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Advantages, Disadvantages and Challenges of Sustainable Vertical Cities

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Abstract – *In view of increasing pressure on land, we have no option but to develop our cities vertically. As of now, there is no vertical city is designed or constructed which can also be considered sustainable and this is an emerging area of interest among building professionals. This paper not only differentiates between Mixed Use Development and Sustainable Vertical Cities but also deals with the aspects to be considered in conceptualization and engineering of Sustainable vertical cities. In the course of the paper, various advantages and disadvantages of the sustainable vertical cities are identified. Various aspects of research related to sustainable vertical cities (SVC) are also been identified and touched upon in the paper. The challenges of SVC are also elaborated in the segment of the paper.*

Key Words: **Sustainable Vertical City, Vertical Development, Future City, Environment, Engineering Challenges.**

1. INTRODUCTION

"Men come together in cities for security; they stay together for the Good Life." - Aristotle

Habitable land area (barring deserts and mountains) on earth is estimated as 24,642,757 square miles or15.77 billion acres, which will not expand, rather shrink in the time to come. Current global population of about 7 billion has the potential to reach 9 billion by 2050 and 80% of population shall live in urban areas (Al-Kodami, 2012). Earth could support about 13.4 billion population (Cohen, 1999). Demand of land for living and farming is ever increasing and we have no option but to envisage growth of our cities upwards than outwards. Empire State Building, Sears Tower, Petronas Tower, Lotte World Tower, Taipai 101, Burj Khalifa and Shanghai Tower are some of the steps in this direction. However, none of these landmarks can be considered as a Vertical City, because these do not fulfill all the functions of a city and expectations of a city life. These appear primarily as giant sculptured objects in their urban surroundings, while the external spaces between the different elements of the composition have little or no definition or character of their own (Abel, 2010).

Feasibility and sustainability of vertical developments including 'vertical towers having mixed use' and/or 'vertical city' as an answer to the urban sprawl can be argued until it is determined through research with comprehensive and reliable analysis prior to consensus on long term vision in view of sustainable development strategies (Dalal & Bass, 2002).

Sustainable Vertical City (SVC) is generally perceived as a Mixed Use Development (MUD) in the form of a cluster of interconnected high rise buildings, whereas, SVC is to be envisaged as a Built Environment to facilitate Quality of Life for all its inhabitants and visitors. Vertical City is a vision of a complete ecosystem in the sky-a place you never have to leave if you don't want to (Schiller, 2014). Ebenezer Howard had suggested Garden City for the targeted population of 32000 (Rangwala, 2016) in early 20th century, whereas, as per European Union (2011), urban center should have at least 50000 inhabitants. Functions and magnitude is the basic difference in an ideal 'SVC' and 'MUD' i. e. recently developed skyscrapers in 21st century.

Perception of Sustainable Vertical City (SVC) may be different for various professionals / scholars / researchers and definition of SVC needs more clarity in terms of its magnitude and expectations from SVC by the all stakeholders like inhabitants, government, financers, technocrats, social scientists, environmentalists and service groups. Functions and zones of a city need to be discussed and accordingly parameters of SVC are to be determined. Challenges are associated in thoughtful conceptualization of SVC, particularly determining targeted capacity of inhabitants, habitable built up area required per inhabitant open and common areas required as a ratio of habitable built up area. Statistics of total built up area and targeted capacity of inhabitants of vertical mixed use developments so far may not be relevant for SVC, since these developments (even Shanghai Tower) are merely multi-functional buildings and not vertical cities. Parameters of sustainability are also varied in various regions in view of type of development. We may need to relook on current practices and it would be worthwhile to re-define parameters of sustainability for SVC to achieve real sustainability. Challenges associated with requirements and availability of various types of construction materials need to be discussed. Apart from

engineering aspects; social, cultural and economic issues are also to be probed.

Thorough study, research and analysis is required to determine optimized areas for various zones like residential, commercial, administrative/governance, industrial, eco-farming, transport and circulation, open public / green areas. Parameters and interrelation in ratio of these zones may be different in a vertical development than a conventional city having outward growth and this require thorough research. Separate research can be conducted on each of the following aspects;

1. Magnitude of SVC (Capacity in terms of inhabitants & built-up area footprint)
2. Configuration / Anatomy of SVC
3. Optimization of SVC height
4. Effect of climate and culture on vertical development
5. Energy footprint of proposed development
6. Water footprint of SVC during construction phase
7. Energy and water requirements during operation phase
8. Feasibility of Concept / Models of SVC
9. Integration of resources and smart systems in SVC
10. Sustainability aspects and parameters for SVC
11. Transportation strategies across levels
12. Construction technology and materials for SVC
13. Environmental Impact and Management Plan
14. Strategies for onsite energy generation through renewable resources
15. Beyond Zero (full proof) Public Health and Safety Management
16. Eco-System in SVC
17. Solid waste management & recycling / reuse
18. Water treatment and recycling (targeting zero discharge city)
19. Targeted / Design life cycle of SVC / Life Cycle Cost of SVC
20. Disaster management aspect and mitigation plan.

