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Short Communication

Sustainable development of eco friendly initiatives through green Building Information Modeling (BIM)

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ABSTRACT:

World Commission on Environment and Development (WCED) defines sustainable development as set of actions performed to fulfill the needs of current generation without causing any damage to the future generation. LEED is one of the most applicable systems for rating green buildings. Building Information Modeling (BIM) is a set of parametric information which is applied to make decision about designing, making qualified building plans, predicting building performance, price estimation, time scheduling, operations, maintenance procedures, and contract management. The model of the recent research is a villa which is assumed to be located in Tehran. Relevant action to green building information modeling was conducted such as building location, building orientation, wind direction, sun path and relevant analysis to rainwater and grey water harvesting, web site design and analyzing energy by Revit (2015) (energy + ECOTECT applications). A questionnaire with 19 technical questions was designed and answered by experts. This questionnaire was designed based on Likert scale and data was gathered by Delphi method and the obtained results were analyzed by Cronbach's alpha method. The questions cover issues such as the application of BIM, received certification of different projects, different aspects of BIM implementation, BIM cost of using, BIM score, related analysis to BIM and applied tools in BIM. In addition, some other issues such as marketing return on investment, the application of human-made systems including photovoltaic panels, wind turbines, mechanical and lighting systems and developing green building are taken into account.

Keywords:

Building information modeling, Green building, Rating system, Sustainable development.

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INTRODUCTION

Today, issues related to environment, fossil fuels saving and sustainable development are in the center of attention all around the world. Moreover, increasing rate of population caused so many problems and threat human life. The population of the world would reach five billion in 2030, while in 1950, only 30% of the population lived in urban areas. In 2000, the number of population who live in urban areas reached 74% and it was predicted that it will reach 60% on 2030 (Bahari, 2014). Lack of energy, global warming, city development, air pollution, large number of landfills, lack of water and emergence of different diseases were brought up in 21 century, unless we take actions about sustainable development. The most important definition for sustainable development in Rio conference is as follows:

A sort of development which satisfy current human needs without causing any damage to the future generation are needed and it pays attention to the future needs. So many definitions are given for the concept of sustainable development and they all put emphasize on next generation and protection of the environment. Saving energy, energy demand management, building sustainability, paying attention to aesthetic criteria, shaping and changing form, synchronization with the environment, flexibility in changing shapes, controlling natural disasters (flood, surface runoff, etc.) protecting environment, preventing surface runoff from being polluted, increasing green space per capita, modifying psychological environment, making sound and thermal insulation, increasing lifetime of roof isolation, reducing energy consumption, taking advantage of production cycle, air purification, reducing relevant damages which are caused by storms, torrential rain etc., are the results of implanting related policies to building information model (Gorgi, 2010). Green building have 30% of energy saving, 35% of carbon reduction, 30-50% water saving and 50-97% of waste reduction (Asadpour and Marzban, 2013).

Methodology

Choosing a suitable method for conducting a research depends on the goals, the importance of research and executive facilities etc. Current research is a descriptive and practical one. In descriptive research, the researcher does not manipulate or control variables and he just studies, describes and analyzes the data (Kriegel and Bradli, 2014). It is practical because it is applied in the construction industry. It is descriptive and has many theoretical models. Questionnaire is one of the most popular tool for gathering information in the survey research. In descriptive research that has a wide geographical scale or research which has a wide statistical society, questionnaires are applied (*Ibid*) to drive away the delusions. In designing questionnaire according to likert scale, information is gathered by Delphi method and data are analyzed by Cronbach's alpha method (Hafeznia, 2000).

The application of Delphi method

This method is applied when there is a need to talk about and analyze the ideas of a group of people.

Requirements for the application of Delphi method

Among the most important requirements for the application of Delphi method, the following items can be mentioned: experts' judgment and the ideas of people, common agreement in obtaining results, existence of a big problem, lack of enough information, to be in contact with experienced experts, time limitation and the absence of cost method.

The validity of Delphi method

The validity of this method does not depend on the number of participants who take part in the research, but on academic credit of experts. The number of participants in Delphi research is 5 to 20. This method is

