State of Play for Circular Built Environment in Africa

Countries considered:
Egypt, Ethiopia, Ghana, Kenya, Malawi, Nigeria, Rwanda, South Africa, Uganda and Zambia

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One Planet Network

The One Planet network has been formed to implement the 10-Year Framework of Programmes on Sustainable Consumption and Production (SCP), which supports the global shift to SCP and the achievement of SDG 12. The One Planet Network acts as an enabler bringing actors from all regions to pool their expertise, resources, innovation and commitment towards a shift to more sustainable modes of production and consumption. The network comprises of six programmes: Sustainable Public Procurement, Sustainable Buildings and Construction, Sustainable Tourism, Sustainable Food Systems Programme, Consumer Information for SCP, Sustainable Lifestyles and Education.

Sustainable Buildings and Construction Programme

The Sustainable Buildings and Construction Programme (SBC) aims at improving the knowledge of sustainable construction and to support and mainstream sustainable building solutions. Through the programme, all major sustainable construction activities can be brought together under the same umbrella. The work involves sharing good practices, launching implementation projects, creating cooperation networks and committing actors around the world to sustainable construction. The goal of the programme is to promote resource efficiency, mitigation and adaptation efforts, and the shift to SCP patterns in the buildings and construction sector.

State of Play Reports

The Sustainable Buildings and Construction Programme has been preparing regional reports on the state of play for circular built environment in Africa, Asia, Europe, Gulf Cooperation Council countries, Latin America and the Caribbean, North America, and Oceania. In addition to regional outlooks, a global report has been produced to summarise and compare the state of play regarding circularity in different regions. A crucial role of the reports is not only to provide a benchmark but also recommendations on how to move forward towards a sustainable and circular built environment.

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List of acronyms

EMF	Ellen MacArthur Foundation
EPA	Environment Protection Authority
GDP	Gross domestic product
IPAP	Industrial Policy Action Plan
ODI	Overseas Development Institute
OECD	Organisation for Economic Co-operation and Development
RICS	Royal Institution of Chartered Surveyors
SABS	South African Bureau of Standards
SDG	Sustainable Development Goal
SOC	State-owned company
UNEP	United Nations Environment Programme
US	United States

Executive summary

This study provides a brief overview of the state of play of the circular built environment in Africa in 2020. It sets out the characteristics of the sector and explores how these could be enhanced through circular economy approaches.

It shows that significant challenges face the African built environment and construction sector. Rapid growth and limited capacity have meant that infrastructure and service backlogs are increasing and significant proportions of urban populations have to turn to the informal sector for their livelihoods and accommodation. Out-of-date and fragmented policy and regulatory frameworks, as well as limited implementation and enforcement capacity, have resulted in unregulated and sometimes dangerous and unhealthy living and working environments.

At the same time, there is a diverse and resilient tradition of indigenous construction in Africa that creates comfortable, affordable buildings from local materials using local labour without generating waste. The informal sector has found untapped economic trade and waste opportunities which have resulted in increased access to affordable food, significant reductions in waste and provided many with incomes.

A review of the strengths of and challenges facing existing and emerging practices can be used to identify significant opportunities to integrate circular economy approaches within the built environment and construction sectors in Africa. These opportunities include enhancing standards of construction and maintenance; avoiding early obsolescence and ensuring the right to repair; increasing upcycling and recycling of building materials and components; creating simpler, locally sourced buildings; enhancing informal economy processes; developing waste micro-grids; and supporting local organic waste recycling and soil fertility.

1. Introduction

This report provides a brief overview of the state of play of the circular built environment in Africa in 2020. It sets out the characteristics of the sector and explores how these could be enhanced through circular economy approaches.

It has a focus on Egypt, Ethiopia, Ghana, Kenya, Malawi, Nigeria, Rwanda, South Africa, Uganda and Zambia. These countries have been selected to provide a representative sample of the diversity of built environments and construction types that exist within Africa.

The report draws on statistics from the World Bank and the United Nations as well as a review of scientific literature on construction and built environments in Africa. It is structured as follows:

- First, the significance of the issue is outlined. The discussion shows how conventional approaches are struggling to keep up with some of the fastest-growing populations and rates of urbanisation in the world, and demonstrates why it is important to explore alternative circular approaches.
- Second, an overview of the African context is provided, with specific mention of Egypt, Ethiopia, Ghana, Kenya, Malawi, Nigeria, Rwanda, South Africa, Uganda and Zambia. This includes a review of built environments and the construction, materials and waste sectors.
- Third, policy and legislation in African countries that are supportive of circular economy approaches in the built environment are presented and discussed.
- Fourth, opportunities to include a circular economy approach within the built environment and construction, materials and waste sectors are identified and discussed.
- Finally, conclusions and recommendations for policy development and further research are presented.

2. Significance of this work

Africa has some of the world's fastest-growing populations and rates of urbanisation. Cities often struggle to keep apace with this growth, resulting in mushrooming informal settlements with no, or limited, electricity, water, sanitation connections and solid waste collection.

Governments, the private sector and communities themselves are trying to address this situation but the scale of the problem and limited resources mean that conventional approaches will take many years to address infrastructure and service backlogs.

It is therefore important that innovative, alternative approaches are explored. Circular economy methodologies represent a valuable alternative approach that leapfrogs conventional solutions to improve services and environments rapidly and cost-effectively while creating employment and enterprises and reducing waste and pollution.

This report explores circular economy opportunities within the construction sectors in Africa, with a particular focus on Egypt, Ethiopia, Ghana, Kenya, Malawi, Nigeria, Rwanda, South Africa, Uganda and Zambia.

It provides an overview of the current context and characteristics of the sector including rapid urban growth, significant infrastructure and service backlogs, a diverse and poorly regulated construction industry and a large informal sector. Against this background, circular economy approaches are proposed and discussed, and recommendations for policy development and further research are made.

3. The African context

In 2019, the world's population was estimated to be 7.86 billion, with about 1.25 billion (around 17%) of this population being from Africa. Within Africa, Nigeria has the highest population, with 200,962,417 people. A number of other countries, such as Egypt (101,168,745), Ethiopia (110,135,635), Kenya (52,214,791), Uganda (45,711,874) and South Africa (58,065,097), have populations above 50 million people. Ghana (30,096,970), Malawi (19,718,743), Rwanda (12,794,412) and Zambia (18,137,369) have smaller populations, although all of these but one are over 15 million people (Worldpopulationreview.com, 2019).

Africa's population is experiencing growth well above other parts of the world. Average growth for the continent is 2.49%, compared to growth rates in Asia of 0.87%, rates of 0.06% in Europe, 0.97% in Latin America and the Caribbean, 0.73% in North America and 1.37% in Oceania.

Africa also has a young population, with a median age in 2019 of 19.4 years. The median ages for the selected countries were as follows: Ghana 21.6, Nigeria 18.5, Egypt 24.7, Ethiopia 18.1, Kenya 19.9, Uganda 15.9, Malawi 16.7, Rwanda 19.8, Zambia 16.9 and South Africa 27.3 (Worldometers, 2019). This compares to the median ages for Germany (48.9), Japan (46.8) and Finland (44.3) (Worldpopulationreview.com, 2019).

