Towards Sustainable Housing Construction in Southeast Asia

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1. Introduction

Figure 1: A traditional house in Malaysia

Traditional houses (Figure 1) in Southeast Asia are typically constructed using prefabricated of ready-made housing components. This construction technique is feasible due mainly to the geography and climate of the region, namely proximity to the sea and high annual rainfall, and has been passed down through generations by the local people. However, a shift of socio-economic pattern from traditional agriculture to monetary-based agriculture and later to manufacturing industry has changed the Southeast Asian planning pattern and construction system as the adopted planning laws, building codes and regulations borrowed from the West have forbidden housing development based on traditional concepts, because the regulations promote heavy weight construction using bricks and reinforced concrete as the main materials. This causes an increase in the incidence of flood-prone areas and land erosions, due to the large number of land clearings and reclamations for housing and commercial industry, as well as the construction of highways. These issues are often raised today as problems of uncontrolled development of urban growth as concern for the environment is not considered. New technology has it possible to apply traditional construction techniques to urban housing, and further studies are important to ensure its potential for future uses. This change could promote the potential of using the traditional system as an alternative construction system towards sustainable urban development in Southeast Asia.

2. Geography

More than eighty-five per cent of Southeast Asia covers the area between10^{o} N and 10^{o} S. Southeast Asia can be regarded as a region of tropical islands because most of the lands is surrounded by ocean with an average distance of less than 200 kilometres (125 miles) from the sea. A quarter of the region is land while the rest is ocean.[1] Nearly half of the total area in the form of peninsulas and extended subcontinents is part of mainland Asia, whereas the remaining area consists of thousands of islands.[2] Cole said, "Of the total area of 4.5 million square kilometres (1.74 million square miles), 2.4 million square kilometres (0.93 million square miles) is in the island countries of Indonesia and the Philippines, together with Eastern Malaysia (Sabah and Sarawak), while the remainder is on mainland Asia."[3] Because of its geographical conditions, there are very few geographical and climatic variations from one Southeast Asian country to another.

Due to these geographical factors, types of major forest in this region are wetlands along coastal areas and lowland tropical rainforest with few areas of high altitude forest. Their existence cannot be separated from the river system. Since most areas in the region are surrounded by ocean, there are many rivers flowing into the sea. According to Abdullah, there are 100 rivers with about 1,800 subsidiary rivers and tributaries in Peninsular Malaysia whose combined lengths amount to more than 38,000 km.[4] The other important factor that creates a large number of rivers is high annual rainfall. Due to the topography, Southeast Asia has a uniform temperature. Proximity to the sea and an equatorial location generate a warm and humid climate, which is constant throughout the year. The average annual temperature is close to 27^{o}C (80^{o}F). Basco, an island in the most northern region of the Philippines, has an annual mean temperature of 26^{o}C (78^{o}F), similar to that of Kupang, Timor (Indonesia), the most southern island. Similarly Penang in Peninsular Malaysia, located close to the equator, has an annual mean temperature of 26^{o}C (79^{o}F).[5] The shade temperature is never over 38^{o}C (100^{o}F). The diurnal range

compared to the mean annual range constitutes a slightly higher difference during the dry season. All areas experience about the same duration of day and night, and have similar annual climatic patterns and seasonal weather.[6]

The region is predominantly cloudy with cumulus being the most commonly-found cloud pattern. The Peninsula is cloudiest in October and November while it has the clearest skies in February.[7] Dobby argued, "The effective sunshine is rendered even less by the high humidity which cuts off many actinic wavelengths."[8] Southeast Asia is one of the regions with the highest rainfall in the world, from two annual monsoons. The monsoon is southwards in January but gradually changes its direction to northwards in July.[9] The climate is dictated by two factors. The first is that most land is at low altitude with a uniform climate throughout the year. The other is that the air streams create a high rainfall. Most areas receive a total annual rainfall of more than 2500 mm (100 inches). The amount of rain varies slightly according to the seasons.[10]

In case of Peninsular Malaysia, the Northeast Monsoon carries low clouds with heavy rainfall to the east coast. The monsoon crosses the Peninsula between October and March. The Southwest Monsoon brings a smaller percentage of the annual rainfall, and crosses the Peninsula between June and September during a dry period. The Peninsula receives heavy downpours and thunderstorms with heavy clouds and overcast skies during the transitional seasons between April and May, and between October and November.[11] Many areas of the Peninsula receive frequent downpours of about an inch per hour in late afternoon and around midnight. The areas along the east coast experience the heaviest rainfalls during the October-December period, with the lightest rain in the dry season in February. Occasionally severe flooding occurs. The heaviest total rainfall is over 3200 mm (125 inches) per year. Larut Hills in the Bintang Range has more than 5000 mm (200 inches) a year. Kuala Pilah, on the other hand, has the lowest rainfall of less than 1900 mm (75 inches) per year.[12] Excessively high annual rainfall accelerates evaporation, which causes humidity. The vapour content varies only slightly between day and night as well as throughout the year. The water vapour is normally from 19 to 24 grams per cubic metre, which is twice that of England during the summer.[13]

3. The Impact of Economic Development to Urban Pattern

3.1 Levels of the economy

Figure 2: The photos shows rapid urbanisation experienced in the city of Kuala Lumpur (left) and Singapore (right) due to robust economic growth.

