

Sustainable Architectural Indicators in Hospital Architectural Design in Contemporary Period

Mehrdad Taheri Kahnamoeei, Hassan Sattari Sarbangholi

Abstract

In contemporary period sustainability notions and concepts have been considered. Due to their importance, hospital spaces require compilation and utilization of sustainability knowledge components in designing architecture of these spaces. The aim of this research was to investigate the main criteria and components related to sustainability knowledge and sustainable architecture in designing famous and up-to-date hospitals in terms of theory and architecture engineering techniques. The statistical population consisted of fifteen important hospitals in England, Canada, America, Italy and Germany. The research method was descriptive and analytical and the research was conducted by content analysis and studying spatial concepts of these hospitals with documentary tool. The studied hospitals in this research are: Hairmyres hospital, Norfolk and Norwich, Royal Infirmary of Edinburgh, Thunder Bay Health Science Center, Rebecca and Johan Moores UCSD Cancer Center, Legacy Salmon Creek Hospital, Indiana Heart Hospital, Peter and Paula Cancer Clinic at the University of Medical Center, Aquarius Banka Q, Treatment Center, Hershey Cancer Institute, Vivian and Seymour Family Heart Center, The Methodist Hospital Research Institute, Baylor hospital Cancer Diagnosis and Yu. C Outpatient Treatment Center. Results showed that lighting and daylight, appropriate green space, resistant materials, spatial organizing, aesthetic components and attention to energy saving measures have been used in these hospitals. The most considered and employed component in all the studied hospitals was attention to energy consumption. Creation and designing appropriate environment grounds and avoiding specific environmental and acoustic pollutions have been used in architectural design of the hospitals plan sites. The results reveal eight concepts in architecture design knowledge including arrangements for maximizing comfort, efficient planning, design for change, minimizing energy costs, maximizing usable spaces, minimizing construction costs, reducing building maintenance costs, protection and valuation of natural resources for application in Iran hospitals architecture design.

Key words: architectural design, sustainable architecture, hospital design, environment

© 2015 BBT Pub. All rights reserved.

Introduction

The sustainable development (SD) of capital and regional cities is one of the most pressing challenges in the world. The growing trade in patients seeking health care in other countries, or medical travel, is changing the forms and experiences of health care seeking and producing changes to hospitals in terms of their design, organization and spaces. What is termed in marketing parlance in Thailand as an 'international hospital' oriented to attracting foreign patients, is a hotel-hospital hybrid that is locally produced through the inflexion of local practices to make a therapeutic space for international patients (Whittaker, 2014). The China Design Standard for Energy Efficiency in public buildings (GB50189) debuted in 2005 when China completed the 10th Five-Year Plan. GB50189-2005 played a crucial role in regulating the energy efficiency in Chinese commercial buildings (Hong, 2015). Energy consumption has risen in Malaysia because developing strategies and increasing rate of population. Depletion fossil fuel resources fluctuation in the crude oil prices and emergence of new environmental problems due to greenhouse gases effects of fossil fuel combustion have convinced governments to invest in development of power generation based on renewable and sustainable energy (RSE) resources. Recently power generation from RSE resources has been taken into account in the energy mix of every country to supply the annual electricity demand. In this paper scenario of the energy mix of Malaysia and the role of RSE resources in power generation are studied. Major RSE source namely biomass and biogas hydro-electricity solar energy and wind energy are discussed focusing more toward the electrical energy demand for electrification. It is found that power generation based on biomass and biogas utilization solar power generation and hydropower has enough spaces for more development in Malaysia. Moreover mini hydropower and wind power generation could be effective for rural regions of Malaysia (Hosseini, 2014). There is a fragmented approach to sustainability in the literature and this paper aims to contribute to better understanding of the meanings and interpretations of that concept while reviewing and discussing the social dimension of sustainability from the perspectives of two fields: urban development as well as companies and products. The analysis identifies commonalities and differences in the understanding of the conceptualization of social sustainability and helps to identify core aspects that is representative of social sustainability is not straightforward as interpretations are context or whether or not a life cycle perspective is used. Nonetheless seems to be an underlying common understanding of what social sustainability is and a set of key themes is suggested as an alternative to put more specific measures and indicators in perspective. However context specific information still necessary in practical application. (Weingaertner, 2014) strategies that guided development throughout the 20th century relied heavily on economic optimality as a chief guiding principle in the design of energy technology markets and policy. A review of the

