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THE IMPACT OF SOCIOECONOMIC CONTEXT ON ACHIEVING LEED PLATINUM FACILITIES IN DEVELOPING AND DEVELOPED COUNTRIES

EL IMPACTO DEL CONTEXTO SOCIOECONÓMICO PARA LOGRAR LA CERTIFICACIÓN LEED PLATINUM EN EDIFICIOS DE PAÍSES DESARROLLADOS Y EN DESARROLLO

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Abstract

The United States (US) and India are two populous democratic nations that are leading contributors to global climate change and greenhouse gas emissions. To address these problems, LEED (Leadership in Energy and Environmental Design) is one of the tools commonly utilized by the two nations to reduce negative environmental impacts of buildings.This research studied the ways in which LEED certified buildings offer social benefits to their surrounding communities in different socioeconomic contexts. For this study, two LEED Platinum Rated Buildings were purposively selected in the US and India, and technologies and strategies used to achieve the Platinum rating were identified. These technologies and strategies were classified based on social benefits offered to the surrounding community, and cases were compared to evaluate whether benefits varied between the two contexts. For the building located in the US, 26 out of 70, and for the building located in India, 18 out of 57 technologies and strategies were expected to offer social benefits to the surrounding community. For these cases, no significant difference was found in the proportion of potential societal benefits expected between case study projects in the developed vs. developing country. Future research should further explore and quantify the actual societal benefits achieved by certified buildings.

Keywords: LEED, LEED Platinum Buildings, Social benefits of LEED

Introduction

The human population has sharply increased in last two centuries and with it the development of infrastructure that is necessary to support population growth. The population grew from 0.98 Billion in 1800 to 1.65 Billion in 1900 and 6.06 Billion in 2000 (United Nations Secretariat 1999). By 2016, the total world population was estimated to be close to 7.5 Billion and the top three populous countries were China (1.37 Billion), India (1.28 Billion), and the US (0.32 Billion) (USCB 2016). Randolph and Myers (2008) project that there will be 11 Billion inhabitants on the planet in 2100. Fulfilling needs of a growing population with aspirations for increased standards of living can pose a challenge due to the finiteness of the resources. Hardin (1968) highlighted the problems associated with the continued growth of the population and its impacts on ecosystems, pollution, and resource consumption. The same argument was supported by subsequent research (Ehrlich and Holdren 1971; Holdren and Ehrlich 1974). The continued growth of human population also implies the need to provide basic resources towards sustenance and ancillary resources for the development of the economy and providing comfortable and equitable lifestyle. With the increase in population, buildings, an integral part of human developmental paradigm, have not only evolved over time but also increased in numbers to provide sustenance to the growing populace. These facilities, designed to support human needs and aspirations, are associated with high amount of emissions, continued consumption of natural resources (water and energy), and influence on local ecology (UNEP SBCI 2009; PNNL 2012; Vanegas 2003). 40% of global energy use and 33% of global greenhouse gas emissions are associated with buildings, both in developing and developed nations (UNEP SBCI 2009). The built environment has also been linked to adverse impacts on water resources, loss of habitat for flora and fauna (WWF 2012), an increase in landfills (AIA 2008), and consumption of limited resources. To summarize, human population needs facilities that can support future growth, but the facilities presently constructed across the globe to meet these needs are associated with multiple adverse impacts that threaten to influence the survival and prosperity of the human race (Keysar and Pearce 2007; Kibert et al. 2002; SOE 2011; WWF 2012).

