Recognition of Sustainable Performance In Iranian Traditional Architecture Using Wind Renewable Sources
Maryam Tehranchi and Mahta Boustanchi

ABSTRACT
A Sustainable architecture means eco-architecture and this global action done to better preserve and management of ecosystems. Dimensions which have been defined by sustainable architecture included in three dimensions: environmental, social and economic dimension which emphasis on the support of local culture and identification in environmental management, reduce the degradation and damage to the environment and its costs and in the end, to make an ecological balance between nature and architecture. These concepts have an especial meaning in traditional architecture. Fine issues and elements of past architecture in Iran has been reflected through the study of traditional architecture which by analyzing of it, we found out principles and values that provided the sustainability for this type of architecture. For example, traditional architecture had the optimal use of renewable energy sources in its construction. The capability and skill in proper space alignment in order to have an optimal use of natural light and proper wind entry and prevent unpleasant wind, were of that time architecture's idea. The aim of this research was to recognize the sustainable architecture performance in Iran past time architecture in the use of wind renewable sources and the research method is a descriptive one. The results shows that there were factors in the utilization of renewable energy sources in traditional architecture which are originated from its sustainability which include, making a central courtyard, wind, corridors and intermediate space. Finally, we have made a summary of these techniques and adapted them to the international sustainable architecture's principle.

KEY WORDS: Sustainable architecture, Iran traditional architecture, wind energy.

INTRODUCTION
A new concept, sustainable architecture, has been emerged using the sustainability in architecture which implies eco-compatible architecture (Jianguo Wu, 2013). The main objective of sustainable development is to provide basic necessities, improving living standards, better preservation and management of ecosystems and a safer and happier future. Iran’s traditional architecture, in this global action and movement, is in line to find ways to meet people’s favorite life.

Iran is one of the world's largest consumer of fossil fuels and responsible for the emission of 1% of greenhouse gases annually, since more than 95% of energy in Iran is supplied from fossil fuel. Production of environmental pollutants in Iran is 8.2 times more than the global standard and the amount of carbon dioxide emissions is increasing every day.

This statistics show the adverse and damaging effects and environmental pollution is critical and in a high importance, due to fossil fuel consumption in Iran. While the geographical position of Iran is in such a way that has a high utilization capacity of renewable energy sources such as solar and wind and this crisis is faded and less in traditional architecture. We achieve values and principles by analyzing the traditional architecture, which caused sustainability in these types and kinds of architecture. (Munda, 2006)

2. Methodology and research questions:
The main questions, based on this research, include:
- What has been the wind role in the sustainability of Iran traditional architecture?
- What is a wind using technique which applied by traditional architect to stabilize their structures?
- What are the traditional architect performance and Strengths and weaknesses in the handling and use of renewable energy compared to modern architects?
The analytical method was used to answer these questions, in order to analyze the principles of sustainable architecture and to explain how to exploit these principles in Iran traditional architecture;

3. Research principles:
1.3. Sustainable Architecture:

Sustainable architecture is method in designing which is done to encourage the use of renewable resources and optimization of nonrenewable resources and its basis is what is needed for survival based on the environment. The concepts of sustainable architecture explained to enhance the quality of living standards rather than preserving life. (Ian, 2011) kibert and et al (1994), has defined the sustainable architecture as "to create man-made environment and responsible management based on ecological compatibility and resource’s return principles. These principles are; minimizing renewable resource consumption, promoting and improving natural environment and minimizing the ecological damage on the environment. In this definition, adjusting the relationship between man-made and natural environment is expressed based on human interpretation of stable behavior and is considerable due to the emphasis on "principles of ecological adaptation" architectural design. (Fayaz et al. 2013)

Sustainable development process is done in a more important and satisfying way and continuation and improvement of education, health, social security and removing poverty are essential parameters (Munda, 2006). Sustainable development is concerned about the depletion of land from resources, but the natural resources are not just at risk, but also other qualities, such as landscape, cultural heritage, peace and the ability of urban region for a healthier and safer living is at risk too. Given a target for sustainable development, and strict consideration to social and economic factors are along with natural environment issues, since an unstable social conditions can result in an unstable environment conditions. (Berton et al, 1996)

According to the above definitions, Sustainability is classified into three dimensions: environmental sustainability, economic sustainability and social sustainability, which are described in the following diagrams.