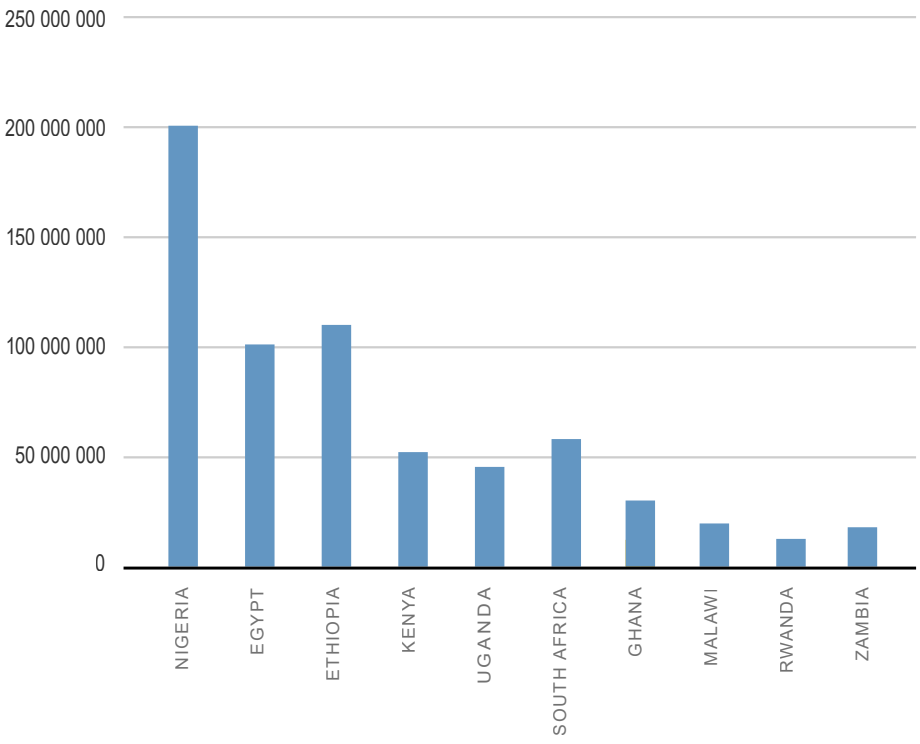

Figure 1: Population in African countries

Data source: Worldpopulationreview.com, 2019
Graphics: Ninni Westerholm

3.1 Economic growth

While the gross domestic product (GDP) of African countries is lower than that of many other parts of the world, growth rates tend to be higher. In 2018, the GDP for Ghana was 11583, for Nigeria 5874, for Egypt 11583, for Ethiopia 1899, for Kenya 3285, for Uganda 1864, for Malawi 1202, for Rwanda 2039, for Zambia 4024 and for South Africa 13497. This compares to Finland's GDP per capita of 44,865 (World Bank, 2019). Figures are in USD.

Economic growth varies across Africa, with some countries such as Nigeria (2.6%), Ethiopia (2.42%), Uganda (3.26%), Kenya (2.48%), Malawi (2.89%), Ghana (2.15%), Egypt (1.8%) and Rwanda (2.35%) experiencing relatively high growth rates. An exception to this is South Africa where the growth rate was only 0.34%. This compares to growth rates of 1.5% in Germany, 0.8% in Japan and 1.7% in Finland (World Bank, 2019).

3.2 Carbon emissions

Despite rapid growth, carbon emissions in most African countries are much lower than they are in European and North American countries. Carbon dioxide emissions in metric tons per capita are as follows: Ghana 0.54, Nigeria 0.54, Egypt 2.19, Ethiopia 0.12, Kenya 0.31, Uganda 0.13, Malawi 0.075, Rwanda 0.074, Zambia 0.28 and South Africa 8.98 (World Bank, 2019). This compares to carbon dioxide emissions in metric tonne per capita of 16.49 for the United States (US), 8.8 for Germany and 8.66 for Finland (World Bank, 2019).

This shows that African countries, other than South Africa, generally produce a fraction of the emissions produced by Europe and European countries. However, Africa still lags behind much of the world in terms of progress towards achieving the Sustainable Development Goals (SDGs).

3.3 Sustainable Development Goals

The SDGs were agreed in 2015 and represent a broad consensus on goals that must be achieved within the next 15 years (Glaser, 2012; Buse and Hawkes, 2015). A review of the SDGs indicates that a number of them, such as 'sustainable management of water and sanitation for all', 'ensuring access to affordable, reliable, sustainable and modern energy for all', and 'making cities and human settlements inclusive, safe, resilient and sustainable', have a direct relationship to the built environment. However, the review reveals that many other goals, such as 'ensuring sustainable consumption and production patterns', also have implications for the built environment, so these need to be taken into account. Outlined below is a brief review of progress made in African countries within the SDG areas of shelter, water, sanitation, education and poverty.

In many African countries, a significant proportion of households are accommodated in slums or informal settlements. In the countries in this study, the percentage of the population housed in slums is as follows: Ghana 37.9%, Nigeria 50.2%, Egypt 10.6%, Ethiopia 73.9%, Kenya 56%, Uganda 53.6%, Malawi 66.7%, Rwanda 53.2%, Zambia 54% and South Africa 23% (World Bank, 2019). This indicates that there are significant housing backlogs in most African countries and that there is an urgent need for large-scale new housing construction and upgrading programmes.

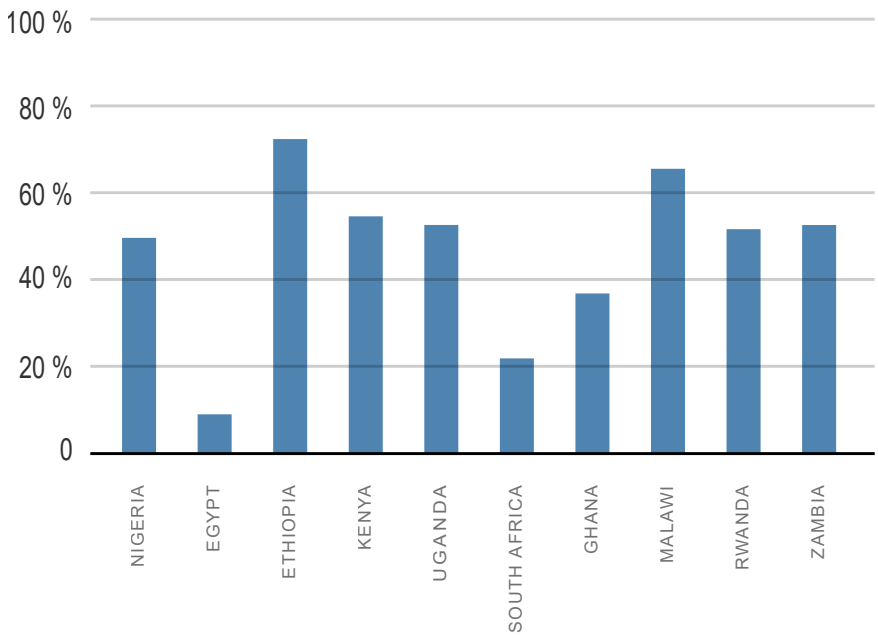

Figure 2: Percentage of people housed in informal settlements

Data source: World Bank 2019
Graphics: Ninni Westerholm

While many African countries have made good progress in developing water supplies, significant proportions of their populations still do not have access to an improved water source. In the countries selected for this study, the proportion of populations with access to an improved water source is as follows: Ghana 42.2%, Nigeria (no data), Egypt 98.6%, Ethiopia (no data), Kenya 58.5%, Uganda (no data), Malawi 67.2%, Rwanda 56.7%, Zambia 61.2% and South Africa 84.7%. This indicates that 40% of the population of some countries do not have access to improved water sources (Sustainable Development Goals Center for Africa and Sustainable Development Solutions Network, 2018).

There are also large backlogs in basic sanitation in many African countries. For the focus countries, current provision, in terms of the proportion of the population with basic sanitation, is as follows: Ghana 29.9%, Nigeria 32.6%, Egypt (no data), Ethiopia 7.1%, Kenya 29.5%, Uganda (no data), Malawi 67.2%, Rwanda 56.7%, Zambia 61.2% and South Africa 84.7%. This data indicates that sanitation backlogs are significantly higher than water backlogs, with up to 90% of the population of some countries having inadequate sanitation.

Many African households do not have access to electricity. In the selected countries, access to electricity is as follows: Ghana 61.9%, Nigeria 57.7%, Egypt 99.8%, Ethiopia 27.2%, Kenya 36%, Uganda 20.4%, Malawi 11.9%, Rwanda 19.9%, Zambia 27.9% and South Africa 89.9%.

Progress in achieving the SDGs has been slow and projections by the Overseas Development Institute (ODI) indicate that most SDG targets are not likely to be achieved by African countries by 2030. The ODI projects that, by 2030, two-thirds of children in African countries will still not complete secondary schooling. It also suggests that there will be an increase in the number of people without electricity, from about 50% of the population currently, to about 66% of the population in 2030, and that a third of Africa's population will still be living on less than USD1.25 a day (measured in terms of 2005 Purchasing Power Parity) (Nicolai et al., 2015).

