A FRAMEWORK FOR SUSTAINABLE ARCHITECTURE IN IRAN WITH EMPHASIS ON THE VIEWS OF SCHOLARS

M.A. Nemati, M.R. Bemanian*, M. Ansari
Department of Architecture, Tarbiat Modares University, Tehran, IRAN
*Corresponding author: bemanian@modares.ac.ir

Abstract
Development of the built environment needs to be addressed in a way that is socially and ecologically responsible. There is great urgency to make sustainable interventions in Iran, while built environments are being created without the above engagement. Lack of awareness and consensus on sustainable actions needs formulation of a framework set by scholars analyzing effects of its components in a comprehensive model. The need to develop an instrument for investigation of views of scholars has instigated the researcher to collect the necessary data through interviews and prepare a research questionnaire. Moreover, the exploratory factor analysis survey method was employed, so that structural equation can be used for modeling purposes. The results led to development of a theoretical model to describe views of sustainable architecture in Iran. Results show that environmental and productivity in the use of nature aspects of buildings is the cause of transition to sustainable architecture. Technology, construction and operations of buildings aspects as mediating variables have effects on environmental awareness as dependent variable of transition to sustainable architecture in Iran. The results can pave the path for further research in this area and orient the research priorities for sustainable architecture in Iran.

Keywords: Architecture, Iran, Scholars, Sustainability.

Article history:
Submitted: 19/01/2017; Revised: 27/03/2017; Accepted: 26/04/2017; Online: 07/05/2017

INTRODUCTION

The complexity, wide scope and ambiguous goals of sustainable development, have made it difficult to implement the solutions. Selection of methods and priorities for sustainable development is associated with significant controversies. It can be said that the interactions of environment and human needs have significantly increased complexities in this field. This dichotomy can be clearly observed in areas such as weak sustainability vs. strong sustainability, brown agenda vs. green agenda as well as shallow ecology vs. deep Ecology (McGranahan & Satterthwaite, 2000). Sustainability when characterized by Holism and entanglement, deals with environment, economy as well as human society and culture. Validity of decisions is determined based on their proximity to the common areas of the above-mentioned categories (ISO FDIS15392, 2008). Thus, each of the major principles of environmental, sociocultural and economic sustainability can guarantee some associated goals (Almasi, 2009).

In recent interpretations of sustainability, economic sustainability is dependent on the fulfillment of social sustainability. Sustainable economy is covered by sustainable society. Sustainable development in the brown agenda approach holds that the sustainability of society and economy will not be realized without a sustainable ecology (Williamson et al., 2003). The International Council for Research and Innovation in Building and construction showed that the status of construction industry depends on interpretations between sustainable development, and social and economic conditions Which may vary from one country to another (Bourdeau et al., 1998). Development of cultural values and promotion of ecological thoughts and behaviors is essential for development of a new and better life in developing countries (Almasi, 2009).

This study seeks to link the theoretical areas of the subject to the conditions of construction in Iran. In this way, challenges between environment and construction in all areas have been considered the same, but differences are in finding solutions appropriate to the circumstances of each area. The authors try to redefine the problem and the solution in the correct direction with respect to existing facilities in Iran. This article tries to explain the factors affecting sustainable architecture, and provides solutions to improve the environment. Accordingly, research problem and its dimensions have been investigated and solutions are discussed. The need for an instrument for investigating attitudes and views of scholars and practitioners of sustainable architecture has instigated the authors to collect the

necessary data through content analysis method. Exploratory factor analysis survey and path analysis are employed to derive latent variables and highlighted issues for further researches.

APPROACHES TO SUSTAINABLE ARCHITECTURE IN IRAN

The construction industry is one of the major resource consumers and waste generators, which has several environmental, social and economic impacts (Gravina & Sattler, 2009). The alternatives,such as recycling and reuse, for reentering building materials and components in the production chain have gained more attention due to the growing international community's concerns about environment (Couto, 2007). Each year more than three billion metric tons of raw materials are used to manufacture construction materials and products worldwide. This is about 40–50% of the global economy's total flow. The inclusion of hidden flows is estimated to be more than double the consumption of resources for construction materials (Calkins, 2009). Building phases including construction, operation and demolition use approximately 30–40% of all primary energy utilized worldwide (Asif et al., 2010). Also, it is estimated to consume15% of the world's fresh water resources (Gunnell, 2009) and produce approximately 40–50% of the global output of greenhouse gases (Asif et al., 2010).

Sustainable architecture, as a solution to the construction industry, is considered part of the integrated sustainability system (Du Plessis, 2007), as well as a way to fulfill its responsibility towards environmental protection (Saghafi & Hosseini, 2011). Agenda 21 for Sustainable Construction in Developing Countries defines sustainable construction as a comprehensive process to restore and maintain harmony between the built and natural environments and reinforce dignity and equality (Du Plessis, 2002).

