ISSN NO.2395-0692

IJAHMS International Journal of Arts, Humanities and Management Studies

Responses towards the Sustainability of the Environment along with the Material in Sustainable Design: The Case Study of University of Mazandaran

SoufiaAhmadi*, Seyed Ali Seyedian & Maryam Abdollahpour*****

****University of Mazandaran/Babolsar,Faculty of Art and Architecture, Architecture Department, ShahidZolfaghari boulevard***

*****Associate Professorof University of Mazandaran/Babolsar , Faculty of Art and Architecture, Architecture Department, ShahidZolfaghari boulevard***

******Faculty of Architecture, Seraj Institute of Higher Education/Tabriz,Maghsudiyestreet***

ABSTRACT

Sustainable architecture could reduce adverse effects of construction in the environment through designing tools, construction methods and establishing an appropriate relation between the environment and building. Building material serve as a significant role in consuming the resources, energy and the environmental impacts during the life cycle. Therefore, using sustainable materials could have major role in realizing sustainable goals, specifically in environmental dimension. This study has been conducted in order to analyze the amount of awareness and sensibility in architecture students regarding the importance of sustainable materials and the necessity of acquainting the architecture students through effective methods. This cross-sectional study focuses on some senior undergraduate and freshman postgraduate students in the field of architecture in University of Mazandaran. The results indicate that in spite of some shortcomings, the attitudes of the students are oriented and ample motivation for changing the function is generated and teaching precepts require a harmony in managerial structure. All of these endeavors could be applied within the framework sustainable evaluation standards in research education and construction arena.

KEY WORDS: *Environmental sustainability, Innovative Materials, Architect students, Sustainable Architecture, Green Materials, Higher Educational System*

INTRODUCTION

Although it has been more than two decades that the concepts of sustainable development entered into the field of architecture in Iranian universities, up until now no qualitative and statistical evaluations regarding the aforementioned concepts and tendencies have been conducted. Therefore, the research question is based on the explanation of how the mental changes and transformations of the students is formed after acquainting with basic concepts of sustainable architecture and sustainable materials. This study aims to analyze to what extent the students are familiar with the principles of sustainability, especially the role of green materials in sustainable architecture. Then the amount of their enthusiasm about every subjects is examined. The study seeks to answer this major question that, whether the current curriculum and presented courses in public universities could cause sufficient motivation in the students to alter traditional

structure of executive management toward sustainable development or not. Therefore, this study consists of 9 parts. The first part discusses some basic definitions of sustainable development. Addressing sustainable development in architectural designs requires deeper understanding of goals and recommendations of sustainability (Armaghan & GorjiMahlebani, 2009). Therefore, sustainable development is discussed and examined from environmental perspective. Architecture schools also play significant role in educating architects who are cognizant of the fact that their way of thinkingtoward life affect others life through the works they create (NorouzBorazjani, 2011). Hence, there is a special importance and sensitivity towards educating sustainability in fields of architecture in comparison with other fields of study (Khatami &Fallah, 2011). So the second part deals with the significance of sustainability in educating architecture and raises this question that which elements play major role in strengthening this position? The third part focuses on sustainable architecture and its relations with building materials especially the green materials, the role of Innovative Technologies in creating sustainable materials and the necessity of understanding these materials. The next section discusses the methodology used in this study. This study is mainly based on a limited survey conducted of the some students' in the field of architecture in University of Mazandaran. In fifth and sixth parts, the findings got from the questionnaire are explained and finally the conclusion part suggests the findings of study and offer some practical recommendations according to the standards of architectural education matched with the goal of the study.

Sustainable development, sustainable architecture and environmental sustainability

Protecting from the environment, and addressing the needs of next generation put forth a new concept of " sustainability" in the literature of the science and art, then the concept of sustainability is discussed in development and designing artificial environment in micro and macro scales. In fact, this concept is based on three principles of saving environmental resources, designing according to biological cycle and human values, which transform production and consumption processes and lead architecture and Urbanism to get use of environmental forces and harmony with ecology (Hosseini et al, 2008). One of the most common definitions of sustainable development is put by Brundtland Commission: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Sarah &Navidpour, 2008). It also highlights the definition put by International Union for Conservation of Nature and Natural Resources(1991), regarding sustainable development: " improve the quality of human's life within the framework of the capabilities of supportive ecosystem" . Sustainable urban development should create a city matched with the needs of its users. This issue should not only based on the efficiency of energy but also the function of suitable place for living (Breheny, 1995).

The origins of movement towards protecting environment and sustainable architecture traced back to 19thcentury. John Ruskin, William Morris and Richard Lethaby are considered as the first pioneer of sustainable architecture. In his book entitled "Seven Lamps of Architecture" Ruskin mentioned that in order to achieve progress we should consider the harmonic order in nature. Lethaby also asks the architects to appreciate the order and beauty of the nature. Similarly, William Morris highlighted on reverting to green space of suburban areas, self-reliance and reviving of domestic industry and recommended the architects to consider these issues (Feizi et al, 2007, p. 82).

ISSN NO.2395-0692
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Concerning triple goals of sustainable architecture (environmental, social and economic), Bethel McCarthy believes that they are proposed to reach the goals of environmental sustainability, including: creating high-quality environment, reusable characteristics, eliminating waste, using materials which are less transformed, converting wastewater into water, reducing the pollutants (Azizi, 2010). In order to achieve an environmental sustainability, we should strike a balance between three environmental systems- "ecological", "economic sustainability", and "social sustainability" which are considered as "major triple factors". Meanwhile, conducting research about the methods of designing building and offering suitable suggestions for the maintenance and creation of an urban space with high quality could be effective in achieving the goals of sustainable architecture (Williamson et al, 2003).

