

Sustainable Minarets: Towards Multifunctional Applications as a New Conceptual Design Model

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Abstract—

This paper presents a conceptual model for multifunctional application of sustainable minarets. Minaret has been built for calling people to pray and this is its main function for centuries. However, we propose a new design model for minarets. The proposed design strategies will include solar passive and mechanical usage, cooling, lighting, electronic and smart communication and usage of recycling material. The proposed design strategies would allow energy, and cost savings as well as, also improve the performance of the mosques. The main contribution of this work is the advancement of new design paradigm for minarets based on multi-functionality design strategies with the aim to improve the comfort of the prayers of the mosques. This will change the concept of the minaret through the ages.

Keywords— Minaret, multifunctional Applications, sustainable minarets, conceptual model, SASMM

I. INTRODUCTION

The mosque is one of the most important buildings for Muslims. The programme of building mosques in the kingdom of Saudi Arabia is more intense than other countries. The number of mosques that have been building yearly all over the country is rapidly increasing. In addition to that, each city council does not issue district permission certificate until planning application fulfils the several requirements. Among these percentage of areas that must be reserved for green, schools and mosque spaces. In most countries worshiping spaces are not considered part of the urban planning. For this reason, it is noticeable in every district of the cities, towns and villages the mosques and particular minarets dominate the landscape and there are considered s one of the land mark within each district of cities in Saudi Arabia. There is no universal architecture design of the. The form of each mosque is mainly driven by financial considerations. This depends upon the amount allocated by the donors for design and construction. Sometimes the amount is not sufficient enough to complete the mosques with to the standard required. For this reason, the architecture of most of the existing mosques does not blend within the existing landscape and most of the times does complies with the planning rules. Although the form of the mosque can dominate the landscape, but the minaret has more influence on the urban formation because of its height. The Minaret usually is symbol of religion place. The minaret is an integral part of the mosque form and structure. Several researchers defined minaret: "a lofty, often slender tower or turret attached to a mosque, surrounded by or furnished with one or more balconies, from which the muezzin calls people out for prayer." [1]. This definition shows the traditional function for minaret which is to call people to pray. This has remained the case up to now. One needs to question the wisdom of providing such huge structures without harnessing the full benefit from their function. If this situation is going to be altered then designers need to embrace the notion that "you have to think out of the box" [2]. This means any designers have to think in different ways and looks to things from different perspectives. The concept design of mosques has been developed decades ago without any substantial change.. In contrast to this, the design of building has been revolutionized through the use of, several strategies such environmental, economic, technical and so on. These strategies have been used to create buildings which respondent to urban landscaping, user comfort, sustainability and climate change issues. Thus, this work advances the design of mosques by proposing a new paradigm for designing minarets to perform several functions simultaneously. the rest of the paper is organized as follows, the first section the history of minarets, the second section explains the proposed design paradigm, the third section presents the discussion and conclusion from this work.

II. HISTORY OF MINARET

As stated the Adhan (call to prayer) is the main core function associated with minarets design. At the beginning of Islamic era the minaret was not construed. "having heard that the Jews used a horn and the Christians a naqus or clapper, they wanted something equivalent for their own use." [3]. One of the Mohamed Prophet's Companions proposed using the human voice to call Muslim people to pray. The suggestion was accepted. After that, they used roof of mosques or other building or city walls for adhan [4]. Researcher defined minaret as follows: "mere reminder of heaven". To some the minaret is being free with considering the surrounding area as well as formed vertical axis. This shape shows the link between the earth and heaven. In addition to that it is similar to the first Arabic letter which is called Alif and its form also straight and vertical axis [5] and [6]. The minarets have different shapes this based on two factors: The first factor is the period of construction the mosque and the second factor is the location and region for its construction. Several

shapes of the minarets design has evolved during the history. This includes square, conical, polygonal cylindrical or complex shapes. The post Fatimid period is a good example for complex shape because its minarets included three shape types which are square section on the bottom, octagonal in the middle and the dome on the top. The link between each section was through using muqarnas decoration as a band [3]. The minarets have been constructed to be a symbol of power for authority especially during Abbasid period [3]. The minarets of Ottoman mosques are distinguished by using pointy minarets, in addition to that, they are located on the corner of the mosques. Also, the minaret numbers has been increased during that period, especially in the mosques that are built in the major cities [3]. This short review shows that the design of minarets is mainly driven by aesthetic and height (to propagate prayer calls) rather the exploitation of the minarets structure to increase the performance of the mosques. The author presents in the next section a new design paragon that may lead to the landscape change of designing and constructing minarets.

