Title: **Toward a Better Urban Life: Integration of Cities and Tall Buildings**

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TOWARD A BETTER URBAN LIFE: INTEGRATION OF CITIES AND TALL BUILDINGS

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ABSTRACT
According to the 2006 UN-HABITAT Annual Report, about 93 percent of global urban growth will occur in Asia and Africa. The process of rapid urbanization is most prevalent where governments are already striving to improve their citizens' quality of life. The demands for rapid expansion and restructuring of cities often results in poor quality, speedy construction, and the short-term return on investments over livability and a better urban life. In this context, the goal of architects and urban planners should be to create a city that is thriving, vibrant, and healthy.

The purpose of this paper is to emphasize that the establishment of well-planned cities containing tall buildings at appropriate locations and their infrastructures will help reduce the demands placed on natural resources and create an enjoyable living environment. Integrating the city with its high-rises requires a collaborative methodology that stresses knowledge transfer and integration in the development of a holistic design. Only though the proper integration of cities and their tall buildings, the collective performance of both can be optimized, which will lead to improved air quality, resource conservation, waste reduction, lower operating costs, lesser strain on local infrastructure, and above all an improved urban life. Case studies are presented to illustrate the concepts.

KEYWORDS: Tall Buildings, Cities, Urban Livability

1. INTRODUCTION

Need for Tall Buildings

Tall building as a building type is a technological innovation of the nineteenth century as a response to the economic, industrial, and social changes. Prior to this time, tall structures have been built and have existed, such as the Great Pyramids of Egypt, Mayan temples, Gothic cathedrals, minarets, tall watch towers, etc.; however, only after the Industrial Revolution this particular building type became an icon of modernity, prosperity, and development in urban settings. Historically, diverse causes have influenced development and implementation within different contexts. For example, North American cities such as Chicago and subsequently New York were the birthplaces of commercial tall buildings due to the scarcity of land in urban centers, high land cost, economic prosperity and material innovations at the end of nineteenth and early twentieth centuries. Globalization, growing population, and rapid economic development in Asian countries during 1980s and 1990s caused this building type to become widely employed, and Hong Kong, Shanghai, Tokyo,

Kuala Lumpur, and Taipei are some of the high-rise centers. Currently, Middle Eastern countries are greatly investing in urban developments, and cities such as Dubai, Amman, Abu Dhabi and Bahrain are utilizing tall buildings for urban growth [Abu-Ghazalah, 2007].

Cities are changing all over the world. In most countries the large cities are getting larger. According to the United Nations [2002], majority of the world's population will live in urban centers by 2015. It is expected that about 60 percent of the world's population will be urban by 2030. In 2050, over 80 percent of the world population will live in urban centers when the projected world population reaches 9 billion; at this time all major cities of the world, particularly those in Asia, Africa and Latin America, will have enormous populations, probably ranging from 30 million to 50 million or even more. Figure 1 shows the timeline of population growth within the last two centuries, and projections for the next two. It is evident that during the last fifty years unprecedented population growth has occurred globally, and it is projected to continue increasing, especially in less developed countries. This will create enormous problems for accommodating a large number of people in urban settlements where they can live and work. Note that the population increased dramatically from 1950 and onward, which also corresponds to the surge of new tall buildings after the Second World War, especially in the United States which experienced an economic boom during that period.

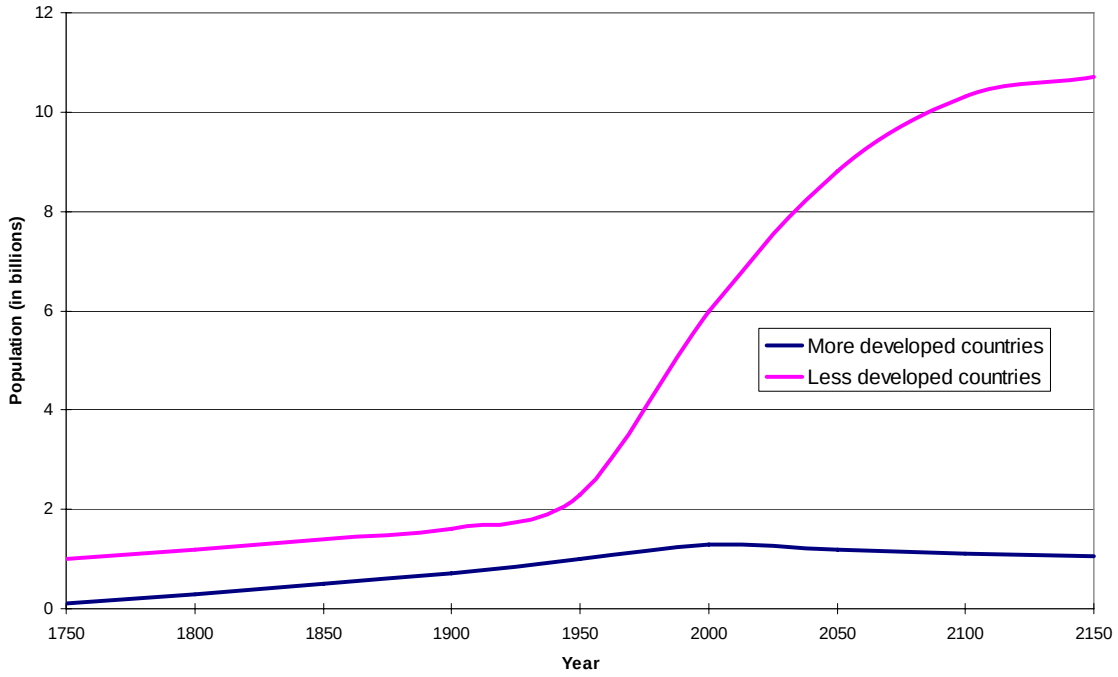

Figure 1: Timeline of global population growth and projections (Source: United Nations, 1998).