Fig. 1: Sustainability dimensions (Berton et al, 1996)

3-2. Traditional Architecture of Iran:

Art explanation and past and its analyses and artifacts have different dimensions and its results and analysis can be an inspiration to current artists (Jianguo Wu. 2013). Iranian traditional architect, an artist who knew the wisdom of Islamic art and the philosophy of human existence. They knew that human are influences and affected by the environment and the environment had an influence on human. They knew that human are part of nature that if he get away of it, his survival will be in danger and since believe was the base of his work and activity, they created a harmony with the form he made. Then, after creating the harmony, he created beauty. Because of these reason his work has been everlasting and abiding. It is clear that the human are an infinite nature element and in spite of being unique in their world, they are affected by other elements in the environment and their direct and indirect dependence to nature is undeniable. (Naebi, 2002)

When we discuses about traditional architecture, the scene of mixed homes in the traditional context, live and religious design and shape and other natural forces (forces in the environment, such as sun and wind), and its coordinate productivity based on natural cycle, in technical method, such as ducts, lantern, water mill makes a complex discipline and order which originated from the earth. Existence thousands of fields which form ducts canals and vital arteries of the city emphasized the efficiency and compatibility with the natural environment. (Ghezelbash and Abolzya, 1985). Truth and real concept of that period architecture can be found by discovering the effective factors in sustainability of Iran traditional architecture and apply the traditional techniques in contemporary architecture to have an improvement in our today’s architecture.
3-3. Factors affecting the sustainability of traditional Iranian architecture:

In recognition and studying the traditional architecture, we found out that the application and use of natural energy and resources is of construction principles and element and space organization. Climatic factors which affects the construction and building, includes solar radiation, temperature, humidity, wind and rain that recognition and understanding each of these factors and control them is the first step in designing. Traditional architecture has been very successful by offering domestic solutions in every area in building’s stabilization which had the most influence on the orientation of the building. In Table 1, a close analysis of these factors and its role and effect on the stabilization of traditional Iranian architecture is done.

<table>
<thead>
<tr>
<th>Effective factors in sustainability</th>
<th>Sustainable role</th>
</tr>
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<tbody>
<tr>
<td>The sun</td>
<td>Influence the building direction</td>
</tr>
<tr>
<td>wind</td>
<td>Locating closed and semi-open spaces around the open spaces</td>
</tr>
<tr>
<td>landscape</td>
<td>Building protection against sun excess heat building protection against disturbance wind</td>
</tr>
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Table 1: analyze the effective factors to the sustainability of traditional Iranian architecture

In this research, we have analyzed the use of wind energy in the traditional Iranian architecture based on the research subject and the research widespread on the effective factor in sustainability. The factors which are indicators of proper use of wind renewable energy in Iran’s traditional architecture work is to make lantern, central courtyard, the interface between open and closed spaces and internal open space that extends in the height.

4. Analysis the wind utilization in a traditional architecture sample:

Wind energy, is energy of moving air. Wind is produced by the uneven and unequal heat of earth's surface which is as a result of sun’s operation (Bengston et al., 2006). Since the earth’s surface is made up of land and water manufacture, it would absorb the sun’s rays unevenly. When the sun shines during the day, the air in
irrigated lands is heated faster than air in water lands. Hot air is kept on land and goes up and the cooler and heavier air on water would replace it which this process builds local winds (Hamin and Gurran, 2009). When the sun shines the earth unevenly, it would result in temperature and pressure changing, which wind is produced to these changing. Since the wind will be produced continuously, until the sun shines on the earth, it is called renewable energy source. (Mahmoudi, Pourmousa, 2010) As noted in research principles, wind is of natural phenomena which has critical role in the shape and composition of the atmosphere, surface and height layering and ventilation of the internal surface in traditional architecture. Therefore, the utilization of wind energy resource in traditional architecture is described in this study.

4-1. lantern in traditional architecture:
Lantern is common in Iran traditional architecture and other Persian Gulf countries. Lantern is a fixed set that act both in an interlude, as well as output form. Its Vertical ducts are placed at the top in four directions and sometimes on both sides and a pair of isolators partitioning diagonal and crossing form until below the lantern longitude. Lantern has the capability to take the breeze from one way and direction and guides the flow of cool air into the room. It can also act as a chimney. So, the hot air would drown back to the lantern as the result of air pressure difference between the top and bottom of the chimney. When the wind speed is low, so the building ventilation will continue just by chimney effect. (Battle McCarthy Consulting Engineers, 2006)

Fig. 1: layering of traditional home spaces to take advantage of the wind
(Schematics sources; documentation center of cultural heritage 82)
Lantern has been a traditional method in Iran architecture to flow air or to reduce environment temperature. The effectiveness of this procedure has been described in traditional architecture;
A) The evaporative cooling: just the sensible air heat decreases, in direct or indirect contact of water and air, and the water is evaporated through heat absorbing and the humidity of air heat is increased by mixing with air. This feature is belongs to 2-side lanterns.