III. MULTIFUNCTIONAL APPLICATIONS OF SUSTAINABLE MINARET MODEL

The proposed multifunctional applications of sustainable minaret model (MASMM) are illustrated in Figure 1. As can be seen the proposed model consists of eight strategies. These strategies can be integrated into design singly or collectively. If these strategies are deployed effectively the author believes strongly they will contribute to economic, environmental and societal aspects of mosques design.

The model is considered as a new design approach that integrated the proposed functions of minarets with the main pillars of sustainability. The model is created based on the knowledge gained from literature review. The model is proposed to identify the possible functions that can be integrated during the early stages of minaret design. It is hoped that this model can change the architect's perspectives from two different point of views. First it can assist them to deploy design strategies to enhance the environmental performance of mosques. Secondly, it will help them to implement sustainability strategies in the design of mosques, which is currently lacking in applications in KSA. The next section of this paper is going to explain the seven design strategies shown in Figure 1.

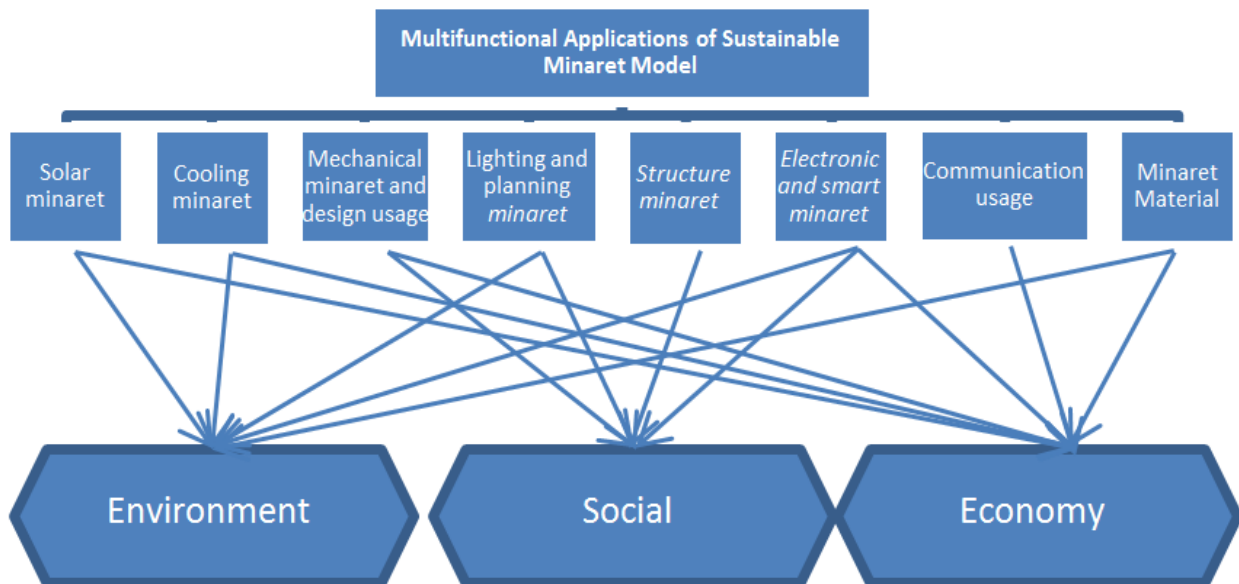


Figure 1: SASMM

IV. MULTIFUNCTIONAL APPLICATIONS

The previous section has been illustrated the proposed model and its several applications which will be explained in the following sections.