Significance of sustainability in architecture education

40 percent of the fuel consumption of every country is allocated to the building and 30 percent of energy consumption is related to public transportation that a part of it is consumed in building activities. Therefore, taking any appropriate preparation could be helpful for sustainability and the prevention of environmental pollution (Khatami & Fallah, 2010). Education is a powerful tool to influence society through enhancing the environmental knowledge. In other words, education could develop awareness and expertise of experts, researchers and producers which would influence the decision makers and thereby fostering remarkable development(Edwards, 2009). In order to pave the way for sustainable future, we should make change in type of view, values and individual and collective function of society. Therefore, the crucial role of higher education is undeniable, since the professional decision makers of the society are educated in such field. These people perform a major role in realizing the future goals of sustainability through increasing sensitivity, awareness, knowledge and essential skills, and explanation of sustainable values. Hence, establishing a sustainable thinking has been widely proposed in higher education system especially in the developed and developing countries in the contemporary era (Khatami &Fallah, 2010).

In addition to emphasizing on the necessity of explanation and promoting sustainability thinking through education and research in the educational and research centers, we should consider 4 major factors listed below:

1- Educating and training human resource
2- Sustainable education in the fields of architecture
3- Major role of architects
4- Using modern Technology in sustainable architecture

Therefore, there is a specific significance and sensitivity towards sustainable education in the fields of architecture in comparison with other fields. In sustainable architecture education, the way of exploiting and protecting the earth, water, soil and energy, frugality in transportation, engineering, building materials, collecting and integrating building systems and versatile usages matched with human and vernacular values have been taught to the students. In order to achieve educational and cultural goals in Iran over the past decades, these measures have been taken:
- proposing interdisciplinary majors to address these issues such as Architecture and Energy
- Including courses related with sustainable construction issues in the majors such as Architecture and Urbanism included Climate and Architecture, Energy and Architecture, Architectural Design based on sustainable architecture.

- proposing courses related with concepts of sustainability in higher education level and even in lower level of education for the next generation in the future (Sayyad, 2011).

The important issue in this education is interaction of fields and its purposefulness in fitting the future generation for leading the society in an appropriate way (Memariyan, 1992). In this way, according to the definition of educational system, we should address three factors of aim, planning and evaluation in the current education system of architecture (Azizi, 2010).

Sustainable architecture's Viewpoint of building materials

The basisof using building materials and the way of construction matched with sustainability views, are discussed as below (Khatamai&Fallah, 2010):

1- Using appropriate methods of designing to decrease the consumption of materials and increase their efficiency.
2- Using building materials in which the amount of energy consumed in production and usage of it has been reduced
3- Using optimized executive methods which would minimize material wastage in construction
4. Emphasizing on the usage of building materials which could be recycled or reusable after passing its shelf life

Considering the abovementioned conditions and solutions, we can achieve the goals of sustainability in designing and construction. In the sources and guidebooks related to the fields of sustainability and green buildings, to evaluate the quality of materials, the title "Embodied Energy"- the amount of energy consumed for producing an object- has been proposed, which is considered as one of the important criteria of evaluating the quality of building material and determining the type and use position of proposed materials in a building (Roaf, 2001).

However, according to the researches done in the field of green buildings, in order to select optimized materials some factors have been proposed which make it necessary to examine the significance of materials in environmental impacts of the whole construction process. Even some executive strategies should be considered before the initiation of construction operations and in the planning phases, so that the building in the construction, utilization and destruction phases have maximum compatibility with its environment and adapt with potential changes in usage and climate changes.

ISSN NO.2395-0692
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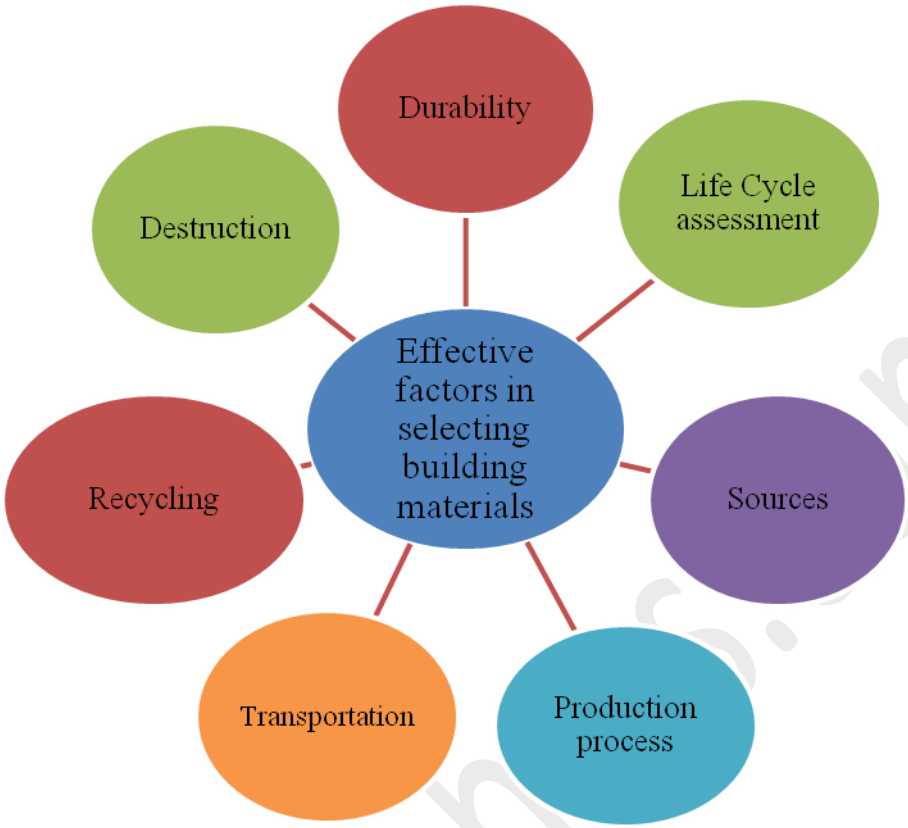