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Multiple Green Building Rating Systems (BRS), such as LEED (Leadership in Energy and Environmental Design), BREEAM (Building Research Establishment Environmental Assessment Method), CASBEE (Comprehensive Assessment System for Built Environment Efficiency), Global Sustainability Assessment System, and others are implemented across the globe to mitigate negative impacts of building and improve health of occupants (CASBEE 2015; BREEAM 2015; USGBC 2016). Most of the projects certified by Green BRS can demonstrate an improved impact on ecology, reduced resource consumption (water and energy), reduced waste production over the lifecycle of the facility, and positive value to the occupants compared to conventional construction. Within the US, LEED is a voluntary third party BRS and has established credibility (Castro-Lacouture et al. 2009). The distribution of LEED Certified Projects across the US is non-uniform, and certain parts of the country have more certified buildings than others do (Cidell 2009). At the same time, multiple federal and state agencies across the US expect or mandate LEED certification on projects to minimize adverse impacts of the built environment (DuBose et al. 2007; Hendricks and Calkins 2006; Langar and Pearce 2011; Langar 2013). As of January 2016, there were (USGBC 2016b):

- 31,000 certified commercial projects
- 93,000 certified LEED for Homes residential units
- More than 1,600 certified K-12 projects
- More than 3,490 certified higher education projects
- More than 690 state government projects certified
- More than 2,230 local government projects certified

Along with the US, 75,000 projects have participated in LEED from 155 nations globally (USGBC 2016c). Canada, China, India, Brazil, and Republic of Korea (South Korea) were identified as the top five countries using LEED, apart from the US (USGBC 2015). Thus, one can conclude that there are indications of growing momentum towards the use of green BRS such as LEED to mitigate the impacts of built environment on the local ecology and in the process improve the health and satisfaction of occupants, both within the US and globally.

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For LEED certified projects, adoption and implementation of green technologies and strategies play a significant role to achieve expected performance levels and offer benefit to direct and indirect stakeholders associated with the project. Kibert et al. (2012) identified technology as one of the ways to mitigate the impact of the built environment and meet the needs of increasing populace. The family of LEED rating systems encourages the use of green technologies and strategies to alleviate the impact of built environment and provide a positive atmosphere for the occupants. Most of the technologies and strategies adopted within a LEED Certified building are intended to minimize negative impact on surrounding ecosystems, promote a positive influence on the users and occupants, and reduce the generation of waste and consumption of resources over the lifecycle of the facility. At the same time, when any building is constructed, it influences the community residing in the particular area. The same stands true for Green BRS. Potbhare et al. (2009) also state that the success of a green BRS lies in the ability to bring together all direct and indirect construction stakeholders including the surrounding community. Wang et al. (2014) state that the

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apart from the benefits of green buildings on economy and ecology, communities can also benefit from such projects. Specific social benefits associated with green buildings include enhanced occupant health, comfort, and productivity; enhanced employment and business opportunities; and reduced strain on local infrastructure (Pearce et al. 2012; USGBC 2016b). Newer versions of the LEED rating system also include specific credits targeted toward improving social impacts, including the new LEED pilot credit "Social equity within the community" that rewards contributions of a project to both communities influenced directly and indirectly by the project (USGBC 2016d).

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Given the nature in which LEED is growing within the US and globally, and the array of potential benefits it offers to environment, economy, and society, one question that remains unexplored is whether and how the use of green technologies and strategies in LEED certified buildings improves social benefits to the surrounding community, and how these benefits might differ based on the context of the project. The aim of this study was to explore this question in two different contexts: a corporate headquarters building in a developed nation, and a business incubator project in a developing nation.

Methodology

The study aimed to identify social benefits offered to surrounding community by technologies and strategies employed to achieve credits in LEED buildings and then observe whether any variation of social benefits could be observed across two Platinum certified projects located in different socioeconomic contexts.

Case study selection and development:

For this study, two LEED Platinum Certified buildings located in separate socioeconomic contexts were selected to observe the difference. LEED Platinum certified buildings were chosen for this study because such buildings are expected to have 70% lower environmental impact than a conventional building (Cidell 2009) and in the process such buildings represent the "best of breed." The decision to focus exclusively on LEED Platinum cases rather than multiple levels of certification is justified in case study analysis since projects certified at this level represent the extremes of green design (Yin 2009).

