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Research Article

A study on detection and examination of sustainable architecture effects on decrease in fuel consumption and environmental pollutants

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ABSTRACT
Nowadays, decrease in fossil resources and increase in pollutions arisen from use of these resources have caused the researchers at different areas strive to develop a variety of solutions to resolve such problems. The industries related to construction sector such as cement and steel factories more likely contribute to increase of such pollutions. On the other hand, using modern construction methods such as sustainable architecture to achieve a healthier environment, reduce environmental pollutants and decrease fuel consumption, the architects strive to help for creating a sustainable environment and green building in use of materials and type of design methods. In the present research, sustainable architecture effects and green architecture elements in reduction of environmental pollutants and fuel consumption have been examined using library sources and descriptive-analytical research method; then operating instructions for sustainable buildings are proposed by means of detection of different elements of sustainable architecture and different methods for use of green architecture.

Key words- sustainable architecture, green architecture, avoidance from air pollution, reduction in fuel consumption

INTRODUCTION
Sustainable architecture has been regarded as one of the most important styles of modern architecture which encompasses different environmental, climatic, social and economic goals with an emphasis on green architecture. Use of such architecture can cause saving energy, creating stylized space, creating sense of vitality among people, avoiding fuel consumption and reducing environmental pollutants, resulting in environmental sustainability. Green architecture enjoys a variety of elements including green roofs, green walls, and utilization of wind turbines, solar cells and so forth which play a major role in sustainability of constructed architecture.

Problem statement
Nowadays, sustainable architecture with an emphasis on green architecture can face numerous problems and become a suitable solution for different problems. Surplus attention

to increasing progress of urbanization as well as excessive increase of population and subsequently diversity of vehicles and excessive utilization of fossil energies and pollution from them can raise unsustainability and environmental problems in urban communities, such that in recent years urban environment has gradually excluded from natural conditions due to excessive constructions non-compliance with the required standards, resulting in rise of irreparable consequences on the nature in urban area(Estakhr, 2013). In this regards, inattention to design of building and its elements has affected visual and urban features in addition to unfavorable climatic and environmental consequences (Alavi, A. 2011). With regard to utilization of green architecture, preparation of wind turbines and solar cells, utilization of green roof and so forth, it can play a major role for health of environment and beauty of architecture. Use of sustainable energies in design can come effective in sustainability of architecture.

Objectives

The main purpose to examine role of sustainable architecture in avoidance from fuel consumption and reduction in environmental pollutants can be mentioned as follow:

-detection of different methods to raise sustainability in architecture to reduce fuel consumption

-utilization of different methods to raise sustainability in architecture to reduce environmental pollutants

-utilization of different methods to raise sustainability in architecture to raise a healthy environment

Questions

-what are different methods to raise sustainability in architecture to reduce fuel consumption?

-how use of sustainable architecture can come effective in modification of air quality and reduction of carbon pollutions resulting in rise of environmental sustainability?

-how green architecture strategies are made so create a healthy environment?

Hypotheses

-different methods of sustainable architecture can cause reducing fuel consumption and saving fuel consumption.

-use of sustainable architecture can come effective in modification of air quality and reduction of carbon pollutions resulting in rise of environmental sustainability.

-use of green architecture strategies can be considered to raise a healthy environment.

Theoretical background

Sustainable architecture

Use of concepts of sustainability and goals of sustainable development to reduce waste of energy and pollution of environment in architecture has raised an issue named sustainable architecture. In such architecture, not just the building adapts with the climatic conditions but also makes a mutual relationship with those conditions. This is in a way that Richard Rogers has said building are assumed as the birds which have pushed their feathers and adapted themselves with new conditions of environment, regulated their metabolism in this way. Indeed, Sustainable architecture which has been regarded as a subset of sustainable design can be considered as one of the important contemporary issues that can be accounted as a logical reaction to the problems at industry age. For instance, 50% of the fuel reserves are consumed in buildings which this results in environmental crises, thus the necessity for further development of sustainability can be observed in architecture properly. Sustainable architecture likewise rest of architecture issues has specific principles, encompassed three stages as follows:

-saving in resources

-design to return to lifecycle

-design for the man

It should be noted that each of stages has their own strategies (Herdeg, 2011).

