

Identifying Environmental Sustainability Indicators of Urban Construction Applied in Tehran Municipality Projects

Saina Sheini Mehrab Zadeh¹, Mojtaba Hoseinalipoor¹

¹Architecture Department, Shahid Beheshti University,
Tehran, 1983963113, Iran

¹Architecture Department, Shahid Beheshti University,
Tehran, 1983963113, Iran

Abstract

The concept of sustainable development entered the international literature in 1968. According to this concept dimensions of sustainable development are defined as economic, social and environmental domains. Due to the direct interaction between them, the environmental domain has major importance in urban construction and the lack of environmental sustainability can lead to serious environmental, social and economic damages. Therefore proper attention and actions are required to prevent them from happening. Sustainable development saves the future. This article provides a view over sustainable development, environmental sustainability and its general indicators and studies current state of environmental sustainability in urban construction projects of Tehran municipality as the employer of major numbers of Tehran urban projects. Finally, the most important indicators of environmental sustainability in urban construction projects are identified. The most neglected areas of sustainability are represented according to used indicators in urban construction projects of Tehran municipality. The results have been obtained through questionnaires which were filled by 30 project managers and executives in Tehran municipality organization.

Keywords: Sustainable Development, Environmental Sustainability, Sustainable Breakdown Structure, Sustainable Evaluation Tools, Environmental Sustainable Development Indicators.

1. Introduction

In 1950s and 1960s, a large number of industries and civil projects were reported to cause unintended environmental consequences. The concept of sustainable development entered the international communities in 1968. This concept is dynamic. Its original meaning is defined as the necessity of stable equilibrium over time. This can be obtained if only all the factors disrupting the equilibrium are eliminated or neutralized by opposite forces. Additionally, sustainability implies conservation of resources and assets by all generations. Sustainable development objectives, including economic, social and

environmental ones, should be followed all together. Reaching the point of mutual interest of these three is the most effective way to obtain sustainability. If the balancing mechanism does not work properly, there will be conflicts between economic, social and environmental benefits. Since 1970, some indicators have been presented to achieve these objectives. Great amounts of construction waste and other types of pollution are imposed on the environment in the process of urban construction. As previously mentioned, Tehran municipality is the employer of major numbers of urban projects. Considering growing number of projects and consequently the pollution caused by them, it seems necessary to consider reliable indicators in order to do environmental sustainability assessment of projects. Indicators of urban construction applied in urban construction projects of Tehran municipality are identified and presented.

2. Review on literature of environmental sustainability in urban construction

2.1 Environmental Sustainability

The word sustainability is derived from the Latin word *sustinere* (tenere, to hold; sub, up). Sustain also means "maintain", "support", or "endure". Most widely quoted definition of sustainability defines the concept of sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Following major evolutions due to the oil crises and Greenpeace group protests, the discussions on sustainability were raised. The protests were focused on the Land pollution and environmental degradation as a result of industrial development accumulation of toxic waste of factories, and damage to the ozone layer. On January 1st 1970 United

States approved the first law on environmental impact assessment for major projects as the first country in the world.

As environmental crises increased, international reactions were formed in 1960s. The most important ones in chronological order are shown in table 1.

Table 1. International Conferences on Sustainable Development

1972	Stockholm conference on human environment
1980	World Conservation Strategy
1983	World Commission on Environment and Development
1987	Montreal Negotiations about the ozone layer
1990	Green paper on the urban environment
1992	Earth Conference in Rio de Janeiro
2000	Netherlands Conference on Climate Change
2002	Johannesburg Conference on sustainable development
2006	Finland conference on carbon and global warming
2007	Indonesian Conference on Climate Change
2009	Copenhagen Conference on Climate Change
2012	the future that we want in Rio

Environmental impact assessment is a new concept in Iran. However, some simpler rules can be found under different headlines in Iran’s environmental regulations.

There is not any known term as Environmental Assessment or Environmental Impact Assessment and not even any defined evaluation process before 1975 in Iran. In 1976, for the first time, the parliament approved a law that according to it the issuance of establishment license of any type of new factories and workshops and also development or conversion of the existing ones was bound to compliance with rules and regulations of the environmental protection and improvement. In 1995, the Supreme Council of Environment ratified the assessment of important projects and clarified the duties of the Environmental Protection Agency on environmental impact assessment according to the clause number 2 of the “the environmental protection and improvement code” approved at 1976 and adjusted at 1993.