record of performance of this decision making process is following by review of proposal to redefine energy progress on sustainability principles. An emerging 21st sustainability paradigm is described which relies on common based economics and long term ecological viability. (Byrne, 2015) In discussion of the sustainable development and consequently sustainable architecture any building should interact with background and natural environment. The most challengeable issue is manner of interaction and type of arrangement. This issue was used by Iranians by specific skills and employing rules and techniques on optimal utilization of energies and natural resources particularly solar energy, wind and climate and nowadays it has been forgotten due to ignorance. What had the past architecture as a tradition it has been remained as dead corpus, hence, modern societies research on the recognition of the forgotten values trying to discover and use the past values (Pour Ahmadi, 2003, 2). Among the architectural spaces there is no space than treatment space which was intersection of the medicine and art and more than two thousand years ago Plato believed that disease and illness are in the man body and they are not the reward and punishment of God. However, in spite of considerable progress in medical science during centuries, illness and unnatural states which sometimes leading to death have led to importance of treatment spaces (Taheri, Sattari, 2014, 4).

Sustainable Architecture

Sustainable architecture is architecture compatible with economic, social and natural environment and it is process of creation of space that natural resources receive less damages during construction and utilization. There are three main principles for sustainability in architecture: resources consumption reduction which deals with reduction of consumption, reuse and recycle of the natural resources used in the buildings, designing based on life cycle which proposes a method for analysis of construction of buildings and its effects on environment and finally, human design which concentrates on interaction between human and natural world. Connection with nature: an architectural monument interacts with ground since time of creation that should take steps for structuralizing: it receives water from ground and after changing appearance and chemical and physical properties returns it in different amount and stands against wind and accompanies the nature and productivity (Pour Ahmadi, 2003, 4). Sustainable development is a kind of development that meets the needs of this generation without damaging next generation capabilities. In other definition sustainable development is meant proposing solutions for development structural, social and economic models that prevents destruction of natural resources, reduces pollutions and encounters with climate change, increase of population, injustice and reducing quality of life. Development is meant considering continuous changes in centuries particularly shift in economy, technology and socialization of human societies and sustainability is considered as a uniform and efficient process. This concept was considered by IUCN in 1980 since proposing universal strategy of protection of natural resources by general goal of achieving sustainable development by natural resources. Sustainable development was proposed for the first time in report of WCED famous for Brundt land report in 1978. This report is known as our common future including set of propositions and legal codes for achieving sustainable development in the developing countries which emphasizes evaluation and using environment issues (Mahlabani, 2010, 3). The earth is place for human activities and humans change environment for optimal life and use resources for survival. For this reason, humans have tried to change environment to live in comfort and in addition, different generations have encountered with shortage of natural resources for survival and consumption. Attention to various environment dimensions is one of the important issues in recent years so that the issues on protection and maintenance are discussed in communities and training programs have been considered related to environment (Mohammadi, 2013, 5).

The main examples of application of sustainable architectural design principles in hospital design in third millennium

Hospital	City/country	Construction year	Architecture group	Application of sustainable architectural design principles	Figures
Hairmyres hospital	East Kilbride, south Lanarkshire, England	2002	HLM	This hospital has been designed in the main frontage which light is provided from glass ceiling. Since yards are located in the north part and the patients can be benefitted so it is a very good resource for natural light. This hospital was constructed by steel framework and adobe façade. Of the important designing point it can be referred to creation of spaces with high quality for intimate space and also energy saving and considering future development (Khanizad, 2012, 112).	
Norfolk and Norwich	NORFOLK & NORWICH, England	2002	Anshender	The movement and access to hospital surroundings are creative and each section can be used independently. It was constructed by resistant materials mainly from glass and adobe and the spatial combination and middle yards are unique. Spatial organization depicts novel idea in designing hospital (Khanijad, 2012, 116).	
Royal Infirmary of Edinburg	Edinburg, Britain	2033	Kippe design group	During first six months construction of this complex, 5000 trees were planted in different parts of the site. This hospital is one of the standard hospitals in England and has received several international architecture prizes (Khanizad, 2012, 122).	