Detection and examination of these implications help the architect for further understanding of the environment which must be designed.

Sustainable energies

Sustainable energy has been introduced as supply of energy constantly to meet the needs without jeopardizing ability of future generations in meeting their needs. The technologies which assist for sustainable energy include renewable energy resources including hydropower, solar energy, wind energy, geothermal energy, wave energy, artificial photosynthesis as well as the technologies which have been designed to improve energy efficiency. Therefore, dual pillars of sustainable energy include energy efficiency and renewable energy. It must differentiate the term "sustainable energy" from rest of terms in this context such as alternative energy, because sustainable energy puts emphasis on ability of energy resource to continue supplying energy. Sustainable energy might almost raise environmental pollution, but amount of pollution is not that much high to ban high use of it as a resource for infinite time (Moradi, 2010). Sustainable energy differs from low-carbon energy because the term 'low-carbon energy' is sustainable as it does not add carbon dioxide to atmosphere. Green energy is another term at this area. Green energy refers to a kind of energy which can be extracted, produced and/or consumed without a huge impact on environment. Our planet has a natural capacity for recovery, thus the energy that the pollution from it does not exceed from this extent of ability may be also called green (Moradi, 2011). Green energy refers to a subset of renewable energies which indicate those resources of renewable energy which raise the most environmental benefits. Endless energy is called eternal energy; renewable energy is considered as this kind of energy; the technologies used for this purpose include solar energy, wind energy, wave energy, geothermal energy, tidal energy, ethanol biodiesel, hydrogen and hydroelectricity (Vahedi, 2013).

Green architecture

Green architecture has been regarded as one of the most important styles of modern architecture which encompasses different environmental, climatic, social and economic objectives. Use of such architecture can cause saving energy, creating stylized space, creating sense of vitality among people, avoiding fuel consumption and reducing environmental pollutants, resulting in environmental sustainability. Green architecture enjoys a variety of elements including green roofs, green walls, utilization of wind turbines, solar cells and so forth (Oveisi, 2009). Green architecture has arisen from sustainable architecture and sustainable development which this has also arisen from the man's need against adverse consequences of industrial contemporary world. Protection from the world's natural resource, protection from environmental pollution and air pollution, protection from ozone layer, physical and mental health, and the future of humanity have been regarded as the issues which have been proposed in this context, revealed with the necessity as a global duty which goes ahead.

The method to use green architecture to reduce fuel consumption

In advance, a green building requires a creator before being built. This issue, creation of a green building, will help for health of a person who lives there and breathes in the environment around it and will protect him/her and will ultimately result in satisfaction and utility for him/her. This issue requires precise application of the strategies confirmed in architecture. In following, some of these strategies have been proposed:

-use of natural energy in everyday consumption

-Stability of status of internal environment

-Use of waste and effluent water for irrigation of green areas
-Using appropriate methods to reduce wasted energy and control them and optimize energy consumption
-attention to climatic features of the region
- Use of non- chemical recyclable materials and materials that do not endanger human health
-Design with materials close to nature
-use of natural plants as the inspiration for the green design
-Avoidance from damage to the land status to benefit more
-Achieve the highest quality of life in the light of reliance on the environment
-How to use the land
-attention to the character of the region's ecology

Reduction of fuel consumption using green buildings

Color of wall in green buildings

There is a mutual linkage between color of wall surfaces and receiving solar energy. Using different colors in exterior surfaces at walls of a building, it can control thermal outcomes of sun radiation at interior spaces. The light colors might reflect solar energy to 85%, yet reflection attribute of dark colors is just about 15 %(Setyowati, 2013).