Malaysia, Thailand and Singapore (Figure 2) are the leading countries in Southeast Asia with robust economic growth in spite of the recent economic 'currency' crisis. These countries report almost a full recovery from the crisis while Indonesia and the Philippines have experienced setbacks due to the recent political instability. Unlike the rest of the countries in Southeast Asia, Myanmar and countries in Indochina (Cambodia, Laos and Vietnam) are left behind, having few economic developments since 1950s due to ideological crises. Even though there are differences in terms of economic development among the Southeast Asian countries, in general socio-economic patterns in this region throughout history share similar patterns of development – a major shift of economic dependency on agriculture to industrial-based production.

The traditional socio-economic activity is paddy cultivation as rice is the main food for the whole population. In addition, the villagers grow vegetables and coconuts, and breed chickens, goats and cows for daily food

consumption. The different villages have no frequent economic dependency on each other due to the rainforest topography which isolates the villages from one another, resulting in a limited transportation system. During the colonial period, the Europeans introduced monetary-based agriculture economy with intensive plantation of rubber and oil-palm for the overseas market. The shift has not only changed the agriculture pattern where paddy growing activities become less important, but it also creates the emergence of new types of villages like new specialised agriculture villages and cash cropping agriculture villages. The other type of village is a mixed-used agriculture village where the villagers converted parts of their paddy fields to grow lucrative crops like rubber and oil-palm. After independence, all countries in Southeast Asia continued to rely on colonial agriculture as the major export. Even today they are still the World's largest rubber and palm-oil exporters. By the early 1980s however, the demand for rubber and palm-oil has drastically decreased. As a result, the governments in these countries have shifted the economic pattern from agriculture to industrial production in order to tackle the problem.

For example, Malaysia experienced an economic boost in the late 1980s as the government managed to attract foreign investors in industrial production through its economic policy. This investment was worth RM$22.67 billion in 1994. The United States of America is the country's largest investor followed by Japan, Singapore and Taiwan.[14] Even though Malaysia's economy is orientated towards manufacturing industry, the agricultural and mining products still find a place among the country's major exports. The earnings from raw resources such as rubber, palm oil, petroleum and tin ore constitute about 50 per cent of the total exports.

The industrial sector has lifted the economy from its continuing recession despite the control of the timber industry and the fall of rubber, palm-oil and tin exports. The industry contributed 32 per cent of the total Gross Domestic Product (GDP) in 1994. Based on 1993's exports, the profit was worth RM$85,350 million, far exceeding the total earnings from raw materials such as rubber (RM$2,138 million), palm oil (RM$5,841 million), saw logs (RM$3,441 million), crude oil (RM$8,002 million) and tin (RM$674 million). In 1994 agriculture only contributed 14.5 per cent of the GDP. The major product was rice (2.07 million tonnes), with pineapple (167,900 tonnes) and other fruits (554,585 tonnes), tobacco (12,000 tonnes), rubber (1,210,000 tonnes from 1994 estimates), and palm oil (7,350,000 tonnes). The shift creates new types of professions, which has attracted migration by the rural population to the city.[15]

The migration caused a drastic increase in the urban population, an increase from 10.7 per cent in 1921 to 49 per cent of the total population in 1990. By the year 2000, the country is expected to house more than 60 per cent of the total population who live in the cities. The rate of migration is high, based on 1991 census, with about half a million newcomers, primarily high school and university graduates who migrate to the cities.[16] The migration of the rural population to urban areas is inevitable because of the search for work. The unemployment percentage is relatively low with only 2.5 per cent unemployed. A similar trend occurred the neighbouring countries of Thailand, Indonesia and The Philippines especially before the economic downturn due to the 'currency crisis' in 1997. Indonesia experienced an annual increase of 4% in urban population from 22 per cent in 1980 to 38 per cent. The poverty level in Thailand decreased from 23 per cent in 1981 to less than 10 per cent in 1994. Compared to the rural population, poverty levels of urban population in Southeast Asia was small. Benefits of the countries' economic growth were mostly enjoyed by the urban population.[17]

The urban population explosion, however, has caused a housing shortage, with the cities having become overcrowded. When newcomers find that the cost of buying or renting a house is more than they can afford, they build a shack which is illegal in the central city. The squatter environment is poor and exposed to pollution, diseases, fires and hailstorms since there is minimal provision from the public authorities. The growth of the slum and squatter areas is uncontrollable. A survey by Kuala Lumpur City Hall recorded that in 1981, 45,209 families lived in squatter areas. This constituted 20 per cent of the total Kuala Lumpur population. By 1983, the squatter population had grown to almost 30 per cent and if no attempt is made to control this trend, the number is certain to increase if the city is to house 2.2 million by 2000.[18]

The government as well as private developers have initiated a residential programme to alleviate the shortage. The projection from 1981 to 1985 by Kuala Lumpur City Hall (DBKL) showed that an additional 92,225 low-cost units were required. Applicants who earned less than RM$700.00 a month were entitled to buy a house. The houses cost RM$25,000 per unit.[19] At a national level, the government requires 800,000 new houses from 1996 to 2000. The low and low-medium cost units represent 73.2 per cent of the total needed to meet the demand. The

price of the low-cost house remains the same as it was in 1981.[20] As a part of a strategy for decentralisation, new towns are being built around the city's fringe. The programme creates an environmental threat to the existing villages and rain forest surrounding the city. Traditional villages are being wiped out and a large part of the rain forest, and rubber and oil-palm plantations, has been bulldozed for modern housing developments. The plan reveals that environmental concern has played only a small part.