The two contexts selected for the study were the US and India. Both countries are among the top three most populous democratic nations worldwide, supporting 0.32 Billion and 1.28 Billion people respectively (US Census Bureau 2016). Along with large populations, both countries were listed as two of the top five contributors to global climate change (Matthews et al. 2014), and two of the top three contributors of CO2 and Greenhouse Gas emissions (World Bank 2015a; World Bank 2015b). At the same time, other significant differences characterize these countries. Most importantly, the US is considered a developed nation, whereas India is a developing country

(UN 2014). In terms of Gross Domestic Product (GDP) per capita, the US ranks 19th out of 229 countries with a per capita GDP of USD $55,800, whereas India ranks 158th with a per capita GDP of USD $6,200 (CIA 2016). However, regarding real growth rate of GDP, India ranks 12th out of 225 countries with a growth rate of 7.3 percent, whereas the US ranks 127th with a growth rate of 2.4 percent (ibid.), showing the comparatively rapid level of economic growth in India vs. the US. The official poverty rate for the US was about 14.8% in 2013 (USCB 2015), and the poverty rate for India was 21.3% in 2011 (World Bank 2015c).

After identifying the countries of interest for analysis, purposive selection of projects was conducted based on the following factors:

- Both projects should have similar availability of information
- Both projects should be certified under the same version of LEED, to a Platinum level

After identifying the two cases, literature available on the projects was compiled. In this process, technologies and strategies utilized by the project stakeholders to achieve LEED credits were identified based on specific mention as part of the case study materials compiled. These materials included case studies on each project published in the literature. In addition to compilation of the data from available resources, the researchers interviewed the designer of the project located in India. The result of the interview process resulted in the identification of technologies, strategies, and design process used to complete the project. All compiled information was transcribed and added to existing information obtained from the literature. The researchers were unable to obtain any response from the designers of Genzyme.

The result of the interview process resulted in the identification of technologies, strategies, and design process used to complete the project

Classification of Social Benefits:

The next step was to characterize each identified technology or strategy regarding potential social benefits. To operationalize the construct of social benefits for this study, the term was defined as benefits emanating from the implementation of a technology and strategy on a project that directly improve the quality of life and health of community members or promote the economic growth of the community surrounding the project. For this study, building occupants were not considered. Based on the operationalization of social benefits, each technology or strategy employed on the projects was classified into one of two categories or piles depending on whether or not they were likely to afford social benefits to the surrounding community. For example, implementation of bicycle racks, showers, and locker room for bicycle commuters contributes towards achieving SS Credit 4.2 within LEED NCV2.0, and utilized in both the analyzed projects. The implementation of the strategy encourages people to use a bicycle, rather than vehicle, and in the process reduces the vehicles used. With the use of bicycles, traffic and pollution are reduced, and such a strategy could benefit the surrounding communities. In addition, the use of bicycle can encourage people to reside closer to the facility and provide economic growth to the surrounding community. Therefore, when the strategy was analyzed in the context, it fit well with the established construct for social benefits and was placed in the pile of technologies and strategies that offered social benefits to the surrounding community. This process of analysis and sorting was conducted for all identified technologies and strategies. Thus, the process of classification or pile sorting allowed researchers to identify technologies and strategies that offered social benefits offered to the surrounding community. The classification was based on hypothesized benefits to communities resulting from implementing each technology or strategy on the project. Two major kinds of benefits of implementing green technologies and strategies were classified as social benefits for this study:

Thus, the process of classification or pile sorting allowed researchers to identify technologies and strategies that offered social benefits offered to the surrounding community.

1. Creating awareness by using the building as an educational tool
2. Mitigating wastes generated and impacts from the building to the surrounding community by reducing all forms of pollutions generated throughout the lifecycle

Technologies hypothesized to result in any of these two types of benefits were counted as offering social benefits in analyzing the case studies. The lists of technologies and strategies for each project were then compared in terms of the proportion of items offering vs. not having social benefits.

Results

The two LEED Platinum certified projects were CII Sohrabji Godrej Green Business Centre (GBC), located in Hyderabad, India, and Genzyme located in Cambridge, US. Both projects were certified as LEED Platinum under version 2.0 of the LEED rating system. At the time of certification, these buildings were part of a very small population of projects achieving LEED Platinum certification. The CII Godrej GBC was the first LEED Platinum building in India, and the Genzyme building was an early exemplar Platinum project in the United States. Table 1 provides basic information about the projects.