Aspects of the environmental assessment of all types of projects have been mentioned in clause 10 of this code:

1. Environmental effects on physical environment:

- Effects on soil: morphology and quality
- Effects on water: water quantity and water quality
- Effects on climate, air and noise: air and precipitation changes, air quality
- Secondary effects between soil, water and air

2. Environmental effects on natural environment

- Effects on plant species
- Effects on animal species
- Effects on habitats, landscape and bird migration route

3. Environmental effects on social and cultural environment

- Effects on health
- Effects on social environment: employment, housing, education
- Impact on the cultural environment, cultural and religious beliefs of people, cultural heritage

4. Environmental effects on development projects

- Effects on other development projects in agricultural, industrial and service section
- Effects on regional planning scheme
- Effects on land use

2.2 The benefits of sustainable projects

Many powerful organizations are aware of the application of project management knowledge on business: lower costs, higher efficiency, improvement of customer and stakeholders’ satisfaction and more competitive interest. In addition to the previous, business is affected by the environmental, social and financial benefits. Sustainable design and construction practices not only decrease negative impacts on the environment, they also provide economic and productivity benefits and enhance public relations. Sustainability improves the economic bottom line by reducing operating costs and optimizing life-cycle economic performance.

The U.S. Green Building Council which is one of the pioneers of sustainable buildings development has divided the benefits of sustainable projects into three sections: environmental, economic and social, as in table 2.

Table 2. Benefits of Sustainable Projects

Environmental benefits	Potential or direct effects
	Air and water quality maintenance or improvement
	Reduce waste
	Natural resources conservation
Economic benefits	Reducing operating costs
	Promotion of the value of capital and

	profits
	Reduction of the cost of investment
	Marketing appeal
	Reduction of the probable risk
	Improvement of workforce performance and satisfaction level
	Maximizing the economic efficiency lifecycle
Social and safety benefits	Creating thermal and acoustic comfort in the environment
	Improvement of safety and comfort of residents
	Reducing the pressure on local infrastructure projects
	Building partnerships to improve the quality of life
	Creating safety for the project team
	Providing new opportunities for job
	Attracting and retaining employees
	Creating a sense of satisfaction from doing the job

The quality of human environment is more affected by urban construction projects than any other civil projects. These effects include air quality, urban green space, environmental health, audio and visual pollution and a variety of social effects. Increasing the sustainability level helps advancing sustainable urban development. The other reason is the growing number of these types of projects which increases the need to promote the sustainable level. Not only the environment is affected by construction through consuming its resources, it is also damaged by water, air and other types of pollution caused in the process of constructing. The approximate amount of created pollution by construction is given in table 3. According to table 3, construction projects create considerable environmental effects. Due to the high number of Tehran municipality projects, implementation of environmental sustainability in these projects seems to have great effects on environmental sustainable development of Tehran. Implementing the environmental sustainability indicators in Tehran municipality projects is a big step towards sustainable development.

Table 3. Created Pollution by Construction

Percentage	Pollution
30	Air quality (cities)
50	Global warming by gases (CFC, CO ₂ , ... which are released during the construction activities)
40	Contamination of drinking water
50	Waste disposal
50	Thinning of the ozone layer

3. The effective indicators of environmental sustainable development in urban construction

3.1 Sustainable breakdown structure

A structure has been presented with the caption of sustainable breakdown structure based on the three pillars of sustainability in construction projects shown in Fig. 1.

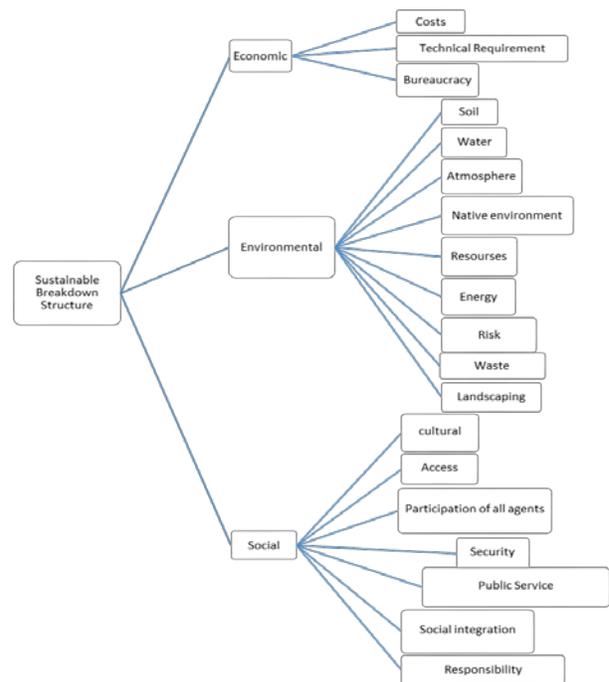


Fig 1. Sustainable Breakdown Structure

The above structure is used to identify sustainability indicators of construction projects.

