PAPER

Circular Economy for the Built Environment: Reconciling the Actions and Intentions of Building Professionals in Africa and the Global West

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Long before Circular Economy became a buzzword for sustainability-oriented businesses, it was in industrial practice as resourceful people acquired waste for sorting and reuse, often on a smaller scale. This model meant that materials had multiple lifecycles, reducing waste while providing auxiliary economic opportunities for some people. Architectural practice has typically relied on a linear model that produces, constructs, and uses materials until they become waste. The result is a failure to see deteriorating buildings as being at the start of a new life cycle, and instead marks their end by depositing the materials in a landfill.

This paper compares different approaches to Circular Economy using examples from Africa and Europe. Its understanding and application in emerging economies differs from those of more developed economies, because building practitioners in the former approach Circular Economy from a need-based perspective, making use of discarded building materials and affordable, easily sourced natural resources to construct buildings that will serve low to middle-income families in the society. Contrastingly, economies like Europe take a more opulent approach, with iconic buildings that are built to serve more exemplary and experimental purposes than occupancy reasons.

Case studies from Senegal, Malawi, and the United Kingdom examine how different approaches to Circular Economy offer insights into ways the United States' building industry could better utilize Circular Economy principles. Communities in developing economies are an untapped resource when it comes to learning about model sustainability practices. In Europe, good intentions to use recycled materials have often become one-off experiments that bring attention to the problems temporarily but rarely affect meaningful change. The case studies highlight the need for more professionals because designers, building experts, and building users need to see what is and is not working, and ought to be inspired by a broader cross-section of global examples.

INTRODUCTION

The construction industry has been exposed as a major consumer of natural resources and one of the foremost sources of Greenhouse gas emissions globally. Solid waste from the construction and demolition of buildings forms a large percentage of the rubble that goes into landfills. Even though the concept of waste reduction in the built environment has been prevalent for some time, little has been done to replicate some of the recommended management strategies on a global scale.[1] Waste is defined as all solid, liquid, or gaseous substances which are discarded as useless or unwanted and generally arise from human practices. Construction waste mostly refers to solid waste generated from the building, demolition, and restoration work for all kinds of structures.[2] Bearing these in mind, waste reduction focuses on decreasing the amount and toxicity of hazardous waste that is generated within a region on the earth's surface.

Circular Economy (CE) as an approach to combat environmental challenges and promote sustainable development has received increasing attention in the discussions on industrial development in recent years. To the building industry, this means reducing, reusing, and recycling waste from construction activities. Of the waste found in construction trash heaps, 80% is recyclable in numerous ways. In 2018, Europe had a record number of countries with the highest rate of recycling. The past few years have seen a combined abundance of global, European, and national waste-related legislation, policies, strategies, and guidance documents to effectively manage construction waste and increase recycling rates across all construction sectors. The current predicament of global construction waste has spurred incremental research and efforts to cultivate waste control and management procedures and tools.

CIRCULAR ECONOMY IN THE CONSTRUCTION INDUSTRY

The CE concept as it relates to the construction industry dates back to the early 1990s when there was an introduction and triumph of mass production and, with it, an accumulation of waste that began leading to environmental problems. It became clear that although manufacturers understood the purpose of utilizing resources, they were mostly driven by the goal of maximizing profit. In 1981, a report was published to the European Commission (then known as Commission of

the European Communities) associating all industrial energy consumption with the extraction or production of basic materials like steel and cement.[3] Less than a quarter of all steel and cement is used in the manufacture of machinery and construction. Of the amount being used in heavy machinery production, only 71% of steel material gets recycled, and a far less percentage of other building materials.[4] According to a 2014 report released by the European Commission, construction and use of buildings in the European Union represent 40% of final energy use, 35% of greenhouse gas emissions, 50% of all extracted material, 30% of water use, and 35% of all generated waste. In the United States, construction and demolition debris consisting of materials like concrete, asphalt, wood, and other building materials amount to a quarter of the total national waste stream.[5] These statistics emphasize the fact that the building sector is large enough to be deemed strategic when designing sustainable policies, especially in terms of the use of limited resources and managing waste from later demolition.