Chart 1. Effective factors in selecting optimized materials (Motevalli&Seyedian, 2015)

The role of green materials and the importance of their 'EmbodiedEnergy'in the process of sustainable development

In the past times, major materials were clay, mud and brick, now this question arises that considering the development of materials and construction technologies, how can we have the architecture which is compatible with sustainable development? (Mahmoudi&Nivi, 2011). Today, due to the existence of some problems such as global warming, air pollution, indiscriminate consumption of energy and its high economic costs, natural resource shortage, using technologies of sustainable architecture especially green materials has gained considerable significance. Daily production of urban dirt and debris in Tehran city is five times more than urban trash and every day 40 thousand tons of construction waste has been produced in this city, caused by high volume of destruction and renovation of buildings in Tehran (Mohammadi, 2007).

The theory of recycling the buildings and their internal elements are part of the history of architecture. Santa Elbas Monastery which is renovated during 1077 and 1115, used the bricks of ancient Roman building in their vicinity. The wooden frameworks used in the medieval times, were pieces of wood cut in the Carpentry workshop and attached with each other, then were codified and separated from each other and moved to be used in the buildings (Foroughi, 2009), which are a group of green materials- materials got from construction waste- and more or less we have considered them within the goals of sustainability. In fact, green materials are the materials produced from less harmful substances, used less natural resources, have green environmental

characteristics and in comparison with other materials have more recycling capability (Zarei&NabiMeibodi, 2011).For instance, in the Hearst Tower, 80 percent of recycled materials has been used in its building, and in NBA Bank there is 80 percent of recycled materials in its building and 90 percent of recycled steel in its designing, in both of these cases, the designer chooses building materials to cause less pollution (Bachman, 2003). In summary, the major benefits of these materials are as below:

- Converting and saving energy
- Environmental adaptability and being reversible
- Environmental health, the capability of returning to the cycle and renewability
- Reduce maintenance costs
- The best designing and flexibility (Atman &Zohri, 2011).

Moreover, biomaterials including biological polymers and plastics, Nanomaterials and etc, are also in this category. With the emergence of innovative and intelligent Technologies in combination with these materials, another step along with the achieving the goals of sustainable architecture has been taken.

The role of innovative Technologies in sustainable construction: using innovative materials and the necessity of knowing it

Technologies and new developments in some fields such as in designing and construction, pave the way for having access to new building materials (Ahmadi, 2004).They are also used in green buildings in an effective and innovative way. It is obvious that using technology without environmental considerations would not only solve the problems but also result in irrecoverable consequences (Shaeri&Rahmati, 2012), hence, in green buildings, in addition to the clever use of innovative technologies and managing the exploitation of nature, we address some other subjects of designing so that we could achieve sustainable development from various perspectives.

Using innovative constructional systems is considered an important factor in achieving the goals of sustainable development, which could lead to increasing usage of appropriate constructional systems and the cause of changes in urban resilience (Khatami &Fallah, 2010). Similarly, understanding innovative materials in a practical way could encourage the architects to use these materials the great benefit of which would be optimization and effective management of energy along with the goals of sustainable development (Gorji& Haj-Abutalebi, 2009). Architects should fully understand new materials and pay attention to their proper usage and combine them with network equipment to design the buildings. In fact, the presence of architecture in this field would not be understood unless we consider the significance of sustainability, environmental threats and producing clean energies (Ziabakhsh, Bahaeddin& Zia-al-Haq, 2013). Therefore, it is expected from the designers of future buildings to use these innovative systems and safety considerations in the buildings and create safeand healthy environment which is not only economic but also has effective and useful effects on the protection of environment. Hence it is incumbent on the architects and those who are involved in construction to understand the characteristics of these materials and use them in buildings (Naghavi&Seyyedian, 2015).

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METHODOLOGY

This research used quantitative analysis, mainly based on a limited survey conducted of the architect students' attitudes under study in University of Mazandaran. In this study, the Likert Scale Questionnaire with a four point scale is used which suggests how much the individuals agree or disagree with a particular statement (See the Appendix). The five point scale would lead to the reduction of variance, since it is likely that most respondents opt for the middle option. Therefore, in order to provide qualitative answers, we consider four point scales. Statistic society of this study consists of some senior undergraduate and freshman postgraduate students in the field of architecture in University of Mazandaran,whichSimilar to other public universities teach under the syllabus of the Ministry of Science of Iran. Since the volume of statistic society is 78, the information of 65 individuals have been collected, and with eliminating incomplete questionnaire, we have the information of 62 people. Based on these information we use statistical software (Excel) to analyze the information and present it statistically through the graphs.

