# The human factors of sustainable design in urban constructions (With emphasize on Residents' psychological Behaviors)

Saeid Yasinian[1]

[1] Department of Architecture, Hamedan branch, Islamic Azad University, Hamedan, Iran
syasinian@gmail.com

**Abstract:** The intention of sustainable design is to "eliminate negative environmental impact completely through skillful, sensitive design". Manifestations of sustainable design require no non-renewable resources, impact the environment minimally, and relate people with the natural environment. This manuscript highlights the human factors of sustainable design in urban constructions. While numerous technical progressions have allowed for the reduction of resource consumption, not much study have addressed the reaction of occupants to these appliances, or the degree to which prosperity in achieving sustainability objectives is dependent upon user behavior. This manuscript reviews investigation in related fields and recommends ways in which psychological, behavioral and social issues might be significant to sustainable design, as same as how ways attending to psychological requirements could enhance the success of meeting these and other objectives. Applied behavior and social psychological analytical approaches are surveyed as methods to answer to conservation and recycling objectives. The physiological and psychological profits that green constructions confer on their inhabitants are also notified, as are fields for future investigation, and steps that the building industry could take to develop more sustainable and holistic building practices which incorporate inhabitant behavioral requirements.
[Saeid Yasinian. The human factors of sustainable design in urban constructions (With emphasize on Residents' psychological Behaviors) . Journal of American Science 2011;7(5):886-891]. (ISSN: 1545-1003).
http://www.americanscience.org.

**Keywords:** Human Factors, Sustainable Design, Constructions, Residents, Psychological Behaviors.

## 1. Introduction

Sustainable architecture is a general term that describes environmentally conscious design techniques in the field of architecture. Sustainable architecture is framed by the larger discussion of sustainability and the pressing economic and political issues of our world (Randolph, John and Gilbert, 2008).

Every day, developers are searching to construct more sustainable constructions, including mega-structures similar to the much expected redevelopment of the WTC (World Trade Center). While there is growing technological awareness on how to complete this objective, there is yet limited investigation on the connection between such progressions and individual building occupants and users. Since social factors are essential parts of sustainable development, it is significant to comprehend the connection between technological promotions in sustainable constructions and the attitudes of, and influences, on building occupants. The primary identified meaning of sustainable development was presented in 1987 as that which “encounters the requirements of the present excluding compromising the requirements of the future”. Sustainability was also expanded and conceptualized at the International Earth Summit (IES) conference in Rio de Janeiro in 1994, to merge considerations for economic, environmental, and social well being. (World urbanization prospects, 1998) The concentrations of this manuscript is on sustainability in the built environment`s context with primary focus on consumption of natural resources, wherein a sustainable construction is one that enhances occupant performance and health, minimizes material and energy consumption, and motivates a healthy ecosystem. There is little investigation on human social and behavioral reactions to themes of sustainability in constructions generally, and even less so for high-rise constructions, which for the aim of this manuscript are limited to buildings over ten or more levels high. Even so, tendencies over the last one hundred years recommend increased building of such structures (Gonchar, 2002) The world-wide event of migration between urban and agricultural communities and intensified awareness of environmental issues related to urban sprawl prepared the impetus for progression of urban projects in large scale. This inclination towards high-rise constructions is supported by technological improvements which have made their building less costly and easier. Traditionally, high-rise constructions consume a large number of resources. These huge structures are dependent upon large quantities of construction materials during building, need respectable amounts of energy to

function, and produce much of waste at the time they reach the end of their life cycle and are ruined. Over seventy-five percent of the energy consumption in high-rise constructions is allocated for ventilation, air conditioning and heating. In the past time, the low cost of technological improvements and energy in HVAC and lighting have discouraged building engineers and designers from making more utilization of passive temperature control apparatuses, such as shading techniques and operable windows. (Wallace, 2005). But current considerations about the growing cost of energy, restricts on availability of drinkable water, and awareness of difficulties with material utilization and waste disposal are likely to affect designers to form a corporation for more sustainable factors into high-rise buildings. While there is growing attention paid to sustainable construction techniques, there has been comparatively limited discussion about the behavioral and psychological points of sustainability and how occupants interact with such structures. This manuscript would discuss psychological, social and behavioral factors that require to be noticed in high-rise facility management, as same as the potential for sustainable constructions to ameliorate some of the difficulties in those domains traditionally related to high-rise constructions. It concludes by distinguishing future investigation steps and topics which the building industry could utilize to develop more sustainable and holistic building exercises (World Commission on environment, 1987).

