Critical Indigenism as Approach for Sustainable Urbanization

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Abstract. Within the next 30 years, cities will grow dramatically. Rural areas will become new urban centers, and open spaces will transform into urban cityscapes. Population growth, demolition of natural landscapes, and urbanization are fuelling the already imminent threat of climate change. Indigenous structures with their own "critical regionalism" touch on a wide range of cultural, economic, and societal aspects. The authors of this paper examine the possible influence of indigenous vernacular structures and the important regional dependencies in African communities. Paradigm would be the use of materials, typologies, building layouts, urban planning, and ecological concepts as well as the question of the importance of a defined urban image. The paper is based on results derived from interdisciplinary and intercultural collaboration within the framework of the Female Academic Leadership Network for Conscious Engineering and Science towards Sustainable Urbanisation FALCONESS.
1. **Introduction**

According to the UN [1], Africa’s population will double by 2050 and quadruple by 2100. This comes along with enormous urban growth. The current urban growth rate at 4.13% is 2.12 times greater than the rural growth rate and nearly twice as high as the global average. Equatorial Guinea and Mauritius have the highest and lowest rates in Africa with 6.48% and 0.14%, respectively. The driving forces for the over proportionally rapid urban growth in Africa are increasing market and employment growth in the service sector contrary to the agricultural sector which is decreasing. This leads to an average of 2.77 times higher income gap to the national poverty level and 2.25 times higher population below national poverty levels in rural regions compared to cities. According to Hoornweg [2], by 2100 13 of the most populated cities in the world will be in Africa. The rapid growth already today has come along with socio-economic challenges. However, the urban livelihood expectations are often disappointed. Nearly 60% of the urban population in Africa lives in neglected informal settlements, with Zimbabwe showing the lowest number at 18% and South Sudan showing the highest at 98%. Furthermore, the co-existence of multiple cultures, ethnicities, and religions will become much more challenging in congested environments. Therefore, it is required to scrutinize existing urban development concepts and identify novel concepts that can balance the need for habitat and urban infrastructure and the need for equitable livelihoods and coexistence of cultural identities. In this context, it is particularly important to look at the specific conditions in Africa. Cities like Lagos and Dar es Salaam are already mega-cities and will grow to more than 80 million inhabitants by 2100 [2], while other cities such as Blantyre are currently relatively small but could increase to 40 times today’s population. Some of the related challenges and demands are discussed here [3][4]. This paper aims at developing viable concepts like critical indigenism, which is adapted from literature, for more sustainable urban interaction that arises from both architecture and construction technology.

2. **Communities and Urbanized Communities**

2.1. **Urban growth and societal implications**

As stated by the UN, the number of urban dwellers worldwide in 2007 exceeded that of people living in rural areas for the first time. In 2018, 55% of the world's population lived in cities – that was around 4.2 billion people [20]. Two-thirds of the world's population will live in cities by 2050 – 90% in Africa and Asia [11]. The processes of urban transformations and the plurality of urban forms have become crucial characteristics of our time, especially in the context of the New Urban Agenda and Sustainable Development Goal 11 (SDG 11) [20].

The development of African cities is a complicated societal development, based on physical, political, demographic, economic, and not least historical factors [20]. The speed of the recent growth of the cities is much faster than the infrastructural and socio-cultural adaptation of the specific environment. The historically grown topographic, socio-economic, or political segregation of the urban realm is challenging the needed evolution of urban, suburban, and rural areas.

In his book about African city typologies and structures [24], Philip Meuser states that cities in sub-Saharan Africa are mostly a collection of many neighborhoods of villages. He describes a mixed community of houses that have not grown upwards but have remained in the “area”. [24].

The main catalysts for the urbanization of African cities are natural growth and migration, leading to the constant incorporation of village communities in the suburban fringe. The communities, which are swallowed by urbanization, are threatened to lose the typical social relations (neighborly relations, social control), fixed structures, and norms (customs, traditions, festivities and associations), the close contact networks, and the strong identity with their home localities [10].