3.4 Urban growth

Many African countries are experiencing rapid urbanisation as a result of people migrating from rural areas to cities to seek employment and economic opportunities. This has resulted in rapidly growing cities, large informal settlements or slums, and service and infrastructure backlogs as governments struggle to keep up with this growth. Annual urban growth rates experienced in the focus African countries in this study are as follows: Ghana 3.39%, Nigeria 4.3%, Egypt 1.8%, Ethiopia 4.6%, Kenya 4.2%, Uganda 5.7%, Malawi 4.1%, Rwanda 2.8%, Zambia 4.25% and South Africa 2% (World Bank, 2019).

These growth rates have resulted in significant increases in urban populations and countries like Ghana (54.8%), Nigeria (51.9%), Rwanda (53.2%) and South Africa (63%) now have over 50% of their populations in urban areas. Other countries, such as Egypt (38.7%), Ethiopia (21.1%), Kenya (27.1%), Uganda (17.1%), Malawi (16.8%) and Zambia (41.4%), still have predominantly rural populations (World Bank, 2019).

The influx of people to cities has led to rapid formal and informal urban growth. Understanding the nature of this development as well as of existing settlements in terms of materials and construction forms a valuable basis for exploring how circular economy approaches can be applied.

3.5 Informal settlements

Informal settlements typically exist on the periphery of urban areas or occupy vacant unused land in cities. Occupation of this land is often illegal and typically occupants will not have title deeds for their dwellings. Informal settlements occur as people move to urban areas to seek employment and improve their economic circumstances and discover that informal dwellings are their only affordable housing option. In these settlements, construction typically consists of a timber frame to which corrugated iron sheets are attached as walls and a roof. Steel frame windows and timber doors may also be used.

There are variations in building construction depending on the availability of local materials and found objects. Thus, signboards, tarpaulins and plastic sheeting may be used in addition to metal sheeting. Dwellings are typically constructed by the occupants themselves and materials are carried in from neighbouring areas manually or in a small pick-up truck. Very limited construction waste is associated with this building type as any discarded or unused materials are used by someone else for their dwelling.

3.6 Traditional dwellings

Traditional buildings are still widespread in many areas of rural Africa and are typically constructed of earth block, timber and thatch. These buildings are generally found in villages or smaller settlements as well on farms and smallholdings. Materials are sourced locally so will vary depending on local resources. Examples of this building type in Southern Africa include huts, which are built of earth block walls smeared with a cow dung mixture to make them more weatherproof, a timber roof structure and a thatch roof. Windows and doors consist of relatively small openings that have timber doors and shutters.

Traditionally, only a limited number of materials was imported, generally used for hinges and a metal capping on the thatch roof. This, however, is changing with modern variations, including more use of glass windows, standard doors, walls made of concrete block and roofs made

of corrugated iron. Buildings are usually built by the occupants themselves, with help from neighbours, and there is very little construction waste. In addition, the nature of the materials used means that waste, and the buildings themselves if not maintained, rapidly return to their natural state. Thatch and timber are consumed by termites and other insects and earth walls rapidly disintegrate and are washed away by rain.

3.7 Government low-cost housing

Government low-cost housing schemes vary but are characterised by dwellings of between four and six rooms with concrete block or brick walls, and corrugated iron roof. Standard metal framed windows and door structures are generally built by contractors using materials sourced from local building industries.

In larger African cities like Johannesburg, houses are added to by occupants to provide additional space for families or to rent out in what are referred to as ‘backyard structures’. These structures are usually constructed either of similar materials as the main house or of timber and corrugated iron. Levels of construction waste depend on the skill and experience of construction contractors. Where contractors with limited experience are used, levels of waste can be high (Aiyetan and Smallwood, 2013). In some cases, poor construction may result in deconstruction with little options for recovery, and therefore in large-scale waste.

3.8 Suburban private housing

Suburban dwellings are larger houses that have been built around the centres of towns and cities. Older dwellings typically consist of brick walls, timber and corrugated iron roofs, and timber windows and doors. Newer suburban dwellings on the periphery of towns and cities may be enclosed in security estates. These dwellings are typically constructed of concrete block walls, timber, corrugated iron roofs, and steel or aluminium doors and windows.

In some African countries, fitted kitchens, tiles, doors, windows and roofing materials are imported from countries like South Africa and China. Levels of waste generated during construction may be high where construction is not well planned as there is limited legislation requiring contractors to minimise waste (Adewuyi and Otali, 2013).

3.9 Colonial-era administration buildings

Colonial buildings are buildings such as schools, offices and houses built during the colonial era. These buildings may have brick or stone walls, timber and corrugated iron roofs, and timber doors and windows.

They were typically built by skilled contractors but may have deteriorated due to a lack of maintenance. The waste generated during the deconstruction of these buildings is limited as the high-value materials are generally extracted and reused.

3.10 Multi-storey city centre buildings

Multi-storey new buildings built in city centres and new urban centres include shopping malls, apartment blocks and office buildings. These typically have cast-concrete frames; concrete or corrugated steel roofs; and brick, concrete block or glass facade walls. Materials such as glass and aluminium facades, lift systems and tiles are usually imported, while other materials, such as concrete, are locally sourced.

Levels of waste produced during construction are generally high as construction may be poorly planned and there is limited legislation regarding requiring waste to be reduced (Aiyetan and Smallwood, 2013). Large quantities of waste are also generated during deconstruction. Some of this waste, such as metals, is likely to be recycled, while the rest will be directed to landfill as many African countries have a limited number of facilities for recycling materials such as concrete.

3.11 Construction waste

The review of building types shows that levels of construction waste differ widely depending on the construction materials and techniques used. Construction and demolition waste is defined as waste that comes from construction sites, road repair, renovation sites and the demolition of buildings, and includes materials such as wood, steel, concrete, dirt, bricks and tiles (Hoornweg and Bhada-Tata, 2012). Globally, construction and demolition waste contributes to about 40% of the total amount of waste generated (Hoornweg and Bhada-Tata, 2012). In Europe, levels of construction waste are between 1 and 4 tonnes per capita per year. This is improving as more waste gets recycled, and estimates indicate that 47% of this waste is now recycled (Sáez, Merino and Porras-Amores, 2011).

In Africa, levels of construction waste are increasing. In Tanzania, construction waste was estimated to be 3.03 million tonnes in 1994; but by 2010 this had more than doubled to 7.9 million tonnes (Sabai et al., 2016). In South Africa, construction waste is estimated to constitute about 20% of all solid waste yet. However, only about 16% of this is recycled (Department of Environmental Affairs, 2012).

3.12 Construction waste opportunities

The overview of building types and construction practices indicates that there are significant opportunities to reduce construction waste and increase recycling through proactive design processes, regulation and standards, capacity development and local support systems. New approaches and interventions, however, must respond to the local context to be successful (Srour, Chehab and Gharib, 2010).

Circular economy approaches, by simultaneously creating social and economic benefits as well as reducing waste, are particularly appropriate and provide an excellent basis for developing strategies to better manage construction waste, and these are explored later in the paper. In addition to construction waste, there are also opportunities to reduce municipal solid waste in African cities.

3.13 Municipal solid waste

Municipal solid waste consists of everyday items that are used and thrown away, such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint and batteries. This waste comes from homes, schools, hospitals and businesses (Environment Protection Authority [EPA], 2019).

The total amount of municipal solid waste generated in Africa in 2012 was estimated to be 125 million tonnes (United Nations Environment Programme [UNEP], 2018). This is an average of about 0.78 kg per capita per day, which is significantly lower than the global average of 1.2 kg per capita per day (UNEP, 2018; Hoornweg and Bhada-Tata, 2012).

For the selected countries in this study, the volume of municipal solid waste generated in Africa in kg/year per capita is as follows: Ghana 0.54, Nigeria 0.54, Egypt 2.19, Ethiopia 0.12, Kenya 0.31, Uganda 0.13, Malawi 0.075, Rwanda 0.074, Zambia 0.28 and South Africa 8.98 (World Bank, 2019). This indicates that some countries within the continent's interior have very low levels of solid waste generation.

