International Sustainability Trends in Construction and Potential Applications in the American Market

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The construction industry evolves everyday as it attempts to stay up to date on current technologies, meet the needs of consumers, and take action on the ever-pressing topic of sustainability. Sustainability is one of the main ways the industry continues to advance. The United States is one of the world leaders in sustainable construction, however with limited research and restrained interest there is only so much progress that can be made when solely relying on domestic resources. By studying and collaborating with foreign construction institutions, the American construction industry has the potential to improve its sustainability performance significantly. By performing case studies on specific firms and projects in a variety of international markets, East Asia, Europe, and Australia, the goal is to highlight international sustainable building methods that have proven to be successful and analyze the feasibility of implementing these methods in the American market. These case studies, along with a qualitative survey involving several US construction firms’ sustainability commitments, will identify how the American construction industry currently excels, and where improvements can be made to ensure future achievements.

Key Words: Sustainability, International Practices, Green Building, Implementation, Feasibility

Introduction

Sustainability is a component of construction that becomes more and more relevant each passing day. Construction firms must work to meet an ever growing client demand and society driven focus on the topic of environmental consciousness. Trends such as a focus on efficiency in terms of water usage, HVAC systems, solar energy, renewable materials, and more are becoming commonplace in new projects not only in America, but around the globe. Based on factors including government incentives, societal prioritization of eco-friendliness, and development patterns, certain markets around the globe are leading the pack in terms of sustainable growth.

Literature Review

East Asia

The continent of Asia, specifically nations lining the Pacific Ocean, have seen unprecedented rates of urbanization and development over the past few decades. The UN predicts that in 10 years, roughly 5
billion people will live in major Asian cities. Along with the construction of urban structures needed to house and provide for the influx of people, an estimated 4.5 million new buildings, comes the responsibility to build sustainably and with environmental consciousness. China pledges to have net-zero carbon emissions by 2060, with other countries such as South Korea, Japan, Hong Kong, Singapore, and Malaysia releasing similar statements. Many governing organizations of Asian nations institute systems of incentives to motivate builders to achieve certain ratings of green building. These incentives, along with a societal awareness for preservation and a generally temperate climate allow for several countries in East Asia to implement unique methods of sustainable construction.

Singapore, also known as the Garden City, is one of the world leaders in sustainability and modern development. Its tropical climate allows for developers to utilize living roofs and green walls as a major component in the sustainability of their projects. These systems help to absorb CO₂ and other pollutants from the air, retain rainwater to prevent street flooding, aid in sun-shading and reduce heat islands, and provide an unmatched aesthetic. Specifically, Parkroyal houses a fern facade measuring more than 15,000 square meters. The Oasia Hotel is home to a 27-story tall living shell. Pedestrians walking by the Treehouse condominium building can witness a nearly 25,000 square foot green wall, the largest in the world. This green wall alone is predicted to save the building more than $500,000 in energy and water costs annually. These are just a few of the many remarkable projects being completed in the region. Encouragingly, similar construction does not show signs of stopping. With extensive capital and endless public support, it is the perfect market for developers such as CapitaLand. The firm is the largest in Southeast Asia and its mission statement is, “our sustainability objectives are guided by the belief that lowering the environmental footprint of our developments through innovation creates value for our stakeholders.” This statement perfectly displays the builder’s commitment to the environment and citizens as all parties interact with a project in one way or another. Additionally, BCA Green Mark, Singapore’s certification system for green building, has certified more than 1,700 buildings since its founding in 2005. The organization has pledged more than $80 million to firms who successfully achieve sustainability in modern construction. In fact the Prime Minister of Singapore, Lee Kuan Yen, has credited the current green wall boom to this unique government policy, which will sometimes fund green building projects up to 50%.

![Figure 3. Singapore’s Parkroyal Resort exterior façade and living walls.](image-url)
South Korea is another nation in Asia leading the front on sustainability. The rapidly developing nation has pledged that all multi-family housing will be net-zero by 2025. South Korea plans on achieving such seemingly impossible benchmarks by instituting a highly structured incentive system. It will include energy pricing reforms, establish a national carbon market, provide tax deductions on low carbon items, and contain provisions on feed-in tariffs and subsidies. The overall incentivized system is meant to motivate builders to install efficient HVAC and MEP systems and encourage buyers to seek out structures that provide quality amenities while preserving environmental standards. The Korean Green Building Council helps regulate these performance standards and encourage continuous improvement.

Malaysia is working to implement a very similar system of incentives as South Korea in hopes of fueling future sustainable development. The nation contains just as much resources and demand as other surrounding nations. If proper sustainability guidelines can be established, environmental quality can be preserved and Malaysia’s presence in the world’s green building could skyrocket. Projects such as KLCC, a massive mixed-use development in the heart of Kuala Lumpur, show lots of promise.