Since sustainable construction can be regarded as a subset of sustainable development, it definitely requires a continuous process to create a balance between environmental, social and economic dimensions (Du Plessis, 2007). In Sustainability in Building Construction document of ISO (ISO / TC59 / SC17, 2008), 3 dimensions are defined as follows:

- Economic Dimension: In addition to direct and short-term considerations, sustainability is supposed to cover life-cycle costs as an instrument to measure the long-term costs.
- Environmental dimension: Sustainability should create a balance between renewable and non-renewable resources. Negative effects on the quantity and quality of resources through local and global ecosystems should be monitored.
- Social dimension: social aspects of sustainability are based on ethical principles, and recognize the intrinsic value of ecosystems, traditions and cultures. Also, in the matter of social dimension, Cultural values, human rights and quality of life must be taken into account (ISO FDIS 15392, 2008).

While there are many similarities between developed and developing countries, the differences are even larger, and the scope of the problems is more extreme. There is a sense of urgency about introducing sustainable construction practices in Iran. Firstly, the country is still largely under construction and every minute means the construction of a building that will, in all likelihood, not be sustainable. Secondly, the pressures on resources mean that we cannot afford to make mistakes and have to make sure that what is being constructed now will be sustainable. However, sustainability is still a relatively new concept for the construction industry in Iran, and it is not yet receiving sufficient attention (Samari, 2012). Society and government faced with the extreme survival issues prevalent in the developing world tend to adopt a crisis-management approach to development with little regard for the long-term impact of their actions on both the environment and society (Du Plessis, 2007).

Thus, while it is agreed that we share a common goal (achieving a state of sustainability) the authors realize that there are different ways of defining and meeting this goal. These ways can best be determined at local level. The study, therefore, merely provides a loose framework of areas in which research is needed, and places the emphasis on developing enablers Similarly, the suggested actions have to grow from local initiatives, making use of local strengths and addressing local barriers. The value of the strategy for action lies in providing a global strategy that can be used by local champions to encourage action within their own communities (Du Plessis, 2003).

Scholars seek to replace professional responsibility with legal obligations in an attempt to develop ethics and skills (Almasi, 2009). In developing countries, sustainability mainly emphasized on social and economic equity and non-technological issues. Moreover, recognition of the cultural, social and political conditions is essential to identify the most appropriate strategies for sustainability in the built environment (Du Plessis, 2007).

Agenda 21 on Sustainable Construction (A21SC) has worked to create a conceptual framework that coordinates the global concept of sustainable development and the construction industry (Du

Plessis, 2005; Sjostrom & Bakens, 1999). To address the specific problems of developing countries, the International Environmental Technology Center (UNEP-IETC), in collaboration with the United Nations Environment Programme, has undertaken to prepare the Agenda 21 for Sustainable Construction in Developing Countries (A21SCDC) A21SCDC report in 2002 was presented in Johannesburg Executive Program (Du Plessis, 2002). This report indicates that developing countries have the potential to use their cultural heritage and traditions, and offer innovative solutions for natural environment in order to obtain a key to sustainability. In the developed countries, solutions are generally sought in new technologies. In developing countries, policies are people-centered development. People-centered development is an approach that focuses on improving local communities' self-reliance, social justice, and participatory decision-making (Kamp et al, 2003).

Attitudes to sustainable architecture in Iran are varied due to fluidity of the sustainability. This issue has been addressed in different areas of expertise and study (Table 1).

Table1: Attitudes towards sustainable architecture. (Source: Authors)

Approaches	Aims and Scope	Period	Main components	Strategies	measures
Resources Energy-oriented	Political Economic	Early 70s	Energy efficiency, Climatic architecture	Climatic architecture, Passive and active systems, Recycling	Use of renewable energy, Energy-efficient components, Reducing energy consumption, recyclable materials
Environment-oriented	Political Social	Late 70s	Health, Environmental Quality, Optimized performance of architectural spaces	Environment sensitive architecture	Use of low energy facilities, Examples of reconciliation with nature
	Social Environmental	Early 80s	Indoor Environmental Quality, Visual comfort, Interaction between building and nature	Green movement, Changes in organizing the built environment	Organizing Site, Indoor Environmental Quality, Visual and thermal comfort, Materials selection, Construction practices
Ecology-oriented	Cultural Vernacular	80s	Phenomenon in context	Contextualism	Inspiring from nature, Local and cultural history of the project, Architectural adaptation with context
	Traditional Cultural Social	90s	Technology and ecology	Ecotech architecture, Integration of technology and ecology, Least environmental damage	Inspiring from natural systems by technology
Holistic approach	Social Environmental Cultural	21st century	Balance, Integrity of the environment, Systematic approach	Context sensitive architecture, Responsive to Environment, Culture, Economic issues	Dynamic interaction between Social, Cultural, Natural and Physical layers

Some Iranian scholars regard sustainability as an important goal of architecture and believe that reduced energy consumption and preservation of natural resources are basic steps. Today in Iran, energy-oriented approaches have received a lot of attention (Mofidi, 2008). Emphasizing on importance of sustainable architecture as an architectural response to the recent crises, some believe that architecture features two dimensions: environment and society (Mousavi & Mahdavinejhad, 2013). They consider sustainability as a response to human life and promotion of maximum physical and psychological comfort in the context of the environment (Mofidi, 2007).