Why should tall buildings be particularly emphasized in the realm of urban architecture? Among other reasons, two are paramount. First, the exploding population, largely urban, creates an increasing demand for tall buildings. The ever increasing population and growing economies in major cities of the world mean increasing urbanization globally and the continuing rise in population density in urban areas. Arable land areas are constantly being eaten away by urban spreading through suburban developments. In countries where arable land is scarce or threatened by development, disappearing agricultural land must be protected from further development. Some municipalities have attempted to address the

problem of unrestricted outward growth and suburbanization through so-called "no-growth" policies and improvements in the public transportation infrastructure. Related to this is the fact that concentration in multi-story development helps save costs and the energy involved in transportation and urban services. The tall building can accommodate many more people on a smaller land than would be the case with low-rise building on the same land. A tall building is in effect a vertical transformation of horizontal expansion. Second, it is generally expected that there has been evident neglect of the human factors in urban design at the expense of livability and quality of life. The outward expansion of cities into the suburbs has resulted in increased travel time and energy consumption. Clustering of buildings in the form of tall buildings in densely built-up areas is generally recognized as efficient in terms of transportation and reducing the carbon footprint. Quality of life is improved by building tall that offers the opportunity for creating open spaces such as plazas, parks and other community spaces by freeing up space at the ground level. Besides the impact on the city skyline at their tops, tall buildings influence the city fabric at the level where they meet the ground. Agglomeration also reduces the per capita carbon footprint which improves the ecological environment and contributes to environmental economy. A review of high-rise literature will reveal that tall buildings generally grew as a building type out of necessity—not based on arbitrary willfulness [Beedle et al., 2007].

The exploding urban world population creates an increased demand for tall buildings in areas that are experiencing growth, which consequently poses requirement of economy in construction, increased urban services, and sensible planning. Table 1 presents population growth projection by major world areas, and it is evident that the highest growth will occur in Africa and Asia. Livability and quality of life depend on social factors, and must be considered in the overall urban development. For commercial buildings, the need for tallness is a matter of economics and agglomeration. As countries become industrialized and service-oriented, tall buildings are required to consolidate people and services in order to conduct business in urban centers. For residential buildings, intrusion on agricultural land, increase in the cost of energy, and efficiency in the delivery of urban services cause increased demand for building tall.

Table 1: Population growth by world area.

	Estimated Population in Millions			*Predicted Population in 2050 in Millions*			
Area	1950	2000	2003	Low	Medium	High	Constant
Africa	221	796	851	1516	1803	2122	3279
Asia	1398	3680	3823	4274	5222	6318	7333
Latin America and the Caribbean	167	520	543	623	768	924	1032
North America	172	316	326	391	448	512	453
Oceania	13	31	32	40	46	52	58
World	2519	6071	6301	7406	8919	10633	12754

Source: United Nations, 2002

The phenomenal increase of the number of tall buildings in the world during the last century created awareness for the importance, uniqueness, and impact of this built form on urban life. Evidently, urban areas and tall buildings are interdependent, and the connections between the two create a unique setting for evolution and development of vibrant, functional, high-quality environment for living. Integration between the two depend on many different

factors, such as economy, context, physical systems, infrastructure, transportation, environmental effects, history and culture.

Tall Buildings and Cities

Tall buildings are integrally connected with the city because they are responses to unique development conditions found within an urban environment. Too often tall buildings have been designed without considering them as part of the larger urban context and vice versa. To fully understand and appreciate the complex phenomena of both technological and socio-economic aspects of the built environment organized efforts are needed to bring together and expand upon our current knowledge of both the tall building as a building typology and the city.

Most cities just grow. Some of them had urban plans from the beginning and many had none. Zoning is now fairly common; but except for height limits, it has been a rarity to find an urban plan that considers the implications of tall buildings in an urban setting. During the last few decades, however, many city planning authorities have begun to employ the concentration of tall buildings as an integral feature of their plans for density and infrastructure utilization, as well as land use. Growth of suburbs and satellite towns is another recent development where people can live away from the central business districts. Some cities created a green belt around them to discourage further growth. Local planning authorities should identify appropriate locations for new tall buildings in the development plan documents. In addition, the following considerations should be included:

- Spatial, scale and growth requirements;
- Appropriate mix of uses;
- Public consultation;
- Historical context;
- View of the skyline;
- Streetscape and access;
- Sustainable design; and
- Vision for the future of a place.

In the nations of the developed world, urbanization most often takes the form of a centrifugal force spreading outward from the urban core. In developing countries the tendency is rather the reverse. The supposed attractions of city life and job opportunities result in a centripetal force, with crowding to the urban core. In developed nations there is a tendency for growth of cities in many different areas. In less developed nations, on the other hand, there is the tendency for one or two cities to become very large and growth is relatively unchecked unless special controls are used.

The final form and texture of an expanding city depends on a number of factors, including the choice between high- and low-rise developments. Various factors in the expansion are as follows:

- The availability of land;
- Preferential balance between public and private transport;
- Population pressures;
- Strength of planning and development regulations;
- The availability of urban services;
- Existing infrastructure; and
- Future plans.

The city is a resilient and complex organism capable of absorbing new built intensities inserted into its fabric. More compelling is the view that the city is a marketplace of ideas, a place in which the very ideas of congestion and expansion are intrinsic to its functions and its vitality. Congestion and expansion become not a barrier to its correct functioning, but an enhancement. A city of tall buildings need not be disturbing so long as congestion is kept within an acceptable limit and expansion is controlled, and this could in fact be a catalyst to enliven the city for its inhabitants [Ali and Armstrong, 1995]. Integration of tall buildings within the urban environment indicates prosperity and activity, as well as platform for future development.

2. TALL BUILDING DESIGN FACTORS

Contextual Factors

The social, political, psychological and cultural effects influence the design of tall buildings. Social and political changes such as growing population, development and transformation of information technology, communication systems and stable political governments are key elements of social and political environment of a city. Social factors influencing the design of tall buildings include users and their activities, urban density, and socio-contextual features of the site. Cultural influence plays a role in the design of tall buildings. Climate, religion, history, traditions, demography and quality of life are all factors affecting the culture of a society.