Since the 1980s, a lot of significant studies have been carried out on CE, some with funding or promotional support from the Ellen MacArthur Foundation, a UK-based charity founded by celebrity English sailor Ellen MacArthur. Many practicing building industry professionals, researchers, businesses, and thought-leaders within the European Union and the United States highlight CE's potential to create jobs locally and reduce resource consumption, greenhouse gases emissions, and waste accumulation. [6] However, of the numerous research findings that have been executed, only a few in European, North American, and Asian economies use innovative techniques to approach reduction, reuse, and recycling. For emerging economies where adequate and functional housing is a challenge primarily due to lack of affordability, recycling and reuse of construction waste can become a contributory prerequisite to enhancing housing affordability. By highlighting the use of recycled materials in construction, innovative solutions to common building problems will become feasible and easily adaptable for building industry stakeholders across the globe.

Out of necessity, circular principles have been used for generations in most emerging economies. However, the language of CE was not present because of a knowledge gap between the young nations and the global west. This gap is a result of the economic conquests that occurred over three centuries ago, enabling some economies to experience an exponential rate of industrial innovation while others grappled with the negative effects of transatlantic slavery. Among the emerging economies, Asia has set a record recovery pace in the pursuit of building technology and innovation, leading the world through high-tech development. The African building industry has mostly remained close to nature, sometimes celebrating its indigenous materiality through vernacular styles but often repossessing building materials for individuals and groups to save costs in the harsh economy. Many small-scale examples of the resulting projects can be found in civic buildings like community centers and school buildings. Despite the back story, these projects represent future opportunities to maintain circular principles, increase their adoption at a bigger scale, and invest in innovative products and services. This paper makes a case for a CE approach that is sustainable, less resource-intensive, and transferrable conceptually across the globe. CE concepts are not as widely discussed in the United States yet, therefore many lessons can be learned from industrialized and emerging economies that will benefit the building industry stakeholders in the United States and globally, and inspire the growth of healthier building practices.

The three identified obstacles to CE are economic, sociocultural, and technological obstacles. For one, most financing institutions view green and circular projects as unconventional because they do not fit the typical architectural and construction standards.[7] As a result, they are often unwilling to lend money to builders and buyers because of the risk involved. This can be discouraging as it implies that builders and buyers need to have sufficient cash before committing to the development of buildings that make society more sustainable. Secondly, studies show that people often get anxious and image-conscious when it comes to investing in the reuse and recycling of various products.[8] It can be challenging to convince clients to opt for CE building projects because of the misconception of used materials. The process of sorting reusable building construction waste can also be taxing, and more so when considering the detachable, extendable, and reusable criteria recommended by the European Union.[9] However, some studies provide evidence on how people are more likely to consider CE after they have been shown the potential to create a new life for reusable materials in buildings. Technological obstacles to the adoption of CE stem from an inadequacy in reduction, reuse, recycling, and renewal techniques. Additionally, material innovation with unconventional but useful elements is lacking among industry professionals, resulting in a default to conventional building practices. Every stakeholder in the building industry has a role to play in CE. Architects bear the responsibility of linking clients, consultants, and other building professionals with each other after providing innovative solutions for a design that fully translates CE principles to a new system. To fully utilize the

Figure 1. *Women's Centre, Rufisque, Senegal.* Juha Llonen.

potential of this position, they will need to acquire additional skills among stakeholders in green supply chain management, material science, and technological administration.[10] Clients and financial institutions are also very important, as they are key sources of funding for material and technological innovations.

CASE STUDIES

The case studies from Senegal, Malawi, and the United Kingdom are used in this paper to examine how the different approaches to CE offer insights into ways that the international building industry can better utilize CE principles. In some African countries, for example, people in informal settlements are an untapped population when it comes to learning about model sustainability practices. When faced with critical challenges such as poverty, uneven wealth gaps, and frequent disease outbreaks, community members often work together to form collectives that help them improve their economic opportunities by building shelters and locally recycling waste. In Europe, good intentions to use recycled materials have often become one-off experiments that bring attention to the problems temporarily but rarely affect meaningful change. Both sets of case studies need more visibility in the professional context, because designers, building professionals, and building users need to see what works or not, and should be inspired by a broader cross-section of global examples.