**2. Overview**

Building construction and operation have extensive direct and indirect impacts on the environment. Buildings use resources such as energy, water and raw materials, generate waste (occupant, construction and demolition) and emit potentially harmful atmospheric emissions. Building owners, designers and builders face a unique challenge to meet demands for new and renovated facilities that are accessible, secure, healthy, and productive while minimizing their impact on the environment. Considering the current economic challenges, retrofitting an existing building can be more cost effective than building a new facility. Designing major renovations and retrofits for existing buildings to include sustainability initiatives reduces operation costs and environmental impacts, and can increase building resiliency (WBDG Sustainable Committee, 2004).

**3. Sustainable building materials**

Some examples of sustainable building materials include recycled denim or blown-in fiber glass insulation, sustainably harvested wood, Trass, Linoleum, sheep wool, concrete (high and ultra high performance roman self-healing concrete), panels made from paper flakes, baked earth, rammed earth, clay, vermiculite, flax linnen, sisal, seegrass, cork, expanded clay grains, coconut, wood fibre plates, calcium sand stone, locally obtained stone and rock, and bamboo, which is one of the strongest and fastest growing woody plants, and non-toxic low-VOC glues and paints (Randolph and Gilbert, 2008).

**4. Sustainable constructions` behavioral requirements**

Several studies have been carried out showing that sustainable technology does not automatically lead to sustainable user behaviour. Derijcke and Uitzinger (2006) describe a case study in which they studied the behaviour of residents regarding some sustainability related issues in housing. They found that a 'reasonable share of the residents did not know that their toilet had a flush stop, and therefore did not use it'. They also found people misunderstanding a mechanical ventilator with settings 0, 1, and 2. As people believed that 0 meant 'off' (which is not true) they operated the ventilator unnecessarily at higher levels, thereby wasting energy. On the other hand Völlink and Meertens (2006) found that installing prepayment gas meters, creates a form of repetitive feedback that caused a 4% reduction in gas consumption; an example where a technological intervention did lead to more sustainable consumption.

Several authors have discussed how product design can influence users. For instance, Jelsma and Knot (2002) applied (as one of the first) the idea of 'scripting' to sustainable product design. They defined scripting as the design of a product-layout guiding the behaviour of the user, in a more or less forceful way, to comply with values and intentions inscribed into the product by the designer. If it would be the designer's intention to inscribe increased likelihood of sustainable usage into the product, this would mean designing products in such a way that unsustainable behaviour is made difficult or impossible, while sustainable behaviour is made easy or easier, or even automatic. Jelsma and Knot (2002) applied their concept of scripting to sustainable service systems, in particular to clothing care systems (Wever, Renee, 2008).

A part of the oft-cited ecological profits of green constructions are dependent upon the capability to correctly predict occupant behavior. All occupied constructions are designed around implicit or explicit assumptions about inhabitant decisions, behaviors and answers. From a psychological and environmental aspect, constructions are physical forms which, in Bechtel's words, 'enclose behavior'.