Table 1: General Project Information about the LEED Platinum Projects

Category	Genzyme	CII Godrej GBC
LEED Points	52 points (Maximum: 69)	56 points (Maximum: 69)
Architect(s) associated with the project	Benisch, Benisch & Partners, Next Phase studio, and House & Robertson Architects	Architect Karan Grover
Previous experience of architectural firm with LEED projects	Yes	No

Designer selection	Invited competition, with previous green design experience as added benefit	The architectural firm provided services
Site location	Urban setting	Sub-urban setting
Climate	Harsh Winters & Hot summers	Tropical wet and dry climate with border of semi-arid
Design Concept	Innovation, collaboration, and transparency	Efficient use of natural resources and ancient historical techniques
Built up area	Approximately 3, 50,000 Sq. Ft.	20,000 Sq. Ft.
Project start & completion dates	Project started on 06/2001 and completed on 10/2003	Project started on 03/2000 and completed on 07/2004
Project Type	Private	Public-private partnership

(Source: Olmstead and Neely 2005; ABC 2009; Gangwar 2012; Subramanian 2012)

During case study development, the researchers found that the Genzyme, US, achieved LEED credits through active use of technology such as heliostats, prisms in the atrium, U-shaped blinds, occupancy sensors, reflective ceiling tiles and wall surfaces, and others. Some of the aspects were creative and at the same time technologically active in nature. In contrast, for the building in India, the designers used passive technologies and strategies such as lattice walls/screen walls, earth berms, and wind towers to provide cool air to the air handling units, operable windows, use of broken glass as a cladding material on columns, and others. These technologies were used to achieve credits such as "Optimize energy performance" that were performance-based.

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In contrast, when requirements for credits or prerequisites were prescriptive in the rating system, the divergence of technologies and strategies across the two contexts was reduced. Examples of such commonalities were the use of CO2 monitoring, bicycle facilities, and others. Both buildings sought certification under LEED version 2.0, which had credits that were both prescriptive and performance-based in nature. To achieve performance-based credits, there is more than one way to achieve the same results, and choices depended on the context and objectives of the project itself. When stakeholders are allowed the flexibility to implement technologies and strategies under a performance-based credit, solutions might be active, passive, or a combination of both, depending on the project type and the context within which it was designed and built.

After developing the case studies, a comparative list of technologies and strategies used in the two projects was compiled. For Genzyme, US, the researchers identified 70 technologies and strategies mentioned in the literature describing the projects, and for CII Godrej GBC, 57 were identified that enabled the facilities to achieve LEED Platinum Certification. In the analysis for the Genzyme case study located in the US, 26 technologies and strategies were identified that provided social benefits to the community (Table 2). For the CII project, located in India, 18 technologies and strategies were identified that provided social benefits to the community (Table 3).

Table 2: List of technologies and strategies that offered social benefits to surrounding community, for the Genzyme LEED Platinum Building

1. Bicycle racks, showers, and a locker room are available for bicycle commuters
2. Blinds closed at night to prevent light pollution in the neighborhood
3. Brownfield Site (coal gasification plant) was decontaminated as per specification
4. Company contracted Zip Car, to rent by in the main cities across the US to make shared Toyota Prius hybrid vehicles easily available to the staff
5. Company promotes carpooling
6. Company provides a 60% subsidy for MBTA passes and a guaranteed ride home program for carpool commuters
7. Extensive erosion & sedimentation plans incorporated
8. Installation of visual display terminals, use of promotional materials and guided tour program.
9. Insulated roof membrane assembly (IRMA) green roof
10. Low VOC or VOC-free materials used in paints, adhesive, carpets
11. Materials used from local sources
12. Native or adapted plants
13. No CFCs for refrigerant
14. No HCFC for refrigerant
15. Non-roof surface shaded
16. Occupancy sensors for artificial lights
17. Project built in a high-density urban area
18. Recharging stations for electric vehicles
19. Use of material with recycled content
20. Shuttle program between multiple company locations
21. EnergyStar-rated reflective roof surfaces
22. Site close to mass transportation
23. Space allocated in the building for collection and storage of recyclables
24. Trained employees to conduct tours and offer monthly public tour dates
25. Waste management plan for construction
26. Water-based polyurethane finish applied and Milliken carpet tiles in the area of high traffic