3.2 Sustainability assessment tools and sustainability indicators

Sustainability assessment tools also can have an important role in the extraction of sustainability indicators. A comparison has been done between these tools' topics of interest of their rating systems at the environmental field shown in table 4.

Table 4. Comparison between Sustainability Assessment Tools

Tool	Environmental	Tool	Environmental
BREEAM	-Energy -Transportation -Water -Materials -Waste -Land use -Pollution	GRIHA	- Site selection and planning of land - Building and construction Planning
LEED	-Energy and atmosphere -Optimized water consumption -Materials and Resources -Sustainable sites	GBI	- Energy efficiency - Water efficiency - Materials and Resources - Sustainable site and management design
HQE	- Environmental construction	GREEN STAR	- Energy - Transportation - Water - Materials - The distribution and publication of pollution - Land and environmental use
DGNB	- Environmental quality	CASBEE	- Energy - Materials and Resources - Environment Outside the site - Quality of the external environment on the site

23 environmental sustainability indicators were extracted for urban construction after identification of indicators by using sustainable breakdown structure, sustainability assessment tools and review of literature of sustainability. A questionnaire was distributed among 11 of the environmental sustainability elites in order to identify most important environmental sustainability indicators for urban

construction. Respondents consists of 3 members of active corporates in urban construction industry, 2 members of the Sustainable Development Office of Amir Kabir University and 6 faculty members of Shahid Beheshti University of Tehran and Shiraz University specialized in environmental sustainability of urban construction. They were asked to rate and study the indicators regarding their importance in sustainability of urban projects. The rating scores were in the intervals of 0 to 5, 0 as “not important” and 5 as “very important”. The studied indicators are presented at table 5.

Table 5. Environmental Sustainability Indicators for Urban Construction

Main indicators	Sub-indicators	Main indicators	Sub-indicators
1.Environmental quality	Project site	5.The environmental conservation	Artificial forests (urban)
	Quality of external environment on site		Ecosystem
	Indoor air		Environmental footprint (the reproduction of what is consumed)
2.Pollution	Consumption of materials with destructive effects on the ozone layer		Conservation Risk
	The quality of the environment around the project site		Biodiversity
	The concentration of air pollutants		Landscaping
	Water pollution	6.Human resources	Project team members
Transportation	People around the project		
3.The decision-makers' actions		7.Water	
		Energy sources	
			Materials

After collecting the results, 8 most important indicators were identified from 23 environmental indicators presented and corrected using the elites' comments. Main indicators'

scores were obtained from the sub-indicators' scores. The indicators and their scores are presented in table 6.

Table 6. Scored Indicators

Selected Indicator	Given Scores
1. The decision-makers' actions	0.89
2. Pollution	0.81
3. Water	0.8
4. Resources	0.778
5. Waste	0.72
6. Environmental Quality	0.7
7. Conservation	0.68
8. Human Resources	0.58

3.3 Existing Environmental Indicators in Tehran Municipality's Project

The validity and accuracy of the results depend on statistical society. Since this research studies the existing environmental sustainable indicators in Tehran municipality, the chosen respondents must be familiar with the concept of sustainable construction. Therefore, questionnaire was developed and distributed among a society of peers in Civil and Engineering organization of Tehran, a subset of Tehran municipality. 59% of the respondents including project managers, supervisors, program managers and contractors were the project team members outside the Municipality and 41% of them were inside peers. The questionnaire was sent to 30 qualified individuals and 25 of those were filled and sent back. The distributed questionnaires were prepared in the form of a selecting indicators matrix with columns of scores to assess the existence of the indicators in the urban construction projects of Tehran municipality, 0 for "poor" and 5 for "excellent". The "human resources" indicator which was identified as the least important one in primary poll is omitted and the "resource" indicator is divided to two separated indicators, "Energy resources" and "Materials", in order to have greater precision. Analysis of results is presented in the table 7.

