Sustainable urban designs for Asian cities: economic reality and technological choices

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Sustainable urban designs – a realistic resource base

The object of this paper is to generate design approaches that respect a realistic mix of foreign and local resources for sustainable urban design and construction in high-density Asian cities. In order to evaluate this goal at the level of projects, this paper argues that urban designers have to consider within an interdisciplinary frame, technological choices, their environmental implications as well as the foreign resource content of projects.

The general goals and specific objectives of sustainability are embodied in Agenda 21, the United Nations action strategy for sustainable development. In practice, the central goal is to achieve economic goals and social equity without environmental degradation (OECD 2000). The potential conflict is even more serious in the developing countries (DCs).

Researchers on sustainable designs have failed to state explicitly that in the context of developing urban territories, the foreign resource content of projects should match the nation's ability to repay debts incurred in their implementation. For example, ecological modernisation in its present form largely focuses on environmental problems of the affluent Northern hemisphere (Blowers and Pain 1999). Sustainability in economic terms should include a nation's ability to repay foreign loans secured for urban project financing.

Choice of technology for project is central to understanding resource implications. Urban designers have influence over two interrelated areas in particular which impact critically upon technological choices and resource implications: (i) spatial arrangements and infrastructure provisions; and (ii) resources embodied in detailed designs or used in construction of the infrastructure and built forms. In practice, any discussion of choices, e.g., for infrastructure projects, embraces both areas (i) and (ii) above, Kibert *et al* (2000) argue that for a fundamental shift from a non-renewable basis to a renewable system in the way materials are designed, first, buildings have to be constructed so that components can be decoupled and recycled; second, use of renewable energy sources should be increased.

This analysis is concerned about the level of foreign exchange used up for building new projects in particular. Foreign exchange is vital to purchase all foreign resources- energy, finished materials, raw materials for local manufacture, etc. Foreign exchange is in limited supply in all the DCs. This paper uses the terms foreign resource content (in projects) and foreign exchange content interchangeably. The paper hypothesizes that pursuing sustainability goals in the DCs concurrently from the dual angles of preserving natural resources (Kibert *et al* 2000) and conserving foreign exchange reserves, is likely to produce design guidelines that are compatible with the goals set out earlier.

Ganesan (2000a, pp. 6-21) discusses the applications of optimization models to demonstrate that designers in DCs will have to use a mix of foreign and local resources, so as to maximize *total* volume of construction. This state of maximization represents a unique technology appropriate for the pattern of resources available to the whole industry. Subject to satisfying this unique condition, strategies for individual projects may be flexible in terms of the scale of projects, the mix of local and foreign materials and services employed on the project, the method of execution, as well as the share of local and foreign capital used in financing the project. Inappropriate technologies transferred into DCs end up absorbing too much of limited resources available, e.g., foreign exchange reserves and invariably limit the growth of the total industry (Ganesan 1979; Abbott 1985, p.19). Ideally, projects funded mainly from foreign resources should normally generate a part of the revenues in foreign currencies, in order to service foreign liabilities. Otherwise governments have to guarantee debt servicing, drawing from other sources of foreign currency income.

Technological choices for urban design

For individual projects, three approaches are available. The first option is to adopt large scale technologically efficient solutions, such as a large water purification plant and water distribution network, or a pipe borne sewage treatment and disposal system, or large capacity incineration plants for waste disposal and recycling. The technology is being constantly refined. The second approach embraces technologically advanced projects of small to medium scale, where the inputs and outcomes are designed to be harmonious with nature. The Public Works and Government Services Canada (PWGSC 2000) lists 90 "environmentally-appropriate" practices in this category, related to water conservation, waste management, recycled materials, indoor air quality, etc, applicable to commercial building and multi-unit residential buildings.

There is little evidence that these solutions are affordable in developing countries, in terms of either the total cost in local currencies, or the foreign exchange content involved. For example, indoor air biofilters, flyash concrete, building-integrated photovoltaics, cogeneration, reinforced grass paving systems are technologies that embody concepts apparently attractive to developing countries, however, their applications turn out to be costly and problematic(PWGSC 2000; Ganesan 2000a). There are some exceptions. Solar heating panels, e.g., could be adopted on a large scale with considerable benefits.

