Low Cost Local Kinetic Architecture Technology to fulfill the User Needs (Function - Form) of Economic housing in Egypt.

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Abstract

Among today’s limited income families, the majority of the population in developing countries needs essential changes in their economic housing. The most essential change comes for their need for extra spaces in their apartments due to the increase in family members. This need push them to commit buildings offenses to create the space they need in an illegal way due to the limited space of economic housing apartments. The purpose of this paper is to introduce a solution for this problem using low-cost local simple kinetic architecture technology mechanism which can be used when they need extra spaces (indoor or outdoor spaces -terrace-extension) and can also be controlled. Beside, this solution gives the traditional economic housing appearance a diverse and renewable architectural form (nonphysical function) that is also a basic objective of this solution. This low-cost simple technology can stop people from building slums by using a simple mechanism that people can easily control and use according to the function they need, which will make them more comfortable and satisfied with their sustainable home.

Keywords: Kinetic Architecture, Economic Housing, Spaces Extension, Local Mechanism.

1. INTRODUCTION

The issue of economic housing represents a challenge in worldwide, especially in developing countries. Through the observation of the informal settlements in Egypt, many of them have been transformed from government economic housing to informal settlements due to the violations of buildings stark the users made to fulfill their essential needs.

This shift was motivated by admitting that settlements were not an issue but a solution done by the society when the economic housing cannot meet its demand. In Egypt, despite all efforts to holds the increasing of informal settlements, they are increasingly growing.[1]

The kinetic (architecture/buildings) concept and motion of buildings can be found in many shapes such as partially dynamic architecture. This paper assume dynamic architecture (cantilever structure) as an approach to give a solution for the failure of traditional economic housing to meet the needs of the population in terms of space and form. Real dynamic will give an extra dimension to the economic housing form. It makes it a living thing rather than thinking of a building as a solid object.

In design with movement, it is desirable to achieve transformable, motion-capable and user-friendly designs. The words used to describe buildings with movable parts or components associated with a shape change include adaptable, collapsible, enabling, evolutionary, flexible, intelligent, kinetic, mobile, performance based, reconfigurable, responsive, revolving, smart, transformable, and transportable.

1.1 Kinetic Architecture

Kinetic architecture is a concept in which the buildings are designed to let parts of the structure to move, without lessening total structural integrity. A building’s ability for motion can be applied just to: boost its aesthetic characteristics; react to environmental conditions; and/or, execute functions that would be impossible for a constant structure. The possibilities for practical application of kinetic architecture increased clearly in the late-20th century because of progress in mechanics, electronics, and robotics.

Kinetic design has been used throughout history. Yurts with opening and closing elements and movable components are one of such designs. Leonardo da Vinci is one of the first designers who studied the design methods of kinetic structures such as movable bridges. He applied the movement mechanism existing in the birds’ wings to flight Instruments and also to the first movable roof.

Term "Kinetic Architecture” can be clarified as buildings or building parts that work in response to surrounding...
changes whether these changes are in/out doors as well as environmental/human.

Although the first formal definition for the term “Kinetic Architecture” was in 1970, many kinetic solutions that varied from building components to building as whole existed. The use of kinetics was for different reasons such as protective (bridges), entertaining (stages and revolving restaurants), medical (sanatorium and solarium), and residential.[2]

Kinetic systems can be controlled by different means when they are installed in buildings. Controlling kinetic systems may range from simple means by manual control to complicated automatic control. Kinetics can be installed in buildings without using any kind of firm computation and/or automated systems letting buildings users to manually fold, slide or even push different parts creating the environments they desire. Error! Reference source not found.

1.2 Economic housing

Housing is considered one of the most important problems facing the state in Egypt due to the increasing number of population and not meeting their needs. So, this housing is quickly abandoned and some people tend to make changes on it according to what they want. This leads them to committing buildings violations due to building extra space to use.