Table 7. Indicators' Analysis of Results

Indicator	Score
Conservation	3.346
Effects on projects' environment	3.13
Water	2.835
Materials	2.79
Waste	2.75
Pollution	2.715
Decision makers' actions	2.655
Energy sources	2.26

As presented above, all the scores are below 4 which indicate undesirable implementation status of these

indicators in urban construction projects of Tehran municipality. The indicators "Conservation" and "Effects on projects' environment" are above average and their status is evaluated as desirable. However, the 6 lower indicators' scores are below average which indicates their poor implementation. Among all the indicators, energy sources and decision makers' actions have the lowest scores while they were forth and first indicator in the first questionnaire respectively whose results indicated the most important urban construction indicators. The water, materials, waste and pollution indicators identified with high importance are in the middle area of the table with under average scores.

4. Conclusion

Environmental sustainability is one dimension of sustainability which has a great importance. Achieving it has an enormous effect on getting closer to sustainable development. Indicators of environmental sustainable development in urban construction were identified in this paper by reviewing the basis of environmental sustainability and its indicators in Iran and preparing a questionnaire which was distributed between qualified Individuals. 8 indicators of 23 extracted indicators for environmental sustainable urban construction were identified as the most important ones. In the next step, identified indicators were distributed among peers as another questionnaire to survey their status of implementation in urban constructions of Tehran municipality. It was found that those indicators identified as the most important ones have got the least attention in Tehran municipality. It should be reminded that no general approach is available and it varies by different situations. Also it should be noted that a similar study, extraction of urban construction sustainable indicators and evaluation of their implementation in Tehran municipality projects has never been conducted in Iran.

Given the circumstances, the most effective way to start a journey towards sustainability is through the approval of some rules to make the implementation of sustainable indicators mandatory in Tehran municipality projects. In addition, to improve the implementation of environmental sustainability indicators some solutions can be proposed in 3 levels of management: Senior Management, Middle Management and Junior or Project Management. Effective actions on senior management level can be in the form of activities to develop some inside and outside organization rules with the goal of starting project sustainability. It is recommended that the mandatory use of renewable resources, new technologies and application of international rules and standards, reducing water consumption, employing experts in energy management,

material quality standards and waste management areas should be included in these rules. In addition, obtaining legal and financial government support for projects can be very effective. The actions that can be applied in the middle management level include adding clauses on the terms of the selection of contractors in urban construction project tenders of Tehran municipality, including reviewing the level of sustainable knowledge and practices for project implementation, and identifying and using scoring systems for sustainable performance in order to choose contractors. Project managers can include sustainability goals into all of their tasks, logistics management, communications, quality, cost, human resources and risk. Depending on the level of their authority, they can choose the material covering environmental indicators, prefer sustainable approaches, monitor and control the projects' effects on stakeholders, evaluate the amount of workers' satisfaction, use the energy management experts, check the adequacy of feasibility studies and apply the national and international standards concerning project processes.

Acknowledgments

This research was supported by Tehran Urban Planning and Research Center. This paper is resulted from Saina Sheini Mehrabzade's MSc. thesis. We thank Dr. Namazian and Dr. Tahsildoost for comments that greatly improved the manuscript.

References

- [1] M Feizi, "Necessity of environmental assessment of Cement industry and its part in sustainable development" 2008.
- [2] G. Fernandez, and F. Rodriguez, "A methodology to identify sustainability indicators in construction project management-application to infrastructure projects in Spain" *Journal of ELSEVIER*, 2010: p.1193.
- [3] Government, "Regulations of environmental assessment of large projects. Government Information Center". 2011.
- [4] Khaleghian, Mohammad Hossein. "A Pattern for Identification of Effective Indicators in Sustainable Development". M.S. Architecture Department, Shahid Beheshti University, Tehran, Iran, 2009.
- [5] C. Labuschagne, A. Brent, and C Schalk, "Environmental and Social Impact Considerations for Sustainable Project Life Cycle Management in the Process Industry." 2005.
- [6] M. Pakravan. "Identification and Analysis of opportunities and Obstacles of implementation of sustainability in Life Cycle of Building Projects. M.S. Architecture Department, Shahid Beheshti University, Tehran, Iran, 2012.
- [7] Rafiee, Afshin, "Stable housing complex" M.S. Civil Engineering Department, Tehran University, Tehran, Iran. 2009.

- [8] *Report of the World Commission on Environment and Development: Our Common Future*. Transmitted to the General Assembly as an Annex to document A/42/427 - Development and International Co-operation: Environment. Retrieved on: 2009-02-15.)

First Author Electric Engineering (B.S.) 2011, Construction Engineering and Management (M.S.) 2014

Second Author Civil Engineering (B.S.) 1978, Construction Engineering and Management (M.S.) 1982, Building Management (PhD) 1986, Faculty of Architecture Department of Shahid Beheshti University