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HOUSING IN MEGA CITIES - A SYSTEMS ENGINEERING APPROACH

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ABSTRACT

It is all but certain that the 21st century will see more and larger mega cities as magnets for population and economic activities in developed and developing countries around the world. It is similarly certain that the problems associated with the growth of mega cities would only deepen, persist and prolong, unless a new approach is taken to the development and re-development/revitalization of mega cities. Much work has been done to better understand the integrative nature and the interconnectivity of prevalent issues in mega cities - from housing to transportation, electricity and water and sewer infrastructure, and from service industries to government and policy issues. Nonetheless, and despite a full understanding of the need for systems engineering approach, there seems to be two major hurdles in developing workable solutions for mega cities. One is to find a common objective for linking the system of systems in mega cities, and second is to find a community-based approach to adapt the systems engineering concept to different mega cities around the world. In this paper, these two issues are addressed and new ideas are offered for the community of scholars that work on these deep rooted issues.

Key words: Engineering, Housing, Management, Mega cities, Socio-economic, Systems.

Introduction

A decade into the 21st century, it is all but certain that we will continue to see more and larger mega cities as magnets for populations and economic activities in

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developed and developing countries around the world. The world's population living in urban areas has in recent years exceeded that of rural communities [1].

It is similarly certain that the problems associated with the growth of mega cities would only deepen, persist and prolong, unless a new approach is taken to the development and re-development/revitalization of mega cities. Much work has been done to better understand the integrative nature and the interconnectivity of prevalent issues in mega cities - from housing to transportation, electricity and water and sewer infrastructure, and from service industries to government and policy issues. Nonetheless, and despite a full understanding of the need for systems engineering approach, there seems to be two major hurdles in developing workable solutions for mega cities. One is to find a common objective for linking the system of systems in mega cities, and second is to find a community-based approach to adapt the systems engineering concept to different mega cities around the world.

In this paper, these two issues are addressed in the context of "system of systems," which includes both physical and socio-economic systems. New ideas are then offered for the community of scholars that work on these deep rooted issues.

Housing Challenges in Mega Cities

It is common knowledge that mega cities face a number of challenges, from air pollution to traffic congestion, and from disparity in wealth and health to issues of growth [1]. The same factors that make mega cities the strong magnets in their region, often lead to their demise, literally choking them with their own magnetism and attractiveness. As it relates to housing, the two major issues of concern are as follows:

- Poor housing and slum dwelling on the one hand, and homeless on the other hand; and
- Urban sprawl.

One may refer to Mexico City where more than half of the population lives in poor housing, or to Calcutta, where number of people living in slums closely parallels that of the homeless. Urban sprawl on the other hand is associated with decentralization, fragmentation and discontinuity in the city. These two issues are both symptoms of deep rooted socio-economic problems, and also themselves deepen other problems in mega cities - for example the safety and security in various neighborhoods, traffic jams, environmental pollution (e.g., garbage), and the inadequacy of infrastructure to serve the needs of the growing population.

The interconnectivity of these issues is not lost to anyone who has studied the evolution of mega cities. Solutions have been abundant, both in the span of time and

in the diverse locations around the globe, where they have been attempted. Some have made a significant difference in the communities where applied, while others have faded in the sunset shortly after rising to high expectations. The upgrading programs from Manila to Mumbai have had positive impacts. At times, the financial assistance provided by the World Bank has been the game changer for some of these communities, but in no instance an example of a successful neighborhood upgrade can be demonstrated where some albeit limited transformation in the local community has not taken place, either as the prelude to success or as its immediate byproduct.

Perhaps more cases can be cited from mega cities around the world with limited success on their housing challenges, but none has been systemic enough to facilitate portability of the concept and its adaptability to other communities and regions with different characteristics. The most frequently quoted ingredient of any of these successful or partially successful strategies is the empowerment of local communities in taking control of their destiny. This, of course, has been and will continue to be a challenge in parts of the world where such empowerment is not favored by the political system in place. At times, entrepreneurship has been used as a means to empower and incentivize communities towards revitalization. The revitalization of Baltimore City in USA during the 1980's offers a great example of such mechanism.