The average proportions of the total composition of municipal solid waste in African cities are about 57% organic, 9% paper and cardboard, 13% plastic, 4% glass, 4% metal and 13% other materials (UNEP, 2018). This indicates that the organic content of waste in African cities tends to be much higher than is found in Europe and North America, where this equates to around 34% (UNEP, 2015). For instance, waste streams in Kampala, Uganda, have a 77% organic waste content, with other cities such as Dar es Salaam in Tanzania (71%), Ibadan, Nigeria (69%), Accra, Ghana (65%) and Nairobi, Kenya (65%) having a similarly high content (UNEP, 2018).

In many African cities, waste is not directed to landfill or recycled, but is disposed of through uncontrolled dumping or open burning (UNEP, 2018). In many cases, municipal systems, where they exist, have insufficient budgets, poorly functioning equipment, a lack of effective public participation and inadequate waste management governance frameworks to cater for the scale of the waste streams being generated in urban areas (UNEP, 2018).

This results in the average rate of municipal solid waste collection being only about 44% of total waste. In some African cities, such as Jimma, Ethiopia (25%), Wha, Ghana (28%) and Lusaka, Zambia (45%), less than 50% of municipal solid waste is collected. In other cities, such as Kampala, Uganda (65%), Accra, Ghana (80%) and Ibaden, Nigeria (95%), collection rates are higher, but a substantial proportion of waste is still disposed of in other ways, such as uncontrolled dumping (UNEP, 2018). This compares to waste collection rates of 98% in developed countries (Hoornweg and Bhada-Tata, 2012). Rates of collection in African cities are expected to increase to 69% by 2025 (UNEP, 2018).

While current levels of solid waste generated in Africa are low compared to other parts of the world, this is likely to change as a result of rapid urbanisation, population growth, a growing middle class, changing consumption habits and production patterns, and global waste trade and trafficking (UNEP, 2018). Municipal solid waste generation is expected to double by 2025, with the greatest increases expected in areas with the highest incomes and rates of urbanisation (Hoornweg and Bhada-Tata, 2012).

3.14 The informal recycling sector

The level of municipal solid waste recycling in Africa is estimated to be only about 4%, in contrast to rates of 30% for Organisation for Economic Co-operation and Development (OECD) countries in 2013 (UNEP, 2018). As a result of these low rates, the African Union has called upon African cities to commit to recycling at least 50% of their waste by 2023 (AUC, 2015).

Informal waste recycling plays a very significant role in many African cities. It is estimated that over 1 million tonnes of waste per year are collected by the informal recycling sector in Cairo, Egypt, and that over 50% of solid municipal waste is collected by informal recyclers in cities such as Bamako, Mali, and Lusaka, Zambia (UN-Habitat, 2010; Gunsilius, Chaturvedi and Scheinberg, 2010). In 2018, the value of municipal solid waste generated in African urban areas was estimated to be USD8 billion, with 96% of this being lost through waste disposal. This indicates that significant value could be unlocked through increased recycling (UNEP, 2018).

4. Policy and legislation

4.1 Building and construction regulations

Building and construction policy and regulations vary widely across Africa. Some countries have well-developed policies and legislation while in others this is fragmented and outdated (Chitengi, 2018; Iwaro and Mwasha, 2010). Implementation of policy and regulations can be weak as a result of limited capacity within government as well as within the built environment professional and industry sectors (Reffat, 2004).

The integration of issues such as climate change and energy and water efficiency into policy and regulations tends to lag behind that of other regions, such as Europe and Asia. However, in areas related to procurement and local economic and social impact, policies and regulations are advanced and lead internationally. Examples of this are policies and standards on local content, which are discussed next.

4.2 Local content policy and standards

Local content policy supports the use of materials and products made in a country as opposed to those that are imported. There is an increasing interest in this concept as it is seen as an effective and easy way to support local economies and provide jobs (Belderbos & Sleuwaegen, 1997; Qiu & Tao, 2001; Corkin, 2012; Warner, 2011; Stephenson, 2013).

An example of its application is the Industrial Policy Action Plan (IPAP) developed by the South African Government. Here, the power of government as a 'large buyer' is used to support local production (DTI, 2013). IPAP aims to support the growth and diversification of the manufacturing sector in South Africa and to ensure that significant jobs and economic activity in associated service sector industries are generated (DTI, 2013). This is achieved through the following measures:

- Designations for local procurement.
- Deepening of localisation in the large fleet procurement processes of state-owned companies (SOCs).
- Localisation in the renewable energy generation programme.
- Increasing acceptance and implementation of localisation targets across the spectrum of state procurement regimes (DTI, 2013).

IPAP is reinforced through a standard on local content called SATS 1286, developed by the South African Bureau of Standards (SABS, 2011). This standard defines local content as:

> That portion of goods, works and services that have been generated and produced in South Africa. Companies that import raw material and convert this raw material in South Africa also contribute to local content to the extent that the South African value-added processes and additional inputs count as local content (SABS, 2011).

IPAP and SATS 1286 are examples of tools that governments can use to support local economies. Prescribing local content in the procurement of buildings helps to ensure that local materials and products are used. Such policy can be adopted to reduce embodied energy, as transport-related costs are reduced; to ensure that the waste and pollution impacts of material comply with local standards (as they are manufactured locally); and to create local

jobs and enterprises (Takechi and Kiyono, 2003). There are also secondary benefits, as locally produced material and products can be more easily repaired and maintained and will therefore last longer. This also supports local maintenance jobs.

5. Opportunities for circularity in construction and the built environment

The circular economy aims to change the paradigm from one in which we 'take, make and dispose of' goods to one in which products are designed to be more durable and repaired, rather than replaced. By making reused and virgin materials interchangeable, it aims to reduce the high demand for virgin materials and at the same time achieve 40–50% savings in costs (Financial Times, 2019).

The Ellen MacArthur Foundation (EMF) describes the circular economy as a way of redefining growth. Instead of linear systems based on consumption and waste, the circular economy emphasises social and environmental benefits and decouples economic activity from the consumption of finite resources. It aims to create a restorative economy that builds economic, natural and social capital and is based on the following principles:

- Design out waste and pollution
- Keep products and materials in use
- Regenerate natural systems (EMF, 2019).

The review of built environments and waste in Africa outlined above indicates that there is a need to urgently reduce waste and to change current practices. Rapid rates of urban development in Africa mean that there are significant opportunities to avoid unsustainable, wasteful conventional approaches and instead develop sustainable systems that have long-term social, economic and environmental benefits. In particular, there are significant opportunities to apply circular economy thinking and systems to make a substantial contribution to developing more sustainable African cities. This section draws upon circular economy thinking to propose approaches and ideas that can be applied to built environments in Africa.

5.1 Enhanced standards of construction and maintenance

A survey of 1084 buildings in Dar es Salaam by the Directorate of Human Settlement in the Tanzanian Ministry of Lands and Human Settlements Development indicated that only 11% were in good condition. It recommended that 89% of the surveyed buildings be replaced (Sabai et al., 2016). Building collapses in Nigeria, Kenya, South Africa and Mozambique indicate that there are also poorly maintained and constructed buildings in other cities in Africa. This may be a result of substandard construction techniques and a lack of investment in maintenance, but whatever the cause, this constitutes an urgent health and safety issue that must be addressed. There are also significant implications for construction waste as poor-quality existing buildings have to be deconstructed.

Excess waste can be avoided by ensuring that buildings are built to higher construction standards and designed to be readily repaired and maintained. The life of components and buildings can be extended by ensuring that the components of buildings can be easily accessed and repaired or replaced. Ensuring that adequate maintenance is carried out will also be beneficial.

Such changes require the development of design and maintenance guidelines, standards and legislation. They also require capacity building among built environment professionals, contractors, facilities managers and owners of buildings. Initial steps could include a survey of existing buildings and the development of accompanying measures to rapidly address unsafe structures, such as implementing urgent repairs at the owner's expense. There should also be increased supervision and checks by competent authorities who can apply punitive measures to ensure that new construction is safe and minimises construction waste.