**Keywords:** urbanization; sustainability; Africa; indigenous; structures; materials
Vernacular architecture comprises the dwellings and all other buildings of the people; they are customarily owner or community-built, utilizing traditional technologies and materials and interpreted in a modern way. All forms of vernacular architecture have been built to meet specific needs, accommodating the values, economies, and ways of life of the cultures that produce them [17]. Moreover, rural elements appear to be essential to the survival strategy of the greater part of the urban population and also to the prevention of the town implosion [18]. As a result, urban areas are built-up of different communities, whereas culture, customs, and socioeconomic status are experienced differently in neighborhoods in close proximities. If the urbanized village community stays intact, it is dominated by high-density and tertiary socialized environments, settlement patterns, housing typologies, and lifestyles that are characteristically vernacular. UN-Habitat [16] describes it as a possibility to perceive the atmosphere of the rural communities from which they originated.

A well-documented example is Alex Casey Park in Johannesburg where the compound clusters circular in the same protective systematic around a center as in a rural village. The project “Unequal Scenes” by Johnny Miller looks at the separation of communities from the air and makes the strong division of the different communities visible, interrupted by topographical and engineered (political, economic, historic, colonial, post-colonial, and social) barriers (Figure 1).

Figure 1. Left: J. Miller, border of Masaki and Msasani, Tanzania; right: J. Miller, Alex Casey Park, Johannesburg, South Africa [12]

2.2. Spatial organization of rural communities (example of Tanzania/ Nigeria/ South Africa).
Spatial organization of rural communities in sub-Saharan Africa arises from a collection of smaller communities at family unit. Although on a smaller scale, these settlements are well organized, functional, and ordered [14], [12]. In general, the arrangement of the elements including the animal pen, the Great Hut, other huts, and the spaces between them is a representation of social, economic, political, and religious traditions in the community, illustrating both social continuity and identity [14]. As seen in both the Hausa house compound layout (Nigeria) [13] and the Tswana settlement layout (South Africa) [14], both make use of hierarchy and strategic placement of spaces to provide security and social control. While the Tswana layout exhibits control by placing the hut of the head of the family in the innermost area, the Hausa placed the head of the family where it is possible to control activities in the inner part of the compound as well as the outside area. In both layouts, the safety and security of women and children are confirmed by strategically placing male sleeping quarters near the entrance of the compound, with female members at the inner part. Moreover, there is a clear distinction between public, semi-public, and private areas. The same strategic planning of space is also seen in individual houses that are not part of a compound. Case in point is the Nyamwezi House in Tanzania [15] where partitioning in the house is strategically done to enhance privacy and a sense of security.
This shows that in general, the spatial organization in vernacular architecture provides users with a sense of belonging and identity that resonates well with culture and use of spaces. For modern urban development, other criteria for the arrangement of the different sections can occur, whereas the concept of functionally arranged units remains relevant. The fundamental characteristics should be a foundation of planning when scaling up from individual units or compounds to towns at an urban scale level.

2.3. Urban Neighborhood Concept

The typology of a village consists of the community in specific arrangements or characters. Living together in compound/village structures with all its advantages has been established worldwide (e.g. Hakka Village, Slavic Wendland Village, etc.). City planners and urbanists have recognized the importance of living together in a community and have tried to turn visions into reality.

Tema in Ghana, Abuja in Nigeria, as well as the Tanzanian City of Dodoma make use of this principle of the "Urban Neighborhood Concept". Small neighborhoods form an urban settlement carpet. Dodoma was designed as the ideal African city with references to traditional Tanzanian village motifs. The capital was developed as a rural city without skyscrapers or highways, accessible by pedestrian and bicycle paths as well as by a bus system. The planning puts the community at the center of life and works for the residents. Amongst other issues, the master plan failed in terms of infrastructure and is still being revised today. The master plan of Dodoma has been criticized for consuming too much land, infeasible waste and water management because of its impact on city growth, regional ecology, and finally the fact that grown urban structures were ignored [19]. The Ghanaian city Tema with rasterized dense neighborhoods is much more successful than Dodoma, although much of Tema’s development depends on its location in the Greater Accra region and the proximity to Accra.