Tall buildings serve a specific function in meeting urban needs. These functions can be categorized as follows:

- Commercial;
- Residential;
- Industrial;
- Institutional;
- Public assembly;
- Special purpose; and
- Multi-use.

The largest percentage of tall buildings is used for commercial business enterprises, followed by residential function. Usually tall buildings are clustered according to the function, providing concentration of use within urban area. Multi-use tall buildings are also very prominent, where typically commercial and residential uses are mixed. Careful consideration for building type utilization must be performed, since the building form and organization depend on the function. For example, residential buildings have different organization than commercial, since the use affects massing, entrance, and overall form. Users, their traits and needs, must be investigated in the planning phase.

It is necessary to understand the complex phenomena of both technological and socio-economic aspects of the built environment in the tall building design. The tall building is a part of the urban system, and as such depends on the adjacent buildings and street space. It must be considered within the context of the city block, the street, the pedestrian, and with regard to its users and the interior spaces they occupy. The impact of the tall building on the city and its systems is often circulation congestion. Tall buildings may increase or create congestion of their surrounding movement systems (private and commercial vehicles, public

transportation, pedestrians on the sidewalk) as well as place additional load on the infrastructure and utilities.

Tall building developments can also have an impact on the urban fabric, and the historical heritage of buildings and spaces. Since tall buildings have both a physical and social impact on their urban environments, their location and design must assure that the impact not be negative. It is particularly important that they possess aesthetic quality and do not seem to physically overpower the existing environment. When properly designed, they can add important elements to the skyline and cityscape that can indeed be attractive and acceptable to the public.

Dependency on cultural factors, such as local tradition, customs, and style is an important concern for architectural design. Cultural representation is becoming evident in the recent examples of tall buildings, especially in East Asia and the Middle East. [McNeill, 2005; Beedle et al., 2007]. During the planning process, it should be ensured that tall buildings will not jeopardize local environmental quality, existing patterns of street life and subcultures, the existing townscape, and the landscape. Common planning tools are control of land use, outline of zoning plans, development controls, percentage of site coverage in form of open space ratio (OSR), height control, floor area ratio (FAR), building volume and permissible envelope, required linkages, controls of spaces between buildings, rewards for particular contributions, and other devices such as transferable floor-space ratios and sustainable design. The tall building's contextual relationships, therefore, should be the subject of paramount importance for the effective urban design plan for the locality.

Environmental Factors

Building environment, such as location, urban topology, topography, climate, wind, and seismic factors directly affect the architectural design of tall buildings and the quality of urban life. Building codes depend on the specific information about the project's location, and specify the minimum level of safety for structures. External environment affects the overall design, but internal environment, such as indoor air quality, daylight, and ventilation are also major considerations in determining the quality of life of occupants.

The local environment and its features have always been one of the most critical considerations driving the design of the built space. Design of a tall building in an urban environment requires careful selection of the site in order to define context and the open space around the building. Also, sensible consideration of the use of urban open spaces should take into account the larger urban setting on a macro scale [Zacharias et al., 2001].

Tall buildings are capable of creating a significant shadow due to their size, depending on the shape, orientation, and location. Shadows produced at greater latitudes may cover an adjacent site throughout the year. At smaller latitudes winter may be the only problematic time of the year when the sun's altitude is lowest; but the sunlight is most valuable to overcome the coolness of the atmosphere. The shape of the building should be dictated by the sun's path [Gissen, 2002].

The orientation of buildings must be studied to provide for minimum interference and to maximize views. Tall buildings can significantly block the views from adjacent buildings. Shade reduces available natural daylight. This can have a negative impact on building functions in climates that rely on daylight. Solar issues are especially important in intense climates where the summer sun makes building for shading a necessity. In temperate and cool climates planning codes can specify a required amount of sunlight [Zacharias et al., 2001]. Both the designers of tall buildings and the local authorities must assume that an adequate amount of sunlight falls on adjacent buildings and open spaces.

Wind influences the design of structural system of a tall building, as well as the shape and form. There are two principal external effects caused by wind. Turbulence, drafts, and gusts are created affecting people at street level [Aynsley, 1973; Ali and Armstrong, 1995]. Wind can also create problems for surrounding facilities. Some problems caused by wind that may affect buildings include difficulty of operation of entrance doors because of the adverse pressure differences; the ineffectiveness of hoods, screens and awnings; the adverse pressure effects on air-conditioning and ventilation intakes and exhausts; and pollution of cooling towers by corrosive exhausts from adjacent incinerator and furnace flues. Other difficulties include adverse effects on weatherproof seals of joints in materials and window frames, and wind noise. Projections and the irregularities in the façade surface can reduce wind effects from the building surfaces can reduce some of the effects.

A research study investigated the existing urban configuration and the impact on the building environmental issues. The primary topics it examined are the effects of design parameters, such as building height, urban space width, and building cluster arrangements, on airflow in typical urban settings in Abu Dhabi [Al-Sallal et al., 2001]. It focused on the impact of the selected design parameters on airflow path lines and velocity, and analyzed the result with regard to thermal comfort in outdoor urban spaces. The conclusions and recommendations of the study are:

- Variation of height between buildings has a great impact on the wind path lines and turbulence;
- Varying the width of the urban spaces within the range of 20 to 80 meters did not show much significance on affecting airflow path lines and velocity; however, when the width was made less than 30 meters, a significant wind shadow was created;
- The low-rise buildings within the urban context should face the windward direction to reduce the effect of the wind shadow;
- The staggered arrangement provides a more effective passive cooling design than the parallel arrangement because of its potential to cool the large building structures by natural convection in this climate;
- The staggered arrangement is also better than the parallel one in reducing the effect of the relatively high levels of humidity because of its potential to provide higher airflow velocity; and
- The parallel arrangement provides a better wind protection for outdoor spaces existing between windward and leeward directions.