A. Solar Minaret

Using passive lighting strategies is one of the most old design strategy phenomena. Day lighting or passive lighting or passive solar has the same meaning. Among the purposes of its use to save energy and to reduce artificial lighting usage. It is defined as "Lighting Energy Savings: the replacement of indoor electric illumination needs by daylight, resulting in reduced annual energy consumption for lighting"[7]. Investing in day lighting through minaret structure can be easily achieved through the integration of solar cells within the fabric of the minarets. Using solar cells within the minaret design has been proposed as a hybrid system ventilation [8]. Integrating strategically solar cells into the minaret can lead to reducing and minimizing the energy consumption. To achieve this purpose the minaret has to be designed in such a way to support solar collection and distribution of light and heat. The solar cells could also be used to light the mosque and minaret during night. This strategy has been tested in a mosque roof in Drigat Village [9]. However, this was integrated into the roof structure. However, the use of solar cells in minaret might improve its esthetic, especially during the night time. By adopting sort of strategy the objectives the environment and economy sustainability will be achieved by natural means leading to operation cost savings.

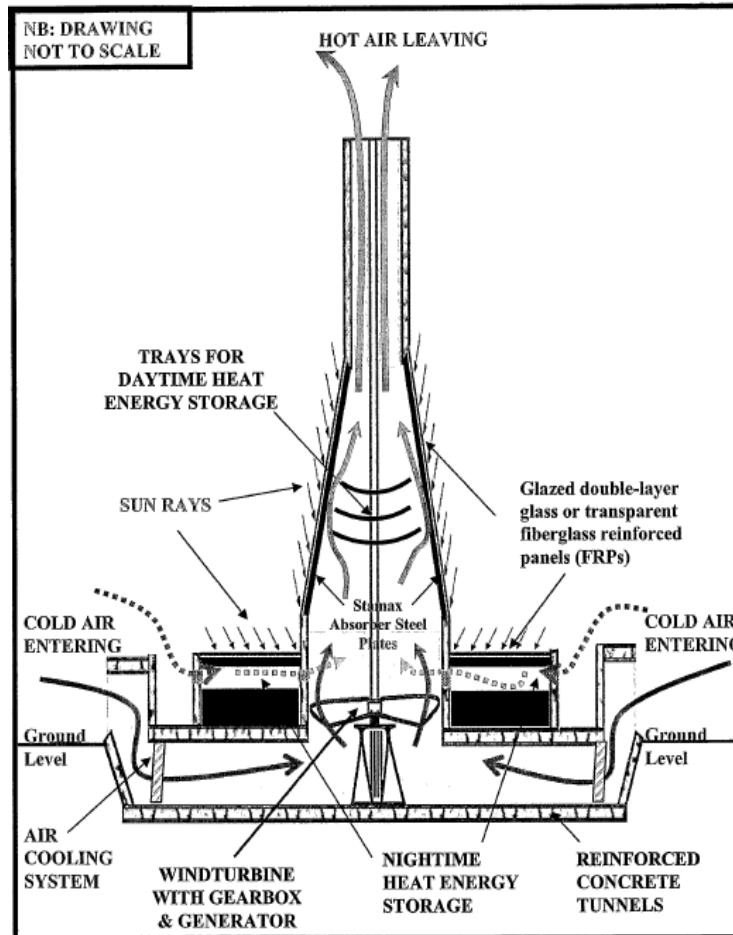


Figure 2: Solar Minaret [8]



Figure 3: Solar Cells on Bousqe Roof [9]