Figure 2. Left: Hausa housing layout [13]; middle: Tswana housing layout [14]; right: Nyamwezi house plan [15]
Figure 3. Dodoma, settlement concept, from compound to the urban quarter [19]

3. Indigenous structures

3.1. Resilience through typology

The architect Frampton named the direction of modern architecture, which functionally considered regional characteristics in the design as "critical regionalism" [9]. We would like to go further and define "critical indigenism" by discussing the successful concept of the "Urbanized Village Community" as "Critical Indigenism". The village compound as a traditional building block functions only at its characteristic size within the city but is not scalable. The functional division of the urban village community, on the other hand, is scalable. However, urbanization in Africa is a multidimensional process displaying huge variations between nations and regions, based on physical, political, demographic, economic, and not least historical factors [20]. There is a need to enhance complex holistic thinking on housing. If one looks at the increasing population numbers, the need for housing is still one of the biggest challenges of the century. Historically, many cultures in differing climates have taken advantage of the availability of earth matter to build long-lasting structures with materials found on-site. The structural characteristics lend themselves to buildings that can be used, and re-used, for centuries. A large proportion of the urban population commonly lives in poor quality and highly overcrowded accommodation in terms of living space per individual. The accommodations lack regular supplies of water or provision for sanitation, no waste collection, and no health services or social perspective, while the smaller urbanized village compounds have their own organizational entities. Overall, it can be concluded that the clusters of urban village communities using local material lead to more resilient urban communities, thus, following the idea of "Critical Indigenism" more than most currently applied cities. Nevertheless, upscaling to the expected rapid urban development also requires novel considerations about mixed vernacular and conventional materials and an application in modern ways.

3.2. Resilience through materialization and structure

Construction requires materials for load-bearing structures, closure, and build-up. In vernacular structures earth-based and plant-based materials like clay, thatch, and timber were used. The processing of materials and typical constructions built from them varied a lot and had a strong relationship to the local climate and the communities' needs. Nowadays ongoing standardization and industrialization of the construction technology have led to a relatively low number of options of structural materials, which in addition are typically often used in all elements in a structure regardless of the specific load-bearing demands. From a structural point of
view, however, more hybrid architecture and structural design would be required where the materials are selected according to their specific load-bearing behavior, e.g. steel for tension, concrete for compression, and timber or reinforced concrete for bending. Therefore, it is important to identify the specific strengths and weaknesses of different materials. Table 1 shows some pros and cons of different materials used for load-bearing structures.

Apart from earth and timber-based materials, these materials do not represent materials that have been used for vernacular structures; however, they can well be combined with vernacular materials. The sustainability of vernacular architecture and materials use is well documented [21] where the architecture of these buildings is critically related to the climatic conditions, material availability, and the tradition in the use of space. This can be illustrated in the cold northern region of Tanzania, where the Chagga tribe house is conical in shape and is entirely covered by thatch. Although the actual degree of insulation provided by the thatch depends upon the type of material and how it is fixed, generally thatch is a good insulator. It can keep buildings warm during the cold seasons and cool during the hot seasons [22]. The thick thermal mass mud walls in the Tembe house found in the central region of Tanzania provide a good time lag for transferring heat to the inside of the building, providing coolness in the day and heat at night [23].