Although there have been many technological breakthroughs for tall buildings, their architectural quality related to the improvement of urban life has not kept pace with them. There is still an alienating attitude towards form of high-rise living and working for its occupants. That mainly aims for increasing the net usable floor area to maximize the developer's financial returns on real estate investments. What is needed today to ensure a more satisfying urban life is to create environments that are connected to the city, that is, more flexible, less regimented, more diverse, with networks of parks and plazas and enclosed places within the tall building that recreate human life at the ground plane. Thus high-rise design should be aimed at urban life involving an integration of socio-economic and political-environmental and physical concerns with the architectural concerns of design [Yeang, 2002].

Socio-Economic Factors

The economics of building tall or not is very much a matter of the local condition. It can be the lowest-cost solution in a developed country in a location with other tall buildings and when the needed infrastructure and urban services are in place with adequate capacity. Tall buildings fit in well where business and organizational structures are geared to large-quantity operations, where building materials are plentiful, and where there is an adequate force of skilled and semi-skilled labor. But it could be the highest-cost solution in a situation where those factors do not exist; the negative impact of these missing resources must be carefully considered.

Tall buildings can project a sense of social power, an image of corporate economic power, and an image of governmental authority. These have been factors from the earliest times, and there is nothing inherently wrong with this unless those in permit-granting authority do not tie to this motivation the requirement that all urban needs be fulfilled at the same time. Tall buildings attract public attention and advertise the image of a city as a leading commercial center. They epitomize people's pride in their cities. They showcase the achievements of modern architecture and engineering.

Community development in residential high-rises should be the heart of the strategies for urban development. During any buildings procurement process, the social needs of the building's neighbors should be high on the agenda. Any new high-rise development provides an opportunity to offer facilities and economic benefits for the surrounding community; it can be an opportunity to employ and to train the local workers to contribute to the building's construction phase and to deliver the building's working functions after it is built. For those working in and visiting near tall buildings, there can be an advantage of a prime location by way of transport links, amenities, and opportunities for banking and athletic facilities as a result of a large number of people in a single building. A numbers of health, safety and security issues can be raised, appropriate both for occupants, visitors and neighbors. These issues must be considered by architects, planners and engineers in the planning and design phases.

In multi-use buildings, social and economic factors may merge because such buildings accommodate both types of occupancies and their activities. Providing banks, retail, recreation facilitates, etc. in the same complex facilitates interaction of people in a community. Providing large lobbies and atrium may encourage more community interaction.

The major contribution of a tall building is its significance to the volumetric dimensions of an urban space [McNeill, 2005]. A city may be developed according to a master plan which anticipates its growth. As it grows, however, the need for remodeling eventually arises for a larger or smaller part of the city. This need could be economic, social, or environmental in nature. Amin and Thrift [2002] suggest that the traditional view of the city as a territorial economic engine should be modified to a site of spatially stretched economic relations to open up a rich ecology of urban life.

The usual major pressure is the decline of the central city. In the developed countries this decline has often been the result of the suburbanization. In less developed countries it is usually the result of the incoming stream of migrants. Residential areas may need to be remodeled. Commercial centers may have decayed, especially around older transportation terminals. It is all part of the process of the recycling of a city without which urban life would not maintain itself. The four fundamentals that decide the nature and form of revitalization are as follows:

- Density of land ownership;
- Employment densities in the urban core;

- Social values in the urban core; and
- Role of public and private sectors.

Two widely different approaches have been used with varying degrees of success in the remodeling of existing cities—urban renewal and planned large-scale developments [Beedle et al., 2007]. Urban renewal consists of clearance of large areas of a city, and complete redevelopment of urban infrastructure. Planned large-scale developments are programs of major renewal of individual areas in a city that are obviously targeted for adaptation of existing infrastructure. The role of the tall building for both methods is crucial, since location, function, and site characteristics depend on services and existing conditions.

High-rise developments may also improve existing dilapidated areas of the city that often are sources of social inequalities in the form of "social brownfields". Urban regeneration is possible in such areas by inserting well-planned and well-designed high-rise buildings with a beautified surrounding landscape. This is a new trend in some American cities to attract young couples, empty nesters, and retirees to the city center where many amenities are available. In some situations social integration of different economic classes is also possible by high-rise developments and communities [Beedle et al., 2007].

3. URBAN TYPOLOGY AND TALL BUILDING DESIGN

Planning and Change

A tall building has to come to terms first with a city that is already there. For instance, it needs to resolve the issue of massing and how the scale of the new tower as a whole relates to the image of the city, to the city block, and to the neighboring structures. Specifically, it must resolve how it relates to the street, the pedestrian scale, the existing land use, and the character of the block or district where it is located. These considerations create a special set of conditions for the architect in such a way that propositions that work at the upper levels of the tall building may not be at all be effective at its ground or lower levels.

The tall building type presents an entirely new form, user, and technological problems that cannot be solved by exclusively delving into historical precedents. Although architects have turned to historical styles for tall building forms and expression, true innovations in tall building design have been the result of collaborations between architects and structural engineers, and advances in materials and technology [Ali and Armstrong, 1995].

Clearly, some form of governmental planning control of intensive developments is essential [Barnett, 1973]. The strategic plan is one mechanism to control tall building development, to direct intensification of development, and to encourage the city's overall urban design policies to be used by some city planners [Zoll, 1974]. The strategic plan defines planning policies that should govern the exercise of power. It defines the principles of environmental management, emphasizing the relationships between the city's urban activities and their integration within its support systems. More important, it specifies the practical actions needed to influence events in the city in the direction that city planners and the public want them to proceed. It fills the gaps that a two-dimensional land-use plan might have left out, by providing a set of ideas, strategies, and objectives for the future of the urban area. The strategic plan affects the city's management, accessibility, diversity, and environment, and it ensures that new developments will be compatible with the local area scale, character, and amenities.

The strategic plan can justify measures that limit the extent of development and ensure that new buildings are broadly compatible with the surrounding land use and circulation

system. A city's zoning regulations may attempt to control the following effects of tall buildings on it:

- Loss of sunlight and air by large, closely spaced towers placed right up against sidewalk property lines;
- Loss of historic buildings and districts with the rapid proliferation of new construction;
- Increased congestion on local streets and increased commuter problems;
- Tower massing; and,
- Strict sun and shadow control, in particular projected shadows over important public or private open space.