Table 1. Reliability statistics

S. No	Cronbach's Alpha	Number of Items
1	0.916	19

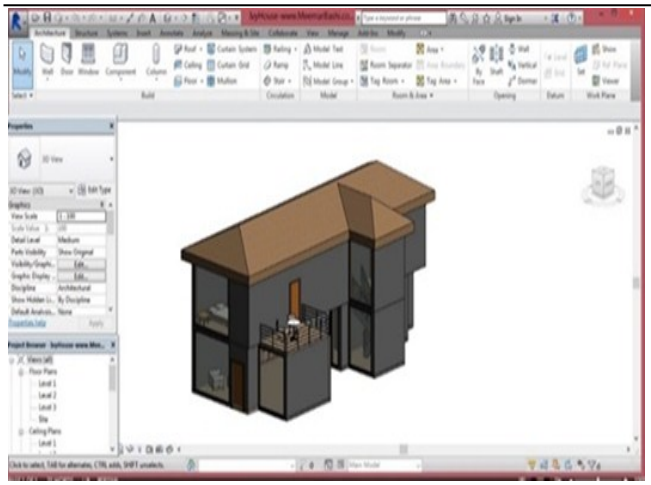

Figure 1. The hypothetical model of the villa in Autodesk Revit 2015 application

applicable in cases which do not require exact analytical techniques. For instance, when data is inadequate, when someone is not certain about data validity, in cases in which there are not any real samples or when bringing people together is not simple (Sarmad, 1997). Cronbach's alpha coefficient is estimated in SPSS application and its value is 0.916 (Table 1). The obtained results are as follows:

Statistical population, sampling, and sample size

Statistical population is defined as all components or persons who share common features with each other in a certain geographical scale (Sarmad, 1997). Statistical society in this research is the members of BIM and LEED association of Iran and experts in this field (Nilhan *et al*., 2007). In this research, information is gathered through questionnaire which is the most common tool in research survey and field study methods also. In descriptive research, a research with wide geographical scale or in research with large statistical population, questionnaires are applied (Khaki, 2011).

Online questionnaires about green buildings, BIM and sustainable development are available for experts in the following websites (Association of Construction Engineering and Management, Islamic Azad University, Science and Research Branch, Tehran): www.iranbimcouncil.com, www.ravanshadnia.com, www.leediran.org, www.iran-gama.com, http://srtscem.blogfa.com/.

Sustainable development

Sustainable development is development through which current needs of human is met and at the same time the needs of future generation and environment is not threatened. Different organs of sustainable development are defined (Azhar *et al*., 2011). These organs should be under consideration and they should be taken into account in all sorts of planning. Green building process and its related policies are ways of reaching development. With changes in the

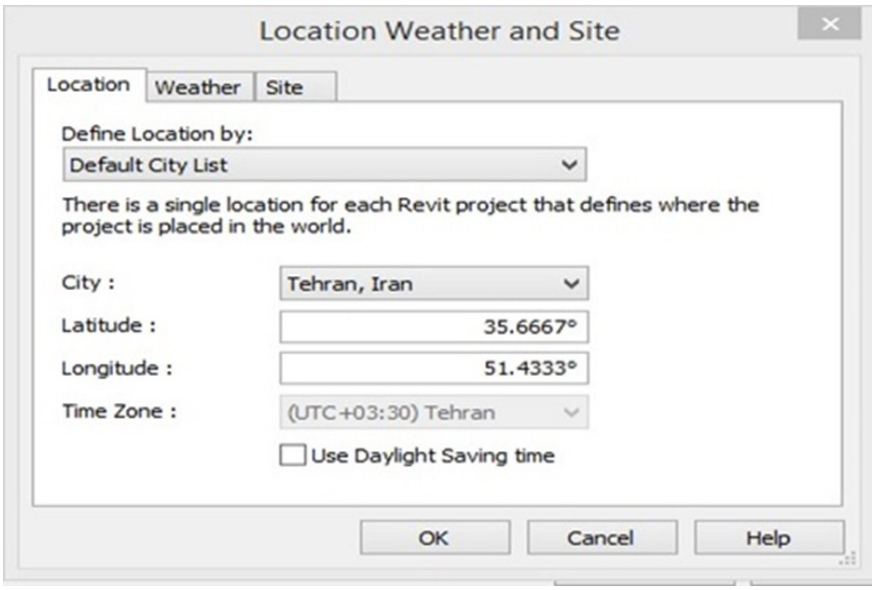

Figure 2. The window of location, weather and cite

Table 2. Monthly-yearly average precipitation in the Tehran rain gauges during 2005-2013 (in mm)

S. No	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Yearly Precipitation (mm)
1	2005	4	50.5	36.5	47.6	74	79.9	17.8	34.2	10.8	0	3.4	2	360.7
2	2006	0	47.7	4	84.2	152.3	0.5	52.8	23.4	3.8	14	0	0	382.7
3	2007	40.5	38.4	22.5	54.5	49	43.5	94.3	45.4	6.8	11.8	0	0	406.7
4	2008	7	18.4	89.9	39	90	8	0	5.5	7	0	0	0.3	265.1
5	2009	2	37.5	42.2	19.5	43.5	21.5	61.3	49.5	20.5	0	0	10	307.5
6	2010	4	68.6	34.1	25	44	39.8	0	32.5	0	0	0	0	351.5
7	2011	3	54	2	59	42.1	92	1.5	52	1.5	0	0	35	360.6
8	2012	0	239.5	7	31.4	98.6	13.4	7.5	19.7	7.5	24	2.6	0	494
9	2013	5	75.7	0	0	0	23.1	4.5	9.9	4.5	0	2	0	142
Average		7.28	70.03	26.47	40.02	65.94	35.74	46.99	30.23	6.93	5.53	0.89	5.26	341.32

industry, we use sustainable design instead of green buildings, because sustainability has more effects but the term green just refer to the natural environment (Asadpour and Marzban, 2013).