That is, constructions prepare facilities and shelter from the components to support people activities. They are planned to provide for occupant behavior, social, psychological and requirements. Whether or not they are prosperous, depends in great part upon the degree to which architects accurately predict and comprehend which activities are likely to occur and needed, and their ability to utilize this knowledge to make facilities and space to uphold their predictions. If the space is to be utilized as a school, it should uphold likely class size, lighting and acoustical needs, staff meetings, private student-teacher discussions, different teaching methods, etc. If it is a factory, it should provide space for manufacturing processes and equipment, but also attend to lighting and acoustic requirements, facilities for employee meetings, meals, and breaks (Dunlap, 2004). When designers are determining the needed technical size and performance of construction systems, they should make reasonable estimates of items such as how much water and energy would be consumed, and how much solid and liquid waste would be produced. These are, in large scale, behavioral factors since occupants activity shapes the utilization of these resources and thus the costs involved and amount of savings probable due to conservation. People make behavioral selections that influence these systems, such as when to increase their personal console by closing or opening windows, adjusting thermostats and raising or lowering drapes and blinds. Behavioral determinations are involved in these actions as the amount of water utilized for washing dishes, the amount of showers, whether or not to use up recycled water, what products to buy and whether and how to recycle. These selections by residents could be critical in determining how efficiently and well construction systems perform. Green constructions are typically designed to be particularly efficient in these respects, but there are as still not sufficient anecdotal knowledge or formal appraisal of sustainable high-rise constructions to decide how effectively they react to variations in human requirements (Miodonski,1999). Environmental effect projections of a sustainable construction might be based upon expectations of consequential levels of recycling participation and water and energy conservation, requiring very careful utilization of construction systems by tenants. Such a facility may be so sensitive to changeability of occupant behavior and can suffer greatly if the substantial usage varied meaningfully from that predicted in the planning levels. If tenants were unable or unwilling to match to high standards, same as taking short showers, turning down thermostats in the winter, or purchasing minimally packaged products, the construction's performance can fall well below predictions. One of the reasons passive solar designs could not become more widely utilized by the end of the twentieth century might be the perceived requirements they made on user effort and time. The sensitivity of construction performance to user behavior is illustrated in the study of a green factory construction in the USA (Yeang, 1999).The building was considered to be operating sub-optimally in various respects. For instance, energy consumption was clearly higher than forseen, in part as workers kept huge bay doors open for the clean pure air and for the views that these doors prepared. While the original plan had allowed for good views and more effective ventilation and high shelving was deduced after initial occupancy which blocked the views and vents, encouraging users to open the bay doors. In some of the cases, sustainable constructions may be less sensitive to variations in occupant activity, if, for example, they relied upon smart technology or heavy insulation which controls temperature, lighting, and windows to keep energy.

Such a building may be called sustainably robust if it was able to resist important variations in behavior and still preserve optimal performance. The robustness, or sensitivity, of the building in responding to user behavior might be an major dimension in determining the ability of a sustainable building to meet its aims throughout its operational lifelong. It is also vague at this point what level of knowledge or training may be needed of occupants in sustainable buildings. Will structure systems in these facilities be technical, complex, and require careful maintenance and monitoring? and will they be, in the vocabularyof marketing, 'automatic and carefree'. These are major questions for future research. The potential for sustainable structures to arrange efficiently depends to a certain extent upon response to conservation technologies. For instance, even if builders install low-flow showerheads, water consumption might remain high if people bathe for an extremely long time (Schmidt, 2004).Likewise, early production low-flow toilets did not always result in the anticipated water savings due to public perceptions of problems with their use. Response to (and success with) later production low-flow toilets appears to be better. Increasingly, developers are integrating recycled water into their houses. Different policies for preserving water have been developed which include recycling of 'grey water' (domestic water from sinks, bath or water washing machines) or 'black water' (water containing animal, human or food waste), and here, psychological- and culturally-based responses might be especially important. The success of these dimensions is significantly relying on user perceptions and response. What remains most controversial is the utilization of recycled water for