Current information technologies allow for improved planning, visualization and simulation of growth, land use, and infrastructure control. Geographic Information System (GIS) technology is effectively utilized for research, development, implementation, and monitoring of the planning efforts. Graphical interface to complex sets of data, mapping, and three-dimensional visualization offer simplified analysis of complex sets of factors [Brail and Klosterman, 2002]. Virtual cities in conjunction with GIS offer navigable environment and effective digital simulation of real cities, which give planners and designers an opportunity to visualize unbuilt spaces and interaction with the existing infrastructure [Dodge et al., 1998]. In that sense, dimension of height and footprint of a building can be used to generate three-dimensional models of the cities, which can be enriched with attribute information about thematic data.

The Internet has emerged recently and spread worldwide for the last couple of decades, and the spread was rapid due to its freedom from the physical restrictions. The formation of cyber space made it clear that this virtual space is another layer of the urban realm. Although its is not physically spatial, it has its structure in existence and as its physicality and locations lose their significance, the "cyber city" fills the spaces with corresponding elements such as communal locality instead of physical locality [Lee, 2007]. Thus cyber urbanism has distinguishing features from the conventional urbanism. Connectivity is now the defining characteristic of the twenty first century [Mitchell, 1995]. The so-called cyber city has been created more purposefully than other urban spaces and its creation is based on human needs. The simulation process in the virtual city is rendering the parallel existences of the physical and cyber spaces more and more near and connected.

Urban Services

The tall building is a dominant physical factor in the growth of cities. McNeill [2005] states:

> The materiality of the skyscraper--its height, form, massing, footplate, infrastructure and neighbourhood--endows it with a special place within urban territories. Socially, it opens up numerous questions about the nature of transnational knowledge flows, and how barely visible material transactions are housed. Collectively perceived as a skyline, it is able to horizontally define cities in a convenient representational frame, exploited by film-makers, politicians and architects alike. Its sheer verticality raises questions about urban futures, and the art and work of living high, but also demands an attention to roots and the invisible cities of service areas and underground transport.

It is evident that the decision to build tall is not necessarily a straightforward proposition. In the urban core where there is greater density and design choices are more constrained, there may be fewer options. Where no tall buildings exist at all, great care must be exercised before making such a decision. The major factors that directly influence decision-making process are civic infrastructure and services.

The infrastructure of a city that provides the urban services has a great impact on the growth of tall buildings—particularly new developments. The urban services comprise water supply, power and waste disposal under the technological umbrella; health, welfare, recreation and education under the social category and fire protection, crime prevention, and food services under the functional category. Another very important civic infrastructure consists of transportation. The major factors determining what urban growth patterns might be are as follows [Beedle et al., 2007]:

- Resource distribution patterns;
- Transportation and communication developments;
- Historical mold and cultural heritage;
- Level of national development;
- Development policies and strategies; and
- Urbanization.

The ability of a city or community to support and sustain its current population and anticipated growth is directly related to its infrastructure of transportation (streets, roads, and public transport systems), utilities (water, gas, electric, sewage), and services (garbage, waste removal, maintenance). If the infrastructure is too small it cannot sustain added burden as the city grows in area and population. On the other hand, if it is too large then it is too costly to maintain relative to the populace or geographic area that it serves. Good planning involves predicting and coordinating urban growth with its infrastructure system so that they can grow incrementally together over time.

The impact of the tall building on the city and its systems is often circulation congestion. Tall buildings may increase or create congestion of their surrounding movement systems (private and commercial vehicles, public transportation, pedestrians on the sidewalk), as well as place additional load on the city's infrastructure and utilities. Tall building development and the city's transportation requirements are interrelated. The city's land-use plan and its transportation plan must be interlinked. Since tall buildings can create a dramatic impact on roads and other public infrastructure, changes must be properly anticipated and accommodated, or the result will be the deterioration of the city's transportation systems and other services.

The tall building's development will also have an impact on the capacity of the city's public utilities and services, such as its telephone lines and exchanges, water supply and recirculation system, refuse collection and disposal, electrical supply and load shedding, sanitary system and discharge, and its postal services. Theoretically there are thresholds for each of these, beyond which these systems will not function effectively unless expanded.

If provision is not made with the foreseeable future in mind for the large amounts of traffic generated by tall buildings, the existing system will quickly be overtaxed and subsequent high municipal costs will result as the city attempts to solve the problems thus created. On the other hand, since tall buildings create concentrations of people, their concomitant development with an urban transportation system that is sustainable can produce significant economies both for the developer and the city.

Integration Factors for Tall Buildings and Cities

Tall building as a building type is a viable solution for land scarcity and increasing population density. However, as stated before, it also poses increased demand for urban services and infrastructure, so careful consideration of positive and negative consequences should be addressed. The complexity of the factors is shown in Figure 2, where urban factors, such as economy, environment, climate, infrastructure, population, and governmental and political decisions regarding the location, size, function, structural system type, building systems, and type of envelope are demonstrated. The interrelationship of these factors is not regimented and could be intricate.

Presence of tall buildings within urban environment is the dominant physical characteristic of the integration. Skylines are urban signatures and determine urban identity. Radical transformations of the urban skyline through time have altered the identity and hierarchy of urban skylines from power invested in religious institutions to secular ones. The modern city has inverted the hierarchy of past symbols and reconstituted their meanings in tall buildings reflecting the dominance of private enterprise and its global aspirations. In some cities a single feature can dominate the skyline and encapsulate the city as whole.