In Bangkok, Thailand, the rooftop of Thammasat University was constructed as a functioning rice patty and solar farm. The 236,000 square foot roof collects more than 3 million gallons of water and produces enough food for more than 34,000 people annually. Furthermore, the roof works to prevent heat islands and collect solar energy to power the structure below. The project was recently certified by TREES, Thailand’s equivalent of the USGBC and is just one example of how new sustainable construction methods can be used to uplift an entire community.

Europe

Many nations in Europe are rapidly advancing when it comes to sustainable construction. European experts on the topic of innovative development credit the recent boom to advancements in digital technology, government policy, and efficient finances. These enabling factors help create evolving business models and circular economies, ensuring the continuous use of resources with little to no waste. Each European market has had to cater its design and infrastructure to its specific needs. For instance, climate wise, the Iberian peninsula currently emphasizes the importance of water efficiency as it copes with a crippling drought. On the other hand, cities such as Amsterdam and Venice deal with preventing floods and erosion. Factors such as high rates of urbanization and resource scarcity further complicate development, however sustainability remains at the forefront. In recent years, large-scale development parks have gained popularity across Europe. The projects provide a plethora of goods and services to citizens in a relatively compact area. These facilities lessen commute demand and create well-rounded, independent communities.

In Athens, Greece, work is currently underway on the Hellinikon Development Park. In 2001 when the city’s main airport shut down, more than 6.2 square kilometers of land became vacant. Developers and the Greek government slowly realized the potential of the area and in 2014 the massive lot was sold to Lambda Developers for €915 million. Demolition of pre-existing structures
began in July of 2019 and project completion is set for 2045, with partial opening beginning as soon as 2025. When completed the project will boast more than 8,000 houses, 3 hotels, a casino, 6 office towers as part of a new Central Business District, a university, 2 malls, research labs, a 2 square kilometer urban park (the largest in Europe), a 1 kilometer public beach, a marina, 50 kilometers of walking and bike paths, sports facilities, museums, a recycling center, an aquarium, and much more. The project will be connected to the city's existing metro system, thus eliminating the need for large parking lots and reducing the CO$_2$ footprint. Total project costs come out to around $8 billion, however the project is projected to create more than 75,000 jobs, 60,000 of them being permanent, and earn annual revenues upwards of $14 billion. The Hellinikon Park is predicted to attract more than 1 million annual visitors and greatly increase tourism, culture, entrepreneurship, innovation, and public awareness of environmental preservation. Overall, this specific project is projected to increase Greece’s GDP by 2.4%. Furthermore the project will plant more than 33,000 trees, helping combat Athens’ smog levels. Development projects such as the Hellinikon Park demonstrate how cooperation from developers and governing parties completely revitalize communities. Additionally, it demonstrates how when sustainability is prioritized, one of a kind projects like this can remain functional and profitable at the same time.

Figure 1. Rendering of Hellinikon Development Park in Athens, Greece.

Similarly, the Zlote Tarasy SuperMall in Warsaw, Poland is a prime example of how large, multi use development complexes integrate efficiency and sustainability into European society. The 205,000 square foot project, completed in 2007, was completed by Skanska and ING Real Estate. It houses 200 shops, 40 restaurants, hundreds of offices, a public park, entertainment centers, foreign embassies, parking, and other amenities. It also is connected to Warsaw’s Central Rail Station to allow for easy public access and a lessened dependency on inefficient transportation methods. The roof of the 26-story structure is assembled from more than 4,000 triangular glass panels. Together, these pieces form an organic wave pattern. Additionally, the glass panels are all low-emissivity, meaning they filter the amount of light and UV rays able to permeate (usually between 40%-60%). This system provides stellar indoor-outdoor ambience and greatly reduces the electricity and HVAC demand. It also protects visitors from the damaging UV rays. Many of the development’s handrails
and stairs are made from recycled rubber and the Hydrotech waterproofing ensures the building will not suffer any weather related damage, further reducing costs.

Many similar projects are currently underway in various European cities. Battersea in London, set to complete in 2026, is centered around the repurposing of a decommissioned coal-fired power plant. When completed it will provide more than 2,800 flats and dozens of other amenities within its 47 acre lot. Nordhavnen in Copenhagen, nicknamed the “Sustainable City of the Future”, involves the redevelopment of harbors and docks in the city’s decommissioned shipping yard. Upon completion in 2025 the project will possess 165,000 square meters of residential space and 140,000 square meters of commercial space, as well as parks, a marina, and several other facilities. The 500 acre project is fully state funded and is being developed by the firms: Ramboll, COBE, and Sleth. It will provide 40,000 with housing and careers. It recently received the German Sustainable Building Council’s gold certification, considered the ultimate achievement in European green building. Project Manager Jacob Ceichmann stated that Nordhavnen, “rethinks how ways of living can be combined with sustainable energy, environment, traffic, and cityscape solutions.” Les Grones in Paris, EuropaCity in Berlin, HafenCity in Hamburg, and the Lyon Confluence are among some of the other large development parks aiming to transform the way European communities function, all while upholding sustainability as a central tenet.