Insulation of walls in green buildings

Through all the surrounding surfaces of building including walls, ceilings and floors which connect to the exterior space or uncontrolled space on one hand and controlled space inside building on the other hand, energy is wasted due to lack of suitable insulation in the building. Therefore, compliance with heat insulation in design and implementation of buildings reduces the need to heating and cooling and avoids waste of produced heat and cool and ultimately causes huge saving in energy consumption (Emilsson, 2007). Major types of insulations in Iran include rock wool, glass wool, slag wool, polystyrene and polyurethane foams. In selection of thermal insulation for walls and roof, it must pay attention to resistance of insulator against heat and forces and behavior against fire and absorption of water in fire.

Double-skin façade to optimize energy

The terms which are used as synonyms for double-skin façade include: Two-sheet facades, two-skin facade, double facade, double coverage, double-walled glass facade, façade of ventilation wall or ventilation facades. With regard to the definition, it can define two-skin facades as follow: A pair of glass skin which are separated by an air corridor. The major glass layer is generally insulated. This air space between glass layers acts as insulator against minimum and maximum temperature, wind and sound. Shading devices are almost between two skins. All the elements can be arranged with filled and transparent membranes.

Ground-coupled heat exchanger in green buildings

To reduce energy consumptions in the buildings, the air exchange heat should reduce through leaks from the heat shells of buildings as least as possible. In airtight buildings, use a mechanical ventilation system must be used to supply fresh air for residents. a mechanical ventilation system in a building not just paves the way for use of a heat exchange to receive energy of the outlet air but also paves the way for use an underground heat exchanger to save energy and increase efficiency of building in terms of energy. Yet, use of underground heat exchangers is not just enclosed to the buildings with mechanical ventilation system but also the buildings with air heating system. The temperature in ground depth is more in winter and less than temperature of outlet air in summer, which this difference of temperature can be used to preheat the incoming cold air in winter and precool the hot inlet air in summer and help to provide thermal comfort conditions without energy consumption. Hence, one way to reduce energy consumption in

buildings is to use underground exchangers which enter the fresh outlet air into the building. Underground heat exchangers refer to pipes and air ducts which are located in the underground, entering the fresh air into the building. Temperature of air passed through underground pipes changes through the exchange of energy with the ground, entering to the building with a temperature closer than temperature of outlet air to comfort temperature (Bradley, 2010). Length and diameter of the underground heat exchanger pipes depend on the size of the building in which the exchanger is used, e.g. underground heat exchanger of a small residential building can have a diameter about 20 cm and length about 40 m. in underground heat exchanges of small buildings, the cold outlet air is sucked into the pipe to the length of 20-50 m which is at the depth of 1 meter beneath the building, thereby the temperature of cold outlet air increases to a large extent at the coldest days of winter before entering into building. In summer, the temperature of outlet hot air decreases to a large extent by passing through the mentioned system before entering into building (Aben, 2012). A variety of factors affect extent of exchange of energy between ground and the air passing through heat exchanger and as a result extent of energy saving.

Soil type, soil density, heat capacity and thermal conductivity of the soil, soil temperature difference, groundwater levels, volatility of the air flow required for ventilation and air exchange, outlet air temperature and factors related to the underground heat exchanger such as number of exchanger pipes, length of pipes, diameter of pipes, the distance between the pipes and the depth of the pipes have been mentioned as the factors which affect extent of energy exchange in this exchanger and energy saving.

Green roof

Green roof is called to a roof which in part or totally is covered via vegetation and soil or growing medium. Green roof can be considered for the roofs which have witnessed with green architecture such as solar panels and/or photovoltaic panels.

Advantages of green roofs

-Providing consistent space for users of building

-Possibility to grow fruits, vegetables and flowers

-Reduction of heating by adding mass and thermal insulation layer and cooling through evaporative cooling, especially if they are made of glass, acting as greenhouse or solar heating system. According to a research (2005) by Brad Bass of the University of Toronto, it was showed that green roofs can reduce heat loss and energy consumption in winter.