WOMEN'S CENTRE, RUFISQUE, SENEGAL

Rufisque is an old port city in Senegal that was once heavily influenced by ongoing commercial development in the country's nearby capital, Dakar. However, growth in Dakar's activities led to a drastic decline in that of Rufisque, such that the cement work industry has become the only active industry in the city. The design of the Women's Centre, also known as the Red House or Maison Rouge to Rufisque locals, was approached to turn the challenge of homelessness into a strength by creating a low-cost building out of easily sourced and mostly biodegradable materials. The Women's Centre would make the lives of Rufisque's women easier by providing a building where their various commercial and communal activities could be carried out. Portions of the building are dedicated to a public square, a local restaurant, a handicrafts shop, and small spaces for the production of fabrics and other crafts that tourists come to the city to purchase. Though established as an NGO project and funded through Finnish agencies, the plot was donated by the city council and local community members made donations to the project.[11]

Typical of traditional West African architecture, the building has an internal courtyard that separates the public from the private in an obvious but flexible manner. The materials used for the structure emphasize the intent to use original and recyclable structural components. For example, the cement and insitu concrete used for the walls was sourced from the local cement mill. These walls have few openings and many shading features like masonry grilles and arcades, resulting in a reinvented way

Figure 1. *Women's Centre, Rufisque, Senegal*. Juha Llonen.

of manually cooling the building. Recycled iron was used as reinforcement for the structure. Over the cast-in-place column and beam structure, corrugated metal roofing sheets were placed, sustained by steel beams combined with thick woven straw matting to provide insulation. To further enhance cooling, old, scrapped car rims were used as ventilation holes in the masonry while the bottoms of old glass bottles were used for the bathroom windows.

The Women's Centre was completed in 2001 but most importantly is being highlighted for what it represents materially and in an ethical approach to sustainable building projects. Careful environmental consideration was embedded in the phases of a supply chain, ranging from the purchase of local material first before bringing in other materials, to closing the loop by selecting recyclable materials.[12] The building design, material selection, and end-of-life plan for the project were integrated in a way that did not subtract from its environmental and cultural contexts. The primary role of the architect in this project involved guiding, giving technical advice, and ensuring that the construction was implemented as specified in the drawings. The construction was supervised by the contractor, who hired a crew mostly from among residents. This in turn provided jobs, trained more skilled workers, and created a work setting where there was a collective sense of responsibility.[13]

There are two obvious challenges in this case study: scale and the perceptions of CE. In considering scale, the Women's Centre was so successful and well-received that it attracted both women and men. Now that the building has exceeded its ideal user capacity, community members are faced with the challenge of expanding or creating a similarly affordable building over two decades later. While a lot has changed, reuse is still considered by many of Africa's high-income earners to be a practice for the rest of the population experiencing poverty.[14] As a result, many people aspire to get to the level of income where only brand new materials are used and one is no longer willing to recycle. In environments like these, architects and other building professionals must portray through their actions that CE strategies can be cheaper in the long run, beautifully executed, and even more functional than buildings built without such considerations.

Figure 2. T*he Legson Kayira Community Center and Primary School.* Architecture for a Change..

THE LEGSON KAYIRA COMMUNITY CENTER AND PRIMARY SCHOOL, RUMPHI, MALAWI

Named after the famed novelist Legson Kayira, the primary school and community center was built in 2014 by Youth of Malawi, a New York City-based Nonprofit Corporation that collaborates with building professionals in the development of healthcare buildings, educational buildings, and agricultural facilities.[15] Legson Kayira, designed by South African Architects A4AC, is located in Rumphi, a lively agricultural town in the northern region of Malawi, Africa.[16] A landlocked country, Malawi is one of the most densely populated parts of the world. Towns like Rumphi face dire environmental challenges despite providing exciting living conditions. For example, the country's generally slow pace of life affects the availability of updated technology, road and electricity accessibility, and proximity to both affordable and quality schools in its towns. Some of these challenges were considered when the proposal for Legson Kayira came up. The facility now serves as a primary school, an adult learning center, and a community center. It addresses the need for a functional, efficient, and durable environment that brings the locals together because of the spaces provided.

The construction of Legson Kayira features the provision of shaded, open-air, well-ventilated, and well-lit spaces through an interplay of local and imported materials and design principles. A4AC was hired because of the company's experience with the conversion and customization of refurbished shipping containers into various kinds of spaces. In many parts of Africa, shipping containers that are used to bring in imported goods are commonly repurposed into tuck shops, hair salons, mobile traffic warden posts, and lately, homes, offices, and schools. The upcycled containers are cost-effective, structurally sound, quick to assemble, modular, and durable. Local masonry was adopted for the classroom louvers, which served as shading

Figure 3. *Shipping Container turned into a kiosk.* Solar Kiosk, 2017.

and roofing structural support systems. Lightweight steel, local masonry, and corrugated iron were additional materials that contributed to the overall appearance of the building within its local context. Water tanks were brought in to collect rainwater from the roofs. Rainwater harvesting is very common in many African traditional communities.[17]

