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A case study on regenerating informal settlements in Cairo using Affordable and Adaptable Building System

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Abstract

This paper is a scientific review of the results from research project A²L-Mobilus, which is an ongoing research project partly funded by the German Federal Ministry of Education and Research (BMBF). Today the process of urbanization has reached an unprecedented level. Most of the rapid urbanization phenomena happen in developing countries, triggering a series of social, economic, and environmental challenges as well as opportunities. In particular, nearly two thirds of Greater Cairo Region's population are living in informal urban settlements, and the number is expected to continuously increase, which causes a series of issues such as overpopulation, land shortage, high unemployment rate, lack of adequate infrastructures, and environmental challenges. As a result, in the foreseeable future, the situation will be more problematic if no innovative measures are taken. Based on A²L-Mobilus, the goal of this paper is to present an integrated solution to improve the living condition of local residents and to catalyze the vitality of local community. With regard to the research methods, a small housing unit in Cairo's informal area is chosen as the object of the case study. Accordingly, field trip study by Egyptian partners is conducted in order to better understand the housing's condition as well as its surroundings. Based on the case study findings as well as the Open Building concept, the results consist of an Affordable and Adaptable Building System (A²BS) and a cluster of Decentralized Processing Units (DPUs), which generate key elements to improve energy efficiency, mobility, and life-work patterns. Furthermore, specifications and technological details of the proposed system will be presented in this paper. In conclusion, this case study provides a valuable model for further research on regenerating informal urban settlements.

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Keywords: Egypt; advanced building technology; informal urban settlements; open building; urban regeneration

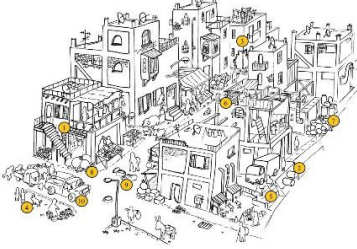
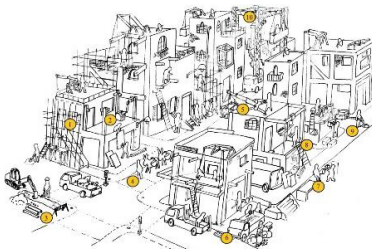
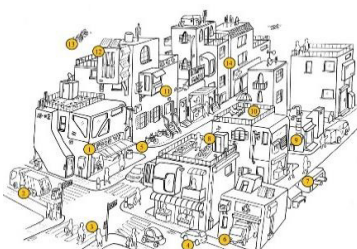
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1. Introduction

The process of urbanization today has entered an unprecedented era. According to a recent UN study, 66% of world population will be living in urban areas by 2050 [1]. Most of the current urban sprawl phenomena happen in developing countries, which trigger a series of social, economic, and environmental challenges as well as opportunities. For instance, Greater Cairo Region is arguably the largest in Egypt, Africa, and the Middle East, and one of the most crowded metropolises in the world. Nowadays approximately two thirds of Greater Cairo Region's 20 million population live in informal urban settlements, and the number is expected to dramatically increase, thus causing serious issues such as overpopulation, land shortage, high unemployment rate, lack of adequate infrastructures, and environmental challenges [2]. Consequently, in the foreseeable future, the situation will be even more complex and problematic if no innovative and integrated solutions are implemented.

Therefore, this paper aims to present an integrated solution to improve the living condition of local residents and to catalyze the vitality of local community in the coming years (see Table 1), based on the research project A²L-Mobilius (short for Affordable and Adjustable Living and Mobility for Sustainable Integrated Urban Systems in Egypt), which is partly financed by the Federal Ministry of Education and Research of Germany (BMBF) [3]. A residential building in Cairo's informal urban area Sakiat Mekki is selected and studied. A method based on requirements engineering (RE) is developed in order to ensure the fulfillment of the stakeholders' needs in the existing housing unit [4]. Accordingly, a renovation and extension design based on Open Building is proposed to regenerate the selected case with advanced building technologies [5]. The results consist of an Affordable and Adaptable Building System (A²BS), and a cluster of Decentralized Processing Units (DPUs), generating a key component to improve energy efficiency, mobility, and life-work patterns [6]. In order to demonstrate the feasibility, specifications and technological details of the proposed system will be presented in this paper. In addition, an innovative business model for the local residents will be presented as an example which additionally supports the building system to promote local economy. In conclusion, this report will provide researchers, architects and urban planners with a valuable model of regenerating informal urban settlements.

Table 1. Existing situation, expected transition, and future vision of Cairo's informal settlements

Existing situation	Expected transition phase	Future vision
		
<p>Existing street condition:</p> <ol style="list-style-type: none"> (1) Inadequate living condition (2) Poor infrastructure system, e.g. old sewage system (3) Poor quality of housing construction (4) Lack of schools and health care facilities (5) Lack of public amenities (6) Lack of adequate planning and building regulation (7) Poor environmental conditions (8) Random rubbish disposal (9) Rising manhole cover, poor road surface (10) Poor road safety 	<p>Regeneration taking place:</p> <ol style="list-style-type: none"> (1) Renovation and building improvement work (2) Single task robot is in operation (3) Improvement of the infrastructure system (4) Improvement of road surface (5) Removal of livestock from the roof top (6) Removal of rubbish pits (7) Upgrading of sewage system (8) Human and construction robot interaction at work (9) Upgrading the water supply system (10) Demolish of an existing building 	<p>Conceptual street scene:</p> <ol style="list-style-type: none"> (1) Improved living condition (2) Regular rubbish removal (3) Improved road safety (4) Sufficient parking (5) Well organized street and sidewalk (6) Adequate waste recycling (7) Improved sewage system (8) Roof garden and vertical farming (9) Decentralized industry (10) Improved amenities (11) Decentralized modular pod for energy generation (12) Decentralized modular pod for live & work integration (13) Rapid logistic system (e.g. drones) (14) Improved water provision

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