Sustainable Building Design in Kenya

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Abstract

Sustainable design strategies involve complex interactions among social, economic and environmental factors those should be analyzed and solved quite differently by heterogeneous disciplines and stakeholders involved. Focusing on the cities of developing countries in tropical regions, characterized by fast urban population growth and a staggering increase in the energy consumption for building sector, it emerges that appropriate active strategies and building energy optimizations are promptly recommended. For this purpose, in the present work, energy evaluations were carried out for the designing of a residential building in Nairobi, Kenya, considering different strategies and solutions, taking into account also the affordability and considering the possibility to push local based economies through the use of built-on-site materials. This strategy may lead to a significant cost reduction and energy saving due to lower construction costs and in addition also a lower embodied energy of the building materials. Furthermore, in a region understudy, characterized by unstable economic security, the employment of local labor forces may lead to the formation of local based economies.

1. Introduction

Majority of the world’s population today lives in cities, with over 863 Million of people living in slums and informal settlements [1] characterized by also low quality of electric supply service [2]. In this respect, some researches which address the prevailing lack of electricity access are already developed [3-5]

However, urban populations are continuing to grow at a rate faster than the cities can manage, leading to serious problems on infrastructure and other services like housing. If current development trend will continue, the global area of urbanized land could be tripled in 2030 with respect to 2000 [6]. Almost 90% of the global urbanization between now and 2050 will take place in countries of the developing world, mostly located in tropical/subtropical regions [7]. By the end of the current decade Eastern Africa urban population will be increased by 50% and the total number of urban dwellers in 2040 is expected to be five times with respect to 2010 [8].

Urban areas are responsible to about 70% of global energy use and energy-related GHG emissions, thus cities in the developing world [9], where most of the growth will take place in future, will have a significant impact on GHG emissions, seriously threatening any effort to reduce them – unless new urban...
developments are designed to minimize their impact. New urban development design is a key issue for coping with global warming. An appropriate urban and building design may lead to very low emission cities if properly designed [10-12]. UN-Habitat estimates that African cities become home to over 40,000 people every day [13]; considering that Nairobi is one of the biggest cities in East Africa with an estimated population of over 3.2 Million people [14] and a projected growth of 14 Million by 2050 and 38 Million by 2100 [15], a strategic intervention is essential among all also in building sector. Despite increased levels of urbanization, only 35,000 new homes are built in Nairobi against a demand of 120,000 housing units per year [16]. The result of this mismatch has led to increased housing prices and continued emergence of slums and informal settlements resulting to 60% of the city’s population living in the informal settlements [17]. The present work hence focuses on the development of a design methodology, in order to identify critical aspects and intervention strategies for the creation of sustainable and affordable residential building in developing countries. In this framework, multi-criteria evaluations and a specific design methodology have been developed and applied on a case study building in Nairobi considering different strategies and solutions, taking into account energy performance and affordability and also considering the possibility to push local based economies through the use of built-on-site materials.

2. Methodology

Sustainable building design requires considerations about all three sustainability dimensions: environmental, economic and social. However, due to the massive urban development ongoing in developing countries, in order to avoid a dramatic increase in energy consumption and consequently GHG emissions, one of the main goals for designer is the reduction of building energy consumption and this challenge will require a radical transformation in building design procedure. For such reasons, the methodology proposed in the present work, although is more focused on the energy issue, also include the economic and social aspects. More in detail the methodology is divided into three closely interconnected thematic areas (Fig. 1). The first area focuses on the analysis of the climatic context and economic and social constrains, which allow the definition of the main principles and guidelines to be used during the concept design of the building. Subsequently, the energy consumption of different building configurations, characterized by different type of envelope, derived from the principles identified in the previous step, have been compared and the optimal solution in terms of energy savings have been selected. Finally, the selected solution has been verified in the third step, based on economic feasibility analysis through the estimation of the final construction cost and the building operating costs.

![Flow chart of the methodology](image-url)
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