Building Information Modeling (BIM)

National Institute of Building Sciences (NIBS) defined BIM as the computable display of all physical and practical features of a construction and related information to the project that should be kept and used as a source of information during project life cycle. NIB defined building information modeling as a digital and virtual display of things in buildings with physical geometry (2 or 3 dimension) and other practical parameters (such as materials, spatial connections etc.).

Designers gather the components of BIM to provide a definition for a construction model. In the model, physical and practical information are applied. After modeling, all required information for construction, analyzing, construction planning, cost estimation and managing affairs are provided during operational step (Kasmaii, 1993; Kasmaii 2008).

BIM capabilities

- **Three-dimension model:** It is a mathematical display of each item such as length, width and height. There are different types of three dimension model in BIM; design models such as architecture and construction models, construction-analysis models and design models for construction sequences etc. (Shokouhian *et al*., 2007).
- **Four-dimension model:** In this model one more dimension is added as CPM. The four-dimension models of BIM connect three dimension components to project timeline.
- **Five-dimension model:** Here the fifth dimension is added as cost estimation data.
- **Six-dimension model:** When a project is ready to be delivered to owners. It consisted of related information to construction such as products data, maintenance procedures, utilization pictures guarantee related data, communication links to online production resources, contractions, construction information, etc. This model is so helpful in maintenance and utilization of project life cycle.
- **Seven-dimension model:** It is related to the

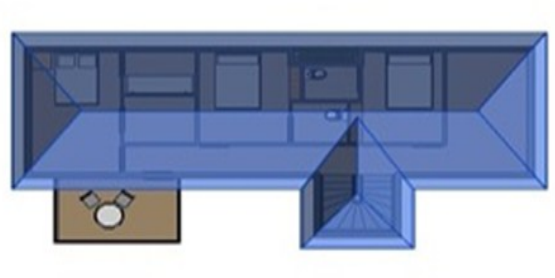

Figure 3. Roof level calculation

project procurement management.

- **Energy analysis:** We can connect BIM model to energy analysis tools to have energy assessment during the design process.
- **Identifying encounters:** Various designs by different organizations can be gathered to be compared to each other. By doing so, they are analyzed, identified and in addition geometry opposition between architecture systems are removed (Kasmaii, 1993).

Green construction

All principals of sustainable architecture should lead us to have a healthy environment (Soleimani, 2008). All green building certifications should meet sustainable development criteria. For instance, there are some instructions in seven environmental chapters of LEED systems and buildings in which mentioned principals are obeyed and can receive LEED certification for green buildings and they will be ranked according to their scores (Helena, 1998).

Different levels of LEED certification are as follow

1. LEED certification (26-32 points)
2. Silver LEED (33-38 points)
3. Gold LEED (39-51 points)
4. Platinum LEED (+52 points)

The most important indicators for determining maximum points are as follow

1. Compatible cites with environment (sustainable): 14 points.

Preventing air pollution resulted from construction operations, choosing the right site, reaching optimum density in near places to urban service network, restructuring damaged cites, providing convenient access to public transportations, creating convenient parking capacity, maximizing open space, qualitative and quantitative management of rainwater, preventing the appearance of urban heat island and reducing light pollution.

2. Water use efficiency: 5 points

Reducing water consumption, reduce of water consumption in irrigation systems, recycling wastewater through creative technology.

3. Energy and atmosphere: 17 points

Ensuring that energy systems in buildings work properly, energy consumption should be minimized, preventing the ozone layer from being destructed *via.*, cooling equipment, optimizing energy consumption in buildings and applying renewable energy resources.