Solutions developed by advocates of cheaper technologies for development, such as the Intermediate Technology Development Group, London, constitute the third category. The technology adopted is either an innovation based on traditional technologies, or advanced technical solutions available on a small scale; the products are thought to be affordable and require limited foreign exchange. Improved septic tanks for sewage treatment or soil cement building blocks are two examples. High-density urban settlements require large scale integrated services. The first two approaches outlined above demand large expenditures in foreign currencies, and there are physical constraints in adopting many solutions proposed under the third approach.

Lessons from the 1997 Asian Crisis

The 1997 Asian economic crisis was a crisis in allocation of resources and provides empirical evidence to substantiate the preceding arguments. Ganesan (2000a, pp.30-70) reviews the available evidence in considerable detail. Too much foreign debt was incurred and used on domestic projects that failed to generate adequate foreign currency revenues required for repayments. Many of these were construction and real estate projects in large urban locations such as Manila, Bangkok, Jakarta and Seoul in South Korea. The foreign exchange content in many urban ventures such as high rise office and commercial buildings, hotels, and luxury residential blocks reached up to 75% of total project cost; foreign liability was built up largely through commercial loans for project investments, and expenditures incurred through imports of finished materials and equipment, and imported raw materials and energy for domestic building materials production. The revenues in foreign currency earned in many cases were well below the investment level. Apart from increasing foreign debts, these projects also drained away valuable foreign exchange reserves in these countries, leading directly to a loss of confidence in local currencies, collapse of the exchange rates, a foreign exchange crisis and economic shrinkage. Measured in US$ terms, the above cities suffered close to 50% reduction in the volume of urban design and construction activities in the years that followed the crisis. The hypothesis that a developing country can borrow for and in general maximize foreign investment in urban projects stands thoroughly discredited after the 1997 Asian Crisis (Ganesan 2000a). In any event, borrowing excessively and passing the burden of repayment to future generations conflicts with the fundamental concept of sustainability.

What designers need to do in Asia?

Typically, the most important goals facing urban designers in high density urban areas are to achieve a more balanced land use and built form in the high density districts, increase volume of infrastructure and housing construction, provide more efficient transport and reduce traffic congestion, reduce pollution of air, water and land, promote recycling of waste, build more energy efficient spaces and seek greater harmony with the ecosystem. Take Hong Kong as an example. Designers' ability to respond to these challenges is being hampered by three difficulties in Hong Kong. High population densities (up to 3000 persons per hectare), limited supply of buildable land, and a high consumption model dictated by a per capita income close to US$25000 (Ganesan 2000b). Hong Kong has reaped massive economic benefits of concentrating highly skilled people within a relatively small area, while generating huge agglomeration benefits. In consequence, Hong Kong is clearly able to afford advanced technological solutions without any foreign resource constraint, and designers can look upon any constraint as an opportunity for innovative solutions, such as, for example, the "mega city model"(Hyper Building Research Committee 1997).

Practically all major cities in Asia (including China and India) experience the serious problems of Hong Kong in varying degrees, however, without being endowed with comparable levels of financial resources, for example, Chongqing in China (Chongqing Urban Environment Project 2000). The per capita income in these cities is low in the range US$ 500-3000. Poor environmental quality in these cities has recently emerged as a serious deterrent to overseas investors. Sustainable urban design guidelines should be sensitive to these constraints.

Design guidelines for residential and non-residential buildings

In theory, *essential* foreign technologies, material and equipment resources will have to be mixed with a mass of capital saving and labor intensive activities to achieve high volume construction targets. In practice, this means large scale training of skilled workers and managerial workers, expansion of domestic capacities for manufacturing of building materials, increased use of local raw materials in such units emerge as the more important strategies from research using optimization models (Ganesan 2000a). Many developing countries are attempting to adopt such approaches, but have had only limited success in minimizing the foreign exchange content in housing designs, because of rising costs of oil and essential materials. Modern (international style) buildings such as luxury hotels and office blocks continue to use a high volume imported materials and equipment. The foreign exchange content in such projects can be reduced to less than half the total cost if design and construction are undertaken by joint ventures of foreign and local firms(Ganesan 2000a).