-Reduction of the impacts of heating and urban climate changes

-Increased life span (green roofs can play as the rest)

-reduction of flooding

- Air purifiers and air carbon reduction

-Reduction and regulation of intensity of the sounds dB 18 which enter into the building and come out of it to dB3

-Increase of habitat for animals in residential areas

- Improvement of the landscape around the building by providing a beautiful green space

-Enhancement of the lifetime of roof membrane (two or three times more) to protect them against harmful UV rays and weather damage

Role of green roof in environmental sustainability

Reduce heat island effects

Large cities due to extensive impermeable levels and lack of vegetation rapidly absorb heat radiation and act as thermal energy emitting sources. This state is called heat island. In this state, there are significant differences between urban areas that their surfaces have been covered with asphalt and bitumen and the areas which

have been covered via vegetation. This difference on urban heat islands between the city and its suburbs in summer can be up to 10 ° F (Bass, 2007). In this state, the air conditioning and cooling systems will increase, which this increases the rate of energy consumption and intensifies the phenomenon of greenhouse gases which are the most important agent to destruction of the ozone layer. With regard to the report by United States Environmental Protection Agency, temperature of city air can reach to 5.6°C warmer than the surrounding natural land cover (Tabrizi, 2011). Therefore, green roof can contribute to healthy environment.

Reduction in air pollution

In urban areas, trees have largely contributed to reduction of air pollutants. Nevertheless, there is little space to plant tree in most of urban sites, which this is due to impervious surfaces such as streets, parking lots, roofs, etc. Plants absorb air pollutants through their pores and separate their particles via their leaves and also enable to break specific organic compounds such as polyaromatic hydrocarbons in soil or plant tissues (Baker & Brooks, 2009). Moreover, they indirectly reduce air pollution by reducing temperature of the surface through the coolant leakage and shade, reducing the photochemical reactions of pollutants like ozone in the atmosphere (Bradley Rowe, 2010). Since different types of plant species have different abilities to remove air pollutants and greenhouse gas emission, it can select more effective species to maximize improvement of air quality. For instance, evergreen conifers might provide greater benefits of deciduous species because they will enable to play a better role by keeping their leaves.

Reduction of carbon dioxide

The ground is warming due to natural cycle and burning of fossil fuels. Burning fossil fuels emits carbon dioxide as a byproduct of combustion. Carbon dioxide as a confounding factor increases the greenhouse effect and raises the temperature of the environment since it has been regarded as one of the atmosphere gases which avoid transmission of thermal energy near ground level to the upper level. Green roofs can come effective in reducing carbon dioxide in atmosphere in two methods:

1-Carbon is the main component of plants, decomposed in plant tissues through photosynthesis and in soil through root exudates of plants.

2- Energy reduction through the insulation of buildings and reduction of the urban heat island effect (Uraki Kuhshouri, 2011).

Role of green roof in economic sustainability

Concerning economic sustainability, it must pay attention to the factors contributing in saving of energy. Green roof can discuss on waste of resources and saving of energy. Two factors are of great importance in influence on sun ray which radiates on surface of ceiling of buildings, that is, the first is foliage and the second is type and thickness of soil. The more diversity of foliage, the less heat pressure through the ceiling to inside and the less temperature of ceiling surface will be. The more thickness of soil, it will act better as insulator and cause lack of reaching the heat to ceiling in summer and cooling through evaporation in summer. Further, keeping water from rainfall is also affected by factors such as slope and depth of layers beneath green roof (Oraki Kuhshouri, 2011). Flat green roof can store water better and control floods. The more thickness of green roof, the more moisture will remain. These cause saving economic costs in order to regulate weather inside the house.