drinking goals (the so-called 'yuck' element). Some of this hesitancy is due to vague scientific knowledge of its long period safety as part of the drinking supply. Scientific uncertainty is because potential hazards from micro contaminates that are not currently observed in wastewater sewage. Findings from an investigation accomplished in the USA on recycled water suppliers and users show that individuals are concerned about water reuse due to salinity, microbiological elements, and aggregate components such as nutrients, PH, varying quality and organic components. The majority of water recycling plans incorporates grey water utilization into toilet flushing water or lawn care. One instance is the Oakland's East Bay shore Recycled Water program (Case FD, 1984) .This plan will supply 3.5 million gallons of recycled water per day to businesses, industries, and residents across the region for use in toilet flushing, irrigation, and industrial uses, wetlands restoration. As part of this program, a new building was built with a dual pipe system that allows 30,000 gallons of recycled water provided by the utility district to be utilized in the toilets throughout the building. While this kind of water recycling is typically agreed with the general public, some users do declare fear of unknown issues and potential negative effects on children. These uncertainties could be mitigated through organizational commitment, increased public outreach, and well-managed information, trust, and decision making. In some respects, water recycling is not novel since different communities have long drawn on each other's water resources. For instance, New Orleans gets its drinking water from the Mississippi River and asserts that this water has already been used seven times before it is accessed by the City. It might be, then, that confirmation of recycled drinking water must depend on the implementation of suitable technologies to address potential contaminates as well as public awareness campaigns. Some water utility officials believe that negative public comprehensions of recycled drinking water will alter in time but further application of social psychological study might be suitable in easing these transitions.

**5. Improving sustainable behaviors**

Most programs to foster sustainable behavior continue to be based upon models of behavior change that psychological research has found to be limited. Although psychology has much to contribute to the design of effective programs to foster sustainable behavior, little attention has been paid to ensuring that psychological knowledge is accessible to those who design environmental programs. This article presents a process, community-based social marketing that attempts to make psychological knowledge relevant and accessible to these individuals. Further, it provides two case studies in which program planners have utilized this approach to deliver their initiatives. Finally, it reflects on the obstacles that exist to incorporating psychological expertise into programs to promote sustainable behavior (Doug McKenzie, 2000).

Many of the behavioral issues encompassing sustainable design have been explained in existing study on the effect of human behavior on water and energy conservation, and on recycling that was stimulated by the 1970 s energy crisis. Sustainable structures might differ from these earlier conservation policies in the method that many or all of these issues are declared collectively to try and produce a 'no-impact' building (Pope, 1998) Psychological study on conservation issues has taken two broad methods: social psychological researches, which concentrated upon efforts to change and understand attitudes; and applied behavioral analyses, which evaluate critical behavioral possibilities. Efforts to alter or strengthen pro-environmental attitudes are usually based upon the intuitive notion that attitudes underlie behavior, and, thus, by altering the previous, the latter will follow. While this seems reasonable, it is not certainly supported by research. Social psychological researches over many decades have indicated that there is usually little correspondence between behaviors and attitudes and that in some cases attitudes follow behavior changes rather than preceding them (Heerwagen, 1998). There is some proof that conservation education can be effective, although more researches have presented no impact or a very weak one. On the other hand, there are researches that propose that policies which try to draw out a personal and public commitment to a particular pro-environmental action from people could lead to remarkable and even lasting alteration. As Stern emphasizes, the relationship between behavior and environmental attitudes might not be a simple one. The behaviors in query, he explains, typically "lie at the end of a long causal chain containing a variety of contextual and personal elements," such as demographic and social elements, constraints and incentives, values, knowledge, and commitment. Altering any one component might not be sufficient to influence behavioral change. For effective strategy change it might be necessary to address and assess the specific situational constraints that inhibit change, as demonstrated by McKenzie-Mohr who used a combination of psychological methods and marketing polices to decrease water consumption (Brown, 2001).

**6. Conclusion**

Climate change and degradation of the environment are global problems associated with many other challenges (e.g., population increases, reduction of glaciers, and loss of critical habitats). Psychological science can play a critical role in addressing these problems by fostering a sustainable environment. Multiple strategies for fostering a sustainable environment could draw from the diversity of topics and areas of specialization within psychology. Psychological research on fostering environmentally sustainable behaviors is rather well developed, as illustrated by interventions focusing on education of the public, message framing, feedback, decision making, the media, incentives and disincentives, and social marketing. Other sciences and professions as well as religion and ethics are actively involved in fostering a sustainable environment. Psychology ought to be more involved directly, systematically, and visibly to draw on our current knowledge and to have palpable impact. We would serve the world very well and in the process our discipline and profession (Kazdin, 2009).