Systems Engineering Approach to Housing in Mega Cities

The foregoing discussion reinforces the importance and interconnectivity of social construct and the economic infrastructure of the region in defining and implementing possible solutions to address these challenges. One may therefore draw the conclusion that the problem is too complex and too layered to be untangled by an engineering solution. After all, it has been said that engineers tend to define problems too narrowly, too deterministically, too simplistically, and yes, of course, way too linearly!

Notwithstanding such perceptions, engineers have always provided decision makers with an array of solutions and a clear understanding of the measures of effectiveness of each alternative. What is missing from the process is for engineers to be at the table at the time of decision making rather than offering partial solutions and/or data that are studied in abstract and without weighing in other non-quantifiable boundary conditions. The premise of this paper is that engineering must be applied at the cusp of decision making together and interactively with all political and socio-economic layers, and not as a prelude to the process and in the abstract of real interaction with non-physical constraints.

This paper does not attempt to discount the importance of political and governing issues in the prevailing equations [2], but rather to the contrary, it offers to integrate them (and a whole array of socio-economic issues) with the physical systems. The integration is both across the systems and throughout the entire geographical region.

Even though the decision may ultimately be made solely based on economic or political factors, what is currently missing from the process is a systems engineering approach whereby all factors are integrated and interconnected to lead to proper decision making.

This paper proposes that one must assess these challenges through the lens of systems engineering, whereby the mega city is considered a "system of systems." The interconnected systems could be overlapping layers of socio-economic and political systems with the systems of physical infrastructure. Just as housing affects transportation or the environment, it is naive to presume that socio-economic systems and physical infrastructure systems co-exist with limited or no interconnectivity. The challenge is to integrate them with engineered systems in a harmonic way that is based on cause and effect relations. Such relations can be defined and re-defined many times over – they can vary from one community to another, and can also vary over time. But it is detrimental to defer such integrations to the pinnacle of the decision-making process and even then, only intuitively and from the gut! Although the same approach could be taken for many other societal challenges, the benefits are manifold for the issue of housing in mega cities.

Through this approach, issues of progress, sustainability and resilience can all be addressed systemically and logically. Within a "system of systems," it is logical to define terms of progress for a mega city and to weigh the impact that change in one system may have on the others. It is only then that sustainability can be defined holistically and with an appropriate time stamp for the entire mega city. And it is only in that context that various scenarios of natural and societal stressors and their impacts on the mega city (or housing in mega city) can be assessed.

For example, to help contextualize resilience, consider mega city as a complex interacting system of systems of coupled natural, engineering, and socio-economic systems. The natural environment and the resources contained within it provide the basic building blocks for the community. Infrastructure systems support the basic functioning and underpin the prosperity of urban/suburban communities or regions. The infrastructure comprises both physical (i.e., lifelines, transportation, communications, and the built environment) and human (social, economic, and political) systems. Together and within a complex system-of-systems, they contribute to the operability and sustainability of communities. Because these systems function interactively, when impacted by stressors the ability of the entire community to respond, cope, and recover is seriously compromised. Community resilience, encompassing both engineering and socio-economic systems enables the community to restore its functioning at socially acceptable levels. To foster resilient and sustainable communities requires an understanding of these coupled systems, including their operational interdependencies and vulnerabilities. It also requires knowledge about system behavior under normal operating conditions as well as when

subjected to disruptive steady or transient stressors. This provides a platform for portability and adaptability.

Conclusions

Given the exponential growth of mega cities, and the enormity of their housing challenges, a new approach must be taken for their development and re-development/revitalization. The systems of systems approach requires engineering leadership, an interdisciplinary approach to integrate socio-economic factors with physical infrastructure, and a robust and dynamic decision support platform and tools to be used by a variety of stakeholders for performance-based and consequence-based decision-making. Only then, one can find a common objective for linking the system of systems in mega cities, and find ways to adapt the systems engineering concept to different mega cities around the world.

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