At the same time, some scholars believe that sustainable architecture is by no means a vernacular architecture, but more comprehensive (Moardi et al, 2013). They define vernacular architecture as a perfect example of sustainable architecture. Accordingly, they regard society as the beginning of sustainability and believe that acceptance of technical issues requires fundamental changes in people's way of thinking (Fallah, 2005). In this regard, sustainable architecture is not merely a style to conserve resources or a way to reduce the environmental damages, but is considered a necessity to respond to the needs of human societies.

Others emphasize on the combination of values and believe that sustainable architecture requires technical knowledge in design and construction processes in order to create Eco-friendly environments (Almasi, 2009).

In general, it seems that today the so-called sustainable architecture in Iran is used for a wide range of critical approaches to the environment. Diversity of perceptions has made some critics

conclude that the concept of sustainable architecture should not be considered as a complex architecture version, but should be taken into account as an approach with formation of new attitudes towards the factors affecting the built environments (Eynifar, 2009).

In the extensive spectrum of sustainable architecture, either professionally or theoretically, it is claimed that the isolation of the term "sustainable" from architecture will be temporary. Architecture will incline towards a more environment-sensitive and provident approach (Samari, 2012).

PROPOSED THEORETICAL FRAMEWORK

Sustainable architecture is based on a comprehensive perception of design. It can be argued that with a holistic system, sustainability is able to be achieved. The authors believe that for systematic access to issues related to social, economic and environmental conditions in Iran, it is necessary to understand the intellectual structure of scholars in this field.

In order to achieve the theoretical model of the study, components of sustainable architecture are identified with a comprehensive overview of sustainability issues. Accordingly, three sets of Environmental and Productivity in the use of nature criteria, Socio-cultural criteria as well as Technology and Construction criteria, were identified as the main factors affecting sustainable architecture. Research hypotheses are:

- The productivity and ecological adaptation affects Building efficiency.
- Technical Components through mediation of social and cultural components affects environmental awareness.
- Environmental factors, intelligent interact with the environment and socio-cultural factors affect the continuation of temporal-environmental awareness.

As the diagram 1 shows, theoretical model of the study consists of six major components and some of them have effective relationships. In general, Environmental and Productivity in the use of nature criteria, affect the Socio-cultural criteria by influencing technology and construction criteria. Efficiency in Construction and Operation of Buildings and Technical components, are mostly affected by the Environmental criteria. Moreover, all components of the model finally affect temporal and environmental awareness components. This factor is directly affected by environmental and socio-cultural factors in a systemic relationship.

RESEARCH METHODOLOGY

The need for an instrument for investigating attitudes and views of scholars and practitioners of sustainable Architecture has instigated the authors to collect the necessary data through interviews and content analysis method to prepare research questionnaire. Content analysis can be considered as a method for conversion of qualitative data to quantitative data (Flick, 2014).

The initial questionnaire is designed as a descriptive non-experimental instrument through the survey (James, 2012). In addition, since the content obtained from the analysis of the interviews don't have the necessary theoretical commonalities, heuristic method was used through factor analysis. Next, exploratory factor analysis survey is employed. After determination of the validity and reliability of the survey, correlation study is used to perform structural equation modeling in order to test the research hypotheses. In this study, regression analysis was conducted using SPSS, Ver.17 software and then the software Amos, Ver.18 was used for hierarchical regression and factor analysis, in order to reach structural equation modeling.

The results led to development of a theoretical model for description of sustainable architecture in Iran from the perspective of scholars. In the present study, 3 hypotheses were formulated and validated. The results can Pave the path for further research in this area and orient the research priorities for sustainable architecture in Iran.

RESEARCH STEPS

Interviewing Scholars

Conduction of an interview through content analysis is the first step in designing a questionnaire as the research instrument. In content analysis, the researchers attempt to make inference from the data, about certain aspects of the text and explain the inferences based on perception of key components of the research system (Krippendorff, 2005). Accordingly, the scholars were interviewed based on the information obtained from the theoretical literature (Table 1), in an attempt to infer the basic elements of sustainable architecture in Iran.

Framework of Interviews was based on the theoretical literature, and the vote of architectural scholars and practitioner on sustainable architecture in Iran and the hypothesis of the study. All the

respondents had the same characteristics such as membership in the top-ranked departments of architecture in terms of sustainability, supervision of dissertation in this field and professional backgrounds in sustainable architecture. Views were analyzed through Content analysis in order to provide a basis questionnaire.

The views of interviewees were documented in order to achieve the target-content table and develop the research questionnaire. First, the detected approaches were formulated comparatively (Table 2). Then, the research data and descriptive statements required for development of the questionnaire were collected (Table 3).