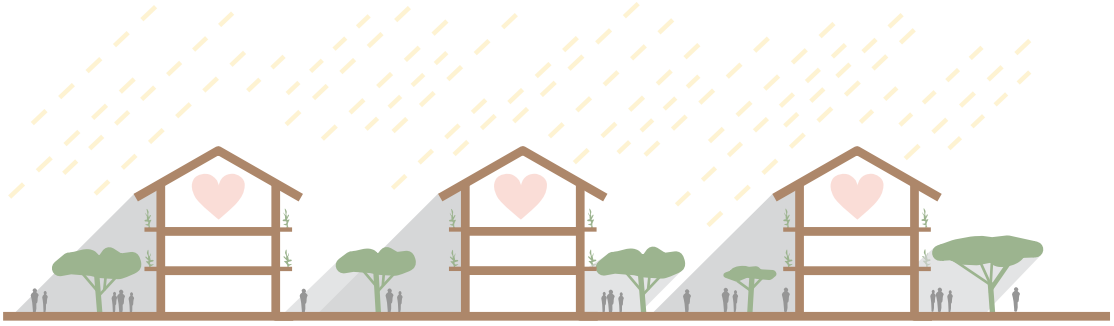

Figure 3: Safe, healthy, and durable buildings

Graphics: Ninni Westerholm

5.2 Avoiding early obsolescence and ensuring the right to repair

Large quantities of waste are generated by poor-quality, unrepairable products being dumped. This solid waste, which includes toxic waste, cannot be recycled or reused easily.

This can be avoided through better regulation of the manufacturing of products and control of imported products. Regulations could be developed that require products to comply with standards that support a circular economy approach. For instance, there could be a requirement that products be made from non-toxic materials, be repairable and be designed to have a long working life.

Material standards based on life expectancies and environmental impacts of materials and products could draw on scientific methodologies, such as the whole life carbon assessment for the built environment developed by the British Royal Institution of Chartered Surveyors (RICS), to ensure that transparent and effective criteria are established and applied (RICS, 2017).

By applying these regulations to all imported products, including construction products, very substantial future waste streams could be avoided. The benefits of this approach include reduced waste streams and the avoidance of the negative health impacts associated with toxic waste. It would also support maintenance and repair enterprises and create significant local economic benefits and employment as a result.

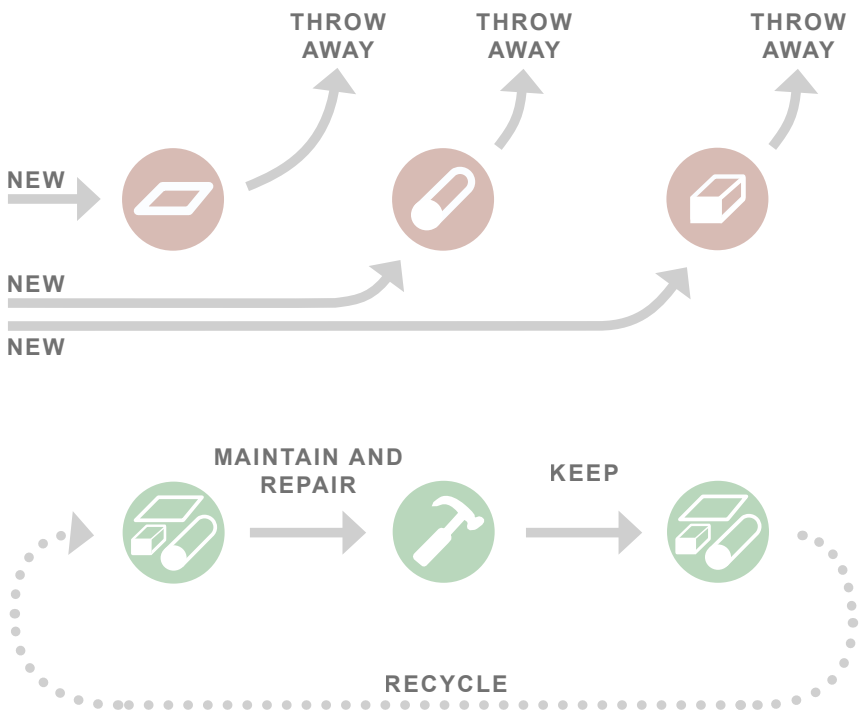

Figure 4: Linear economy (above) compared to circular economy (below)

Graphics: Ninni Westerholm

5.3 Upcycling and recycling building materials

Research by Lawson (2006) shows that 95% of the embodied energy in materials that would otherwise go to waste can be saved by their reuse. Levels of savings vary and range from 95% for aluminium to about 20% for glass products. Research by Sabai et al. (2016) indicates that a large proportion of demolition waste in Tanzania can be readily upcycled into new concrete blocks that can be used for new construction.

In South Africa, industrial waste such as fly-ash and slag has been identified as having significant recycling potential in the construction industry as aggregates and is increasingly being used in new construction (Department of Environmental Affairs, 2012). In Kenya, new enterprises are being developed to recycle waste plastic into useful building products. Ecopost, which has been produced in this way, is a commercial alternative to timber that is estimated to have created over 300 jobs and avoided the deforestation of 100 hectares of forest, as well as taking over a million kilograms of plastic out of the waste stream (Hawken, 2014).

The upcycling and recycling of building materials can be supported through policies, incentives and systems. Government procurement policy could recognise recycled and upcycled content and provide incentives to incorporate this into new buildings. Increased waste levies and taxes could also be used to promote recycling and upcycling as well as new businesses and products in this area. Waste clubs could be used to link demolishers and contractors to ensure that waste, instead of being disposed of in landfill, becomes a valuable input for new construction.

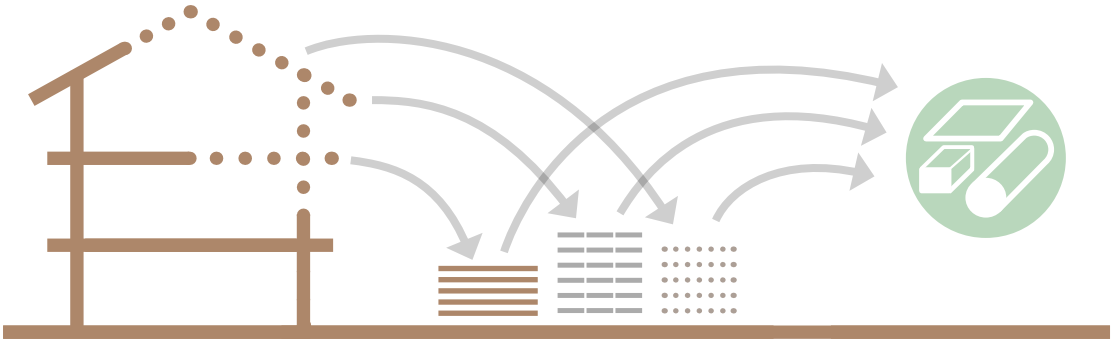

Figure 5: Selective demolition

Graphics: Ninni Westerholm

5.4 Creating simpler, locally sourced buildings

The review of traditional buildings outlined earlier shows that construction waste is avoided and building products and materials are sourced locally and can be readily repaired locally. This approach can be replicated in modern buildings through careful design approaches. Simplifying buildings to reduce the number of materials used, using locally grown materials and avoiding synthetic material can be used to increase rates of recyclability and reuse (McDonough and Braungart, 2002). Lawson (2006) and Lawrence (2015) also show that sustainably sourced, locally grown materials such as timber have one of the lowest levels of embodied energy and the lowest environmental impacts of all construction materials.

The use of local bio-based products could be supported through incentives for local manufacturing entrepreneurs, design guides and training (Gibberd, 2008, 2016). It could also be promoted through schemes that enhance local capacity, and industries and agriculture schemes to develop grown building products, including high-performance cellulose-based and timber products (Lawrence, 2015). In addition, local content standards could be incorporated into government and private sector procurement procedures to ensure that locally manufactured products are used and local enterprises supported (Warner, 2011; Gibberd, 2014, 2015).