Findings

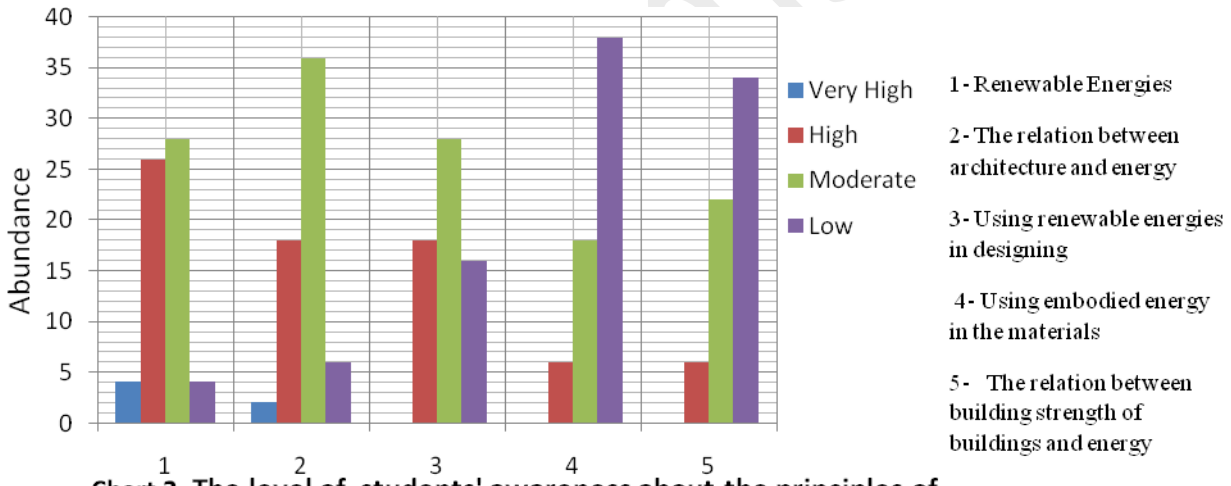

Chart 2. The level of students' awareness about the principles of sustainable architecture

As it is obvious in Chart 1, the level of students' awareness about the principles of sustainable architecture is examined in 5 items. If we investigate them separately we find that the level of the students' awareness in items 1 to 5 is gradually decreasing, and the most level of awareness is about renewable energies. If we want to examine the table in an average way in the chart, we realize that approximately %32 of the students have low awareness, %42 of them have moderate, %24 high and %2 very high awareness. Therefore, the architecture students participated in the survey have low awareness about the principles of sustainable architecture.

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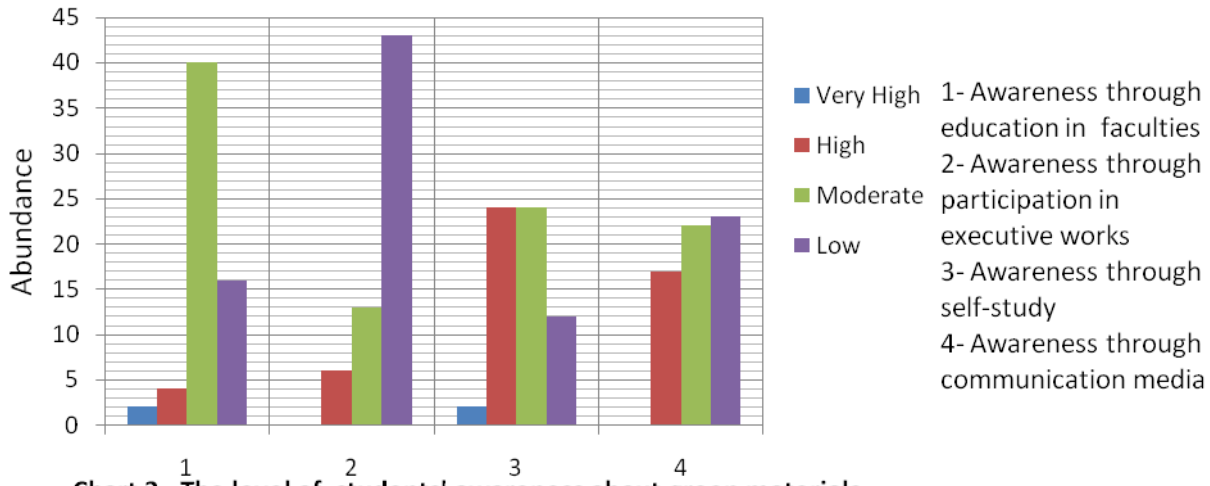

Chart 3 . The level of students' awareness about green materials

As we can see in Chart 2, the level of students' awareness about the green materials is investigated in 4 items. If we examine them separately we find that the level of students' awareness about the green materials is relatively low, and in average approximately %38 of students have low awareness, %40 of them moderate, % 20 high and %2 have very high awareness.