B. Cooling Minaret

Natural ventilation strategies are essential every design. They are also required by regulation to improve interior air quality and comfort of the occupants.. Thus, it is not surprising to see wind catcher has been used for centuries in different cities around the world to moderate high temperatures. For example, the strategy is used in Iraq, Iran, Qatar, Saudi Arabia, United Arab Emirates and Italy as cited on [10]. In Iran it is called badgir. The concept of this badgir is that to be opened from different direction to catch the air and directed it is not the building. In some cases the air collected through wind the catcher is passed over water devices to improve the efficiency of temperature moderation. This concept is illustrated Figure 4. The badgir form is similar to minaret. Hence, there is no reason why such a design strategy, i.e., shape and form of wind catchers, that have been tested for centuries cannot be adopted in minarets design.. In addition to that, it can be used as hybrid system with solar cells as explained in the previous section.. Using natural resources such as passive ventilation can lead to reduce consuming energy as well as eliminate or reducing air condition units. The latter consumes a huge amount of energy in KSA.



Figure 4: Badgir [10]

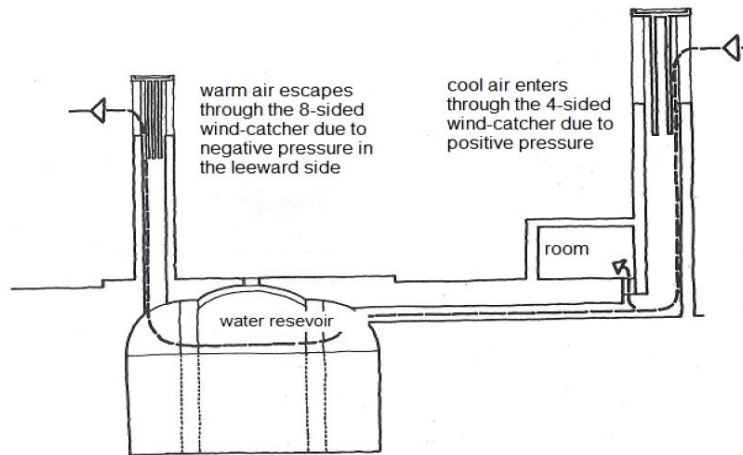


Figure 5: Water Reservoir[11]

C. Mechanical Minaret and design usage

Most of the minarets are designed to have it's a square section. This shape or cylinder shape can be designed to house the mechanical services. This is may include elevators and services ducts as shown in figure (5). Some mosques have more than one minaret which can be used as elevator for both male and female as well as for disable people and elderly people. Minarets are designed in in different styles depend on the region and its built era of their location. The minaret design consist of three sections. These are base, shaft and gallery. Always , part of the shaft design is the inclusion of spiral stairs which supported by structure of the shaft. The gallery usually is covered by an ornate roof or other decorations. The decoration is used as an indicator about its period and time. [13]. The space in the minaret shaft can be used, in addition to ventilation, and circulation, for several usages such as a room or storage. The use of minarets for vertical circulation will solve a huge problem in the inner cities, where land is in premium, and it will solve the problems of disability access.



Figure 6: Elevator [12].

D. Lighting and planning Minaret

Part of minaret functions is to be a landmark for the district or neighborhood. As it has been pointed out a minaret is . " used as a landmark building. It is usually surrounded by densely packed buildings so as the approach through narrow"[14]-[15]. It is wildly common to guide people who stray from the district or road through using the minaret of the mosque as a clear sign that can be find and guild easily. Can be used as way finding to allow people to orient themselves in physical space and navigate from place to place within the city. One way to improve way finding in the city is to use lights in

minarets. Using lighting as part of minaret has been borrowed from the industrial sector. This is clearly shown on the Mohammad Alameen Mosque at Muscat in Oman which is classified as the land mark of Muscat as illustrated on the following photo [16]. Minaret can give the society an identity and can be classified as a symbol for the district or the neighborhood as well as rallying point..



Figure 7: Minaret Lighting [16]

E. Structure Minaret

Columns are part of the mosque components. However, part of the Islam rules is to avoid praying rows to be between the columns. To be the whole row is straight by prayers and connected [17]. Using the minaret as columns that can hold the ceiling throw wires steel. This may lead to the cancellation of columns entirely from inside the mosque and resolve religious problematic for as long as scientists shed. As used on a suspension bridge. Achieving the religious value is part of society dimensions. However, this can be achieved through considering the mosque dimensions, the minaret height and the minarets width and length, as well as the minaret location.