A number of design criteria can be isolated that determine the physical character of the urban skyline including height, shape, and approach [Kostof, 1991]. Evans et al. [1982] developed a model of landmark form and urban recognition in order to understand how people perceive buildings and cities. Following building characteristics are significant in constructing a skyline:

- *Movement:* The number of persons and other objects moving in and around the building;
- *Contour:* The clarity of the building contour, ranging from blurred, partially obscured to free-standing;
- *Shape:* The complexity of the shape, ranging from simple block shape to more complex multiple shapes;
- *Use intensity:* The extent of building use, from limited use by a small segment of the population to daily use by large numbers of people;
- *Use singularity:* The uniqueness of building function, ranging from only one function to many building with shared functions;
- *Significance:* The extent of cultural, political, aesthetic, or historical importance of the building; and
- *Quality:* The amount of physical maintenance, the upkeep of the structure.

Stamps et al. [2005] developed a methodology for pre-construction validation of urban design guidelines, mainly dealing with the features of skylines. The methodology tests skylines for three prominent factors—overall skyline shape, number of turns in the skylines, and the level of variance in building height, width, depth, and setback. The shape defines whether the skyline is convex, concave or flat. Level of variance in building attributes has the strongest effect on the perceived qualities of a skyline, and the complex skylines are more preferred. It suggests that for planning purposes, these building attributes should be the driving forces for the creation of a city's skyline.

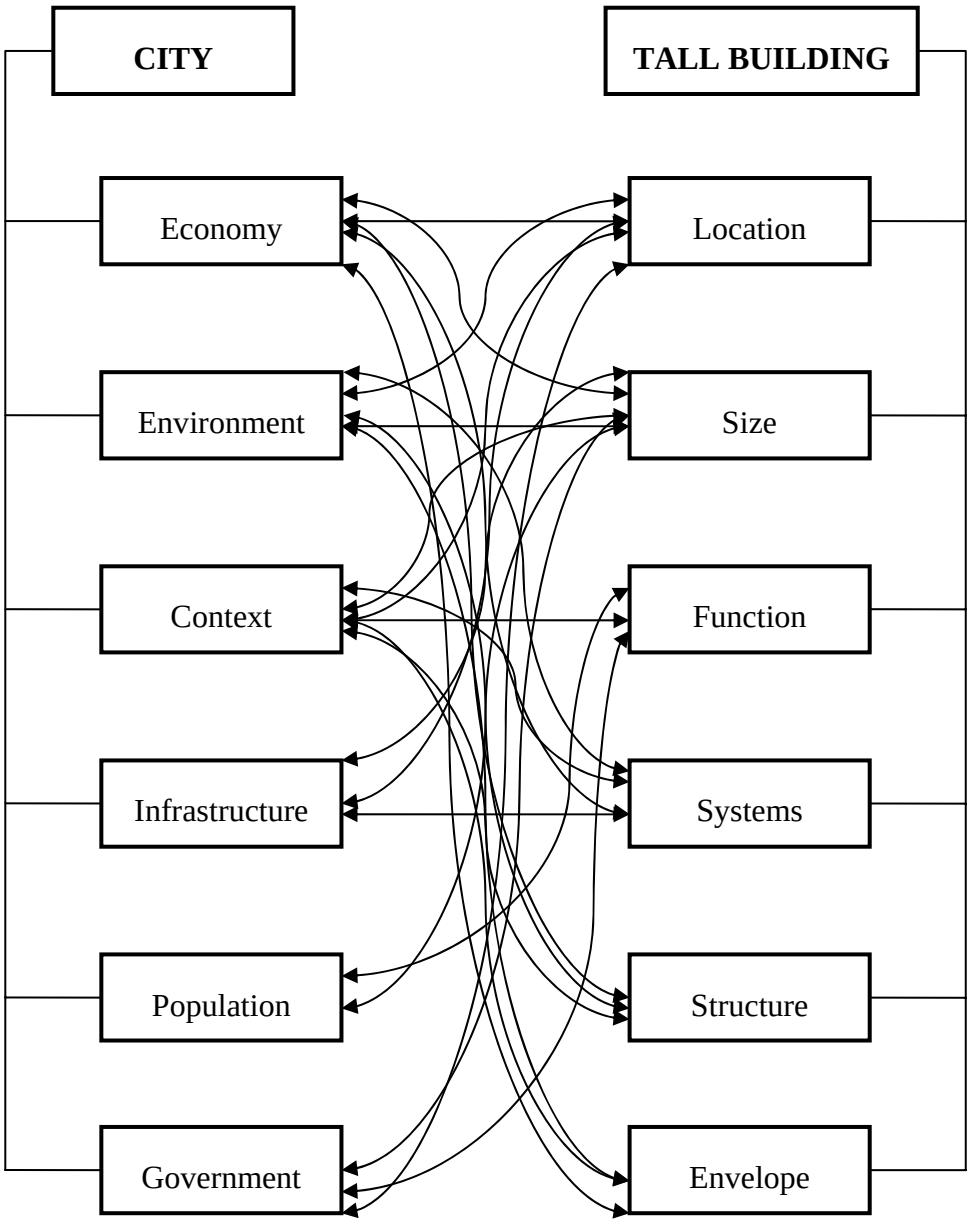

Figure 2: Integration factors for tall buildings and cities.

Urban living condition is directly related to social services like security, health care, recreation, education, and fire safety. They are factors that are of major significance in the viability of a city and may vary from region to region. A city's inhabitants are impacted by all these issues. Therefore, while designing tall buildings these social services in their context must be duly considered. In establishing design standards, public health and safety are of basic importance, as well as two other major factors which are water supply and sewerage. When these standards are appropriately accounted for during the design process, the urban life is dramatically improved.

4. CASE STUDIES

Four case studies are discussed to illustrate the differences in need, context, reciprocity and equivalence in the development of tall buildings and cities. Both reciprocity and equivalence define the interdependence of tall buildings and cities to generate a harmonious balance between them which results in better urban life. Previously presented design factors, integration of tall buildings and urban habitat, and relationships between the two are treated distinctly in each case. Chicago, Jakarta, Dubai and Song Do City are chosen to convey the diverse perspectives and requirements of cities and their vertical architecture.