Housing development in Malaysia reached its peak in the 1990s. Housing demand has exceeded the supply with still more people looking for accommodation each year. Before the late 1980s, the age group demanding private housing were in their 40s. But by the early 1990s, it was becoming comparatively normal for young couples under 30 years of age to own a private house. An increasing number of the population are graduates who earn better salaries. Another reason is the increase in the private sector employment, where salaries are higher than in the public sector. This growth has caused a drastic increase in urban development. The government has undertaken many attempts to sustain the rainforest. The capital city - Kuala Lumpur is planned on a 'Garden City' concept. "It remains a fact that it is perhaps the only capital city in the world which still boasts a natural forest reserve." In addition, the government has provided a resettlement policy to keep pace with Malaysia's rapid economic growth - 'to eradicate hard-core poverty, to bring a better quality of life to her people and to conserve her forest eco-system for future generations'.[21] The question, however, arises concerning how far these programmes have succeeded in providing for the physical and social well-being of the population. The claim by the government, that Kuala Lumpur is planned on a 'Garden City' concept, is controversial; the modern terraced housing development gives little respect to 'ground connection' to the rainforest landscape and thus causes negative impacts to the environment. The development of the traditional house-on-stilts must be promoted because the built form and its pattern evolve within the existing landscape without harming the landscape. Frank Lloyd Wright, speaking of his design for the Marin County Administration Building, notes:

"We will never have a culture of our own until we have an architecture of our own. Now, an architecture of our own does not mean something that is ours by way of our own taste. It is something that we have knowledge concerning. …… the good building is not one that hurts the landscape but is one that makes the landscape more beautiful than it was before that building was built."[22]

The major problem of Malaysian residential housing today is that it has lost its built form identity in terms of the rainforest. The existing housing programmes and consequent development do not value or respect the existing tradition. Instead they bring a Western concept, which is essentially foreign, to the Southeast Asian landscape. Due to a chronic and severe housing shortage, government planning and development agencies have sponsored many housing programmes; however, since their goal is simply to augment the housing supply with minimum concern for social tradition and environmental issues as a part of the country's Vision 2020, an idea introduced in 1988 by the Prime Minister, Dr Mahathir Mohamad with an ambitious master-plan which forecasts that Malaysia will qualify as one of the fully developed nations by 2020. The development has, however, resulted in the unnecessary site clearance of wetlands and rainforests for urban development.

Figure 3: Land clearings for building construction especially for terrace houses due to uncontrolled urban development near Kuala Lumpur.

Issues commonly raised today are problems of uncontrolled development of urban growth, which is not managed based on environmental concern (Figure 3). One of the tangible results of this human error is an increase in flood-prone areas and river pollution, indirectly suffered by the population living in related areas. Management of the problem by government is insufficient, and the situation is no better due to low levels of awareness of the issue by the people in these areas. One factor of mismanagement is the intensive development in already overdeveloped flood-prone areas, which are already identified as low-lying levels (wetlands). Inputs from both parties are crucial. This little input has made those who involve in construction industry to aim generating profit as their primary agenda rather than figuring better environment while making housing projects to house the population.

3.2 Construction Industry

Modern construction techniques are still widely used in the housing industry in Malaysia as well as in its neighbouring countries. The resulting impact on the environment occurs at a more frequent rate because the rapid economic growth has spurred the development of the land throughout the cities since the 1980s, especially in housing and commercial development. This development is based on the concept of a 'Garden City' following the establishment of a Town and Country Department in order to play a vital role in the Garden City' movement since colonial time by the British, a concept which continued to be employed by the new government after the country's independence. Due to government effort, the number of residential units in urban areas has increased from 827,100 units in 1980 to 2,071,100 units in 1991. By 1991, the total units in urban areas had increased from 31 per cent in 1980 to 51 per cent while the total percentage in rural areas had dwindled from 69 per cent in 1980 to 49 per cent in 1991 (Figure 4).[23]

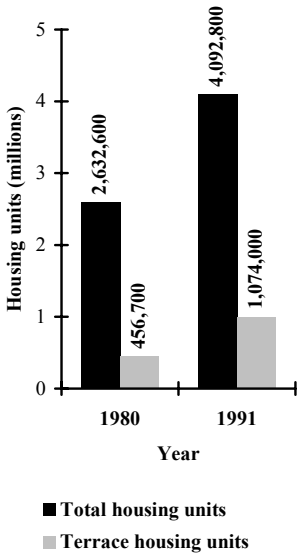

Figure 4: The number of terraced housing units had increased between 1980 and 1991 compared to the total housing units in Malaysia. Source: Department of Statistics Malaysia

Figure 5: Terraced houses.

Terraced housing (Figure 5) is the most typical of the modern housing industry built based on modern construction techniques that require either site's reclamation or land clearing. Built on a rectangular plot, the frontage forms a narrow section of the plot. The house form is popular because it complies with the adopted Western codes and regulations and is constructed using bricks due to their durability in any weather. The Europeans introduced terraced housing in the 19th century during the colonial period. Before brick walls are constructed, reinforced concrete structures are built. Walls are constructed with bricks by placing one block brick on top of another, and side-by-side to construct layers of brick walls between two reinforced concrete columns. This type of construction method contrasts to the existing prefabrication system used in the erection of traditional houses. The terraced house is low-rise but it can be built at a very high density in a regimented layout. About 40 to 50 units are built on one hectare. The development of terraced housing is encouraging. Figure 1 shows that there were about 456,7000 terraced houses in 1980, but by 1991 the number had grown to 1,074,000, representing 27 per cent of the dwellings in Malaysia. The number increased dramatically in urban areas where about 40 per cent of the total were terraced houses in 1991. Thus, the terraced house represents the most common housing type in urban areas instead of detached and semi-detached, townhouse, townhouse link, traditional house, mid-rise and high-rise house type.[24] According to C. C. Wong, writing in *Majalah Akitek* (the local Architecture Journal) in 1984, terraced houses were introduced to Malaysia in 1980 as a result of a rapid economic growth. The adopted housing codes and regulations in the 1980s had only few changes to that of their original introduced by the British before the country got the independence. He adds:

"In spite of their myriad appearance, these housing estates have essentially the same layout. Rows and rows of identical houses on 80 feet by 20 feet (24 metres by 6 metres) plots line the 40 feet (12 metres) to 50 feet (15 metres) road in conformity with the antiquated and restrictive planning laws. The pace of development was rapid and there was no time to draft a set of more flexible by-laws. Even the 20 feet (6 metres) back lane, already outlived its usefulness with the introduction of modern sanitation and fire control, and is still a standard requirement for nearly all the local authorities - regardless of how much it costs to maintain. The most noticeable characteristic of this new form of settlement is the absence of meaningful spaces."[25]

3.3 Land Erosion and Consequences

There are two major factors that have degraded the wetlands, lowland rainforest and river system as well as their habitats, which are forest clearing and land reclamation activities. These activities have impacted greatly on the urban areas where it is human sense to build almost all settlements and cities along the river valley. This causes a high concentration of suspended sediment (Figure 6) in downstream stretches of the rivers. The lower stretches of the rivers are characterised by heavy silt loads especially after heavy rains. In urban areas, this is the direct consequence of large number of land clearings and reclamations for housing and commercial industry as well as highway's constructions, and as a result this causes major land erosions during heavy rains. Based on studies made by the Drainage and Irrigation Department of Malaysia, the data shows that erosion from cleared and reclaimed lands in urban area results most of the time in a sediment load to the rivers. Studies of the land erosion due to these activities in Kelang Valley show that about 2,950 tons soil in one kilometre square is lost every year, which is equivalent to erosion of 3mm depth of the land surfaces. Compared to the amount of land erosion of the same area each year in undisturbed forest, which only varies from 10 to 100 tons, this figure is relatively high.[26]


NATION

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Paradise lost to siltation

Contractor took steps to prevent silt, says Samy

Figure 6: Problem of river sedimentation becomes one of popular issues in the local newspaper.

This high rate of land erosion will continue to happen if land reclamations and clearings are used as an adopted system in the construction and this will cause tremendous strain and excessive silt loadings on the riverbed. As a result, the river's depth will decrease and this could increase flood-prone areas. These activities are the major causes of the gradual changes in the river ecosystem. The role played by the river has diminished in importance, and its ability to support the ecosystem is greatly threatened. Reports by the Drainage and Irrigation Department of Malaysia state that floods have recently become more frequent where 9% (29,000 km^2) of the country's total area inhabited by 12% of the total population is flood-prone. Among the impacts of floods are the loss and destruction of private property, damage to public facilities and services, restriction of economic activities and social events, destruction of agriculture areas, and loss of human lives. This results in huge costs to the government in rescue and flood relief operations and rehabilitation works. The total costs of flood damage have increased due to the increase in flood-prone areas caused by clearing and reclamation activities for modern housing and commercial developments. The expansion of urbanisation has changed the natural flow of rainwater in that it used to be intercepted by the vegetation, which filtered it to the ground, slowing down its flow time to the river. However, rainwater is now swiftly collected from the roofs and paved grounds into drains, which quickly transports it to the nearest river. Frequently, the existing rivers are not able to cope with these excess loads and thus, flooding occurs. The increase of flood damage forces the government to spend millions of dollars every year for flood control and operation. These costs have increased from (RM = Ringgit Malaysia) RM16.5 million spent from 1975 to 1990, to RM164 million between 1985 to 1990, and to RM449 million in a period of 1990 to 1995, which indicates a huge increase. From 1995 to 2000, the government has allocated RM925 million, which is about twice of the total expense between 1990 and 1995.[27] (USD$1.00 = RM3.86) Chan argues;

"Related to poor enforcement of flood control regulations is the development of hill land. Massive hill development may be another contributory factor to increasing flood risk, exposure and vulnerability. In particular, the clearing of vegetation and cutting of hill slopes will bring about increased and accelerated water runoff, increased soil erosion, a high probability of landslips and landslides, all leading to increased flood frequency and magnitude. In the flood event of 18th September 1995, more than 60 landslips and landslides occurred. Landslides not only endanger the safety of residents in the vicinity but also affect motorists, pollute rivers and bring siltation, which ultimately results in floods which endanger the population in the lower reaches of a river."[28]

3.4 Floods and Mitigation Programmes

The problem becomes more acute as the uncontrolled development continues to happen without adequate attempts to reduce the problem. If natural hazards occur, those who are involved in the construction industry

commonly argue that the hazards like floods, landslides and land erosions happen due to natural phenomena such as heavy rainfall, rainstorms and La Nina effects. Natural hazards, however, are rare in Malaysia compared to other countries like the United States, Japan and India, who experience severe natural hazards like earthquake, volcano activities, hurricane, typhoon annually. The common natural hazard, which is on increase, is floods and the blame cannot be solely focused on natural forces, but must also be attributed to human error. The flood-prone areas are increasing every year even though level of annual rainfall is similar from one year to another year, causing floods to be the most common natural disaster faced by the population in Malaysia.

According to Chan Ngai Weng, floods occur for two reasons, namely natural causes and human error due to intensive urban development. Politicians and those involved in the building industry, however, always look for an excuse blaming nature as the cause of disaster.[29] Based on a report by the Department of Drainage and Irrigation of Malaysia, 29,000 square kilometres or 9 % of the total area is indicated as flood-prone area, much of this being residential, due to the typical city and urban development being concentrated along rivers. These areas are heavily populated and if floods occur, the disaster affects a large number of inhabitants. At national level, the disasters caused by floods are regarded in a very serious light, causing the government to allocate large portions of its budget to floods mitigation projects. In the Seventh Malaysian Plan (1995-2000), the government allocated RM925 million for the budget expenditure, which is more than twice that allocated in the Sixth Malaysian Plan. If disasters due to human error continue, it is likely the allocation will be about 2 billion in the Eighth Malaysian Plan. This amount is a considerable expense by the government just for floods mitigation projects.