Table 2: Comparative approach to the views of interviewees. (Source: Authors)

Interviewee	Emphasis	Attitude	Extents of the Subject	Approach
Interviewee 1	Technical View of the issue	Past-oriented, technology-oriented	Specific and partial	Technology-oriented
	Harmony with nature, Proper aspects of the design	Holistic, Participatory, Cultural	Comprehensive, up to date, systematic	Environment-Oriented, Ethical
Interviewee 2	Problem solving methods	Holistic approach	Relatively wide	Environment, energy and natural resources, history of architecture
	Continuity of meaning and identity	Qualitative approach to sustainability, Logical process	The general principles	Environmental, Historical, Vernacular
Interviewee 3	Normative approach to the subject	Holism, Architectural principles	Extensive	Contextualist
	Ideology, culture, Reform in Construction methods	Participatory attitude in process, Interactions of resources and site	Comprehensive, coherent, Participatory methods	Contextualist, Environmental, Cultural
Interviewee 4	Proper understanding of the problem	Flexibility	Focused on human and general extents of architecture	Social, Cultural, Holistic
	Necessity of education	Energy, environment, Engineering	Comprehensive,	Holistic, Triple Bottom Line
Interviewee 5	sustainable design as a problem,	Social attitudes based on climatic conditions	Specific and partial	Social, Humanitarian
Interviewee 6	Sustainability principles, Super high technology	Comprehensive approach, Holistic	Broad and includes all architectural topics	Holistic, Practical experience in sustainable architecture

Table 3: Target-content, Descriptive statements and the number of questions in the questionnaire. (Source: Authors)

	Trends / target / content descriptive statements	Component	Strategy	Solution
		Related Question Number in the Survey		
	Availability of technology and construction skills	-	-	**106**
Technology and Environment	New technologies and manufacturing techniques	**9**	-	-
	Technical and engineering skills of architects	**12**		
	Durability in sustainable design	-	**14**	-
	Extensibility, flexibility and functional continuity. Management of space and time	-	**50,51**	**48**
	Using super high-tech technology	-	-	**96**
	Efficiency of technology in accordance with the environment and human needs	-	**98**	**93**
	Relationship between built environment and technology	**2**	-	-
	Spatiotemporal characteristics of context	**10**	**89**	-
	The versatility of the building with the environment	**15**	-	-
	The versatility of space with spatiotemporal terms of the environment	-	**70**	**49**
	Relationships of indoor and outdoor spaces and the environments	-	**33**	-
	Systemic interaction with the environment	-	**34**	-
	Orientation, form and receiving energy from the environment	-	**35**	**36**
	Understanding the conditions and capabilities of site	-	**45**	-
	Space interactions with the environment	-	-	**56**
	Self-sustaining of buildings	-	**59**	-
	Influence the form and shape of the building from environment	-	-	**76**
	Considering building methods in accordance with the environment	-	**77**	-
	Relationship of building and ecological system	-	-	**82**
	Intelligent management and control environmental constraints	-	-	**85**

Technology, Climate and Nature	Relationship of built environment and the natural environment	1	-	-
	Maintaining the natural environment	17	-	-
	Benefit from Nature	-	13	-
	Harmony of physical environment and nature	-	30	-
	Cradle to grave attitude	-	46	-
	The use of local, natural and recyclable materials	-	64	71
	Regarding the use of resources in the building	-	65	-
	Building interactions with climatic parameters	-	-	83
	Considering climate as a concept in design	-	105	-
Environmental, economic, technical issues	Relationship between built environment and economy	3	-	-
	Building coordination with the economic environment	-	31	-
	Political goals	11	-	-
	Modification of costly and time-consuming construction methods	-	62.63	-
	Terms of technical and administrative issues	-	-	102
	Flexible planning of functional spaces	-	69	-
	Active management of the building	-	74	-
	Supply and control maintenance costs	-	-	72
	Technical considerations in the design	-	-	75
	Construction with maximum performance	-	-	52
	Relying on practical solutions for sustainability in engineering sciences	-	95	-
	Environmental and economic aspects	20	21	-
	Methods of reducing energy consumption	-	42,43,44	-
	Time management of using space	-	47	-
	Self-sufficiency and self-management of the building	-	58	57
	Efficiency of natural capacities	-	-	84
	Multifunctional and flexible spaces	-	-	53
	Sustainable architecture Beyond energy issues	-	60	-
Environmental, Social	The relationship between built environment and society	4	-	-
	Vitruvian principles: Architecture, Technique, Society	5	-	-
	Responsiveness to the changing human needs	-	26	107
	Determination of the public participation in design process	-	-	78
	Social and environmental relationships	23	-	-
	Natural resources and social justice	7	-	-
	Responsiveness of environment to meet human needs and social welfare	-	66,67	-
	Preparing people to adapt with the environment	-	-	101
Contextualism	Constant contact with social and historical phenomena	-	54,55	91
	Communicate with cultural contexts	-	79	-
	Contextualism in architecture	-	39	-
	Local techniques and skills	-	68	-
	Understanding the importance of ecology and its variables	-	41	-
	Considering traditional architecture patterns	-	40	37
Environmental Cultural	Understanding the cultural characteristics and importance of social issues	-	92	90-104
	Harmony with socio-cultural environment	-	29	-
	Promotion of awareness and public acceptance about sustainability	-	99	100
	Perception, understanding and experience of people	-	-	103
	The relationship between sustainability and culture	-	32	97
	Create a variety in designs	-	-	86
Ethics	Considering the values and moral patterns in design	-	27	-
	Content integration	-	38	-
	Cultural patterns	-	28	-
	Connection to the identity		80,81	88
	Aspects of intellectual, moral and theoretical of sustainability	-	94	-
Environment, Ecology	Harmony with environment	6	-	-
	Local adaptation	-	8	-
	Considering resources	-	25	-
	Integrated understanding of environmental parameters	-	61	-
	Architectural harmony with the elements of place	-	-	73
	Identity and environmental quality	19	-	-
	Interactions of environment with other elements of sustainability	-	24	-
	Compatibility as a component of Environmental Quality	18	-	-
	Ecosystem as a component of environment	22	-	-
	Maintaining the integrity of the environment	16	-	-
	Identification of environmental threats	-	87	-

Research Instruments

The research questionnaire was administered in the following steps:

- **Questions:** After setting the target-content table, at least one question was determined for any of the goals set forth in rows to ask questions about the content, and assess the objectives at the same time.