Infrastructure and Environmental Construction

Most countries possess technologies to deal with basic infrastructure needs such as highways, water supply, sewage disposal etc, The insurmountable challenge at present is posed by demands arising from the poor environment, such as recycling and waste minimization, pollution control, controlling energy use and dissipation, cleaner transport systems, etc. Imported technologies that promise a solution appear to use too much foreign resources and are in the medium to long term simply unsustainable. A total solution to these problems calls for a national multi-sectoral effort. However, urban design itself has some contribution to make. *First*, urban designers from their perspective have to propose spatial solutions that prevent or minimize the occurrence of these environmental problems. *Second*, they have to advance solutions that optimize the use of foreign resources and bring about a sustainable resource base in urban construction and without leading the countries towards another Asian Crisis. Designers have to adopt a sustainable mix of technologies (selected from the three categories discussed above). This paper advances below some practical measures based on the above approach, for adoption during large-scale urban design and renewal.

Transport infrastructure and mobility costs

Urban designers in Asia should consider implications of land use transport interactions in greater detail than in the past. Especially with regard to air quality.

Applying principles of sustainability to transportation will reduce pollution generated by gasoline-powered engines, noise, traffic congestion, land devaluation, urban sprawl, economic segregation, and lead to lower transport costs for the commuters (Commission on San Francisco 1997). Specifically, less reliance on automobiles and improved facilities for pedestrians and bicyclists are advocated (Huyink 1995; the Department of the Environment 1996; Crawford 2000.). This approach may work well in small to medium sized cities. Transport planning in any form becomes almost unmanageable in high density locations, with rising employment and incomes. Conversion of public vehicles to cleaner fuels (e.g. natural gas) will contribute to atmospheric decontamination (Ganesan, 2000b; ICLEI and others 1999). It is essential that current subsidies to gasoline, driving and parking of automobiles be redirected to public transit and other alternative modes.

Energy efficiency

Major sources of energy consumption in Asia are heating and cooling costs of commercial buildings, and secondly, energy costs of transportation. Excessive solid and liquid wastage that remains without being recycled also represents a major dissipation of energy (Ganesan 2000b). Energy efficiency assessments should include energy dissipated in pollution and wastage. Many cities in Asia face a chronic shortage of energy to support increasing urban productivity in general; so much so, nearly 12% of household income is spent on energy (UNEP 2000). In 1997, the commercial users in Hong Kong took up 59% of total electricity consumption for space heating and cooling. In general, energy consumed in buildings depends on the building configuration and orientation, and on the efficiency of building envelope and services. Architects are engaging more energy efficient HAVD systems in modern buildings in Asia. Combined radiant heating and cooling systems, typically using heated or chilled water, are being investigated for use in commercial buildings without excessive heat gains. At the same time, urban designers ought to exploit the potential of the sun, wind and landscaping to minimize heating, lighting and cooling costs. Designs should use winds to reduce adverse micro--climatic changes and release air trapped in densely built locations due to the canyon effect of tall buildings (PWGSC 2000).

Air quality

Urban design should aim for lower levels of pollution especially for the residential locations. There are several approaches to achieve this: reduce traffic flow that depend on petroleum products; increase cleaner forms of transport such as electrically operated mass transit systems; and separate residential districts as far from heavy traffic as possible. Planning guidelines should provide a healthy balance between open spaces, trunk roads and housing allocations, such as to improve air quality in housing estates.

Poor quality of air outside contributes to lowering indoor air quality. Displacement ventilation methods, using 100% outdoor air, can help to remove pollutants indoor, where the outside air quality is of acceptable standard (PWGSC 2000). Operable windows instead of fixed windows can improve space conditions inside buildings at slightly higher costs. Outdoor air quality can be improved through transportation demand management, land use planning and urban design (ICLEI and others 1999). Small communities in mixed-use surroundings need to be identified, and protected from exposure to traffic and pollution. This should be a goal of urban design.