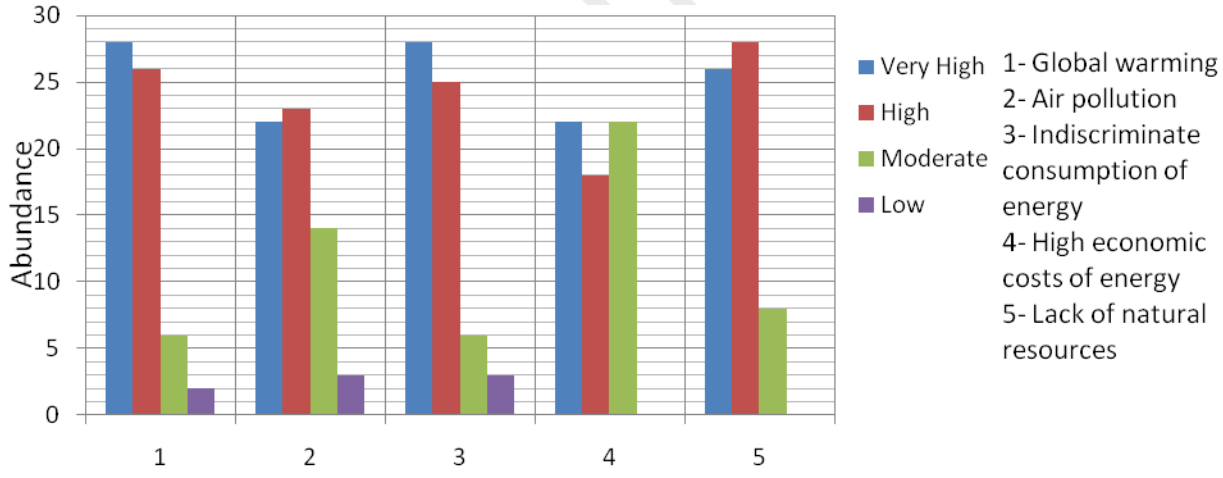

Chart 4. The level of green material's significance for usage

As can be seen in Chart 3, the level of the significance of green materials from the perspective of students is analyzed in 5 items. If we want to examine each of them separately, we will realize that %3 of students mentioned a lower role, %18 moderate, %39 high and %40 very high role of factors listed above. Therefore, if we add high and very high percentages in total or minor average, we will have considerable statistics which indicate great importance of environmental and even economic issues in using green materials from the students' viewpoint.

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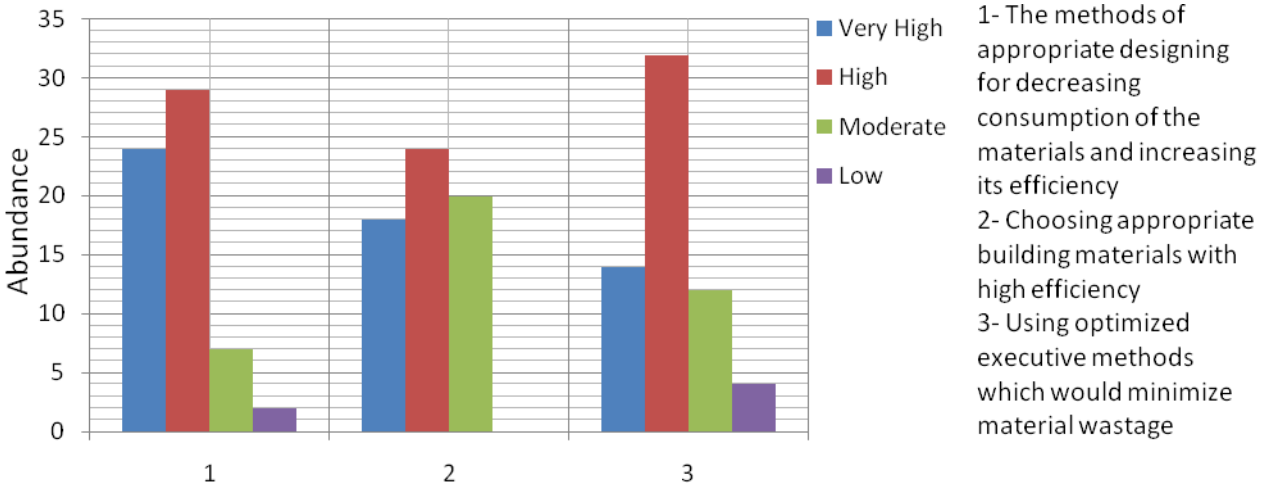

Chart 5. The role of each of the main factors for using building materials in sustainable construction

According to the Chart 4, the role of major factors in using materials in construction process along with the goals of environmental sustainability are analyzed in 3 items. If we add high and very high percentage, we will have significant statistics which suggest great importance of these three items in sustainable construction from the students' viewpoint.