- **Formal validation of questions:** the basic questionnaire consisting of 107 questions obtained from the target-content table, was distributed among six scholars and specialists in order to determine Formal validation of the questions, and was then modified based on their comments.

- **The close-ended questions:** After ensuring the validity of questions, the initial 107-item Likert-scale questionnaire was distributed among a number of scholars with scientific and practical experience for the pilot study.

- **The final questionnaire:** based on the results of statistical analyses of the pilot study, 18 questions were deleted, and the ultimate 89-item questionnaire was administered among a greater number of architectural design scholars.

Statistical Population

The study of population consisted of postgraduate students of architecture from national universities of Tehran with at least three years of practical and professional experience in the field of architectural design. The final 89-item questionnaire was administered in order to understand and evaluate attitudes, interests, scientific and practical knowledge of the population. In the present study the samples were selected through single-stage cluster sampling to estimate the sample size. The sample size is equal to 216, however, due to the loss resulting from the lack of proper response to the test; the sample size was reduced to 213. The confidence level considered for the present study is equal to 97%, and the Sample mean difference was approximately 2%.

Validity and reliability of questionnaire

Questionnaire is considered credible when it is both valid and reliable:

- **Reliability:** In this study, Cronbach's alpha was used to measure the reliability of questions. Given that the acceptable value of Cronbach's alpha is at 0.7, the questionnaire items with Alpha value of 0.964 are considered reliable.

- **Content Validity:** In the present study, the target-content table (Table 3) was used to verify the content validity of questions. Research content validates by navigation of scholars opinion about the subject. After the formation of the initial questionnaire, in order to determine the face validity of questions, specialists and scholars who were familiar with the subject matter, were asked to ascertain whether the questions can clearly show the purpose of this study. Sampling contains researches on the related field of study from high-ranked universities in Iran.

- **Construct validity:** Construct validity of questionnaire was evaluated by relation of the results with theoretical expectations. Therefore, the authors need to assess measurements according to research hypotheses, and compare the results. This stage is performed through a plan mentioned in research methodology (collecting, classifying and analyzing data).

Factor Analysis

Data analysis is time consuming, especially, when the data is of considerable size, it might increase the research errors. Therefore, Classification of data can facilitate the data analysis. In the factor analysis, the main variables are reduced to fewer numbers (which are called factors). Accordingly, factor analysis is used when the researchers aims to draw on correlation of a set of variables to narrow their changes within the boundaries of a smaller number of factors or determine the underlying characteristic of a data set (Sarmad et al., 2010).

Moreover, structural equation modeling is used when the researcher aims to test a specific model in terms of the relations between the variables under investigation. In both cases it is necessary to analyze the measured covariance matrix of variables. On the other hand, KMO and Bartlett test are used to check the suitability of the sample size. KMO test result of 0.693 is considered acceptable and sample size of 213 is suitable for analysis.

Table 4: KMO test and Bartlett's test. (Source: Authors)

KMO, Kaiser-Meyer-Olkin Measure of Sampling Adequacy		**0.693**
Bartlett's Test of Sphericity	**Chi-square**	**5785.788**
	degree of freedom	**2346**
	Sig	**P <0.001**

According to Table 4, in Bartlett test the null hypothesis is rejected for "chi" value of 5785.788 and degree of freedom of 2346, at the 99% confidence level. Therefore, the final questionnaire items are correlated and significant enough to develop factors, and employment of factor analysis is permissible in this case.

In The present study, factor analysis serves as the principal component analysis method. In the aforementioned method, the Eigenvalue is used to extract factors. Scree plot shows that 11 factors are required for rotation purposes. After varimax rotation of the aforementioned 11 factors, the Eigen Value of factors 1 - 11 will have a more uniform distribution (table 5).

Table 5: matrix of 11 factors after varimax rotation. (Source: Authors)

Variables	Factor										
	1	2	3	4	5	6	7	8	9	10	11
Ideology	0.841										
	0.800										
Cultural patterns	0.718										
	0.671										
	0.668										
	0.596										
	0.594										
Moral aspects	0.572										
	0.523										
Historical context	0.452										
Climate		0.692									
nature's capacity		0.688									
		0.671									
		0.666									
Ecological systems		0.548									
		0.522									
		0.474									
Durability			0.660								
			0.641								
Flexibility			0.608								
Harmony with nature				0.657							
Environmental identity				0.608							
local conditions					0.685						
					0.662						
Energy						0.640					
						0.579					
Interactive connection							-0.016				
							0.750				
							0.612				
Efficiency in construction								0.536			
								0.504			
Efficiency in operation									0.800		
									0.601		
Time-space adaptation and Awareness										0.590	
										0.424	
											0.614
											0.534
											0.400

Eleven factors obtained from the above steps, are named and made reliable according to table (3-18). The reliability of the first, second, third, fourth and fifth factor is equal to 0.888, 0.798, 0.761, 0.732 and 0.703 respectively and they feature greater uniformity and effectiveness. Thus, these factors were considered the principal factors. Another important point is determination of the questions related to all factors, in order to pave the path for interpretation on the basis of shared content questions related to each factor (Table 6).