Table 3: List of technologies and strategies that offered social benefits to surrounding community, for the for CII Godrej GBC Platinum Building

1. Material used from local sources
2. Bicycle racks, showers, and a locker room are available for bicycle commuters
3. Close to the railway and main road lines
4. Electric vehicle for staff uses and recharging stations available for electric vehicles
5. Extensive erosion & sedimentation plans incorporated

6. Green Building Educational Program
7. Green roofs
8. Low VOC or VOC-free materials used in paints, adhesive, carpets
9. Minimum site disturbance and significant vegetative open spaces
10. Native or adapted plants
11. No CFC
12. Non-roof surfaces shaded
13. Pervious blocks used in the parking area
14. Pond constructed on the lowest end to collect storm water
15. Recycled content materials
16. Space allocated in the building towards collection and storage of recyclables
17. Use of material with recycled content
18. Waste management plan for construction

The difference in number of technologies and strategies offering social benefits is not an indication that one LEED facility is more socially beneficial than the other facility. This difference in the number of technologies and strategies that provide social benefits to the surrounding community can be attributed to the project size, complexity, and other factors. Proportionally, for both the buildings, the researchers found that approximately one-third of the total identified technologies and strategies for both buildings offered externalized social benefits.

Conclusions

Based on the findings of the study, the researchers found that LEED Certified projects provided benefits to the surrounding community. Approximately one-third of the total identified technologies and strategies for both buildings offered externalized social benefits. At the same time, earlier versions of LEED focused on achieving environmental benefits. Newer versions of LEED explicitly include a greater focus on societal benefits with the inclusion of new pilot credits targeted directly to these objectives, as well as by encouraging technologies and strategies that have both environmental and social benefits (USGBC 2016d). Therefore, the researchers expect that newer version of LEED would provide greater societal benefit than the earlier version, but it needs to be tested. In addition, the researchers found that to achieve performance-based credits, there is more than one way to achieve the same results, and choices depended on the context and objectives of the project itself. Greater use of performance-based credits rather than prescriptive credits in newer versions of the rating system is also likely to result in a variety of technologies and strategies employed in different contexts, which may lead to different externalized social benefits as well. To summarize, LEED

Based on the findings of the study, the researchers found that LEED Certified projects provided benefits to the surrounding community

Platinum buildings in both cases offered social benefits to the surrounding communities in similar proportions.

Limitations and Future Research

This study explored the spectrum of social benefits associated with the adoption of specific green building technologies and strategies in two dramatically different contexts. Although possible societal benefits were hypothesized to be associated with the implementation of specific technologies and strategies, actual benefits realized by the project were not quantified. A critical area of future research is the quantification of social benefits to the surrounding community that is associated with projects certified under green rating systems. With this additional research, further exploration could reveal how quantified social benefits derived from buildings constructed in developed countries compare with buildings located in developing nations.

A second limitation of the study was that the case studies used in the project were based largely on secondary descriptions of the projects developed shortly after project completion rather than direct inspection and analysis of the project plans and specifications or measurements post-occupancy. Although the case study materials were extensive for both projects, it is possible that not all technologies and strategies employed in the projects were mentioned in the source materials, due to perceptions by the authors of those materials about what was most interesting to report. Further studies should include primary data (plans and specifications) as well as secondary reports in developing case studies for analysis.

References

American Institute of Architects (AIA). (2008). "Construction Waste Management Strategies." Also available at < http://www.aia.org/aiaucmp/groups/secure/documents/pdf/aiap072739.pdf>.

Asia Business Council (ABC). (2009). "Research: Green Building Case Studies." Also available at <http://www.asiabusinesscouncil.org/ResearchBEE-4a.html>.