From this short review it is obvious that the behavior of occupants and tenants of a sustainable facility is likely to play a major role in determining the degree to which the building 1 Kats found productivity to increase on the order of 1–1.5% in LEED— Gold, Silver, and Platinum buildings. These various kinds of buildings indicate how the US Green Building Council defines the energy and environmental efficiency of a structure with Platinum buildings having the least effect. It is necessary for planners to make the systems and strategies that make it easy for users to engage in recycling and conservation; they are designing for human behavior as well as for engineering and physical systems. A number of questions remain concerning occupant behavior and sustainable design: What types of behaviors are expected and/or required of occupants in a sustainable building? How 'sustainably robust' are technologies? How much behavior change is tolerated before a building falls below its stated sustainability aims? It is also obvious what level of training or knowledge may be needed of occupants in sustainable buildings. Will building systems in these facilities be technical, complex, and require careful maintenance and monitoring, or will they be 'automatic and carefree'? These questions all require to be addressed by applied environment behavior researches. Mega-structures might have particular benefits of economies and centralization of scale, but they come with built-in challenges concerning the psychological and social needs of building users. Users within mega-structures lose a factor of personal control over their life safety and conditions. Once within these structures, occupants become remarkably dependent on technology for light, air, and even the shortest of trips. In addition, as explained, the larger the structure, the more those in it are disengaged from natural components. There is increasing proof that such segregation has negative results for psychological states and behavior resulting in poor health and efficiency loss. The green skyscraper, by contrast, has the potential to promote upon this position by addressing all of these results. It could approach zero-impact in part by giving control back to the individual and by being designed to support fundamental behavioral requirements. It could help modify the lost connection with nature that most high-rise tenants suffer by giving greater access to and contact with natural components in the form of vegetation, suitable ventilation, non-toxic materials, day lighting and views to the outside.

**References**

[1] World urbanization prospects: the 1996 revision. New York: Department for economic and social affairs. Population Division—United Nations; 1998.

[2] Gonchar J. Green building ratings get easier. Eng News Rec 2002;249(3):10.

[3] Wallace B. Becoming part of the solution: the engineer's guide to sustainable development. Washington, DC: American Council of Engineering Companies; 2005.

[4] World Commission on environment and development: our common future. Oxford, UK: Oxford University Press; 1987.

[5] Dunlap DW. At ground zero, new tower pushes higher than original. The New York times, september 16 2004 p. B8.

[6] Miodonski B. Editorial: Don't flush the 1.6 gpf mandate by. Available from: http://www.supplyht.com/CDA/ArticleInformation/features/BNPFeaturesItem/0,5333,73926,00. html; 1999.

[7] Yeang K. The green skyscraper. London, UK: Prestel; 1999.

[8] Schmidt CW. Sprawl. Environ Health Perspect 2004;112(11):A620.

[9] Case FD. Design implications of living with passive solar homes. J Archit Plan Res 1984;1(2):85–104.

[10] Pope S. Low-tech applications merit attention: President's message SOL: SESCI newsletter 1998 p. 107.

[11] Heerwagen J, Wise JA. Green building benefits: differences in perceptions and experiences across manufacturing shifts HPAC heating/piping/air conditioning February 1998.

[12] Brown JL. First 'Green' residential high-rise planned for New York city. Civ Eng 2001;71(2):32–3.

[13] M. Masters, "Energy for Sustainability: Technology, Planning, Policy," Island Press, Washington, DC., 2008.
[14] WBDG Sustainable Committee, Whole building design guide, 2010. URL: http://www.wbdg.org/design/sustainable.php, accessed in 2011.
[15] Doug McKenzie-Mohr, Promoting Sustainable Behavior: An Introduction to Community-Based Social Marketing, Journal of Social Issues, Fall, 2000.
[16] Wever, Renee et. al., User-centred Design for sustainable Behaviour, International Journal of Sustainable Engineering, Vol. 1, No. 1, 2008.
[17] Kazdin, Alan E., Psychological Science's Contributions to a Sustainable Environment: Extending Our Reach to a Grand Challenge of Society, American Psychologist, v64 n5 p339-356 2009.

5/2/2011