Table 6: list of factors and statements related to each factor. (Source: Authors)

Factor	Related statements
1:Culture	Connection to ideology - Cultural patterns - Constant contact with the socio-cultural phenomena - Insight and moral aspects - Identifying cultural features of residents - Appropriate contact with the historical-cultural context
2:Productivity in the use of nature	Reflection of climate and weather - Building orientation for receiving energy - Regarding the technical and executive issues - Efficiency in the use of nature's capacity - Optimal interactions with climatic parameters - Technical considerations in sustainable design as well as building management - Identification of the environmental threats - The relationship between building and ecological systems - The use of efficient technologies
3:Intelligent interaction	The durability of building with various activities in different periods, a strategy for saving materials and land - Space flexibility as a fundamental issue of sustainable space management - The durability of Building with environmental conditions - Measurement of the Role of flexible functional spaces
4:Manging environmental quality	Environmental compatibility - Harmony with the natural and physical environment - preserving environmental identity

5:Ecological adaptation	The use of local materials for construction - Regarding the fate of resources - Adaptation to local conditions
6:Energy efficiency	Energy storage in buildings - Energy saving
7:Intelligent interact with the environment	effective management and smart control of natural constraints - interactive connection of building with the environment is necessarily Systemic
8:Efficiency in construction	Control of building maintenance cost - Minimum consumption and maximum performance
9:Efficiency in operation	Participation of inhabitants in the design process - Multi-functional and flexible spaces in an appropriate scale
10: Time-space adaptation and awareness	Understanding the factors of time and place conditions on the project - interactions of visible and invisible patterns in space environment - Adaptability of the space to the needs of any period of time - Understand the importance of ecology and its variables by designers self-sustaining of the building - Building continuity of performance in different periods

The results showed that eleven factors affect the sustainable architecture in Iran (Table 6). According to this analysis, the relationship between variables and path analysis is investigated in causal modeling (Figure 1).

Goodness of fit test

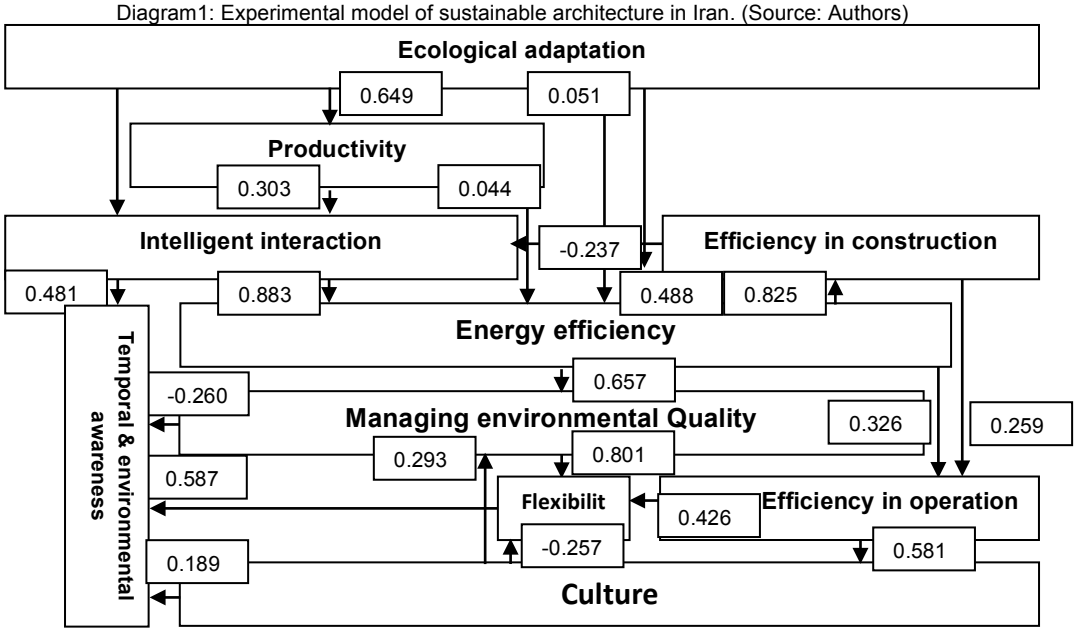
According to the model, the value of the goodness-of-fit index is equal to 189. 273. The value of x2/df is equal to 1.097 and the CFI is equal to 0.990, which represents an acceptable Goodness of fit for the obtained model (Table 7). In other words, this model is fitted and is adapted with the reality of population.

Table 7: Goodness of fit test. (Source: Authors)

x2/df	Significance Level	Degrees of freedom	Fitting index	CFI	GFI	RMSEA
1.097	0.85	168	189.273	0.990	0.93	**0.021**

According to the model (Diagram 1), the research hypotheses can be expressed based on the relationship between variables. It should be noted that, if the significance level exceeds 0.05, the hypothesis is rejected, and considered to be insignificant. In case the significance level is lower than 0.01, the hypothesis is confirmed and considered significant at confidence level of 99%.