2. ADVANTAGES OF SUSTAINABLE VERTICAL CITIES

Following are some of the advantages of SVC;

1. Built environment requirements for ever increasing population are supported. Remodeling and / or redevelopment of existing cities become easier because of migration to new developments.
2. Land is spared for other purposes including agriculture, mitigating environmental challenges and maintaining eco-system.
3. Cost and Fuel / Energy consumption in vehicular transportation and urban services is significantly reduced and thus air pollution is also reduced.
4. Inhabitants live within comfortable walking distance from their workplace, recreation, study and worship.
5. City systems are to work 24x7 and hence, opportunities of employment within cities and public participation in service, administration and management are enhanced.
6. Urban metabolism may turn healthy through efficient use of energy, materials and resources, waste management and recycling. Resources are optimally used and services are better managed through automation and integrated systems.

It will be interesting to search for which kind of analysis and simulated results can be helpful in SVC; and the parameters for new design strategies in urban design (Palme, 2013).

3. DISADVANTAGES OF SUSTAINABLE VERTICAL CITIES

SVC can be fascinating and enjoyable for particular strata of society and may be difficult to afford for some (particularly economically weaker section). Certain limitations are always associated with vertical growth. Following are some of the potential disadvantages of SVC;

1. Environmental Impact is associated with such a large vertical development, particularly adverse of greater degree during construction phase and hence working out environmental management plan in line with established sustainability guidelines is a herculean task.
2. Cities are planned for generations with a growth potential and they do transform in course of time. In case of vertical development growth potential is restricted.
3. Vertical development is designed for a targeted life span. After completion of lifecycle, it has to be abandoned and chances of its reuse are not clear at this stage. Considering SVC as a No Growth City may be considered even an advantage of SVC; yet to be argued.
4. Evolution and growth of human settlements / cities is known from centuries and their further remodeling and transformation is feasible being horizontal growth. Whereas, concept of SVC is not

time tested and hazards associated with its development and maintenance cannot be predicted at present.

5. Energy and Water footprint of SVC in construction phase is envisaged much higher than development of conventional city of outwards growth model.
6. SVC may impact on microclimate of the region and may affect the natural flora and fauna of nearby areas, because significantly large surrounding area will be under wind and sun shadow by SVC.
7. Industrial zone (medium and heavy industry) is difficult to be incorporated in scheme because of associated air and noise pollution and other environmental hazards associated, and hence sustainable economy is questionable.
8. Connectivity to other such cities via air travel is not feasible in small SVC.
9. Chances of mass destruction are higher in case of natural calamities and other action generated disasters.

In planning for a sustainable future for our planet, it is vital that we achieve a seamless and benign bio-integration of all human interventions in natural environment (Yeang, 2009).

4. CHALLENGES OF SUSTAINABLE VERTICAL CITIES

Conceptualization and determining the magnitude (total covered habitable and common open built up area) of SVC and construction in itself are challenges. Cities with the growing urban mass will turn to a more resource, land, food and energy demanding consumers and they should be productive to be genuinely sustainable (Riffat, 2016).

Some of potential challenges envisaged in building SVC are being mentioned hereunder;

1. To fulfill demand of sustainable building materials, energy, water and soil from nearby areas for building SVC.
2. To create / mimic nature in sky and integrating natural ecosystem with urban ecosystem of SVC in order to provide open public spaces / gardens for visual and psychological comfort.
3. Rapid Transportation across levels for public connectivity (apart from elevators for vertical movement installed in various service cores).
4. Food Security is a formidable challenge and innovative solutions for incorporating agriculture, milk production and vertical eco farming facilities within SVC to cater to the daily needs of inhabitants is imperative.
5. Generation of onsite energy through renewable resources to cater to the demand of about 25% of annual energy consumption of SVC.
6. Connectivity and coordination of horizontal and vertical movement and services for efficient functioning.

Challenges are interrelated and should not be addressed independently. These often seem contradictory objectives; and their interrelations and contradictions need to be properly understood. Linking rapidly advancing technological scenario to the fields as diverse as climate, history, philosophy, economics, politics, culture, environment, aesthetics and pragmatics is a challenge to conceptualize SVC (Cuthbert, 2006). SVC has to manage resilient and inclusive local economy and environment which is linked to the global economy and environment.

5. CONCLUSIONS

"God created the countryside, man created the city."
– William Cowper

We have been successful in adapting ourselves in settlements; growing, refining, remodeling, transforming and designing new cities. We are also able to manage and control our environments. The concern is that there have been unpredicted consequences and we are experiencing adverse byproducts of urban sprawl. Design and execution of SVC project is still a dream and all stakeholders must ensure that it's done right. It's vital to learn as much as we can to avoid potential problems. A holistic approach is to be adopted considering human, social and environmental values, innovative technological solutions together with territorial dimensions of urban development to turn the dream of SVC to reality.

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BIOGRAPHIES

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