Chicago: Birthplace of Tall Buildings

Chicago is the birthplace of tall buildings. Located strategically on the Great Lakes, the city begun as an important transportation connector between the eastern and western United States. During the nineteenth and twentieth centuries, connection between the Great Lakes and Mississippi River made Chicago a prominent economical center for manufacturing, trade and retail. During the nineteenth century Chicago expanded immensely, with population growing from 30,000 to 1 million by 1890 [Gibson, 1998]. Today, the City of Chicago has close to 3 million inhabitants, with metro area of about 9 million [US Census Bureau, 2006].

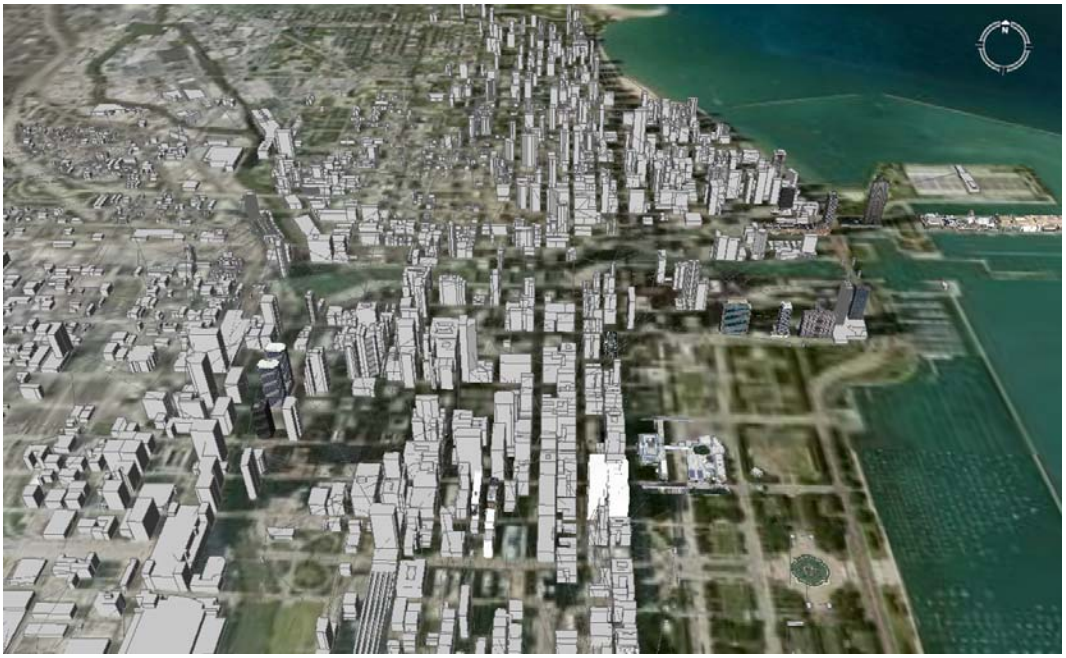

Figure 3: Concentration of tall buildings in Chicago urban core (Source: Google Earth).

Initial plan for Chicago was created by James Thompson in 1830, which was organized into rectangular blocks and uniform streets. Majority of the buildings were constructed by light wood framing, thus the results of Great Chicago Fire of 1871 were devastating. The fire destroyed a third of the city, including the entire business district. The redevelopment efforts requested increased fire protection and safety, as well as improved construction methods. Material innovations and technological advancements, such as elevator and steel framing allowed for the development of tall building as a reaction to the soaring land prices in Chicago. The first steel framed building was Home Insurance Building of 1885 designed by William Le Baron Jenney, which initiated the construction of steel-framed buildings.

Tall buildings have advanced greatly since the earliest efforts, and Chicago has been one of the major focal points, as seen in Figure 3. Today, it is one of the leading cities for sustainable urban growth. Revitalization, infrastructure improvements, and development are evident as the quality of urban life is constantly improving. Two supertall buildings under construction now are the Trump International Hotel and Tower and the Chicago Spire.

Jakarta: Megacity in Developing Country

Jakarta is one of the largest cities in the world, having population of more than 20 million. It is located in island-country Indonesia, thus land scarcity is the major issue that limits the development. It is an example of developing city that struggles with overpopulation, inadequate housing, employment, transportation and environmental quality [Cybriwsky and Ford, 2001]. The post-colonial period for Jakarta initiated massive development efforts, undertaken by various agents, such as governmental institutions, large and small private companies at local, regional, national, and global level.

Figure 4: Dispersed locations of tall buildings in Jakarta and relationship to low-rise (Source: Google Earth).

Tall buildings have been widely used for commercial and residential functions in Jakarta to address the issues of land scarcity and enormous population, as seen in Figure 4. The investments consisted of combinatory funds, where the local government, private firms, and often foreign funds were used. The transfer of knowledge was evident in the stylistic expressions of forms, where modern, postmodern, regional and traditional characteristics have been used.

Three economic sectors are rapidly developing in Jakarta—manufacturing, which is mostly located in the periphery; finance, which is located in the urban core; and property, including large-scale housing and new town development projects in the outskirts, and offices, hotels, residential tall buildings and retail in the center. The development efforts have been "highly supported by the existing infrastructures, including the international airport, seaports, telecommunication, electricity, water supply, local transportation, and social amenities"

[Firman, 1998]. The development of large-scale housing projects and new towns in the periphery has intensified the interaction with the urban core, since the new developments are socio-economically dependent on the center. This has increased transportation problems and congestion.

Dubai: International Commercial Center

Dubai is located on the Persian Gulf and is one of the fastest growing cities in the word [Al Marashi and Bhinder, 2008]. Over the last thirty five years it has transformed from a traditional to modern economy due to the oil industry. Especially during the last ten years, rising prices of oil have resulted in immense influx of commercial activity in this region, resulting in unprecedented growth and expansion. Davids et al. [2008] state:

> A casual observer in Dubai would say that this was simply a shallow display of wealth fuelled by selling oil. However, living and working in Dubai we discover a more startling reality, that it is an act of Nation Building. For a nation being born, these built forms can be as important as grains of sand to an oyster. They provide a sense of place where such a sense did not exist, and something to share where a wider sense of community has no roots.