Diagram1: Experimental model of sustainable architecture in Iran. (Source: Authors)



SUMMARY OF FINDINGS

First Hypothesis

"The productivity and adaptation to deal with ecological conditions affects Building efficiency". Building efficiency is described in areas such as energy, construction, maintenance and operation. Energy is a technical and economic matter. In the production of materials, internal energy is taken into account, and energy consumption is also of great importance in the construction and operation phases.

Productivity in the use of nature plays a decisive role in determination of building construction, maintenance and operation procedures, while this role doesn't hold true in vice versa.

Second hypothesis

"Technical Components through mediation of social and cultural components affects environmental efficiency". It can be said that "productivity in the use of nature" along with "efficiency in construction and operation", affects "temporal and Environmental Awareness" through mediation of "social and cultural components" as well as "intelligent interaction". In addition, social components, which include "time-space adaptation", "intelligent interaction" and "cultural" factors of architecture, facilitate the effect of technology and building efficiency on environment.

Third hypothesis

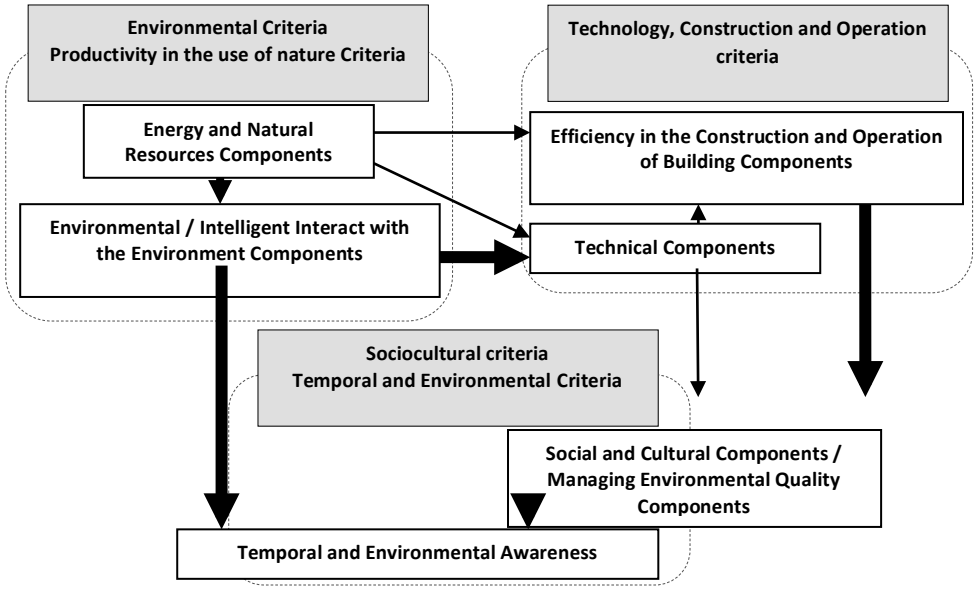
"Environmental factors, intelligent interact with the environment and socio-cultural factors affect the continuation of temporal-environmental awareness". Space, environment, as well as human and social factor are regarded fundamental and effective factors in sustainable architecture.

CONCLUSIONS

Conclusions are structured in three layers. According to the results of theoretical studies (Diagram2), this layer covers the triple criteria of sustainability (nature and resources, technology and construction, culture and society) that provide the ground for acquisition of the second layer. The second layer provides the ground for development of six fundamental components for transition to sustainable architecture. The third layer will be discussed at the experimental level and describes the observation-based and measurement-based knowledge which is used to assess the methodology:

According to the empirical model of this study, "energy and natural resources components" and "environmental components" directly affect "temporal and environmental Awareness". In the meantime, other variables may also affect the final dependent variable of the model. Recognition of the influence of "efficiency in construction and operation components" is also of great importance.

Diagram2: Relationships between components in the proposed model. (Source: Authors)



On the other hand, the mediating variables that facilitate the relationships in the model will also be discussed and identified in sociocultural criteria section. It should also be noted that "energy and natural resources components" as well as "environmental/Intelligent interact with the environment components", purposefully influence "technology criteria". These components first affect "efficiency and technical components" to achieve "socio-cultural criteria". Moreover, "temporal and environmental awareness" is achieved through mediation of this variable.

The complexity of research in the field of sustainable architecture in Iran due to the exclusive socio-cultural situations and lack of reliable data led to the formation of this research. Results require extensive interdisciplinary scrutiny and diverse research. This study is focused on building a common

vision towards environmental, social and technical issues in the context of sustainable architecture in Iran. Measurements, criteria and strategies are going to be developed under the presented concepts.

References

Almasi, S.M. (2009). *Examine the necessity of sustainable architecture in Iran.* PHD dissertation of architecture, Islamic Azad University, Science and Research branch, Tehran.