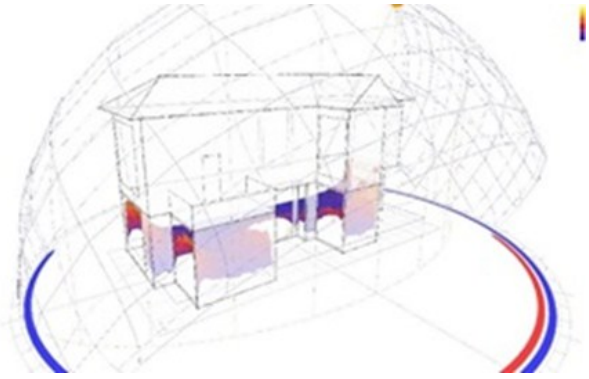

Figure 4. The reflection of inner light in ECOTECT application

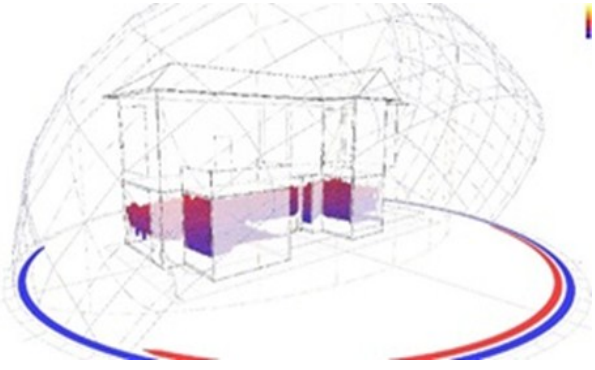

Figure 5. The reflection of inner light in ECOTECT application

4. Preserving materials and resources: 13 points

Collecting and saving recyclable materials, reusing buildings by keeping non-structural elements in buildings, managing waste of construction, reusing materials used in construction and utilization of recyclable materials.

5. Inner quality of building in terms of environmental criteria: 15 points

Providing good air conditioning systems in buildings, controlling cigarette smoke in the inner space of the building, installing systems to measure carbon dioxide of exhaust air, installing ventilation systems, applying materials with low pollution level, installing suitable lighting systems and designing thermal comfort systems are important environmental criteria in designing buildings.

6. Innovation in designing: 5 points

Having innovation in designing according to LEED factors.

7. Regional priorities:

Putting emphasize on local priorities. During last years, related policies to green building and construction have come to the center of attention and it becomes a global concern. As a result, the scientific requirements of this field are developed in different aspects such as management, construction, utilization, etc.

Designing questionnaires

After getting information, an online questionnaire was designed through these websites to help expert gathering the data: www.iranbimcouncil.com, www.ravanshadnia.com, www.leediran.org, and www.iran-gama.com, http:// srtscem.blogfa.com/ (Association of Construction Engineering and Management, Islamic Azad University, Science and Research Branch, Tehran).

Since this field of study is new, there are not many professional experts in this field and it is not popular among the people. Due to limited number of relevant websites and professional experts with academic education, it appears that having access to experts is through mentioned websites. Three months after the publication of questionnaire, ten people answered the questionnaire among which one answered just one question, so the answers of nine people were analyzed.

Table 3. The obtained results of energy analysis during a year *via* energy plus application

S. No		Single glazed glass	Double glazed window	Double glazed window with a layer of
1	Heat transfer	6	2.5-3	1.1-3

Analysis of the results

In the first question, experts were asked about the percentage of using BIM. Nine people answered this question, eight of them (88.88%) used BIM project less than 30% and one (11.11%) had used BIM project 30-50% which sounds logical according to the situation of Iran, since this technology is new in Iran. In the second question, experts were asked about the costs of using BIM in their projects. About eight people answered this question and five of them (62.5%) declared that this cost is less than 2% of total cost of project. Two of them (25%), estimated this cost between 2-3% less than 2% of total cost of the project and only one person (12.5%) said that this value was between 3-5% less than 2% of total cost of the project.

In many other countries, this value was also 2% less than total cost of the project. In the third question, the experts were asked to what extend it is possible to get LEED score. About five persons have (62.5%) answered that this score was 20 and about three (37.5%) declared that this score was 10. This value is about 20-30 points in surveys and foreign study resources. It seems that all capabilities of BIM are not applied to get LEED score.

Table 4. Cumulative effects of proper orientation on energy perspectives

Orientation + shadow +day light			Orientation + shadow		Orientation		
S. No	Savings annual operating costs	Energy consumption (kw/h-year)	Savings annual operating costs	Energy consumption (kw/h-year)	Savings annual operating costs	Energy consumption (kw/h-year)	Orientation
1	24.47%	9904.67	10.89%	11684.67	base case	13113.00	South
2	23.94%	9973.67	10.40%	11749.33	-1.39%	13295.33	East-15
3	24.84%	9856.00	11.63%	11588.00	0.69%	13022.67	West-15
4	23.68%	10007.33	10.52%	11733.33	0.28%	13075.67	East-30
5	25.08%	9823.67	12.48%	11477.00	1.87%	12867.33	West-30
6	24.18%	9942.33	11.74%	11574.00	2.28%	12813.67	East-45
7	25.65%	9749.67	13.78%	11306.67	4.12%	12573.00	West-45
8	27.96%	9446.00	17.92%	10763.00	11.20%	11644.00	East
9	26.99%	9574.00	16.44%	10957.00	9.73%	11837.33	West

Scores which can be obtained by Revit from LEED are as follows: choosing site (1point), controlling storm water (1 point), reducing the influences of heat islands (1 point), collecting and keeping recyclable materials (1 point), reuse of construction materials (3 points), recyclable materials (2 points), using regional materials (2 points), using standard wood (1 point), IAQ MGI design before and after construction (2 points) and innovation in designing (4 points). Scores which can be obtained by Virtual Environment (VE) from LEED: waste water related technology (1 point), reduced water consumption (2), minimized energy performance-optimizing energy performance (10 points), thermal comfortable (1 points) - lightening and view (2 points) and innovation in designing (4 points).