Australia

Australia is another leading market in sustainable construction. Contrary to the large incentive system used to encourage green building in Asia, Australia’s efforts are motivated by client demand. 94% of Australian builders practice sustainability and state that they want to improve client health and satisfaction. There is also a monetary incentive in the sense that green buildings are proven to be 15% lower in operating expenses in the long run. Trends including passive design, indoor-outdoor construction, and smart technology among others are being implemented in hundreds of new developments across the nation.

Passive design includes features such as open layout and natural materials which lead to lower HVAC requirements and operating costs. The General in Melbourne is built with solar balustrades as a glass façade. Made out of Onyx Solar Photovoltaic glass, the façade aids in thermal reduction and serves as an energy source for the building. Another leading project in solar energy is Sunshine Plaza in Melbourne. The supermall contains 4,175 solar panels which power 45% of the development. Countless other new structures utilize solar panels to reduce heat intrusion and generate power.

The Central Institute of Technology and Green Skills in Perth is built entirely of sustainable and/or recycled materials. This has earned the compound a 6 star green star rating. An example of these emerging materials is cross laminated timber, which is cost effective, less labor intensive, has lower CO₂ emissions, and is more compatible for demolition and recycling.

Water efficiency is another feature used to set many Australian projects apart. The collection of rainwater, and the recycling of black and greywater help mitigate the potential consequences of Australia’s harsh flood/drought cycle. For example, 1 Bligh Street in Sydney recycles 100,000 liters
of blackwater per day. This drastically reduces the building’s water requirements and therefore expenses.

Figure 2. Aerial view of 1 Bligh Street in Sydney, Australia.

Perhaps the most recent breakthrough system being implemented in Australia is the Tri-Generation System. It involves the removal of heat from water using “green transformers”. This produces cold water for use, as well as heat that can be transformed into energy to be used in the building. An absorption chamber is linked to a combined heat and power system. Developments such as One Central Park in Sydney use tri-generation plants where energy, heat, and cold water are produced for 3,000 residences and 65,000 square meters of retail space. The use of this system also eliminates 7,600 tons of greenhouse gas emissions at this one project alone.

Australia’s use of a unique medley of green practices including: passive design, water efficiency, solar energy, and smart technology help set it apart from other markets entering the world of sustainable construction. Australia’s economy has plenty of potential for growth and it will be exciting to observe how the nation continues to execute sustainable development in the coming years.

**Survey Analysis**

I conducted an anonymous survey involving data compiled from various US commercial construction firms. These firms perform substantial work within the United Stated and complete an average of 25 projects annually. When asked what proportion of these projects involved some form of sustainable construction, roughly 90% of the firms answered that more than 50% of their firm’s projects did. Furthermore, 70% of firms stated that nearly all of their projects incorporated sustainability into them.
I was curious what domestic construction firms’ motivations were behind sustainable construction. 89% of firms answered that building code requirements and client demand were the two main reasons behind their involvement with sustainability. Coming in at a frequency of 30%, the firm’s independent decision/commitment to sustainable performance also impressed me. This is much lower than the 94% statistic observed in Australia, however in America’s cost/profit driven society, any internal push for sustainability is worthy of acknowledgment.

*Roughly two-thirds of firms stated they had a designated sustainability department or specialized team members, however 78% of firms declared that they continuously train and inform team members on topics such as emerging green technologies and sustainability. This statistic is especially meaningful when discussing industry evolution and productivity. Slightly less than half of participating firms admitted to factoring in sustainability performance when selecting subcontractors and suppliers and accepting bids. This practice is essential and goes hand-in-hand with the emerging concept of “best value delivery”. Industry members and firms alike are beginning to comprehend that success and prosperity goes beyond simply lowest cost. Customer satisfaction, sustainable performance, and many other factors play a key role in the overall success and wellbeing of the firm and community.*

*When asked what the most common methods of green building consisted of, the firms provided a wide range of answers. The most frequent responses were: solar panel installation variants, ethical material selection including emphasis on local, recycled, and renewable products, waste reduction methods, water recapturing/repurposing, green roof installation, and electric vehicle and equipment chargers. I found the variety of responses to be interesting as firms specializing in different sectors and sizes and scopes of projects will have to adjust their practices to best fit their project specific needs and jurisdiction requirements.*

*In order to compare sustainable practices of American firms to common practices in Asia, I asked about experience in constructing green roofs and living walls, both described earlier as being revolutionary in the Asian construction market. Only about 22% of American firms displayed significant experience in the construction of these features. Perhaps it is geographic or climate-based constraints which limit the use of green roofs and living walls. Another reason for this may be due to the lower rates of government incentivization that are displayed in Asia. Only two-thirds of the responding firms had reported working on projects at least partially incentivized by the government.*
This limits what sustainable construction measures can be implemented as burdens due to costs and delays are fully borne by the construction firms themselves.