F. Electronic and smart Minaret

Researchers are engaged in investigating smart homes, intelligent building and intelligent transportation. A smart home contains different devices. Personal health, environment sensors, entertainment comforts and displays are good examples in addition to that, security monitoring and remote home energy. These ways can make the user life easier [18]. There is no reason why these technologies cannot be incorporated in the design of minarets. Mosque minarets can be modified through addition electronics and intelligent applications to control aspects of lighting and ventilation by the Imam or the Muaathen. In addition they can be used to provide Wi-Fi for the visitors, passers or prayers. This is part of society benefit that can be achieved through this application.

G. Communications usage

Saudi cities are similar to other cities in the region which are polluted by sporadic communication towers as shown in the figure below. These towers can be replaced by green roof using native plants that are drought resistant. Environmentally friendly telecommunication towers can be designed to blend with the minarets fabric without creating visual intrusion. The rent that may generated from these towers can be used for mosque refurbishment and maintenance. This can be classified as sustainable economy and society.



Figure 8: Communicaion towers

H. Minaret Material

The minaret is built using different materials. The traditional minaret built using stones. An example of this is the traditional minaret in Syrian. The location of minaret tower is normally built opposite the mihrab. An example of this can be found in the Great Mosque of Damascus [3]. Also brick was one of the materials that used to construct the minaret towers. It was used to build in normal way and sometimes blended with ornament artifacts. Some minarets has been used a brick shaft and a stone base [3]. However, to use this material alone its structure stability will not support the idea of integrating other functions as discussed in the early of sections this paper. However, using recycling material such as stone powder or marble powder as a part of concrete can on the one hand lead to achieve the structure goal, and on the other hand, it can also fulfil the two dimensions of sustainability economical and environment.

V. THE CORRELATION BETWEEN MINARET APPLICATIONS AND SUSTAINABILITY PILLARS

The introduction of a new design paradigm that take into consideration the issues highlighted in the table below can be inspire architects to achieve sustainability aspiration in the design of mosques. Table below shows how the proposed design strategies map into the sustainability aspiration.

Table 1: The corolation between the main pillars of sustainability [(1) environment , (2) social (3) economy].

Num ber	The correlation between minaret applications and sustainability pillars			
	Application name	Environme nt	Societ y	Econom y
1	Solar Minaret			
2	Cooling Minaret			
3	Mechanical minaret and desig usage			
4	Lighting and planning minaret			
5	Structure minaret			
6	Electronics and smart minaret			
7	Commnication usage			
8	Local material			

VI. DISCUSSION

This paper proposed a conceptual model for minarets design.. The model was created through proposing several deign strategies which can lead to sustainable minaret design. This paper has explained the seven applications and their functional role within minarets design process. The challenges is not with the applicability of the technology but it is with how to think strategically to create the hybrid minaret harmonize between the different functional aspects of the proposed strategies during design applications. This will require further investigation, construction detailing and simulation of proposed strategies so the optimum solutions can be extracted.. However, as illustrated some success example of applications have been clearly exits . These give us hope and inspiration that with a bit of endeavor the vision presented in his paper can accomplished.

VII. CONCLUSION

The main thesis of this paper is to demonstrate that there is a lack of research in the area of sustainable minaret design. The spectrum of researchers in the built environment working on minaret application is very limited. The paper gives an overview of some applications that have been carried out in relation to sustainable building with an approach that links several applications to buildings or mosques. The approach has been developed through various review process to some extent, the researcher have illustrated that socio-eco-economic drivers ought to be considered during design of minaret in order to meet sustainability requirements and society needs. SASMM is a significant model that is able to help the architect to rethink about minaret design during the design processes by using these applications as a benchmark for design requirements. The seven various applications will lead to improve the design functions and make them more beneficial.. Regarding the future research, this research can be a link or a bridge from the theoretical approach to application approach for each of the proposed design strategies.

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