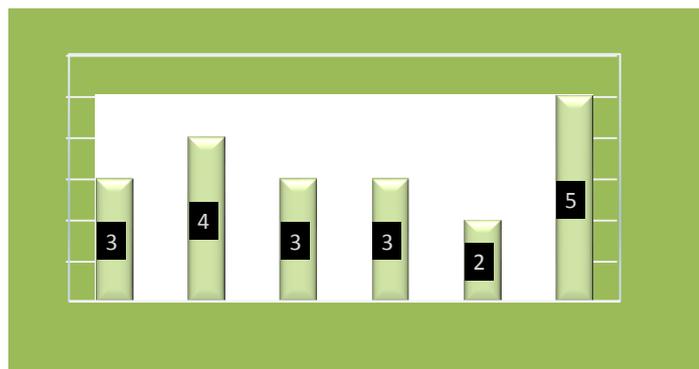
Thunder Bay Health Science Center	Thunder Bay, Toronto, Canada	2005	Lead design group	This hospital is in Canada and wood used as the main material. The first cancer center in this country which daylight enters by three ceiling lighting in light therapy ward. It is based on wood rooted in the region culture and history and water sewage enters to the near river and refined(Khanizad, 2012, 126).	
Rebecca and Johan Moores UCSD cancer Center	California, America	2005	Zimmer Gansolfra sca	This monument is five floors as research center. There are two structures on the base and surrounded by gardens for personnel and patients satisfaction. Merging some detailed elements with trivial difference in height and density associate a village and there is a wall made of aluminum and glass depicting laboratory wards.	

Resource: author

Hospital	Employed components
Hairmyres hospital	Lighting by glass ceiling, appropriate green space, natural lighting, resistant materials, high space quality, energy saving
Norfolk and Vorwich	Appropriate green space, independent access to each ward, resistant materials, spatial organization, beauty energy saving
Royal Infeirmary of Edinburg	Appropriate green space, observance standard in hospital design, energy saving
Thunder Bay Health Science Center	Wood as the main materials, direct and natural lighting from ceiling, appropriate green space, respect to environment , energy saving
Rebecca and Johan Moores UCSD cancer Center	Resistant materials, appropriate green space, independent access to each ward, spatial organization, energy saving

The main criteria in hospital design

Component	Repetition
Lighting	3
Appropriate green space	4
Resistant materials	3
spatial organization	3
Beauty	2
Energy saving	5



1-lighting 2-green space 3-resistant materials 4-spatial organization 5-beauty 6-energy saving
Architecture design

What has been considered by the design researchers and can represent the reality of the intricate event like designing is centralization on the research on the skilled and elite designers in design since the real creative notion can be traced in the mental processes of these designers. These functions are those functions that the architecture education tries to guide students' mental process toward it so research on the skilled and elite designers can have significant outcomes. Familiarity with ups and downs of the elite designers' ideas can offer the low experienced trainers meta-cognition and self-esteem(Nadimi, 2012, 2). Function is the simplest concept in architecture and turning point in architecture design. Contemplation on the application of function in architecture shows this concept was not obvious in architecture. Oldness and continuity of attendance of function in human artifacts from pre-history has old record in architecture theories sine Vitruvius period and converting to fundamental concept in late eighteenth century architecture theories, ambiguity in the authors require explanation. The level of this complexity can be seen in contradiction of the architects' views belonging to an architectural movement(Gharibpoor, 2013, 5).

Hospital

As health care systems evolve, innovation is becoming a key driver of performance in the hospital sector. However, innovation management has been adopted only sporadically in hospitals, and dedicated innovation functions remain in the development stage. Using control theory, this study develops a theoretical framework that links control mechanisms (pro-activeness, innovation, process formalization) and a dedicated innovation function to innovation activity and innovation performance. For the empirical analysis, data were collected from a survey of 158 German hospitals, with information provided by general hospital management (Labitzke,2014).Nowadays, health and treatment sector is considered as one of the main scopes of sustainable development in societies due to direct relationship with humans' health(Babaei, 2013, 3). We explored direct and indirect influences of physical work environment on job satisfaction in a nationally representative sample of 1, 141 early-career registered nurses. In the fully specified model physical work environment had non-significant direct effects on job satisfaction,. The path analysis used to test multiple indirect effects showed the physical work environment had positive indirect effect on job satisfaction through ten variables: negative affectivity variety workgroup cohesion nurse physician relations quantitative workload organizational constraints distributive justice promotional opportunity local and non-local job opportunities. The finding raveled important contributions to the understanding of the relationship between physical environment and job satisfaction. The result can inform health care leaders insight about how physical work environment influences nurses job satisfaction (Djukic, 2014).Among the architectural spaces there is no space than treatment space which was intersection of the medicine and art and more than two thousand years ago Plato believed that disease and illness are in the man body and they are not the reward and punishment of God. However, in spite of considerable progress in medical science during centuries, illness and unnatural states which sometimes leading to death have led to importance of treatment spaces (Taheri, Sattari, 2014, 4). We investigated the direct and indirect physical effects of work on job satisfaction in a national sample consisting of 1141 new employed nurses. In this model work physical environment had insignificant effect on job satisfaction. The analysis of path on the indirect effect showed that work physical environment had indirect positive effect (p<0.5) on job satisfaction by ten variables: negative excitement, diversity, teamwork continuity, nurse-physician relationship, low work load, organizational limitation, distributive justice, promotion opportunity, local and nonlocal job opportunities. These findings have a significant share in perception of the relationship between work physical environment and job satisfaction. These results impact on the vision of the treatment management regarding influence of the work physical environment on the nurses' job satisfaction (Kim, 2014).