Figure 1 buildings of economic housing in Egypt.
After checking the economic housing in Egypt, it turns out that the biggest problem for the users is the need for extending the space of the unit they live in. Buildings violations that people commit appear in building extra rooms or re-configuration of balconies and constructing extra space, which leads to deformation of the building and re-shaping the Original design of the building. Due to that, creating a solution to prevent people from building extensions is a necessity and this can be achieved by applying a mechanism easy to use by the people and also easy to construct and maintain in Egypt. The kinetic extension was the best solution as people could control the space they want and change it according their needs.

2 Methodology
The paper highlights the problem of the economic housing, presents examples of the issue and gives a different solution to fulfill user's needs (Form – function). It also presents the proposed mechanism, mechanical components,
and the proposed design beside showing the stages of how the mechanism works with a clarification of its local mechanism components and giving an example of the building after applying the mechanism.

2.1 Proposed Design for unit
The maximum cantilever of the proposed design mechanism is 3m. The average price of the proposed mechanism in one room is nearly 15000 Egyptian pounds which equal 750$ (according to central Egyptian bank in 12-2018). It will prevent people from building on it or committing building offenses. People can also use it when they need extra space as they can control its length according to their needs.

![Proposed Design for unit](image-url)

**Figure 4:** stages of Proposed mechanism design of a (3m length -3.4m width) unit

**Figure 5:** unit plans

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### Figure 4 stages of Proposed mechanism design of a (3m length -3.4m width) unit

### 2.5m

### Figure 5 unit plans
The mechanism is very easy for people to use it, and easy to maintain as it is a local mechanism which can be manufactured and constructed by Egyptian workers.

2.2 Proposed Mechanism

The mechanism consists of three main components:

- Carriage
- Rack gear
- Manual engine

Figure 6 Proposed mechanical components of the mechanism.
Design Key Elements:
   a. Structural System:
      The building is a traditional beam structure. The movable structure is a steel structure.
   b. Used Materials:

Figure 7 mechanical components on the unit
Materials such as steel

c. b. Embedded Computation / Control Mechanism:
The movable skin is manual controlled. This skin moves on railway tracks (gear racks) that can be controlled.

2.3 Proposed building Design consists of (6 apartment)
People begin to do changes in their apartments according to their needs that push them to building offences due to the increasing number of members in a single family. So, they need extra space in their apartment.

Figure 8 example of first floor plan before using the proposed mechanism.

Figure 9 example of first floor plan after using the proposed mechanism.
2.4 Proposed Building Design

The figures show the expected building with the mechanism. We can see the difference between the building before and after using the mechanism. As, the mechanism give the building motion & dynamic sense, it also gives people the feeling of happiness and comfort.

Figure 10 Example of the building before the mechanism.

Figure 11 Example of the building after the mechanism.
Conclusion
The economic housing with the proposed mechanism

a. Meets the needs of the users (function) by:
   - The mechanism creates flexibility in controlling the variable extension and provides the owners with extra space which can be manually controlled by a manual engine. The used mechanism is a low-cost local mechanism with an average price of 750$ for the unit.
   - People will not be allowed to build on the mechanism which will solve the problem of buildings violation (slums).

b. Meets the needs of the users (Form) by:
   - It gives economic housing a live shape/structure with rich architectural forms.
   - More civilized & exciting for imagination.

c. The mechanism is simple and local which will make it possible to manufacture and maintain in Egypt.

d. A new concept of economic housing in Egypt.

References

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Dr. Faysal Abo-Elazm Is an Egyptian Architect and Assistant Professor in Architectural Department, Faculty of Engineering, Suez Canal University, have a broad experience in urban and architectural design. Graduated in 1998 from the Department of Architecture, Faculty of Fine Arts, Helwan University, Egypt. He obtained his MSc. in 2003 from The Department of Architecture in Faculty of Fine Arts, Helwan University and PhD in 2009 from Faculty of Fine Arts, Helwan University. Faysal Abo-Elazm has a wide experience in teaching a lot of architectural courses through working as part-time lecturer in several departments of architecture in governmental and private Egyptian universities. Most of current research work focuses on environment design, structure in architecture, urban design, and social sciences.

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