Mitigation projects involve building artificial and physical structures like reservoirs, dams, embankments, river improvements, urban drainage, levees, retention ponds, and diversion channels in order to reduce flood damages. In river improvement programmes, the involved rivers are deepened, widened and dredged by special floating tractors (these cost at least a millions of dollars each as they imported from overseas) from its upper stream to downstream to ensure that excessive rainwater will flow at fast rate, thereby hindering the formation of floodwater. The programmes are carried out regularly and in addition, underground drainages are built to avoid floods, as the surface drains are not adequate to control floods especially flash floods, which occur frequently in urban areas. Underground drainage is the best alternative when widening surface drainage is impossible in urban area due to limited available land. Another type of mitigation project is locating retention ponds to control floods. Retention ponds function as temporary measures to control floods when the affected rivers are not able to discharge excessive flows of rainwater particularly during the rainy season. The ponds are artificial and also function as recreation areas used as small lakes for activities like boating and rowing. The concept of retention ponds as a part of planning design is currently popular among the architects and urban planners. Examples are lakes of Putrajaya and Shah Alam city, University Science Malaysia (USM) central campus, and housing areas at Subang Jaya. The allocation is also used for maintenance of urban drainage system and monsoon drains which are clear of any blockages like rubbish, remains of tree trunks and branches, and eroded soils and clays on drainage surfaces to ensure that there is a natural free flow of rainwater. Besides maintenance programmes, deepening and widening monsoon drains is necessary and the government is planning the construction of many more monsoon drains, because the existing drains are insufficient. Construction of channels as an alternative to divert excessive rainwater flows to the sea instead of existing rivers, which carry already heavy loaded rainwater, is a part of the project.

A question like why the government has to allocate such a large amount of money for this purpose would be a major concern when the population become aware of it. The reason for this expenditure is based on amount of damages caused by floods. Estimates of flood losses by Drainage and Irrigation Malaysia show that losses of properties are huge when floods occur. There are 4 types of floods in Malaysia, which are monsoon floods, flash floods, tidal floods and a combination of all three.[30] An example of losses due to monsoon floods and tidal floods is floods at Kelantan and Perak river basin in 1967 that the report has estimated amount of damages about RM221.8 and RM171.9 million (based on 1996 prices) respectively. About 320,000 people in Kelantan and 171.9 people in Perak were evacuated. Property damages due to flash floods are also considerably huge, and lately the occurrence of floods is frequent. Occurrence of flash floods at Kelang Valley, Kuala Lumpur, in 1995 has damaged properties about RM222.6 million (based on 1996 prices) and 8,970 people were evacuated.

3.5 Role of Rivers and Wetlands Ecosystem

Before the Industrial Revolution, rivers acted as highways, being used as communication and transport routes. They are used as a means of transport with an establishment of port city, fishery town and trading centre, irrigation to agriculture in the hinterlands, strategic location to inland settlement, electricity from hydropower, and cultural value of the people. The riverside offers the best facilities for the origin and growth of towns. Today, vast areas of the riverside land in urban regions have been consumed by the invasion of industrial and commercial development. In the process of economic growth of the city, society has forgotten all values established by nature. It has started counting everything in terms of economic progress. In Malaysia, rivers currently pose environmental threats due to the rapid development at an uncontrolled level, which has polluted the rivers. Pollution of rivers and degradation of water quality are on the increase. In term of planning and construction perspectives, modern land's reclamation and clearing system, and earthworks activities in city development are major causes of river pollution. A report from the Department of Environment Malaysia based on water quality level of its 908 water quality stations along 117 rivers shows that the number of clean river had decreased from 42 in 1996 to 24 in 1997, while rivers slightly polluted had increased from 61 in 1996 to 68 in 1997, and polluted rivers had increased from 13 in 1996 to 25 in 1997.[31] Based on a survey made by the local newspaper agency, New Straits Times, 82% of the respondents commented that a river near their houses was polluted while only 2% agreed that the river was clean.[32] The figure shows that public perception about the level of river's quality is not encouraging.

Nature has selected some places in the tropics as wetlands (Figure 7). Closely associated with river system, they function like a giant sponge in order to control the occurrence of floods on upper dry land. When the region experiences excessive rainwater especially during rainy season and the river is unable to drain such a large quantity of water at one time, the water gets trapped in the wetlands. The wetlands absorb the water and this prevents the upper land areas populated by man, fauna and floras from flooding whereas during dry season, soils of the wetlands shrink to release water to the river so that the river is not dry and this supplies irrigation and drinking water to man, flora and fauna. Because of their location, the wetlands are responsible for balancing the level of water contained in the river. The problem is that today, many wetlands are reclaimed and forests are cleared for development of the cities. Although man-made drainage systems and reservoirs are built, these are not able to prevent the frequent occurrence of floods and droughts in those areas. As a result of land's reclamation and clearing activities, the original 'wet soil's structure loosens as the soil dries and this can cause soil's breakdown and erosion, creating silts loads and muddy rivers, and increasing flood-prone areas which are dangerous to the settlements. The wetlands play a vital role, namely to control soil structural content of the wetlands and river's ecosystem.

Figure 7: Mangrove swamps forest is one type of wetlands located along coastal and river in Southeast Asia.