In the fourth question, the financial condition of the project is analyzed. In this question it is asked whether the manufacturing cost of the project is reversible or not. Three of eight (37.5%) answered that they have returned on the investment during 20 years. Two persons (25%) found it during 40 years, two persons (25%) got it during 10 years and one (12.5%) got it in 30 years. This duration in western countries is about 30 years. The state of California updates its construction regulations and its design solutions in two environmental performance levels based on sustainable construction and construction with LEED certification. Lower prices of materials, work force and total costs of project in Iran can reduce this duration.

On one hand, lower prices of energy compared to other countries, make this duration longer. So more research should be conducted and these researches should be consistent with project costs, interest rate, energy prices etc. The fifth question analyzes the application of human made systems in green project (Shakoor, 2011). All correspondents answered that they apply these systems (photovoltaic panels, wind turbines, mechanical and lighting systems) less than 30%. Six of nine correspondents (66.66%) expressed their ideas through answering the sixth question and they said that there is not any balance between implementation prices of BIM and its capabilities to reach environmental standards. Two of nine (22.22%) chose the item 'sometimes' and only one of nine (11.11%) chose the item 'never'. The seventh question of the questionnaire is so important. This question is asked from the experts of building information modeling projects and some projects such as official building of Golgohar Mining and industrial company could receive LEED certification. The participants are asked about the level of certification they could receive. Two participants from four (50%) answered that they received

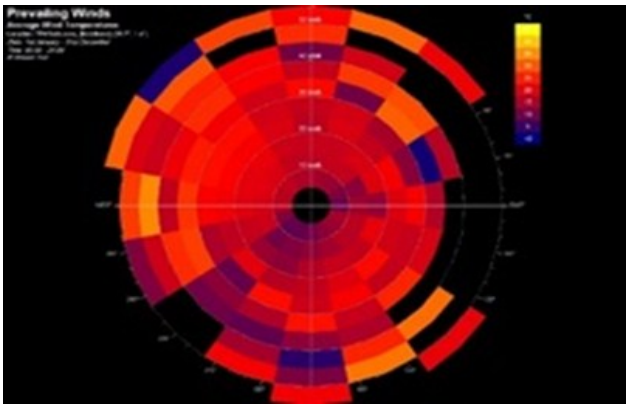

Figure 6. Temperature frequency of wind in Tehran

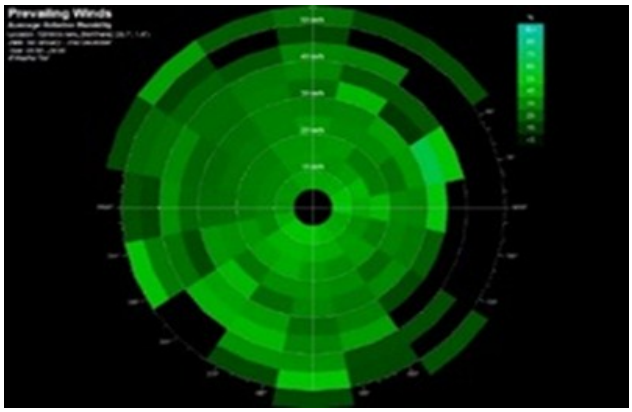

Figure 7. Humidity frequency of wind in Tehran

certification, one of four (25%) declared that he could receive silver certification of LEED and one from four (25%) said that he could receive platinum certification of LEED.

It is hoped that through developments of technology and science, making agencies for giving green building certification, growing professional experts in this field etc., will have improvements in construction fields. The eighth question analysed the application of BIM and its advantages. In this question, it is asked from the participants about the use of BIM policies in their projects. Four of seven (57.14%) answered that they use four dimension maps in addition to three dimension ones which are related to CPM. Two of seven (28.57%), applied the three dimension model, one of seven (14.28%) used five dimension model which estimates cost and none of them applied six and seven dimension model of BIM which are related to cost estimation, maintenance, operation and contraction management.

In the next part of the questionnaire seven multiple-choice questions were asked (questions 9 to15) and participants expressed their ideas (agree, disagree, neither agree nor disagree and somewhat agree). The first four questions (9-12) is about the advantages of using BIM in project and the next three questions (13-15) cover the analysis of the project. In the ninth question, six of eight participants (75%), agreed to have access on BIM tools in order to have quick return for primarily design and to correct it.