The Legson Kayira project shares some logistical commonalities with the Women's Centre in Senegal. Both examples suggest that CE requires collaboration between the different stakeholders involved to create, align, and sustainably connect the value chain. When locally manufactured materials are used in construction, community members develop a sense of ownership and the design is influenced by its environmental and cultural context. When design professionals collaborate with local governments, they can positively influence regulations and policies that will bring additional value to communities and encourage more circular activities.[18] In the case of Legson Kayira, a building that serves multiple purposes becomes a community asset because many people have contributed in meaningful ways to its construction. The building is symbolic to the people of Rumphi, shaping their future through easily accessible education, providing shelter through built infrastructure, and encouraging self-sustenance through practices like rainwater harvesting. On a miniature scale, the project represents the future of building spaces – multi-functionality and flexibility of spatial use.

BRIGHTON WASTE HOUSE, UNITED KINGDOM

In 2014, the UK Statistics on Waste reported 202.8 million tons of waste, of which construction, demolition, and excavation activities comprised 59%. Construction work is responsible for 50% of carbon emissions in the region, coming mainly from materials like steel, cement, plastic, aluminum, and paper.[19] Since then, the United Kingdom has made a tremendous effort to recover, taking actions that currently place them ahead of the European Union as of 2020. The problem with construction waste in the UK is the constant sending to landfills. To quantify this, for every five new houses built in the UK, there exists one house worth of landfill. This information inspired the creation of the Waste House Project. The Waste House project - which some claim to be the first building in the world made with 90% waste - was experimentally constructed in the Grand Parade Campus of the University of Brighton, supervised by Duncan Baker-Brown and Cat Fletcher. The house serves as a studio for postgraduate design students of the university, although it is also open to the public for viewing. It was built with the primary aim of demonstrating CE, particularly waste recycling and reuse as building materials. The building's structure is timber-framed,

Figure 4. *Brighton Waste House, United Kingdom*. Open Source, 2015.

using a mixture of reclaimed wood and plywood from several sources around Brighton. The ground floor slab and foundations were cast by compacting earth and aggregate to evade the use of excess cement. Some of the insulation materials include a lot of cassettes, about 4,000 CDs and DVDs, 2,000 carpet tiles, approximately 21000 toothbrushes, and 1000 rolls of wallpaper.

Waste House is a research project that revisits historical building techniques and some current construction practices used in developing countries. For example, the walls, dubbed "rather unusual" by BBC consist of straw, hemp, waste chalk, and leftover or reclaimed clay earth from building sites. Some of this resonates with the Sudano-Sahelian traditional style of architecture that uses materials from the surrounding community like straw, earth, animal dung, clay, and chalk made from plant pigments to style building walls. The wall exteriors consist of approximately 2,000 carpet tiles from an old office building in Brighton. Their fire-retardant, waterproof underlay faces outwards, providing weatherproof cladding and insulation. Waste House was nominated in 2015 for a Stephen Lawrence prize and according to the Royal Institute of British Architects (RIBA) judges at the time, "has sufficient scientific integrity to be taken seriously by the construction industry" and the potential to alter political attitudes to recycling.

The intentions for CE in the UK are great; the Brighton House does not constitute a novel idea when it comes to the reduction, reuse, recycling, and renewal of buildings. While it appears to be a beautiful project, it romanticizes the culture of interdependence that CE projects ought to have with their respective environments. The building stands tall, dark, isolated from every other building around it, not adding to but taking from the neighborhood building composition. A truly experimental project existing in and for itself. A quick internet search would show how many media rounds the project has made when across the world, individuals and smaller groups have been building houses from waste for many years. Waste House is an example of how institutional bodies that are influential can take a concept like CE and spin it to present the narrative of celebrity utilitarianism, thereby honoring the ornamentalism of the building rather than its functionality and true social value to the community. Glorified projects like this, though undoubtedly educational, belittle several other cultural influences, ideas, and ideals from around the world that have solved building needs.

IMPLICATIONS FOR THE UNITED STATES' BUILDING INDUSTRY

For many years, the global housing crisis has forced people around the world to live in houses made of material scraps. In the United States, the housing crisis is due to fewer affordable housing units. Besides the housing crisis, the building industry supply chain problem worsened when critical items like lumber became more expensive during the pandemic due to shortages and never recovered. The Great Resignation has also resulted in labor shortages and higher wages being offered in a bid to retain workers . Cost is a major impediment to building development in the United States. For the professionals who ignore it, the

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