A peat swamp forest for example, is highly combustible because of the soil's high carbon content, but as long as the water balance is at the control level, the forest is not sensitive to fire. However, development of monetary based agriculture during colonial times and the present manufacturing industry plays a major role in the degradation of peat swamps forest. These activities drain the existing water from the forest to the sea. Man-made drainage systems are constructed to drain the water when the peat is reclaimed. As a result, the water level recedes and the ground becomes dry, and due to clearance of the trees, the carbon content is exposed to direct sunlight which can result in forest fires. Once the forest fire occurs, it is very hard to control. Sustaining peat swamps forest is crucial because the ground is a place, which stores carbon substances that enter to the air. As a result of fire as well as land's reclamation and clearing, the soil's structure will loosen as the soil becomes dry which is hazardous to the settlement. The forest plays a vital role, namely the control of the carbon content of the environment. Degradation of peat swamps forest because of forest fire will release carbon dioxide to the air which is harmful to man and animals. According to Tan Cheng Li, based on his interview with Faizal Parish, executive director of conservation group Wetlands International Asia Pacific, "Drained or burnt peat swamps will lose their crucial functions: soaking and storing water to mitigate floods and as a water catchments; buffering coastal lands from the intrusion of salty marine water; filtering pollutants which will otherwise degrade lakes, rivers and groundwater; providing timber and non-timber products; and providing critical wildlife habitat."[33]

4. Traditional Construction System: Strength and Opportunities

4.1 Prefabrication Concept

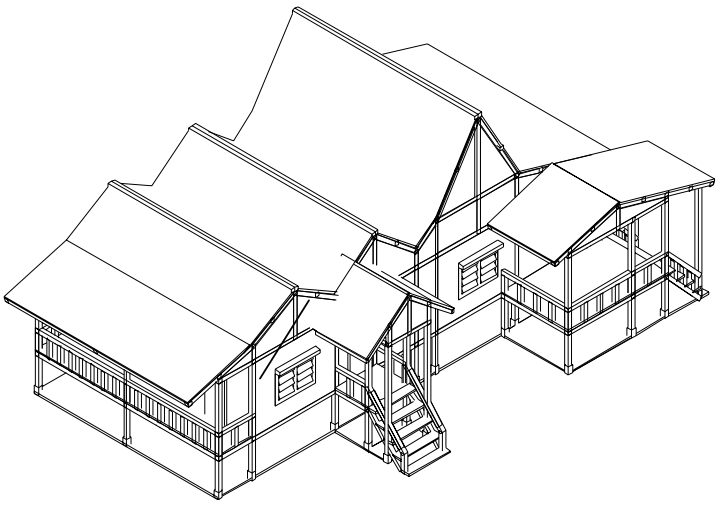
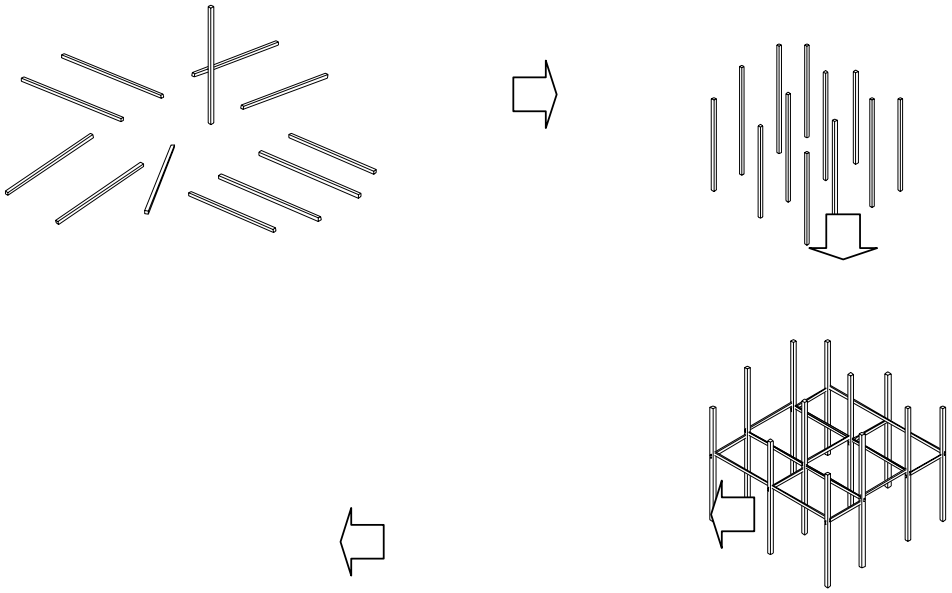


Figure 8: One type of traditional house form in Peninsular Malaysia

Prefabrication of housing components is a construction technique used in traditional houses (Figure 8 & 9). The geography of the region is the main factor why this technique is feasible, adopted by the local people and passed from one generation to another. In a tropical climate, trees are abundant which provide timber as the main material for house construction. There are several reasons for the selection of timber as the main material. In the wet and humid environment timber from the surrounding forest is the most suitable material for house construction. Another reason is the average annual rainfall of 2,500 mm which preclude the use of earth or clay as a building material.



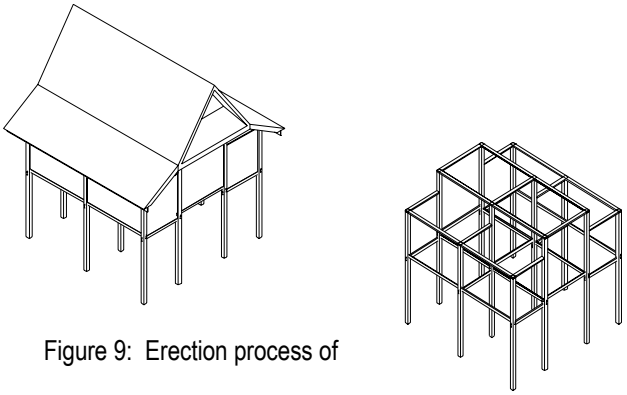


Figure 9: Erection process of traditional house.