One of eight (12.5%), chose the item 'somewhat agree' and one of eight (12.5%) chose the item 'neither agree nor disagree'. In the tenth question, three of eight participants (37.5%) have agreed that by any changes or any plans in related database of BIM, the total program

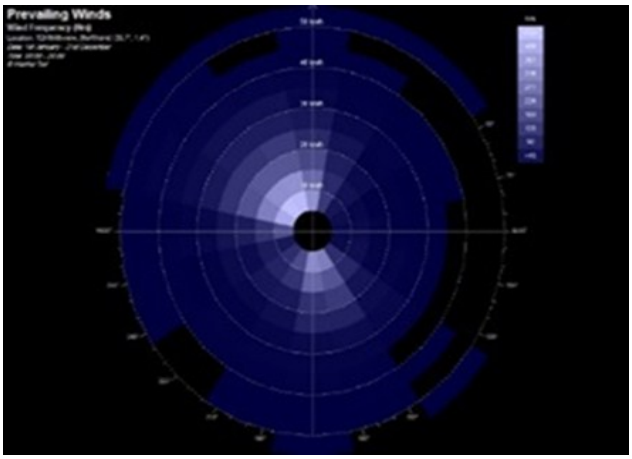

Figure 8. Dominant wind frequency of Tehran

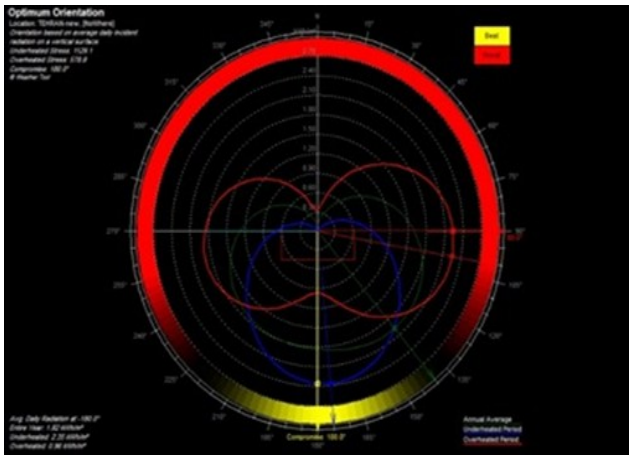

Figure 9. Suitable orientation in Tehran

Table 5. Analyzing earned points of LEED in assumed model for the villa

S. No	Proper choice of cite	Earned points	As explained by Revit app
1	Quantitative management of storm water	1	It is done by water analysis
2	Preventing the creation of heat islands.	1	It is done by the application of green roof
3	Water in the area	2	Through the rotation of rainwater and grey water
4	Reduce water consumption	2	Through the rotation of rainwater and grey water
5	Optimization of energy consumption in buildings	10	It is done through energy plus application
6	Applying renewable energy sources	3	Through the rotation of rainwater and grey water (The effects of rainwater, wind, sun light etc.)
7	Controlling lightening systems	1	It is done through energy plus application
8	Controlling air condition and heating systems	1	It is done through energy plus application
9	Natural light and view	1	It is done by ECOTECT application
10	Light pollution reduction	1	It is done by ECOTECT application

will be changed. Three of eight (37.5%) somewhat agree and two of eight (25%) disagree it. In the eleventh question, four of eight participants (50%), agreed that by applying the model we can figure out whether we can reuse the materials and recycle them or not. Two of eight (25%) somewhat agree and one of eight (12.5%) neither agree nor disagree and one of eight (12.5%) also disagree.

In the thirteenth question, four of eight (50%) agree that it is possible to satisfy customer that the project is done in consistency with the sustainable design. Two of eight (25%) somewhat agree and two of eight disagree. In the fourteenth question, five of seven participants (71.42%) agree with applying different options in a BIM model. Simultaneously, two of seven (28.57%) somewhat agree and none of them disagree. In the fifteenth question, two of seven (28.57%) agree by applying the models of taking advantage of natural light based on BIM standards. Three of seven (42.86%) somewhat agree and two (28.57%) disagree.

The sixteenth question, analyses the various capabilities of BIM. Eight participants answered this question and each of them used one or more capabilities of BIM as follows:

- Six of the participants used energy analysis capability in BIM, at 75% of the projects.
- Three of the participants used sun and light analysis capability in BIM, at 37.5% of projects.
- Three of the participants used shape, orientation and building density capability in BIM, at 37.5% of projects.
- One of the participants used voice analysis capability in BIM, at 12.5% of the projects.
- One of the participants used the capability of recyclable material analysis in BIM, at 12.5% of the projects.
- One of the participants used the water analysis capability in BIM, at 12.5 % of the projects.