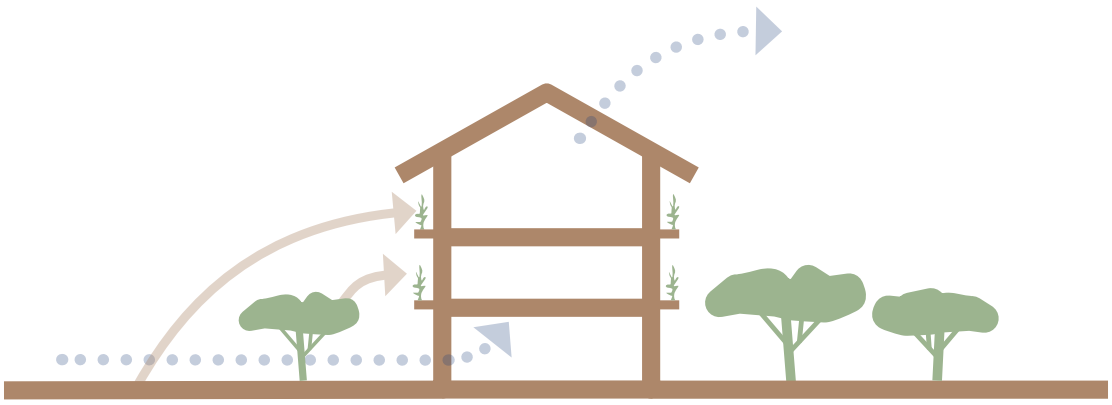

Figure 6: Simple and locally sourced buildings

Graphics: Ninni Westerholm

5.5 Enhancing informal economy processes

The informal waste recycling sector is now well established worldwide, with international markets and transportation logistics, and is estimated to create employment for over two million waste pickers (Hoornweg and Bhada-Tata, 2012). Calculations by UNEP (2018) indicate that if recycling could be increased to 50%, 62.5 million tonnes of waste per annum could be reclaimed, which could generate USD4 billion per annum globally and create many jobs.

In Europe, it is estimated that recycling can support up to 15 people per 1000 tonnes of waste. This does not include a multiplier effect of between 1.5 and 1.75 that can be applied to calculate the number of indirect and induced jobs created (UNEP, 2018). Informal recycling can also produce significant cost savings for business and municipalities. For instance, in Lusaka, Zambia, the net cost of informal waste collection is USD1.60 per tonne, compared to USD10.40 per tonne for formal collections (Aparcana, 2017).

The effectiveness of the informal economy in collecting and recycling waste has been demonstrated in many African cities. For instance, 85% of waste in Bamako, Mali, is collected by informal waste pickers and used to feed livestock and enhance soil fertility. Similarly, over a million tonnes of waste per year is collected and recycled by the informal sector in Cairo, Egypt.

Lessons can be learnt from these systems and improved approaches could then be developed. This could include requiring households and businesses to provide sorted waste in accessible locations outside their premises where waste pickers could easily collect it. It could also include the development of waste picker associations and formal structures that coordinate collection processes and thereby improve their efficiency, as well as working with government and business to ensure that the value of recycling is adequately recognised through subsidies and interventions that improve the income and working conditions of small-scale waste pickers and recyclers.

This approach may be suitable for the many African cities and towns where informal recycling processes already exist and could be easily enhanced. An important benefit of this approach is the increase in the levels of employment and the number of small businesses.

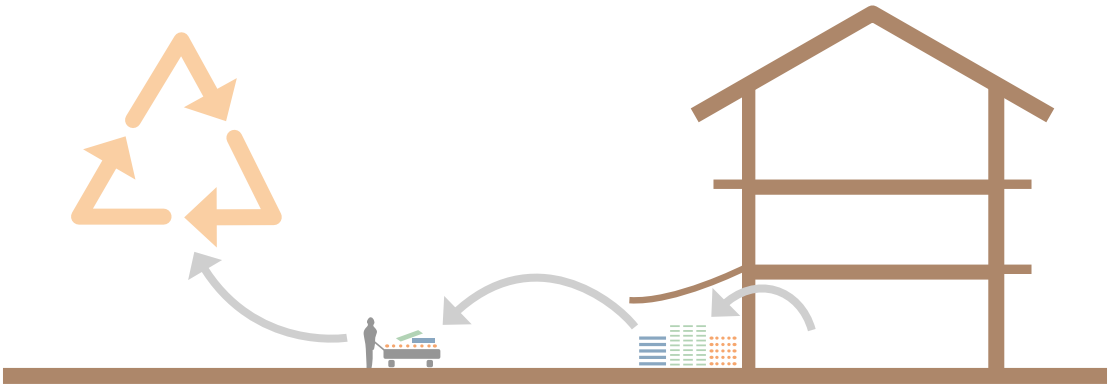

Figure 7: Enhance informal recycling

Graphics: Ninni Westerholm

5.6 Developing waste microgrids

Waste microgrids refer to approaches that enable waste to be reduced, separated and treated within a neighbourhood or locality before being recycled (Gibberd, 2019). They are similar to water and energy microgrids in that local recycling reduces the requirement for municipal or other types of larger-scale waste collection and recycling systems.

Sorted waste is stored and treated at a central location within the precinct or neighbourhood. Some waste, such as organic waste, can be composted and used locally for fertiliser. Other waste can be accumulated until it is of sufficient quantity to be transported to recycling facilities. This approach can greatly increase efficiency as it reduces transportation requirements and provides benefits to the local neighbourhood in the form of income from recycled material as well as fertiliser from the composting of organic material.

This approach may be suitable for many African contexts where municipal waste systems do not exist or struggle to treat the scale of waste being generated, and do not include any recycling. It reduces the burden on municipalities and provides local employment.

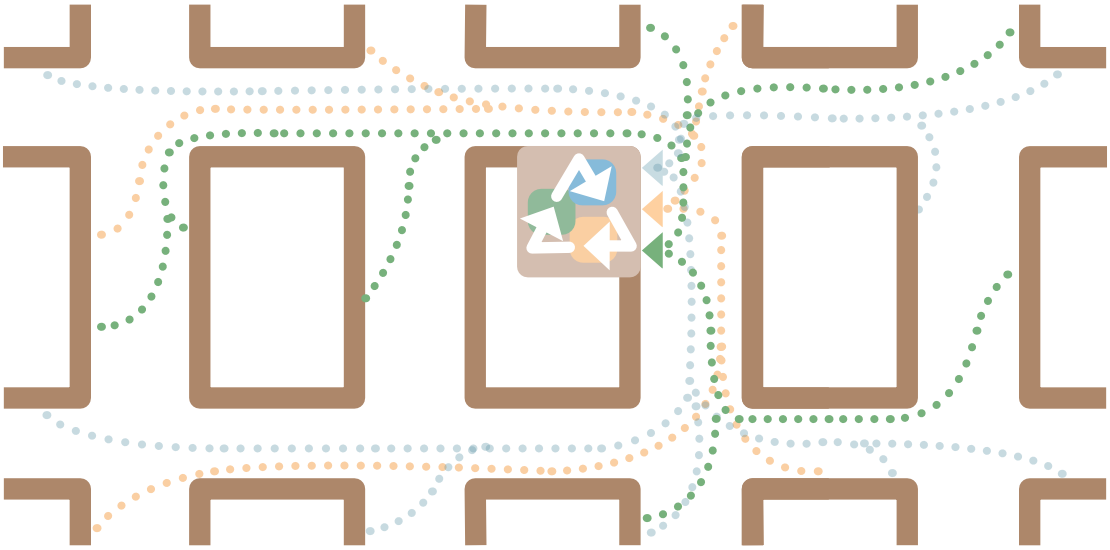

Figure 8: Local recycling hotspots

Graphics: Ninni Westerholm

5.7 Supporting local organic waste recycling and soil fertility

The very high levels of organic waste found in African city waste streams suggest that organic waste recycling could have a very significant impact on waste management. Removing organic waste from municipal solid waste streams at or near the source would contribute to substantial reductions in the amount of waste that has to be collected and disposed of. Figures produced by UNEP (2018) indicate that between 65% and 77% of all the waste generated in cities like Kampala, Uganda, is organic. Other cities, such as Dar es Salaam in Tanzania (71%), Ibadan in Nigeria (69%), Accra in Ghana (65%) and Nairobi in Kenya (65%), also have large proportions of organic waste that could be removed from city waste streams (Rupf et al., 2016).