The other reason is that settlements are mostly located in wetlands. Most villages are built along the river and are relatively close to coastal areas because, as mentioned earlier, most regions in Southeast Asia are in the form of peninsulas and islands, which are surrounded by sea. Wetlands are the best area for settlements because most lands are flats and suitable for paddy growing activities. Paddy is the main food for people who live in Southeast Asia and for generations paddy cultivation has been a significant socio-economic activity by the indigenous people. Most traditional villages are located on wetlands. Settlements on wetland topography have influenced traditional construction techniques, which are closely related to the general design of the traditional house form. Houses are traditionally built on series of piles with the floor elevated several feet above ground level. Elevated floor systems are necessary in the wetlands because of the frequent occurrence of floods. Wetlands are one type of tropical rainforest. Another type of forest is the lowland rainforest, generally regarded by most people as a tropical rainforest. The hilly and dried state of the lowland rainforest is one of the reasons that the area is not suitable for communities whose primary socio-economic activity is 'wet' paddy cultivation. The other reason is that unlike typical forests in cool-temperate regions, lowland rainforests have the densest vegetation in the world and are therefore not suitable for traditional settlement patterns. Based on a report by the Malaysian Timber Council, the country has more than 14,500 species of flowering plants, 2,500 species of trees, 76 species of ferns and 1,300 species of plants.[34] The villagers are all aware of dangers of the jungle and prefer not to travel too far from the village. The jungle, as argued by Geddes[35], conceals demons roaming to seek a victim, an adoption of spiritual power of natural forces like animals and trees passed from one generation to another generation. This belief is still regarded as certainty by the Iban tribe in Sarawak who embrace this kind of superstition as one of their laws of survival in the jungle. Even to the local city residents, living in the jungle is considered as frightening and threatening.

For prefabricated housing all the components that make up the structural framework, roof trusses, stairs, wall and floor panels, and roof surfaces, are made before erection of the house begins and are assembled on site Structural framework such as columns (*tiang*) and beams (*rasuk*), secondary beam (*gelegar*), primary roof beam (*alang panjang*) and secondary roof beam (*alang pendek*) are assembled on site to form the primary framework. The foundations are very simple as no land reclamation and intensive site clearing are required. Most traditional houses basically have 12 columns. The early houses used to have their columns about two to four feet deep in the ground, but once masonry construction was introduced, that technique was mostly abandoned. Nowadays, it is typical to find that most columns are placed on plinths (*batu alas*) which function as the house foundation. The plinths are made from stone or masonry and are either placed on the ground level or buried several feet in the ground. The role of the plinths is to ensure all columns are levelled. Ground is only excavated to make way for the columns and plinths, which means that clearing of existing vegetations and habitats is minimised as much as possible. Stone and masonry plinths nowadays are preferred because the materials are long lasting, preventing the timber columns from rotting due to the regional climate, which has high annual rainfall, and warm air and high humidity. The timber columns, buried directly in the ground will eventually rot as they continuously exposed to ground water. This problem is common to columns not erected on the plinths.

There are three types of columns used in house construction. The shapes of the columns generally typify status and wealth of the occupants. Round-shaped columns are the simplest prefabricated components used by poor families to construct their house while the square-shaped columns are the most typical columns found in traditional houses built by middle and wealthy class families. The columns range in size from 10" by 10" to 12" by

12". The houses of royal families have square columns with their edges trimmed-off slightly so that the columns look octagonal to make the components decorative. Most traditional houses have 12 columns. Core houses (*Rumah Asas*) have 6 columns but as the floor area increases due to extensions, the number of columns also increases to maximum of 16 columns. Extensions are common to the traditional house, occurring when the occupants have additional income or when their family size grows. When all the columns have been erected, beams are laid horizontally several feet above the ground level along the perimeter of the floor plan connected from one column to another. Traditional beams have two types, which are *rasuk* and *alang*. *Rasuk* is a lower beam that is used in the floor system while *alang* is an upper beam supporting the roof system. The number of *rasuk* and *alang* is based on the number of columns of the houses. The 16 columns houses have 8 *rasuk* and 8 *alang*. The floor joists (*gelegar*) are then placed along the short *rasuk* to support the series of floor timber panels. Timbers are planned by using traditional tools (*ketam*) and smoothed by using sander tool (*kikir pari*) to make floor planks. The panels are manufactured side by side with gaps of about quarter to half inch, which allows the dirt to fall to the ground thereby helping to keep the floor clean. The other function of the floor gaps is for ventilation. Cooler air from the ground passes through the floor gaps to replace warmer air in the house.