Another important characteristic of vernacular material is its circularity where material is sourced locally and can be recycled when necessary. The recycling and reuse of wastes from urban supply streams will become a significant challenge in the future. Recycled steel for example, has more than six times lower carbon footprint than virgin steel, and recycled concrete can help reduce the carbon footprint by absorbing CO$_2$ from the environment and contributing to lower deadweight. These potentials need to be identified and incorporated into circular value chains. Particularly, mineral binders for concrete bear a high potential for circular value chains. Most importantly, silica, lime, and alumina are required, which can be found in various industrial and agricultural wastes, e.g., metal slags and peel ashes [5], [6]. It was recently shown that, for example, cassava wastes, which today cause significant environmental problems and no value, can be used in parallel as sustainable construction chemicals, green cement replacement, and source of energy plus valuable supplementary resources such as pyrolysis oil and gas [5], [7], [8], [9].

Table 1 shows some pros and cons of different materials that are used for load-bearing structures.

| Structural          | Physical                  | Environmental                  |
|---------------------|---------------------------|--------------------------------|
|                      | Pro                       | Con                            | Pro                            | Con                           | Pro                            | Con                           |
| Concrete            | High compressive strength | Low tensile and flexural strength | Durable, waterproof, thermal capacity, fire resistance | High dead load | Availability of resources | High CO$_2$ emissions |
| Masonry             | Good compressive strength | No tensile and flexural strength, Very brittle | Durable, thermal capacity, Fire resistance | High dead load if solid bricks | Availability | Burning process |
| Earth-based         | Marginal load bearing capacity | Thermal buffer and humidity control | Prone to weathering | Low CO$_2$ emissions without cement, availability |
| Timber              | Compressive, tensile and flexural strength | Often limited to truss and beam structures | Good | Prone to weathering, low fire resistance | Availability, low or negative CO$_2$ emissions |
| Steel               | Very high strength | Stability | low dead load in relation to Corrosion, low fire resistance | High CO$_2$ emissions |

Table 1
By taking this into account, "Critical Indigenism" calls for inclusion of vernacular materials in tandem with use of agricultural waste and recycled material in development and construction of urban spaces.

However, it is important to develop a clear understanding of waste materials in their specific framework and market. There is no one-fits-all-solution, and a decision for the feasibility of materials to be included in circular processes depends upon parameters such as secured availability, supply robustness, market prices, transportation distances, availability of technologies, market acceptance, standardization framework, and many more.

From a structural point of view, vernacular structures are often limited in height and span. For example, traditional houses rarely have more than two stories and a span of more than 5 meters. Vernacular materials and construction methods are adapted to this. However, modern requirements demand buildings with more than two stories, and modern living conditions are associated with more spacious rooms at higher standards. Therefore, reinforced concrete and masonry made of cement blocks are often used. Due to its higher strength and durability, reinforced concrete can be used with modern methods to build robust structures over several floors with larger spans. This means relying on construction methods used worldwide and positive aspects of local materials and climatic construction methods are neglected. However, cement causes high CO$_2$ emissions. One of the global concentration consequences on a few materials is that prices are rising and purchasing becomes unaffordable for large parts of the population.

This is where a reinterpretation of vernacular materials and locally adapted construction methods offer great opportunities. For example, the aforementioned cassava shell ash can be used to reduce the amount of cement required [5], [9]. Another possibility is a hybrid construction, using locally available materials according to their material properties (see Table 1). Examples include walls made of earthen material combined with timber or composite slabs made of concrete and timber. If the materials are used effectively according to their strengths, this also leads to a reduction in the number of building materials used, which can effectively reduce the price and deadweight of the structure.

4. Conclusions

The concept of critical indigenism can be applied as a concept for socially and environmentally sustainable urbanization to reinterpret vernacular materials, building methods, and urban structures in a modern way to create more resilience.

The authors of this paper explore, among other topics within the FALCONESS network (Female Academic Leadership Network for Conscious Engineering and Science towards Sustainable Urbanization), the influence of indigenous vernacular urban structures and the important regional interdependencies in African communities in the urban context. We raise the question, how can vernacular construction be adapted within the current building methodology? We see great potential in reinterpreting materials and adapting them to the current state of materials science research. Furthermore, we see the links between engineering, sociological and socio-economic approaches as a strategy to create a resilient, people- and climate-oriented community.

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