Water conservation.

Domestic water consumption accounts for the major share of water demand in urban areas. Chronic shortages of water on tap especially in low income urban location and poor quality of drinking water are the main problems in most Asian cities. These cities are already suspected to be using more than their annual freshwater renewal rate on account of demands from non-renewable resources. Pumping of ground water for drinking purposes has limits due to intrusion of saltwater (UNEP 2000).

In general terms, however, conservation and recycling of water should help to maintain a balance between the water needs of the entire ecosystem and the huge demand for pipe borne water supply in urban locations. Conservation thorough low-level flush toilets and metering of supplies are already being adopted (ICLEI and others 1999).

The recycling of grey (waste) water can increases overall water supply capacities. As grey water can be recycled many times for different purposes, incorporation of advance technology for this purpose could be comparable in cost to developing fresh water supply schemes. The actual difference in costs in a particular city depends on the intended use of the recycled water such as bathing, cooking, cleaning or drinking, as well as on construction and equipments costs. In theory, demand for new water can be eliminated through repeated recycling, but the cost of this technology in less developed urban areas is likely to be more, in comparison to a large number of small scale small scale ground water pumping outlets that now serve many residential schemes.

Planning and implementing integrated wastewater collection and treatment systems is one of the major environmental expenditures looming. Many cities have been constructing sewers, but few are equipped with treatment facilities. Storm water discharge system has to be considered when planning urban sewage system (UNEP 2000). Economics of recycling will be greatly facilitated by proper storm water management (Commission on San Francisco's Environment, 1997). With the rapid increases in population in Asian cities, these are real needs, demanding heavy use of foreign resources.

Waste management and recycling

Disposing solid waste in open dumpsite or as landfill are the dominant means of disposal in Asia. The introduction of sanitary landfill is an urgent priority everywhere in the developing world (UNEP 2000). Even where complementary disposal technologies such as composting or incineration (waste to energy plants) are practiced, a landfill is still required and is the backbone of any sustainable disposal system. This is not only a colossal waste of often-irreplaceable resources, but also occupies valuable development land in urban areas (Ganesan 1999b). The fundamental approaches to reducing waste are 1) to reduce waste generation, 2) to promote recycling, and the purchase and use of goods from recovered materials. Recycling and reuse are significantly more labour-intensive than garbage hauling, and create a new source of jobs in collection, processing, and repair or manufacturing (Commission on

San Francisco's Environment 1997). Effective waste management will also lead to measurable reductions in the massive ecological footprints generated by cities such as Hong Kong. Urban design should allocate space for waste collection, incorporate tools for segregation of waste as desired and recycling centers uniformly.

Strategies to conserve water and energy can also lead to public, residential and industrial waste prevention.

Construction waste

Construction waste is an unusually serious problem in Asian cities with high volumes of urban construction and renewal programmes. Based on the Law for Recycling of Construction Waste, Japan's contractors are obliged to segregate at the sites demolition and construction waste for recycling. The Government also promotes the use of recycled materials and the design of high durability housing systems in public projects (Ando 2000). Urban designers in Asia should provide for taller buildings, using more durable materials and incorporating flexible partitions and high-tech features that are likely to prolong the economic life of buildings. Increased manufacture of components off-site minimises waste during erection of structures.

Conclusion

Notwithstanding the numerous difficulties discussed above, a high density compact environment that minimises wastage and pollution may be an ideal form for Asian cities. Design strategies that seek harmony with nature, and at the same time optimise on foreign exchange use, are complementary to one another. Such designs will in effect prevent the build up of pollution and wastage, and excessive dissipation of energy as seen today. A mix of technological solutions will be needed. Available foreign resources should be diverted to critical infrastructure and environmental projects, where local technologies are yet unable to satisfy the need. Substantial project economies can be achieved by employing joint ventures of foreign and local firms for design and construction of such projects. Non-critical projects should be executed using largely local resources. The classification of projects in a city under these two categories should be determined through research.

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