Architecturaldesign components according to sustainable concepts

Component	Resources
Ecological and Social Sustainability	John Byrne & Job Tamini. 2015. Wiley Online Library
Exploring Social Sustainability	Carina Weigaertner. 2011. Wiley Online Library
The Role Of Renewable And Sustainable Energy In The Energy Mix Of Malaysia	Hosseini. 2014.Wiley Online Library
Sustainable Development Pathways	¹ Martin. 2013.Wiley Online Library

Main components in hospital architecture design

Component	Resources
Identifying Modifiable Factors To Improve Quality For Older Adults In Hospital	Park. 2013. International Journal Of Older People Nursing
The Role Of Dedicated Innovation Functions For Innovation Process Control And Performance - An Empirical Study Among Hospital	Labitzke. 2014.Wiley Online Library
Exploring Direct And Indirect Influences Of Physical Work Environment On Job Satisfaction For Early - Career Registered Nurses Employed In Hospital	Djukic. 2014.Wiley Online Library
Environment Of Care	Tzeng. 2014. Wiley Online Library
Exploring Perceptions Of Designers And Medical South Korea About Design Elements For The Elder-Friendly Hospital	Kim. 2014. Journal Of Interior Design

Resources: author

Sustainable architecture design	Application in hospital design
Energy	As a treatment center hospital consumes significant amount of energy and for energy saving it can be used wind turbines, solar plates, EMS-IBS-BMS. "Wind energy is resultant from moving air, when sun shines unequally on the rough surface it causes to change in temperature and pressure and due to these changes wind flows. Smart building is a building that all interior elements interact by an integrated system"(Giyabaklo, building physics, 2).
Materials appropriate performance	Hospital is a complex that by appropriate materials it can be reduced energy consumption for example, using heat absorbance materials in the walls in winter absorbs sun rays and transfers to inside and also by low thermal materials with low heat transfer in walls it can be used in summer for energy saving and pleasant ventilation.
Environment compatibility	When designing is done compatible with environment it can prevent damages and cause to better perception of environment and orientation toward sun and placing in the site is considered.
Minimum environment damage and energy saving	Treatment spaces consume much more energy for cooling and heating. For reducing energy it is necessary to use renewable energies. For doing so, using natural resources and correct management of spaces can be effective.
Cultural, environmental and climatic conditions influence	As culture influences human life architecture also impacts human life. In creation of sustainable architecture surroundings conditions can be effective in terms of climate and materials and etc.
Correct response to functional needs	Creation of sustainable space requires appropriate spatial diagram since appropriate functional relations in levels and filled and void surfaces and designspaces proportionate with total performance can prevent energy waste and maximum using spaces.
Readability and visibility	A monument in a district should be designed proper for people and aesthetic and cultural principles should be considered in designing to provide familiarity.
Correct using materials from visual and environmental perspective	Using appropriate materials is necessary and structure of a building is shaped by materials on one hand, and color, texture and type of materials influence the people on the other hand, so materials should be used that have less damages in environment and can be recycled.

Resources: author

Environment

Environment is a complex and broad set of different factors influencing human activities and performance. Hence, environment covers different aspects and dimensions. Each country has different plans for growth and development. But developing countries encounter with environment destruction since most of the economic activities depend on natural resources and such activities destruct environment. Hence, economists have considered environmental issues since long time(Shahb, 2014, 2).Environment protection and responsibility to preserve it has a close relationship with different sciences including philosophy, ethics and economics. According to religious teachings, human life depends on environment and observing environmental rights and respect to right to live should be considered all periods. Unlimited use of natural resources has destructive effect on natural system(Entezari, 2012, 2). Environmental issue is one of the main challenges in the world and indifference to it causes to barrier in sustainable development. The importance of environmental issues will be increased by passing of time by increase of transportation and energy consumption and any study on improvement of environment can be important(Panahi, 2014, 4).