Al Nsairat, S. F. (2009). *Developing a green building assessment tool for developing countries - case of Jordan*. Building and Environment, 44, pp.1053-1064

Asif, M., Muneer, T., Kelley, R. (2007). *Life cycle assessment: a case study of a dwelling home in Scotland*. J Build Environ; 42 (3): 1391-1394.

Bourdeau, L., Huovila, P., Lanting, R., & Gilham, A. (1998). *Sustainable development and the future of construction: A comparison of vision from various countries* (Vol. 27). Rotterdam: CIB Report Publication 225.

Calkins M., (2009). *Materials for Sustainable Sites: A complete guide to the evaluation, selection, and use of sustainable construction materials*. Hoboken, New Jersey: John Wiley.

Couto A., (2007) *The construction prtuguese industry seems to ignore the deconstruction method*. CIB World Building Congress 2007: Construction for Development, South Africa;, p. 2397- 2405.

Du Plessis, C. (1999). *Sustainable development demands dialogue between developed and developing worlds*. Building Research & Information, 27(6), pp.378-389.

Du Plessis, C. (2002). *Agenda 21 for sustainable construction in developing countries: First discussion document*. CIB & CSIR-Boutek. Retrieved from http://www.unep.or.jp/ietc/Focus/Agenda%2021%20BOOK.pdf on

Du Plessis, C. (2005). *Action for sustainability: Preparing an African plan for sustainable building and construction*. Building Research & Information, 33(5), 405-415.

Du Plessis, C. (2007). *A strategic framework for sustainable construction in developing countries*. Construction Management & Economics, 25(1), 67-76.

Eynifar, A. R. (2009). *Evolution of human and environment theories and Its role in the development of basic knowledge of architecture*. Andishnamen 1. Tehran. Housing and Urban Development Department.

Fallah, M. H. (2005). *Construction industry and Sustainable Development*. Soffeh. 15(40).

Fowke, R., Prasad, D. (1996). *Sustainable development, cities and local government: Dilemmas and definitions*. Australian Planner, 33(2), pp.61-66.

Gravina R, C., Sattler M, A. (2009). *Discussion on the Reuse of Building Components in Brazil: An Analysis of Major Social, Economical and Legal Factors*. J Resour Conserv Recy; 54 (2): 104-112.

Gunnell, K. (2009). *Green building in South Africa: Emerging trends.* South Africa: Department of Environmental Affairs and Tourism (DEAT).

ISO/FDIS 15392. (2008). *Sustainability in Building Construction - General Principles*. Geneva: International Organization for Standardization (ISO), Final Draft.

James, N. (2012). *Five ways of doing qualitative analysis*.Retrived from: https://uk.sagepub.com/en-gb/eur/the-sage-handbook-of-qualitative-data-analysis/book237405

Kamp, I V., Leidelmeijer, K., Marsman, G., Hollander, A. (2003). *Urban Environmental Quality and Human Well-being Towards a Conceptual Framework and Demarcation of Concepts; A Literature Study*. Landscape and Urban Planning 65: 5–18.

Krippendorff. K. (2005). *Content analysis: Principles and Methodology.* Translated by Naeini. Tehran. Ney.

McGranahan, G., Satterthwaite, D. (2000). *Environmental health and ecological sustainability: reconciling the Brown and Green agendas in urban development*. In C. Pugh (Ed.).

Mofidi, S.M. (2007). *Basic principles of sustainable development and design of the human environment*. Research projects University of Science and Technology. Tehran.

Mofidi, S. M. (2008). *Sustainability and dynamism of passive systems.* Andishname 1. Housing and Urban Development Department. Tehran.

Moradi, A M., Hosseini, S B., Yazdini, H. (2013). *Principles of assessment and improvement of construction systems environmental sustainability in Iran*. International Journal of Architectural Engineering and Urban Planning. Vol. 23, 2: 74-84.

Mousavi, L., Mahdavinejhad, M. (2013). *Search for Sustainability in Contemporary Architecture of Iran*. American Journal of Civil Engineering and Architecture, 1 (6):129-142.

Samari, M. (2012). Sustainable Development in Iran: a Case Study of Implementation of Sustainable Factors in Housing Development *in Iran*. International Conference on Management and Education Innovation. IPEDR vol.37. IACSIT Press, Singapore.

Flick, U. (2013). *The SAGE handbook of qualitative data analysis*. Sage. Retrived from: https://us.sagepub.com/en-us/nam/the-sage-handbook-of-qualitative-data-analysis/book237405

Saghafi, M, D., Hosseini, Z. (2011). *Building Deconstruction and Material Recovery in Iran: An Analysis of Major Determinants.* International Conference on Green Buildings and Sustainable Cities. Procedia Engineering 21, 853 – 863.

Sjostrom, C., Bakens, W. (1999) *Agenda 21 for sustainable construction: why, how and what*. Building Research and Information, 27(6), 347-353.

Soebarto, V. I., Ness, D. (2010). *Rethinking the adoption of green building rating systems in developing countries.* Conference Paper. 11th International Conference on Sustainable Environmental Architecture (SENVAR), Innovation, Technology, and Design of Architecture in Changing Environment. 14-16 October. Surabaya, Indonesia.

Williamson, T., Radford, A., Bennetts, H. (2003). *Understanding Sustainable Architecture*. London. Spon Press.