B) B) reverse-chimney effect; vertical movement of air from top to bottom is by the density difference between outdoor and indoor air. In which, lanterns causes a downward air movement by wind pressure and increasing outside temperature to the inside. This feature is common in Yazd 4-side lanterns.

C) Non-cooling evaporation; a technique in which cooling is done and operated not based on the evaporation but air movement, and in a situation can exit the warm air from the building in reverse form through chimney performance. This capability is seen on the southern coast of Iran and in a one-side lantern.

D) The use of existence chill breeze; the lantern, through proper orientation and placement in the shade, has the capability to cool the inside spaces by the existence cool breeze. There is no any wet surface in this method.

2.4. Internal ventilation with the formation of the intermediate spaces between open and closed spaces:

As seen in Figure 1, closed spaces is attached to the courtyard by semi-open places such as corridors, indoor, terrace, patio… between the courtyard open spaces and the lantern in which air flows. This space layout has caused the inside warm air rising, air flow and internal ventilation, in the absence of wind.
Fig. 2: the internal ventilation by creating intermediate spaces such as corridors and indoor between inside open and closed spaces.

1) Lantern effect. 2) Zoning positive and negative spaces. 3) Intermediate spaces (corridors, indoor). 4) Wind moving perspective by the corridor.

3.4. **Central courtyard and spaces layout in traditional architecture:**

Courtyard in our architecture, depending on the area and the weather, has different Typology. The central courtyard is a key element of space in Iran architecture. This structure is originated from the nature and is consistent with it. Physical structure of introvert houses is formed of closed spaces. These spaces, depending on various factors, are built in four, three or two sides and in a few cases have been built on one side of the yard.
Fig. 3: semi-open and closed spaces layout and its layering (schematic source, documentation of cultural heritage center 82)

Table 2: Evaluation of traditional architecture potentials in sustainable architecture approach

<table>
<thead>
<tr>
<th>Sustainable architecture approaches</th>
<th>Traditional architecture element</th>
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| lantern                             | • reduce sensible air heat by water and air contact  
|                                     | • air displacement  
|                                     | • natural ventilation  
|                                     | • provide shade in the summer to stay |
| Intermediate spaces                 | • rising inside warm air  
|                                     | • establish air flow and internal ventilation |
| Central courtyard                   | • To build greenbelt  
|                                     | • Natural ventilation  
|                                     | • Utilization of solar energy  
|                                     | • Open, closed and semi-open layeying  
|                                     | • Access to running water  
|                                     | • The possibility of air stylized coverage and loss by water and plant  
|                                     | • Confidentiality of the air spaces beside full horizontal ventilation |
Conclusion:
Sustainable design and utilization of renewable energy sources, in today's architecture, is one of the strategies to build optimal structure in terms of fossil fuels (Hamin and Gurran, 2009). Iran traditional architecture, local architecture in most sources, has included the sustainable architecture in it, naturally and the architecture in each region of Iran is designed with that region climate, which the techniques and method of this type of architecture in utilization of wind has been discussed in this study.

1.5. Recognition of using wind renewable energy sources in Iran traditional architecture:
In addition to lantern in the traditional architecture of Iran, there were also other factors to use this renewable energy source which are originated from its sustainability and it has been mentioned in this research.
In Table 3, the treatment and utilization of wind energy is discussed in Iran traditional architecture. Finally, Table 4 has summarized the techniques and adapts them to the global sustainable architecture principles which led to the recognition of sustainable performance of Iran traditional architecture in the use of wind renewable energy sources.