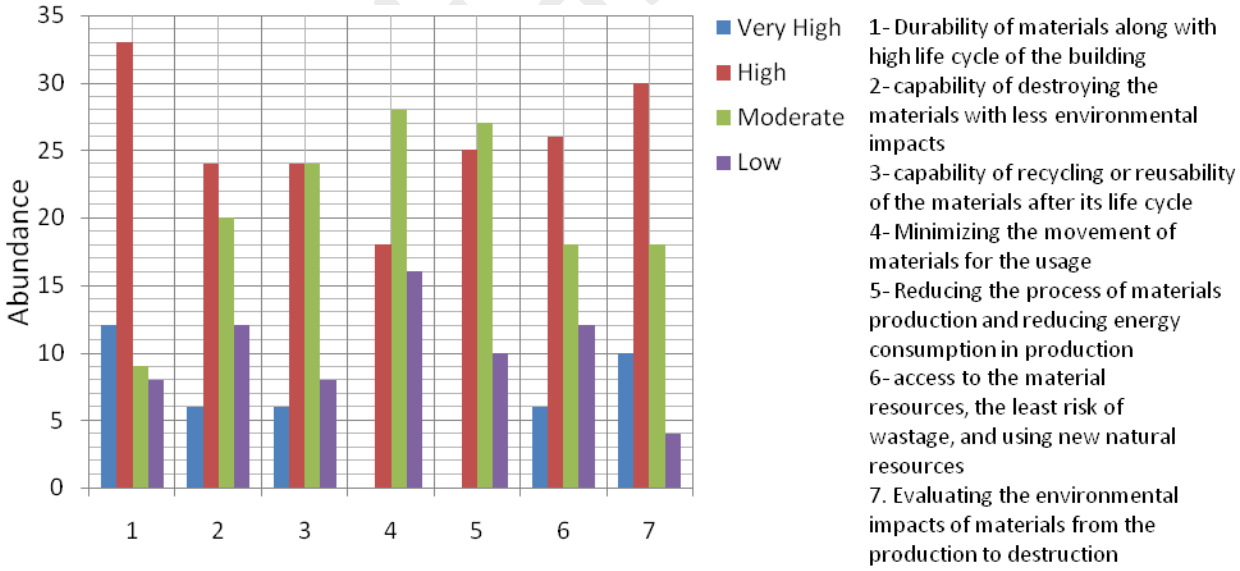

Chart 6.The level of attention to material selection factors in the procedure of educating in order to achieve the goals of enviromental sustainability

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In Chart 5, the level of attention to material selection factors in the procedure of educating in order to achieve the goals of environmental sustainability is analyzed in 7 items. If high and very high percentage in each factors of 1, 5 and 6 is added together, there will be relatively significant amount, but in the factors of 2 and 3, these amount has a little decrease and in the factors 4 and 5 there is a huge increase. If we want to examine them separately, we realize that the importance of these factors in comparison with factor 2 in Chart 4, have a significant decrease. Considering this, from the perspective of %16 of the students, these factors have less importance, %33 moderate, %42 high and %9 of them consider them very high.

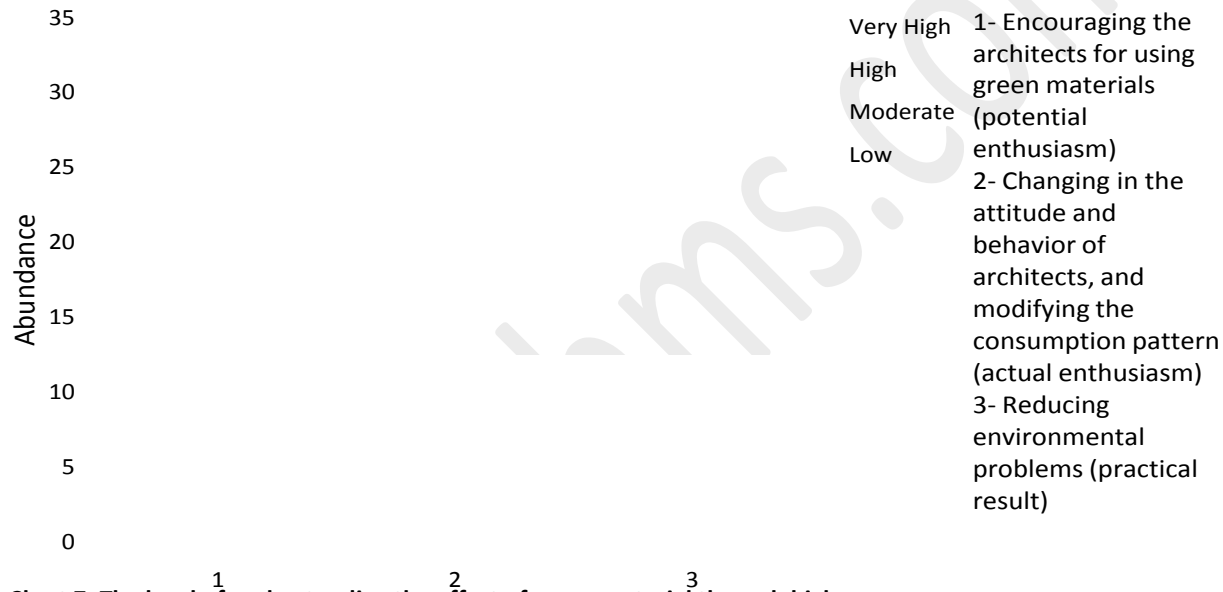

Chart 7. The level of understanding the effect of green material through higher educational system

As shown in Chart 6, the level of understanding the effects of green materials through higher education system is analyzed in 3 items. The findings suggest that if we add high and very high percentage in the first factor, we will have considerable amount, but in the factors 2 and 3 this amount decreases respectively. If we investigate them separately, we will realize that %12 of the students confirm its low effect, %40 its moderate effect, %30 high effect and %18 mention very high effect. Therefore, the majority of the students confirm relatively high effect of education regarding the understanding of materials and sustainable construction through the universities.