Evidently, development of Dubai as a major commercial center required the identity of this urban environment to represent prosperity, prominence, wealth, and globalization. In this context, urban development is a major concern for policy makers, planners, public officials, and environmental advocates [Al Marashi and Bhinder, 2008]. Tall buildings are dominant element in Dubai today, as seen in Figure 5. Combination of factors, such as rapid development, economical growth, low construction cost, and globalization, has caused this particular type to be widely adopted. Mixed use towers are mostly developed, providing commercial, office, hotel and residential functions.

Figure 5: Tall buildings in Dubai and current developments (Credit: Paul Armstrong).

Some people have observed that the City of Dubai is buildings supertall buildings (such as Burj Dubai) and planning other mega-projects (such as the Waterfront City) too rapidly without adequate consideration to the infrastructure to its future sustainability. The consequences, however, remain to be seen.

A reference may be made for the cities near Dubai. Abu Dhabi and Bahrain are to a lesser extent following Dubai's lead. We will witness more tall buildings in these cities. The city of Amman has pursued distinctive development that demonstrated both the interactions of global market forces and local conditions. The global and geopolitical force stems from the competitive environment that pushes the city towards being an attractive venue for foreign investment in conjunction with reducing restrictions for free enterprise [Abu-Ghazalah, 2008]. Such attitudes are reflected in the proposed strategic plan for Greater Amman City 2007-2025.

New Songdo City: Sustainable City

New Songdo City is located in Incheon around sixty kilometers from Seoul. It is a new, master planned development designed and planned as an international business district on reclaimed land. It is currently under construction, and will be connected to Incheon International Airport. It has been designed for 75,000 residents and 300,000 commuters. Being the first international real estate development in South Korea's history, it is poised to help South Korea at becoming the commercial epicenter of North Asian regional markets, among China, Japan, and Russia.

Figure 6: Tall buildings and open space in Song Do City
(Credits: Gale International/KPF Associates PC).

Prior to the development of Songdo City, Korean government initiated a plan to develop International Free Economic Zone (IFEZ) that links Northeast Asia to global economies. Convenience and accessibility in transportation were the key elements for site

location. The plan for the city includes commercial, residential, mixed and green space, as seen in Figure 6. The city includes forty percent of open green space, where about one half of that area is located in the center, and the other on the outskirts.

The master plan promotes technology, sustainability and internationally-designed buildings. The quality of life has been the central factor in the design. Whitman et al. [2008] state:

> In a region dominated by a boom of large scale urban growth and a new order of magnitude of pollution and congestion issues, the need to accommodate the trend towards urbanization in a more sustainable fashion is increasingly paramount. Adapting sustainability onto existing urban landscapes can be extremely challenging, which is why the opportunity to create a new city from the ground up represents such a significant opportunity.

The major factors influencing Songdo City development are sustainable development practices, integration of urban planning, infrastructure engineering, and architecture. Long-term sustainability is considered to be future-oriented design, where systems should be adaptable to changing needs, such as site planning, energy, waste and the impact on larger environment. Social aspects are also important, since the effort is to design transit-oriented development that creates social vibrancy and connectivity, embraces culture, and creates economic creativity.

The planning of the city is well thought out. It encompasses a variety of densities, ample green space, streetscapes with character and rhythm, sustainable transportation and adequate infrastructure. The neighborhoods of the city extend out from both sides of the city center. Mixed-use projects and lower scale commercial development buffer the outlying residential neighborhoods. The transition of land use from high-rise commercial to mid-rise residential/commercial to low-rise residential/amenity is designed to create a vibrant urban environment and an enjoyable urban life.

5. CONCLUDING REMARKS

Well planned cities contain tall buildings at appropriate locations, since this particular building type reduces the demand placed on natural resources. Integration of cities and tall buildings is a crucial factor for cities that are experiencing population increase, land scarcity, and even economic prosperity. The performance of both tall buildings and cities can be enhanced by appropriate measures, such as resource conservation, waste reduction, and infrastructure planning. Improved urban life depends on a city in balance based on the holistic design methodology, where the following factors should be considered:

- Reasons for building tall;
- The availability of land;
- Socio-economic factors;
- Environmental factors;
- Contextual aspects;
- Population growth;
- Cultural and social context;
- Urban character and skyline; and
- Historic character and heritage.

In terms of planning, following considerations should be addressed:

- Strength of planning and development regulations;
- The availability of urban services;
- Upkeep and expansion of existing infrastructure;
- Sun and shadow control;
- Resource distribution patterns;
- Transportation and communication developments;
- Levels of local and national development;
- Development policies and strategies; and
- Future projections.

Tall buildings have a major role to play in a city. They must cater to a city's needs and respond to the context. Both tall buildings and cities should demonstrate reciprocity in which they mutually benefit each other and equivalence in which one of them does not outpace the growth of the other. Tall buildings are essentially a vertical progression of a city. The combination of urban environment and tall buildings is an interdependent relationship as each helps define the other. Integration of tall buildings and cities is the key to a better urban life.

Tall buildings give cities an identity, while cities determine how a tall building will be viable and be constructed giving it a meaning. As a land-use strategy, tall buildings maximize building area with a minimum physical footprint. Extreme compactness drives environmental economy. When developments expand vertically, public space, agricultural lands, and wilderness remain untouched. Commercial and residential towers free the ground plane for the development of ample green space within density that supports connectivity and social vibrancy. For a city to be sustainable, it must consider how it will grow and develop planning guidelines for the efficient utilization of its land mass. Cities cannot afford to grow horizontally without jeopardizing agriculture and other industries that support the inhabitants. This is particularly true in developing countries where megacities are already placing greater pressure on existing land, water, economic, and environmental resources. What is needed now are new ways of integrating city design with the process of economic and social change [Barnett, 1986].

A sense of well-being in tall buildings is associated with the availability of ample daylight, connection with outside environment and the view. The ability to control the immediate environment improves overall satisfaction of occupants. For high-rise buildings in particular, transportation, safety, and feeling of being part of the natural environment on the ground are keys to an enjoyable and satisfying urban life.

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