Propositions of sustainable architecture design practical principles in hospital architectural design in Iran

Principles	Propositions
Maximizing human comfort	Day light/pleasing view/optimal ventilation/ proper acoustic insulator/temperature for feeling comfort in space
Efficient planning	Construction of walk and rider routes/users security/ response to individuals needs/ combination of the monument structure with installation and other members
Design for change	Designing that could adjust with conditions in long-term by increase of district.
Minimizing energy current costs	Using renewable energies/ correct building management
Maximizing usable spaces	Ideal design/ avoiding nonuse spaces/ margining structural elements and installation
Minimizing building construction cost	Using latest technologies in construction/ using up to date technologies/ minimum energy consumption with high output
Reducing building maintenance costs	Using resistant materials/ using and promoting control systems
Protection and valuation of natural resources	Collecting rain water/using installed umbrellas/ construction place for collection of wastes

Resource: author

Conclusion

By emphasis on necessity of protection of environment and attention to sustainability criteria in third millennium hospitals this research has tried to reduce shortages in architectural design of optimal hospitals in world in addition to referring to successful environment factors. Six environment indicators including energy saving, aesthetic concepts, attention to spatial organization, using materials compatible with environment, intelligent use of green space, using day light and optimal light have been investigated in standard hospitals. This research has emphasized concurrent use of ecologic sustainability and social sustainability in designing hospitals open and semi-open spaces. In terms of accuracy in architectural indicators this research has emphasized using eight factors including renewable energies in the site, using correct performance instead of materials, emphasize maximum environment compatibility, attention to energy saving in active and passive ways, attention to cultural and environment components, codification of the demands and response to functional needs, avoiding ambiguity. Achievements of this research can be sued in designing standard hospitals in third millennium considering sustainable architecture components.

References

1. Entezar, A., 2012, Investigation on the foundations of environmental review, Scientific and Research Journal - Journal of faith – verbal research , no. 7, Fall 2012
 2. Bahook B., 2014, The noise pollution in Tehran and How to fight it, Vo. XVIII, No. 69
 3. HosseinPanahi, 2014, Relationship between energy demand and urban transport and environmental pollution through emissions of greenhouse gases in provinces of Iran, Journal of Geography and Planning, 18 No. 5, Winter 2014
 4. Jafari,N.,2012, Evaluation of the level of noise pollution in Feyzhospital wards and the surrounding area, Journal of Research in the health system, year 8, Issue III, August and September 2012
 5. Khalaji M. Babaei, 2013, Examine the factors affecting the nursing work engagement inFarabi Hospital affiliated to Tehran University of Medical Sciences, Public Administration, Vol. 5, No. 4, Winter 2013
 6. Shehab Mohammad Reza, 2014, Investigation the effect of government economic policies on environmental quality in selected countries, environmental science and technology, Volume XVI, No. two, summer 2014
 7. Taheri, 2014, Architectural designof cardiology center in general hospital by technology and energy saving approach in the third millennium in Tabriz, the 2ndNational Conference of Architecture, Civil Engineering and Urban Environment
 8. Gharibpoor, A., 2013, Terminology of architecture performance, Fine Arts Journal - Architecture and Urbanism, No. 18, Spring 2013
 9. Karami, Kh., 2012, Investigation the level of noise pollution in different wards of Ahwaz, Golestan and Bushehr hospitals,Journal of Health Sciences Jundishapur, Issue 4, Winter 2012
 - 10.Karami, Kh., 2012, Investigation the level of noise pollution in different wards of Ahwaz, Golestan and Bushehr hospitals, Journal of Health Sciences Jundishapur, Issue 4, Winter 2012
 11. Mahlabani, Y.,2010, Gilan Sustainable solutions compared with Japanese architecture, Fine Arts Journals - Architecture and Urbanism, No. 41, Spring 2010
 12. Mohammadi, M.,2013, An environmental assessment developed in curriculum of civil engineering, architecture, agriculture and sustainable development with environmental standards, Journal of Engineering Education in Iran, Issue 59, fall2013, pp.75-94
 13. Nadimi, H.,2012, Reference on architectural ideas in some architects ideas,Journal of Fine Arts - Architecture and Urbanism, No. 17, summer2012
- Andrea Whittaker, 2014, Perceptions of an ‘international hospital’ in Thailand by medical travel patients: Cross-cultural tensions in a transnational space, Social Science & Medicine 124
- Tianzhen Hong, 2015, Update to the China Design Standard for Energy Efficiency in public buildings, Energy Policy 87
- Mehrdad Taheri Kahnamoei, Department of Architecture, Tabriz Branch, Islamic Azad University, Tabriz, Iran
Email: Iranstu.arch_taheri@iaut.ac.ir
- Hassan Sattari Sarbangholi ^{Ph.D.}, Department of Architecture, Tabriz Branch, Islamic Azad University, Tabriz, Iran
Corresponding Author: sattari@iaut.ac.ir