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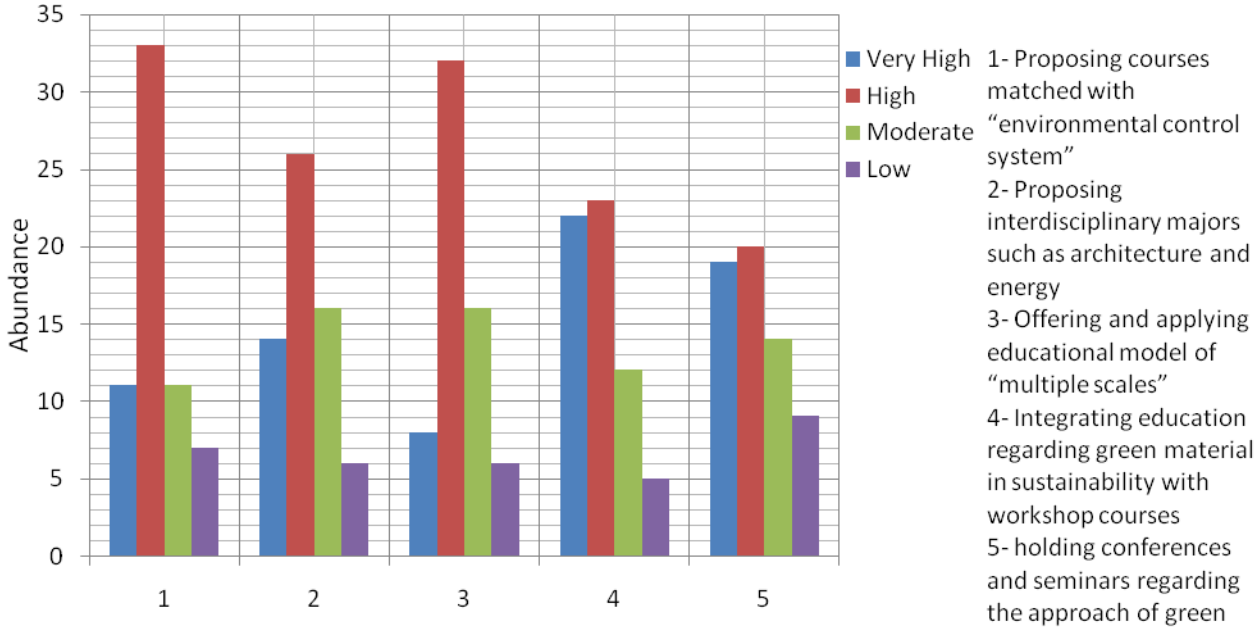

Chart 8. The level of influence of various educational procedures in understanding sustainable materials

As it is indicated in the Chart 7, the level of influence of various educational procedures in understanding sustainable materials is analyzed in 5 items. If we want to examine them separately, we will realize that %11 of the students confirm low effect, %22 moderate, %43 high and %24 very high effects of these educational procedures. If high and very high percentages are added (whether in total average or in every one of procedures), we will witness significant amount which indicates high effect of higher education procedures in understanding the materials.

The discussion and analysis

Analysis1: According to the Chart 1, students have the most awareness about the principles of sustainable architecture regarding renewable energies and have the least awareness of the material's embodied energy and the relation between strength of building and energy. This issue is the reminiscent of students' superficial understanding of the principles of sustainable architecture. However, during the last years there have been many international and domestic journals in the library of universities which allocated many papers to this issue.

Therefore, having deep understanding of renewable energy in architecture which leads to practical and more detailed and awareness of students in the fields of architecture, especially the relation of energy with materials which should be given special attention. Furthermore, according to the data collected, the level of positive awareness of post graduate students in comparison with undergraduate students about the principles of sustainable architecture is more than %20.

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Analysis 2: According to the chart2, unlike communicational media and self-studies, faculties have minor role in education and require more comprehensive and deeper education of this field of study. Meanwhile, the undergraduate students usually trust the media, and educations of faculties and refrain from referring to the books or library sources. However, postgraduate students tend more to self-studies which indicates that the majority of these students have more awareness of green materials. Moreover, the average awareness of the undergraduate students through executive activities is % 0, which indicates delayed entry of the architecture students into the real labor market or the lack of sustainable approach to using materials in the workplace. Understanding and awareness through executive activities could play significant role in shaping the mentality of undergraduate students which is not observed in the students under study, therefore it is necessary to pay close attention to the importance of this issue along with education.

Analysis 3: Considering that the majority of students confirm the great significant of green materials based on environmental reasons (Chart 3), it seems that understanding this issue does not encourage them to have enough information about materials (Chart 2). However, they indicate a positive tendency toward education and recognition (Chart 7).

Analysis 4: The students have low level of awareness regarding the relation between energy and materials in the architecture (Chart 1), but indicates a positive tendencies towards the educations in the faculties (Chart 5).

Analysis 5: In spite of the fact that from the views of the students, understanding green materials encourages the architects on the grounds of sustainable construction and sustainable materials, we have not witnessed desired effects in architects' change of consumption pattern (Chart 6). Maybe one of the reasons could be lack of deep and sufficient understanding of students and architects about using green materials in designing. Furthermore, the role of factors such as costs, the wishes of employers, accessibilityetc., could influence achieving the expected results.

Analysis 6: According to Chart 7, architecture students not only consider the courses of architecture as an important factor in defining the position of architecture and sustainable architecture but also agree with the integration of these courses with workshop, and practical courses as well as holding seminars with such approaches.Therefore, good and detailed plan about the quality of holding these seminars and workshops should be devised.