Building Research Establishment Environmental Assessment Method (BREEAM). (2015). "The world's foremost environmental assessment method and rating system for buildings." Also available at <http://www.breeam.com/index.jsp>.

Castro-Lacouture, D., Sefair, A.J., Florez, L., and Medaglia, A.L. (2009). Optimization model for the selection of materials using a LEED-based green building rating system in Colombia. Building and Environment 44 (6), 1162–1170.

United States Central Intelligence Agency (CIA). (2016). "The World Factbook." Also available at <https://www.cia.gov/library/publications/the-world-factbook/index.html>.

Comprehensive Assessment System for Built Environment Efficiency (CASBEE). (2015). "Welcome to CASBEE website." Also available at <http://www.ibec.or.jp/CASBEE/english/>.

Cidell, J. (2009). Building Green: The Emerging Geography of LEED Certified Buildings and Professionals. The Professional Geographer, 61 (2), 200-215.

DuBose, J.R., Bosch, S.J., and Pearce, A.R. (2007). "Analysis of State-Wide Green Building Policies." Journal of Green Building, 2(2), 161-177.

Ehrlich, P., and Holdren, J. (1971). "Impact of Population Growth." Science, New Series, 171(3977) 1212-1217.

Gangwar, S. (2012). "Architectural planning and construction for Green Building." Also available at <http://117.239.73.14/E4-E5/E4-E5%20Architecture/Word/E4-E5%20Architecture%20Chapter-3%20Architecture%20Planning%20%20FOR%20GREEN%20BUILDING%20CONCEPT.pdf>.

Hardin, G. (1968). The Tragedy of the Commons. Science, 162 (3859), 1243-1248.

Harvard University. (2008). "Thematic Analysis: Foundations of Qualitative Research in Education." Also available at <http://isites.harvard.edu/icb/icb.do?keyword=qualitative&pageid=icb.page340897>

Hendricks, J., and Calkins, M. (2006). "The Adoption of an Innovation: Barriers to Use of Green Roofs Experienced by Midwest Architects and Building Owners." Journal of Green Building, 1(3), 148-168.

Holdren, J.P., and Ehrlich, P.R. (1974). "Human Population and the Global Environment." American Scientist, 62(3), 282-292.

Keysar, E., and Pearce, A.R. (2007). "Decision Support Tools for Green Building: Facilitating Selection among New Adopters on Public Sector Projects." Journal of Green Building, 2(3), 153-171.

Kibert, C.J., Sendzimir, J., and Guy, B.G. (2002). Construction Ecology: Nature as the basis for green Buildings, 1st Edition, Spon Press, New York, NY.

Kibert, C.J., Monroe, M.C., Peterson, A.L., Plate, R.R., and Thiele, L.P. (2012). Working Towards Sustainability: Ethical Decision Making in a Technological World, 1st Edition, John Wiley & Sons, Hoboken, NJ.

Langar, S., and Pearce, A.R. (2011). "Sustainable Innovations and their Routinization." 6th World Sustainable Building (SB) Conference, Helsinki, Finland, October 18-21.

Langar, S., Bhattacharjee, S., Gosh, S., Gowda, V., and Finch, J. (2012). "Comparative Analysis of LEED-NCv3.0 with LEED-NCv2.2" Proceedings of International Conference on Sustainable Design and Construction: Developing the Frontier of Sustainable Design, Engineering, and Construction, Dallas, TX, November 7-9.

Langar, S. (2013). The Role of Building Information Modeling (BIM) in the implementation of Rainwater Harvesting Technologies and Strategies (RwHTS), Doctoral Dissertation, Environmental Design and Planning, Virginia Tech., Blacksburg, VA, US.

Matthews, D., Graham, T.L., Keverian, S., Lamontagne, C., Seto, D., and Smith, T.J. (2014). "National contributions to observed global warming." Environmental Research Letters, 9(1).

Olmstead, D., and Neely, D. (2005). A Case Study of Sustainable Building Strategies. Massachusetts Technology Collaborative, US.