Energy consumption and green architecture patterns

What has proposed green architecture as a modern attitude in construction refers to the needs of modern communities against adverse outcomes and industrial outcomes of the current age. Green architecture which has arisen for sustainable development refers to a phenomenon

that paves the way for protection from the world's natural resources, physical and mental health, and the possibility to create a suitable space based on optimal energy consumption. The world community lives beyond the available facilities, under which we are obliged to continue our life in this limited place and time through proper patterns in such a way not to jeopardize the ground capitals for the future. Design of architecture with green thought refers to a process to resolve the problems in which the natural resources are damaged the least, for which long lifetime and return to natural cycle in addition to optimal use of resources and materials must be considered. Now, the resources are ending and this has become a major concern for architects, urban designers, urban planners, architects, engineers and experts so as to adjust the human sustainability with sustainability of nature. Therefore, the approaches which affect green architecture based on major related factors to sustainability of development and city include:

-the buildings should be designed and implemented in a way to provide access to public transport, bike paths and access of pedestrian to major services, which this helps to reduce use of automobile.

-the buildings should be replaced in a way to exploit from existing plants. Deciduous trees in the South, East and West of building reduce the amount of cold in winter.

-Hedges and rows of bushes and shrubs can inhibit cold winter winds or cause transfer of cool summer breeze to the building

-the building must be designed via Self-sufficient energy

- Buildings next to each other minimize costs for exterior coating of building

-the building must be designed in a way to enjoy optimal solar energy to 40 to 55 degree slope using solar installations such solar water heater and energy consumption

-wastes of construction materials must be minimized by design of standard height of ceilings and dimensions of building

-local construction materials must be used, which transport is important from environmental pollution and energy consumption perspectives

Considerable factors in design of green building

-establishment of buildings on the site including beneficial paths

-orientation of buildings regarding the sun direction

-arrangement of interior rooms, doors and windows

-dimensions and facets of buildings and environment constituents

-color, façade, decorations of building and environment

Design of green buildings

-Small buildings are preferred. Use interior spaces properly via a good plan so that the size of building and the resources used in construction remain as less as possible.

-design building with sufficient energy; Use insulation at high level and windows with high capability in sun direction and use sealed structure. The buildings next to each other minimize the cost for insufficient exterior coverage of building.

-free comfort; normal solar heat, light and natural coolants can be embedded in the buildings with more effective value.

-gain free energy; design the buildings with solar water heater and optical power generator of solar facilities for future

-use materials and minimize wastes with design for standard height of ceilings and dimensions of building

-simplify disposal of water for residents. Consider the factors such as the trash bins close to kitchen under the sink to dispose waste.

-the systems for disposal of roof water can be considered to collect rain water

Green materials

-avoid those chemical materials that remove ozone in mechanical equipment and insulators

-transport is of great importance both in energy consumption and pollution

-use waste construction materials or the products which have been acquired from the renewable materials to cycle of nature including Cellulose, plywood, floor bricks made of glass and plastic recycled into lumber and flooring.

-search authentic wooden products and use the lumbar gained from controlled forests.

- avoid the materials that are contaminated with their gas: solvent-based paints and oils, adhesives, carpet, wood chips and many other construction materials and products.

Green facilities

Use high-efficiency appliances and lamps. Fluorescent lamps are advanced and cheaper than white light aesthetically. Use small solar boilers for use of conventional energy. Use sufficient water facilities. Bathroom faucets and shower systems not just reduce water consumption but also diminish septic system or sewer system performance. Equipment deployment reduces cost of hot water.

Executive instruction of green architecture for residential buildings- how to establish green lands to avoid energy consumption and reduce pollution

-construct at developed regions; despite urban degradation, land and agriculture are maintained in intensive development, whereby adjacency of stores, public services and transport is provided.

- Design multipurpose projects and plans, in which projects, residential and commercial uses are integrated to help for creation of alive communities and reduce the largest pollution source which is use of automobile.

-establish the buildings in a way to provide access to public transport, bike paths and access to major services by the pedestrians. This diminishes use of automobile. Further, rate of driving can reduce by working at home. Therefore, take this point into consideration that the work office at home requires telephone line and appliances.

-repair old buildings; repair of existing buildings is the most biological construction.

-establish the buildings regarding minimization of environmental tension.

-substitute buildings in a way to exploit from existing plants

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