirement is eight, with four tanks required per washroom. Composting toilets are going to be installed as it reduces the water usage and energy that is usually required in pumping water.

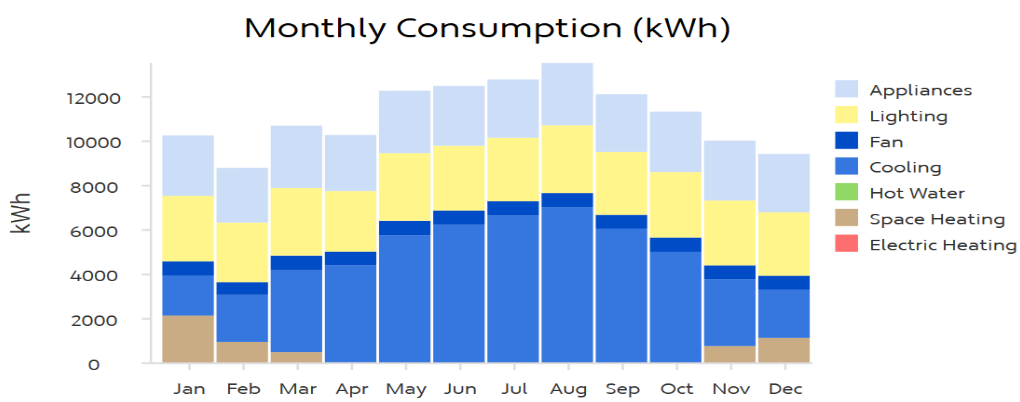

Figure 6. Monthly energy consumption in kWh of the Education center (Sefaira 2016).

5 RESULTS AND ANALYSIS

The integrated systems met its expectation as initially, the building consumption energy was 387,153 kWh/year (Figure 6). After editing the building dimensions and window to wall ratio (WWR) according to prefab system the energy consumption was reduced to 153,089 kWh/year. Applying U-value for walls panels and glazing the number decreased to 134,074 kWh/year. The final stage of the design has an energy consumption of 10,725 kWh/year because of applying passive systems to the building. The PV panel system generates 65,036 kWh/year, which covers 50% of the energy needed for the building. The rest of the energy is covered nearly by wind turbines that generate 42%, which is 56,400 kWh/year. The passive systems used in the educational center helped in reducing the building energy consumption. The natural ventilation reduced the energy by 36,000 kWh/year and the geothermal system reduced it by 5.900 kWh/year.

6 CONCLUSION

The initial goals of a stand-alone educational center in refugee camp, which can generate energy and harvest water, were met. Renewable energy generation sources were found to be possible. From studying the rainfall levels, it was found that calculation of water collection, consumption and saving is possible, which can lead to using harvested water in low rainfall intensity months. With a geothermal system, the education center could be cooled during the summer or heated during the winter to reduce the building's energy consumption. The best orientation and window to wall ratio was selected in terms of energy consumption and ventilation. A multifunctional skylight enabled several functions, such as mounting to provide enough daylight (unlit areas were reduced to 10%) and natural ventilation. As a result, the optimal refugee educational center was achieved. The next step will be to perform optimum cost analysis for the education center and to come up with the most economical model.

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