The seventeenth question covers related

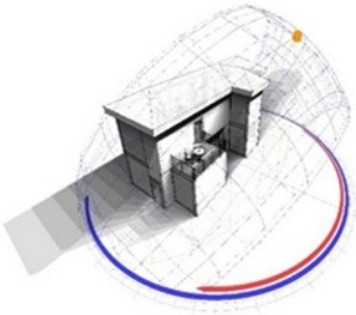

Figure 10. Shadow spectrum in ECOTECT application

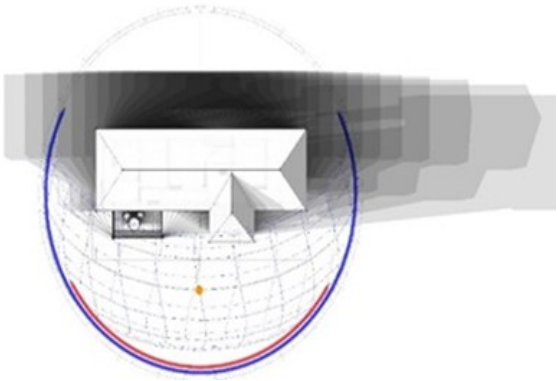

Figure 11. Shadow spectrum in ECOTECT application

applications and tools of BIM. Eight participants answered this question and each of them applied one or more application in their projects. Seven participants had used Autodesk Revit application in 87.5% of projects. Three of the participants had used Navis Work application in 37.5% of projects. Three of the participants had used other applications in 37.5% of the projects. None of the participants had used Virtual Environment application. In the eighteenth question, the most important factor for being successful was asked.

Five of the eight participants (62.5%) declared that the skill of the team member is the most important factor. Two of the eight (25%) answered that the project size is important. One of the eight (12.5%) said that the team communication of the project is so important and none of the participant put emphasize on the organizational external factors. In the nineteenth question it was asked, what is the most influential factor on the development of green building policy? Four out of seven (57.15%) declared that tax exemption for green building is the most important factor.

Three out of seven (42.85%) said that allocating adequate facilities to green buildings is the most important factor and one out of seven (57.15%) believed that the increased energy tariffs are very important, but none of them agreed with the importance of paying allowance submissions for LEED certification.

A Hypothetical model for BIM

It is a model of a villa that is assumed to be constructed in Tehran (Figure 1).

The projects location

According to the fact that the project is located in Tehran., latitude and longitude are calculated:

Longitude: 51.4333 and Latitude: 35.6667 (Figure 2).

The application of building information modeling for water harvesting

Precipitation

Climate data are available in websites such as http://www.tehranmet.ir and http://www.irimo.ir/. The following information of Tehran is gathered from Mehr Abad weather Station:

Weather station: Mehr Abad; city: Tehran; weather station type: airports synoptic; date of establishment: 1942; geographical longitude: 51.19, geographical latitude: 35.41; elevation: 1191.

Monthly Precipitation is measured in the form of excel files during water years *via* http://www.thrw.ir/ website and regional weather organizations of Tehran nearer to the location of the project (Tables 2 and 3).

BIM model

We should gather information to estimate the amount of harvested rainwater *via* building information modeling.

Roof level

Rain water harvesting = roof level x monthly precipitation x 0.8

The applicable roof level is calculated as 110.225

(Figure 3).

Sullage (grey water)

This water is the wastewater of households, office buildings and water tanks. This water is different from sewage water which is the water of toilets and sinkhole. Sewage water is extracted from buildings through water treatment systems. To measure the amount of grey water, first we should have a look at our plans and estimate the number of fixtures in buildings, and then we can estimate the amount of water that is gathered. It should be noted that sewage water is not purified.

For this project, we assumed that there are five residents in building, four women and one man. It is also consumed that the building is always in use. So the average amount of applying facilities is thirteen days per month. A number should also be defined for the frequency of using facilities:

- For men, four times for urinating and two times for using toilet.
- Four women have used the toilet five times.

Daily use of water for toilets is calculated as follow:

(Daily use of toilet for each resident)

The average water consumption for toilets is 1.6 gallon, so we have the following equations:

$$4^* 3 * 1.6 = 19.2 \text{ man}$$

$$5^* 2 * 1.6 = 16 \text{ woman}$$

$$16 + 19.2 = 35.2 \text{ gallons}$$

- So in this project we need 35.2 gallons of water every day, and 1056 gallons per month.
- So reclamation of grey water is about 38.6 gallons per day. Multiplying this value to daily occupancy

$$\text{Recycling percentage} \times \text{the number of residents} \times \text{consumption amount} \times \text{flow rate} \times \text{daily use for each person} = \text{daily recyling of gery water}$$

rate, we have 1158 gallons per month.