Analysis 7: Chart 7 indicates that the majority of students are agree with educational procedures in increasing awareness of green materials in sustainable designing. However, as it is indicated in (Chart 1, 2), low awareness of students through the education in the faculties indicates that current educational system is not fully responsive to the needs of this field and certainly needs educational reforms.

Analysis 8: As there is a change in the level of students, from undergraduate to postgraduate, we have witnessed low effect in the level of their awareness and understanding, but they show a wide perspective of sustainable architecture and the role of materials in education.

Final Analysis: On the one hand, the majority of students' emphasis on some subjects regarding sustainability and sustainable material in their education curriculum, and low awareness of them about this issue on the other hand, indicate the existence of non-comprehensive subjects in the university.

CONCLUSION AND SUGGESTIONS:

The international community needs global collaboration to reduce environmental pollutants, energy consumption and thereby protecting from natural resources and global heritage. To this end, some educational measures should be taken in various social levels especially the universities. Meanwhile, architecture students have significant role in learning these issues, and it is incumbent on them to gain a deep understanding of materials, since materials have crucial role in sustainable designing. Therefore, this study indicates that current educational structure needs fundamental reforms, due to its inability to acquaint the students with the concepts of materials. In this vein some suggestions are proposed as below:

1- Understanding the materials through the comprehensive education: the function and usage of these materials matched with environmental protection and saving energy factors. Since some executive solutions, should be considered even before the initiation of constructional operations, so that the building in construction, utilization and destruction phases have maximum compatibility with the surrounding environment and adaptation with potential changes in usage and climate changes.

2- Understanding green materials and the effect of innovative Technology in the production of materials with sustainability approaches

3- Integration of courses regarding materials with workshop courses

4- Holding Conferences and seminars in order to familiarize the students and architects about these materials and their role in sustainable designing

5- Allocating related courses

6- Communicating with other universities and research centers within or beyond the country to exchange scientific experience

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Appendix A

This questionnaire seeks to analyze the necessity of learning environmental sustainability with an emphasis on the role of materials in sustainable designing among architecture students. Analyzing the level of students' awareness of construction using sustainable materials, the questionnaire indicates the views of students regarding the importance of this issue, education and finding suitable solution to have a comprehensive educational methods.

Age: …… Study Level:……..

How much is your level of awareness about the **principles of sustainable architecture**?		1	2	3	4
No	Related Factors	low	Moderate	High	Very High
1	Renewable Energies				
2	The Relation between Architecture and Energy				
3	Using Renewable Energies in Designing				
4	Using Embodied Energy in the Materials				
5	The Relation between strength of Buildings and Energy				

How much is your level of awareness **about green materials (sustainable materials)**?		1	2	3	4
No	Related Factors	low	Moderate	High	Very High
6	Awareness through Education in Faculties				
7	Awareness through Participation in Executive Works				
8	Awareness through Self-Studies				
9	Awareness through Communicational Media				

ISSN NO.2395-0692
IJAHMS International Journal of Arts, Humanities and Management Studies

To what extent do the reasons below influence the **importance of green materials**?		1	2	3	4
No	Related Factors	low	Moderate	High	Very High
10	Global Warming				
11	Air Pollution				
12	Indiscriminate Consumption of Energy				
13	High Economic Costs of Energy				
14	Lack of Natural Resources				

To what extent do the factors below influence **the Usage of Materials** in Construction Process along with Achieving the Goals of Environmental Sustainability?		1	2	3	4
No	Related Factors	low	Moderate	High	Very High
15	The Methods of Appropriate Designing for Decreasing Consumption of the Materials and Increasing its Efficiency				
16	Choosing Appropriate Building Materials with High Efficiency				
17	Using Optimized Executive Methods which would Minimize Material Wastage				

To How much attention does each **material selection factor** need in **educational procedure** to achieve the goals of environmental sustainability?		1	2	3	4
No	Related Factors	low	Moderate	High	Very High
18	Durability of Materials along with High Life Cycle of the Building				
19	Capability of Destroying the Materials with Less Environmental Impacts				
20	Capability of recycling or reusability of the materials after its life cycle				
21	Minimizing the Movement of Materials for the Usage				
22	Reducing the Process of Materials Production and Reducing Energy Consumption in Production				
23	Access to the Material Resources, the Least Risk of Wastage, and Using New Natural Resources				
24	Evaluating the Environmental Impacts of Materials from the Production to Destruction				

ISSN NO.2395-0692
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To what extent does the **understanding of green materials through the higher education system** can influence the factors below?		1	2	3	4
No	Related Factors	low	Moderate	High	Very High
25	Encouraging the Architects for Using Green Materials (Potential Enthusiasm)				
26	Changing in the Attitude and Behavior of Architects, and Modifying the Consumption Pattern (Actual Enthusiasm)				
27	Reducing Environmental Problems (Practical Result)				

To what extent do the **educational procedures** mentioned below influence the understanding of materials along with achieving the goals of environmental sustainability?		1	2	3	4
No	Related Factors	low	Moderate	High	Very High
28	Proposing Courses Matched with "Environmental Control System"				
29	Proposing Interdisciplinary Majors such as Architecture and Energy				
30	Offering and Applying Educational Model of "Multiple Scales"				
31	Integrating Education Regarding Green Material in Sustainability with Workshop Courses				
32	Holding Conferences and Seminars Regarding the Approach of Green Materials in Architecture				