Organic matter could be composted at both a household and a neighbourhood level. This would provide valuable fertiliser to household gardens and neighbourhood allotments where food is grown, improving food security and the sustainability of small-scale agriculture (Rupf et al., 2016). At a neighbourhood level, small-scale enterprises could also be created to collect organic matter and, through biogas plants, composting or vermiculture, to generate valuable products such as gas and fertiliser, which could then be sold (Couth and Trois, 2012; Jakobsen, 2012). Such an initiative would work well in many African cities and towns where there is already a tradition of urban agriculture and would help enhance local food security, which is becoming an increasingly important concern with the onset of climate change.

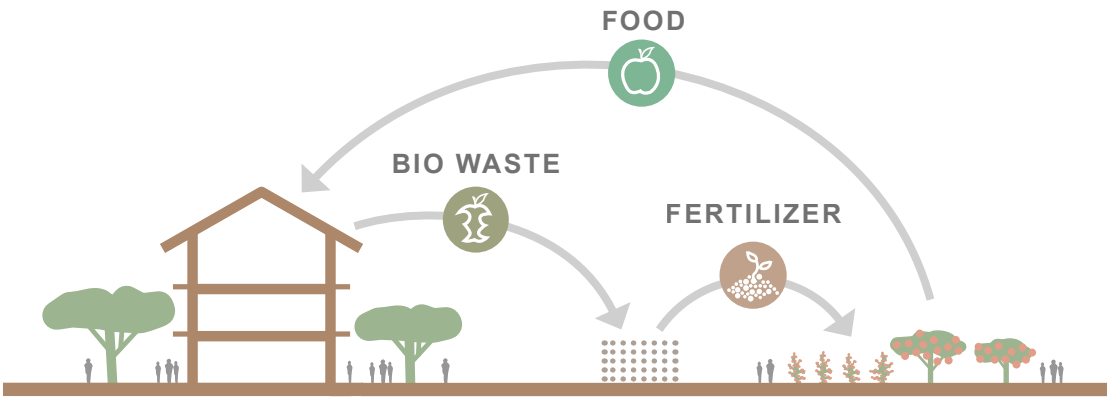

Figure 9: Closing the nutrition loop

Graphics: Ninni Westerholm

6. Conclusion

This study shows that there are significant challenges facing the African built environment and construction sector. Rapid growth and limited capacity have meant that infrastructure and service backlogs are increasing and significant proportions of urban populations have to turn to the informal sector for their livelihoods and accommodation. Out-of-date and fragmented policy and regulatory frameworks, as well as limited implementation and enforcement capacity, have resulted in unregulated and sometimes dangerous and unhealthy living and working environments.

At the same time, there is a diverse and resilient tradition of indigenous construction in Africa that creates comfortable, affordable buildings from local materials using local labour without generating waste. The informal sector has found untapped economic trade and waste opportunities that have resulted in increased access to affordable food, significant reductions in waste and provided many with incomes.

A review of the strengths of and challenges facing existing and emerging practices can be used to identify significant opportunities to integrate circular economy approaches within the built environment and construction sectors in Africa. These opportunities include enhancing standards of construction and maintenance; avoiding early obsolescence and ensuring the right to repair; increasing upcycling and recycling of building materials and components; creating simpler, locally sourced buildings; enhancing informal economy processes; developing waste micro-grids; and supporting local organic waste recycling and soil fertility.

Table 1 identifies the current challenges experienced at the different lifecycle stages in the African construction industry. It also proposes circular economy approaches that can be used to address these challenges and describes the impact of these on capital and operational costs, the environment, new business, and green jobs and skills.

Table 1: Summary of challenges facing construction and the built environment and circular built environment opportunities in Africa

Source: Author
Graphics: Ninni Westerholm

CAPITAL COSTS

MANUFACTURE

Significant proportions of the building materials and products used in African countries are imported. This means that these materials do not create local benefits such as enterprise development and jobs. It also means that negative impacts such as resource depletion, carbon emissions and pollution related to manufacturing affect other communities and are not accounted for locally.

'Local content' standards, regulations and associated procurement strategies can be used to promote the local manufacture of products (Gibberd, 2016). They can also be used to promote materials based on circular economy principles such as products made from grown materials and recycled material. This can be supported through access to capital to create and grow local manufacturing enterprises.

DESIGN

In many African countries, designers, building owners and contractors may specify imported building materials and products in preference to local and traditional materials. This results in reduced investment in local manufacturing and in traditional skills and materials.

Enhancing knowledge of the benefits of local manufacturing and traditional materials and skills, as well as the development of associated standards and training, could be used to support new hybrid construction approaches that combine the best of traditional materials and skills with new technologies. This would support local employment and could lead to bioclimatic low-energy buildings that are easier to repair and maintain using local skills and products.

CONSTRUCTION

The construction of modern western buildings requires significant capital investment in machinery such as cement mixers, cranes and power equipment. It also requires skilled personnel. In African countries, this can make it difficult for small local contractors to compete against well-established foreign contractors. It also results in construction processes and buildings that are energy-intensive and associated with large carbon emissions.

This can be addressed by drawing on new materials, traditional materials and skills, and prefabrication. New materials, such as

bio-based materials, can produce far lower carbon emissions associated with their manufacture compared to conventional materials such as concrete and steel. They can also be manufactured by small local enterprises, thus benefitting the local economy. Traditional materials and skills can be enhanced for use in the construction of high-quality buildings, supporting local small enterprises. Prefabrication can be used to reduce pollution and waste and provide building components that can be assembled by small enterprises without them needing to invest in large-scale machinery. This can help level the 'playing field' between large capital-intensive contractors and small emerging contractors.

OPERATION AND USE

Many buildings in Africa suffer from a lack of maintenance. This reduces their functionality, indoor environmental quality and lifespan.

This can be addressed by designing buildings with higher-quality, low-maintenance materials. It can also be achieved by designing buildings that are easier to maintain safely and by promoting a culture of maintenance. Maintenance standards, training and a professional body that promotes maintenance can also help.

RENOVATION

Building assemblies that make it difficult to extract, repair and upgrade components make maintenance more expensive and reduce the life of the building. This is a characteristic of many low-cost, rapidly constructed buildings in Africa.

This can be addressed by purposely designing buildings so that individual components such as windows, air-conditioning and lighting can easily be accessed and repaired, or removed and upgraded. This prolongs the useful life of the building and reduces waste. It also promotes the development of new enterprises that provide maintenance and upgrading services for buildings.

DECONSTRUCTION END OF LIFE

At the end of their life, many buildings are a liability and significant costs are incurred in their deconstruction and in the disposal of the associated waste. This occurs in many conventional multi-storey concrete buildings in Africa.

This can be avoided by designing buildings to be disassembled easily. This ensures that the value of components and materials is retained, enabling them to be reused or recycled. This approach ensures that buildings are a net asset even at the end of their life.

OPERATIONAL COSTS

MANUFACTURE

Many conventional western buildings in Africa are associated with high running costs. These costs come from maintaining and repairing the building, which often includes expensive imported components and requires specialist skills. Mechanical plants installed in the buildings such as air-conditioners, lighting and lifts are also energy-intensive, leading to high utility bills.

This can be addressed by designing simpler buildings made from locally produced materials and products, which cost less to maintain. By including passive strategies such as natural ventilation and night-time cooling and daylighting, the use of mechanical equipment such as air-conditioning can be reduced or avoided and operating costs related to energy consumption can be reduced. Reduced energy consumption also supports the installation of onsite energy generation such as photovoltaic systems, which can enable buildings to be carbon neutral.