The analysis of day light

In Figures 4 and 5, the direct and diffuse solar energy of Tehran is shown. According to these graphs, we understand that the maximum direct radiation is in summer and the maximum diffuse radiation is in spring. So by applying methods to prevent unwanted log of solar energy in warm seasons, we have optimal utilization of sun energy. In the figures 4 and 5, the reflection of inner light is shown through ECOTECT application. Applying western, eastern and southern openings for receiving acceptable amount of light is perceived. The reflection of inner light showed that day light is deeper and close to the openings (Rakoto-Joseph *et al*., 2009).

In Figures 6,7 and 8, the frequency of prevailing winds, humidity and temperature are indicated. As it is shown in these graphs, the greatest amount of wind is from west and north west. In addition the highest

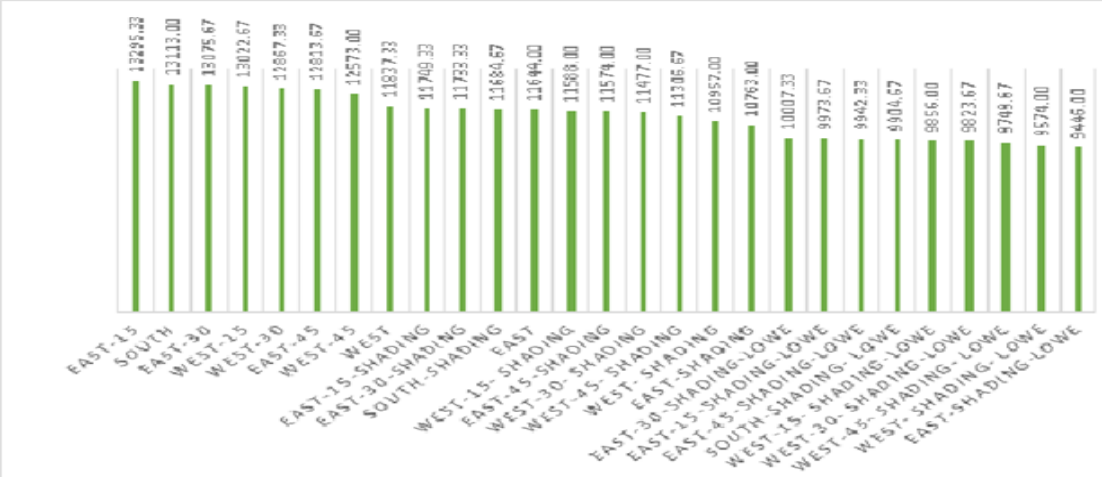

Figure 12. Comparing energy consumption in different orientation *via* energy plus application

temperature is for winds which are blown from west and north west. So, these winds make troubles for resident both in winter and summer. As a result, designing strategy should be applied in which buildings are not located in the direction of wind.

Orientation

Generally, in wilderness areas which have cold winters, buildings should be located in directions which receive the highest amount of sun energy during the year. As it is indicated in below figure that in Tehran, the most parts which are highlighted by yellow are suitable in terms of receiving solar energy. The two figures below show the shadow spectrum in ECOTECT application during a day. According to Figures 9, 10 and 11 building orientation is toward the south.

The analysis of energy

The analysis of energy is done in all orientation by Energy Plus application. In this analysis, it is assumed that the temperature is pleasant. It means that air conditioning systems keep temperature between 23-28^{o}C in summer and 18-24^{o}C in winter.

Low-E glass

Applying low-emissivity glasses that their U-value is lower than single glass profiles lead to energy saving. Imagine that in winter the temperature is lower than zero and you want to keep it on 21^{o}C. If window is made of a 4 mm single profile glass that it's U-value is 6, you need 126 units of energy. But if the window is made of a low-E glass that it's U-value is 1.1, then 1.23 units of energy is required which is 80% lower than what is necessary for ordinary glasses. So, keeping building warm is less costly (Tables 4, 5 and 6; Figure 12).

CONCLUSION

We should gather information from building information modeling to calculate harvested water. When the amount of water harvested is determined, a place is needed to save it. For determining the size of tank there should be a balance between input and output rate. The size of the required system for collecting and saving rainwater depends on the climatic conditions. Generally, tank should be in a size that could provide the water needs of three months in dry weather and one month for humid climate (Ramezani *et al*., 2013)

Mechanical and structural models can be a mixture with architectural models to create an orientation. Software capabilities to perform all aspects of modeling to reach sustainable design are not clear. Since Tehran is not a very cold region and is with optimization of heat and cooling energy, heat energy is not so important, it has the lowest level of energy consumption in east and west. By estimating the exact prices of heating and cooling energy system and hours of using mechanical systems, we will have more detailed analysis.

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