Pearce, A.R., Ahn, Y.H., and HanmiGlobal. (2012). Sustainable Buildings and Infrastructure: Paths to the Future. Routledge, London, UK.

PNNL (Pacific Northwest National Laboratory). (2012). 2011: Buildings Energy Data Book. Buildings Technologies Program, U.S. Department of Energy, MD, US.

Potbhare, V., Syal, M., and Korkmaz, S. (2009). "Adoption of Green Building Guidelines in Developing Countries Based on U.S. and India Experiences." Journal of Green Building, 4(2), 158-174.

Randolph, J., and Masters, G.M. (2008). Energy for Sustainability, Island Press, Washington, US.

State of the Environment Committee (SOE). (2011). An independent report presented to the Australian Government Minister for Sustainability, Environment, Water, Population, and Communities, Australian Government.

Subramanian, S. (2012). "CII Sohrabji Godrej Green Business Center Hyderabad: Architectural Case Study." Also available at <http://www.indiaenvironmentportal.org.in/files/file/CII_Sohrabji_Godrej_Green_Business_Centre-Case_Study.pdf>.

World Bank. (2015a). "CO2 emissions." Also available at <http://data.worldbank.org/indicator/EN.ATM.CO2E.KT/countries>.

World Bank. (2015b). "Total greenhouse gas emissions (kt of CO2 equivalent)." Also available at <http://data.worldbank.org/indicator/EN.ATM.GHGT.KT.CE/countries>.

World Bank. (2015c). "Poverty & Equity Data: India." Also available at <http://povertydata.worldbank.org/poverty/country/IND>.

World Wide Fund for Nature (WWF), Zoological Society of London (ZSL), Global Footprint Network (GFN), and European Space Agency (ESA). (2012). Living Planet Report 2012: Biodiversity, biocapacity and better choices, Gland, Switzerland, WWF.

United Nations (UN). (2014). "Country classification: Data sources, country classifications and aggregation methodology." Also available at <http://www.un.org/en/development/desa/policy/wesp/wesp_current/2014wesp_country_classification.pdf>.

United Nations Secretariat. (1999). The World at Six Billion, Department of Economic and Social Affairs.

UNEP SBCI. (United Nations Environment Programme- Sustainable Buildings & Climate Initiative) (2009). Buildings and Climate Change Summary for Decision-Makers, Paris, France.

United States Census Bureau (USCB). (2016). "U.S. and World Population Clock." Also available at <http://www.census.gov/popclock/>.

United States Census Bureau (USCB). (2015). "Income and Poverty in the United States: 2014." Also available at < https://www.census.gov/library/publications/2015/demo/p60-252.html>.

United States Green Building Council (USGBC). (2016). "2013-2015 Strategic Plan." Also available at <http://www.usgbc.org/sites/default/files/usgbc-strategic-plan-2013-2015.pdf>.

United States Green Building Council (USGBC). (2016b). "USGBC Statistics." Also available at <http://www.usgbc.org/articles/usgbc-statistics>.

United States Green Building Council (USGBC). (2016c). "About LEED." Also available at <http://www.usgbc.org/articles/about-leed>.

United States Green Building Council (USGBC). (2016d). "Social equity within the community." Also available at <http://www.usgbc.org/credits/se-community>.

United States Green Building Council (USGBC). (2015). "USGBC Announces International Rankings of Top 10 Countries for LEED Green Building." Also available at < http://www.usgbc.org/articles/usgbc-announces-international-rankings-top-10-countries-leed-green-building>.

Vanegas, J.A. (2003). "Road Map and Principles for Built Environment Sustainability." Journal of Environmental Sciences and Technology, 37(23), 5363-5372.

Wang, L., Toppinen, A., and Juslin, H. (2014). "Use of wood in green building: a study of expert perspectives from the UK." Journal of Cleaner Production, 65, 350-361.

Yin, R.K. (2003). Case Study Research: Design and Methods, 3rd Edition, Sage Publications, California, CA.