DESIGN

Highly glazed, 'international-style' buildings may be fashionable but lead to high operating costs as a result of the energy required to meet cooling and heating loads. These inappropriate types of buildings are found in many African countries.

Climate-responsive buildings that draw on ambient conditions to keep internal conditions comfortable can be used to avoid significant costs related to heating and cooling systems maintenance and energy consumption.

CONSTRUCTION

Poor construction and supervision can lead to buildings that are difficult to maintain and operate. Building envelopes may leak and experience excessive infiltration rates. This results in heavy air-conditioning loads and an ongoing requirement for repairs, making the buildings expensive to maintain.

This can be addressed through design and specification that takes into account the capacity and practices of local contractors. Improved supervision and construction capacity can also be used to build better-quality buildings. Finally, more stringent pre-occupancy tests, such as air-tightness tests, can be used to ensure that buildings achieve minimum performance standards before being accepted.

OPERATION AND USE

Facilities management is not a well-recognised profession in most African countries. As a result, many buildings are poorly managed, resulting in high operating costs and wastage.

Providing training and developing professional standards and a registration body can be used to improve the quality of building management. This will reduce costs, prolong the life of the building and reduce wastage.

RENOVATION

Sometimes there is a preference for building new rather than renovating existing buildings, even when the existing building still works well. This results in unnecessary deconstruction and production of construction waste.

This can be addressed through increased awareness and capacity. Knowledge of the negative impacts of construction waste can be used to reduce unnecessary deconstruction. Improved capacity can be used to evaluate and creatively renovate existing buildings to prolong their life.

DECONSTRUCTION END OF LIFE

High operational costs are often used as a reason to deconstruct a building. High operational costs in African buildings may be associated with high energy consumption, maintenance and repairs.

This can be avoided by designing low-maintenance, passive, energy-efficient buildings that have very low operating costs. This justifies their continued existence and avoids new builds and the associated consumption of resources.

ENVIRONMENTAL IMPACTS

MANUFACTURE

The construction material and component industries have tended to lag behind other industries. In Africa, many of these industries are characterised by energy-intensive, high-waste processes. Often there is little interest and capacity in upgrading processes and equipment and developing new products to reduce negative environmental impacts.

This can be addressed by developing more stringent manufacturing standards related to energy and waste, and enforcing these. In addition, access to capital and expertise could be used to encourage the adoption of new processes, equipment and product types that are more energy-efficient and less wasteful.

DESIGN

A lack of awareness among designers can result in unnecessarily wasteful designs. Buildings may not be spatially or functionally efficient and large quantities of materials may be discarded during construction as a result of designs that do not align with materials dimensions and modules.

This can be addressed through specific training modules for building designers on designing for building efficiency and avoiding construction waste. This could help reduce the use of materials and the generation of construction waste.

CONSTRUCTION

There are limited regulations and standards on construction waste and pollution in African countries. Where these exist, they are often not enforced. As a result, poor construction practices result in high levels of waste being directed to landfill and pollution from sites damaging local environments.

This can be addressed through more stringent construction management regulations and standards and ensuring that these are enforced. This can be supported by training for contractors and built environment professionals.

OPERATION AND USE

Most buildings in Africa, like elsewhere, have limited specific provision to make recycling easy. As a result, waste is often not sorted and is directed to landfill.

This can be addressed by providing space, facilities and equipment that make sorting and recycling waste easy. This enables waste to retain its value, making it more economically viable to recycle. Onsite recycling of organic matter, such as composting, can also be promoted.

RENOVATION

Buildings that are not designed to be easily renovated and contractors that lack renovation skills often result in large-scale damage to building components during refurbishment processes. This results in waste and limited reuse of materials.

This can be avoided by designing buildings and components to easily accommodate renovation. Contractors can also receive specialist renovation skills. This can be used to promote high-quality, low-waste, efficient renovation processes.

DECONSTRUCTION END OF LIFE

Currently, most construction waste in Africa is directed to landfill.

This can be avoided by the introduction of legislation that requires increased reuse and recycling of deconstruction materials. Waste clubs can also share products and waste between sites, ensuring that more of this waste is reused rather than directed to landfill. Specialist deconstruction skills can be promoted within the industry to support more careful deconstruction processes, enabling the greater reuse of materials.

NEW BUSINESSES

MANUFACTURE

Buildings that incorporate imported materials and components in Africa do not support local businesses and employment.

This can be addressed through standards and procurement policy that promote the use of local building and materials. This can be used to stimulate new businesses and grow existing businesses. Procuring buildings based on more circular processes can be used to encourage the development of innovative new materials and products and related industry sectors.

DESIGN

The design of conventional buildings in Africa is often not energy-efficient and results in high levels of waste in construction and operational processes.

This can be addressed through circular built environment designs that are highly energy-efficient and use renewable energy. This can support new businesses that have a focus on building materials that promote energy efficiency, energy management and renewable energy systems. Designs can also promote new low-waste, low-pollution materials, thereby reducing landfill during manufacture and construction processes, supporting manufacturers of new building materials. Through making provision for waste recycling, designs can also reduce waste during operations and support recycling businesses.

CONSTRUCTION

Conventional construction processes in Africa, like elsewhere, create large amounts of waste that are directed to landfill. Construction processes on large sites are also mechanised and energy-intensive, do not create much employment locally and generate significant carbon emissions.

More circular construction approaches based on bio-materials and earth construction would use less energy and be more labour intensive, reducing waste and carbon emissions while also creating more employment and a range of new business opportunities.

OPERATION AND USE

Conventional buildings in Africa can generate high levels of waste and can be energy-intensive, resulting in significant carbon emissions.

A more circular approach can support the creation of new businesses by designing buildings to support increased recycling and thereby promoting recycling entrepreneurs. It can also promote energy efficiency and renewable energy generation, in turn creating new energy management and energy businesses.

RENOVATION

Valuable building materials and components are often lost in a renovation. In addition, functional buildings are sometimes deconstructed when there is no need to do this as a result of a lack of understanding about their potential refurbishment.

A circular approach maximises the value of materials and components removed from a building during renovation. This value can be used to support the creation of new businesses that specialise in extracting and trading these resources. Similarly, new specialist businesses can be established to identify and develop the potential of existing buildings through renovation, thereby avoiding unnecessary deconstruction.

DECONSTRUCTION END OF LIFE

Most construction waste from sites in Africa is currently directed to landfill.

Circular built environment approaches that recycle and reuse materials and components can be used to support the creation of a wide range of new businesses that extract, sort, refurbish, resell and reinstall components and materials from deconstruction sites.

GREEN JOBS AND BUSINESSES

MANUFACTURE

There is limited awareness and capacity in African building component manufacturing plants about circular economy approaches.

This can be addressed through circular approaches that have an emphasis on new materials, such as bio-based materials, and on reducing waste and energy consumption, which will require a wide range of new skills and expertise.

DESIGN

There is limited understanding and skills among built environment professionals in relation to planning, designing, constructing and managing circular built environments.

Courses and modules at colleges and universities can be used to address this. These can be designed specifically to ensure that designers have the skills and knowledge to design circular systems that reduce material use and waste.

CONSTRUCTION

Current construction training in African countries does not incorporate the use of new greener materials such as bio-based products or construction waste.

This can be addressed by developing training modules for contractors that specifically address reduced construction waste processes, low-waste refurbishment and deconstruction, and new circular materials and components.

OPERATION AND USE

Most facilities managers have a limited understanding of circular systems and therefore tend to manage buildings in a way that results in high levels of waste.

This can be addressed by developing training modules that specifically address circular facilities management approaches and include aspects such as recycling and procurement.

RENOVATION

Renovation contractors tend to damage components and materials being taken out of a building during renovation processes and direct these to landfill. This results in high levels of waste.

This can be avoided through training that addresses how building components can be extracted from buildings in a way that allows them to be reused or recycled.

DECONSTRUCTION END OF LIFE

Contractors tend to damage and mix components and materials during deconstruction. This results in high levels of waste and valuable resources being lost.

This can be avoided through training, standards and regulations that require deconstruction processes to carefully extract, sort and stockpile materials and components so that they can be reused or recycled.

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