Next, I asked firms their level of experience in constructing development parks commonly being built in Europe. These parks house amenities of a variety of sectors including commercial, residential, and utility. Only 33% of questioned firms responded that they were at least somewhat experienced in this field. This was slightly underwhelming as this style of building is seen as paving the way in future development and the creation of unified, accessible communities. In markets where this style of building has been implemented, increased rates in life satisfaction, and decreased rates in negative factors such as pollution and personal injury have been recorded. One can only hope that US development trends learn from and adopt such principles.

I also questioned firms on their experience in incorporating features such as water efficiency (recapturing, repurposing, etc.), solar energy utilization, tri-generation systems, and passive design. These features are very common in Australian buildings and due to the nation’s similar geographies, industries, and cultures, I was curious to analyze the differences. More than 85% of US firms expressed experience in solar energy construction of some sort. Nearly two-thirds of these firms displayed past experience working with water efficiency on their projects. On the flip side, less than half of the firms reported having experience building using passive design or installing tri-generation systems. These low-cost, low-effort elements can benefit projects in many ways including drastically reducing mechanical, electrical, and plumbing demand. I am optimistic that in the coming years, US firms adopt some of these reasonable advancements into common practice.
All construction markets around the globe are structured uniquely due to cultural differences, typical project styles, and countless other factors. I felt it necessary to highlight commonly reported means of sustainable construction utilized by domestic firms. Some of these include financial incentives for employees becoming LEED accredited, carbon emission calculations performed throughout the project, designer/owner selection factoring in sustainability, development of water treatment infrastructure, emphasis on local participation to limit vehicle emissions, BIM utilization to reduce paper/construction waste, and the founding of sustainability departments. The list goes on.

In regards to future goals for sustainable performance, the firms’ responses were quite impressive. Many aim to advise clients on more sustainable approaches to encourage them to incorporate green practices into the scope of their projects. Other responses included: low carbon concrete, increased prefabrication, community involvement and LEED training, solar tile roofs, and many more. One firm even expressed their goal of earning LEED accreditation for 100% of staff. These goals demonstrate the genuine desire for American firms to increase their individual commitment to sustainable construction and encourage other involved parties, owners, designers, suppliers, etc. to do so as well.

**Conclusions**

One cannot deny that the construction industry is rapidly evolving and as the world becomes increasingly more aware and passionate about environmental preservation, sustainable development, and other green topics, American firms are one of the main proponents helping pave the way to change. Nonetheless, there is always opportunity to improve and learn from outside sources. American firms should continue to strive to embrace sustainable construction techniques used in foreign markets such as Asia, Europe, and Australia.

Green roofs and living walls already exist in various US buildings, however their potential has hardly been tapped and should be incorporated wherever feasible. Government incentivization as seen in Asian markets is also key in encouraging firms and owners to prioritize green features in their projects. This technique should also be utilized more often in the American market.
European style development parks are also gaining traction in the American construction field. Recent projects such as Hudson Yards in New York City demonstrate this. Research shows that the environmental benefits of these multi-sector, large scale community development projects are immense. As American culture shifts towards rethinking how our cities are master planned, this style of development should be utilized.

Sustainable techniques commonly used in Australia including water efficiency, solar energy, tri-generation systems, and passive design are already somewhat used in America. However, when comparing the two nations' similar economies, climates, and building styles, there is ample reason to encourage US firms to incorporate these methods more and more in future projects. Australia’s community driven, client demanded emphasis on sustainability should be seen as another inspiration to American builders.

Through independent research and surveying, these techniques described above are proven to be completely able to be integrated into the American market. Sustainable construction and development is a concept that requires attention and active devotion from all parties. This includes builders, owners, government, and consumers.

**Future Research**

It will be interesting to follow up on this research with progress made regarding sustainable construction in America in the coming years. Through research, I have found a number of ongoing/planned projects in the United States that plan on incorporating one or more of the previously addressed concepts into their scope. Future success of the studied projects in Asia, Europe, and Australia will also prove to be fascinating to further confirm the beneficial environmental impact of these projects. Creating a similar survey and distributing it to the same group of firms that first responded will help greatly in tracking the progress made in the American market.
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