<table>
<thead>
<tr>
<th>Effective factors of the wind</th>
<th>treatment and utilization of wind energy wind results</th>
<th>results</th>
</tr>
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</table>
| Disturb and prevailing wind   | • address the most troublesome and annoying aspect of wind  
• to form closed spaces and areas in the height of the wind | • Safety of central courtyard and spaces  
• climate Security and Comfort |
| Pleasant and good wind        | • Utilization of lantern  
• link and attachment between closed spaces to flow air in closed spaces | • natural ventilation  
• reduce internal temperatures of closed spaces |
| Stylized air                  | • formation of spring house space and area  
• The formation of closed spaces around the semi-opened space of spring house  
• Vertical attachment of closed space on top of spring house space | • Natural ventilation  
• Proper layering of spaces |

Table 3: Results of the treatment and utilization of wind energy

<table>
<thead>
<tr>
<th>Wind utilization factors</th>
<th>Sustainable procedure in traditional architecture</th>
<th>Global sustainable architecture technique</th>
</tr>
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</table>
| Lantern                  | • bilateral ventilation  
• Entry the flow from one side and exit from to the other side | Natural ventilation |
| Central courtyard        | • maximum connection of the closed spaces with outside  
• entry of pleasant wind into the central courtyard  
• Safety of central courtyard and closed spaces against annoying wind  
• Create semi- open spaces between closed and open spaces | Atrium, to build in the height |
| To establish lantern in summer stayed area | • this part is full of shadow and cellar is located below it and has the most role to reduce inside temperature | Effective use of natural resources |
| To obviate against prevailing wind(summer stay area) | • rising warm air  
• Protection of inner spaces against annoying wind | To create obstacle against prevailing wind |
| Formation of semi-opened spaces beside open space | • A proper ventilation by creating an intermediate space such as terrace, terrace, porch and patio and corridor between open space of the yard and closed spaces | To create an intermediate space between atrium and inside space |
| Chimney effect of the lantern | • rising inner warm air and establish of internal air flow in absence of wind | ventilation in atrium between open spaces in the height |
| Horizontal and vertical connection between inner spaces | • Warm air rising and built-up air openings at the top and the natural air flow | Double skinned façade and air flowing between double facade |
5.2. To compare traditional and modern architecture performance in utilization and use of wind energy:

We aim to compare advantages and disadvantages of traditional and current architect in sustainable architecture through identifying and analyzing the performance of traditional architecture in the use of wind renewable energy. Documentary articles and books have been used to achieve a true judgment and the final result is provided in SWOT form table.

Table 5: Comparison of advantage and disadvantages of traditional and modern architecture performance in the use of wind energy

<table>
<thead>
<tr>
<th>parameter</th>
<th>Traditional architecture</th>
<th>Contemporary architecture</th>
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| advantages | - Utilization of natural resources  
- Reduce the sensible air heat in lanterns through direct or indirect contact of the weather  
- Chimney effect in the lack of wind and inside air rising and establish a natural air flow by density difference between indoor and outdoor air  
- Cost savings due to the use of local materials, and spaces such as porches, terraces and porches  
- A favorable heat exchange with the ground by creating areas like garden sunken  
- Existence of sunlight in the open semi-open spaces  
- Having special writing principles due to lack of modern technology  
- Proportional to Iranian culture due to building's introvert form | - To use and utilization of available spaces for inner ventilation and not to build pert areas and spaces like atrium, garden in the roof and . . .  
- Not to build or to build the minimum unused and pert spaces  
- Utilization of natural resources |
| disadvantages | - Create pert and unused spaces in the plan, such as wind, corridors, etc.  
- Need for water to wind stylization  
- Lack of efficient power for ventilation in more height areas and high density buildings due to population growth | - Its uneconomical due to costs of equipment and modern systems technologies for the utilization of renewable energy |

Table 6: Comparison of performance opportunities and challenges in traditional architecture and modern architecture in utilization of wind energy

<table>
<thead>
<tr>
<th>parameter</th>
<th>Traditional architect</th>
<th>Modern architect</th>
</tr>
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| opportunities | - Horizontal Natural ventilation to stylize the back spaces which don’t have access to open spaces  
- To form spaces accordance with different climate in different seasons in a building  
- To control greenbelt and prevent drying from extreme cold | - Good ventilation in the height  
- Good at building design in high density  
- Accordance with modern urban design and municipality principles  
- Effective role in urban beautification by modern technologies  
- Technological improvement and BMS |
| challenges | - Inefficiency of a system like a lantern or central courtyard in cold climate  
- Mismatch between population growths due to low-lying buildings  
- Ignoring urban groin due to introvert of traditional architecture  
- Lack of infrastructure in terms of 60% of the area's in traditional architecture design and damage the urban spaces | ...... |

REFERENCES


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