In a hot and humid climate, the roofing system plays a crucial role in keeping the rainwater from entering the house. In Southeast Asia, traditional houses have a pitch roof. It is important to ensure that the pitch is the correct angle. The steeper the roof slope, the quicker the rainwater runs down through the slope. In general, the side roof pitch varies from 20 to 25 degrees while the middle pitch has a slope, which ranges from 50 to 55 degrees. Traditional materials for roof cover are nypa (*nipah:* the needle – like trees) and *rumbia* (palm leaves). Nowadays, the roof cover is made up of new materials like clay tiles, corrugated steel plates and metal sheets, which are not really suited to a tropical climate. New materials are used because they are mass-produced and readily available. Traditional constructions system shows that the indigenous people, particularly those living before 1900, were aware of the importance of the relationship between themselves and their environment. Sanusi Hassan notes;

"This relationship identifies that practice and belief of the pre-colonial Malay Communities in connection to ecological concern is not a new thing, as modern environmentalists have adopted. The distinction is that they had related the concern based on their belief to the surrounding superstitious nature while modern environmentalists were attempting to find solutions to a sustainable living environment relying on a scientific approach. Their belief shows that humans have a right to claim their place in nature. "[36]

Houses are built by a communal effort of the whole family as well as the community in the village; the men do the heavy work such as cutting the poles, while the women make thatched walls and roofs. Those who have sufficient funds usually hire carpenters to build the house. The owners and their family always participate in the erection process. Self-build practice is thus widespread. The layout of the village is based on the result of mutual agreement among the villagers. It represents the adjustment of physical and social parameters to environmental factors. When a villager wants to build a house, he seeks advice and permission from the community through the leader of the village. Traditional house construction is based on a guide by the whole community especially through the ceremonial selection of the site, irrespective of who builds.

The village is headed by the 'penghulu' who is an elected leader by the villagers. Generally most villagers are bonded by kinship into one social unit. The villagers commonly share most activities ranging from mutual economic aid to house construction. Sudin says, "Often the boundary between individual, family and community responsibility is difficult to identify."[37] This type of social unit is important because it signifies the only solution to the problem of survival, as the families are dependent on one another. The practice symbolises the type of social unity and the level which is needed to ensure the survival of a community in the rain forest. Individual work and decisions are impossible. A family is not able to live in a house isolated from the village because they will be threatened by dangerous animals, harmful diseases and natural disasters. Geddes argues, "The jungle is generally a much worse place than the countryside. In the jungle, the loneliness felt is the loneliness of humankind in an inhuman world of life. ... But all persons prefer to get back to the village, with its company, sooner rather than later, and think it by far the best place in all the jungle and all the countryside."[38] The village is the place where people seek protection. Community co-operation is thus crucial. Rapoport elaborates on the type of community as a 'primitive social unit system'. The term 'primitive' defines the involvement of 'the society in which they build'.[39]

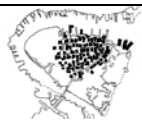
Sudin noted that house construction is always influenced by the community and their customs rather than by individual wishes.[40] Most decisions of house forms and village layout are determined by the community. This is how each house gets a unique form, which is not alien to the general pattern - a practice common throughout the region. Mumford suggested that in contrast to a linear pattern of the modern housing and planning, the 'primitive planning' implemented by the early settlers 'despised specialised labour', but rather initiated village planning in accordance with social grouping.[41]

Through the benefit of prefabrication, the traditional house is capable of enlargement. The basic type forms a 'core' house built according to what the occupant can afford. When additional finance is available, so does the opportunity to extend the size of the house. Most low income and newly married villagers build their homes this way. As they grow older, they may have more savings, their family might grow and an addition to the house is necessary. The process permits flexibility in the development of the house form.

Like the design of the traditional house form, indigenous economic activity has a closed relationship to the geography of the region. For generations they have integrated their economic activity to the pattern of existing topography, which are wetlands. Across Southeast Asia, one can see that many wetland areas have been converted to paddy fields. Constant water supply is necessary to ensure its growth. The biological functions of the existing wetlands are conserved as much as possible since natural wetlands are converted to artificial wetlands.

4.2 The Challenge

Traditional housing patterns in agriculture areas basically have low density of housing units per hectare. Most houses are detached with 8 or 9 units commonly built in one hectare. The density is relatively low compared to the national proposal of housing density, 35 to 40 units per hectare in urban areas. Local authorities argue that developing the housing industry based on the traditional concept is uneconomic due to its low density. So far, terraced houses are regarded as the best housing pattern built based on the required housing density to fit modern Southeast Asian landscape. Most of the population do not like to live in high-rise apartments and prefer living on the ground. High-rise apartments are only popular in Singapore because available land is very limited. The population density in 1992 was recorded at about 4,323 persons per square kilometre, twice higher than that of New York City, USA.

Patterns	Number of roof houses and the area	Density houses per hectare
 Inland water village	295 units in 4.9965 hectare	59
 Outward water village	119 units in 0.5198 hectare	57
 Parallel water village	114 units in 0.5670 hectare	50
 Water village	101 units in 1.9875 hectare	51

 Rivermouth water village	269 units in 5.0890 hectare	53
Average		**54**

Figure 10: Comparisons of patterns of fishing villages based on density
Source: Short-term University Science Malaysia (USM) Research Grant; Researcher: Dr. Ahmad Sanusi Hassan

However, the general public perception of 'low-density' traditional housing character is only true for traditional villages located in agriculture areas. It is not true in case of traditional fishing villages (Figure 10 & 11). These villages have relatively high density housing units per hectare, which can be classified as low-rise high density housing patterns. Their location in wetland topography and proximity to the sea and estuary are the factors, which have shaped patterns of the villages. The villages are built in groups and their density, based on the study of 5 patterns of fishing villages along the western coastal area of Peninsular Malaysia, ranges from 50 to 59 units per hectare as illustrated in Figure 4. Their construction techniques are the same as those used for the construction of traditional houses in agriculture area. Factors of location and topography have made the house form and its housing patterns common to all the settlements regardless of race, i.e Malay and Chinese fishing villages in Peninsular Malaysia, where the construction and planning system minimises damages to the existing environment. Further studies of the traditional house form and its planning pattern is crucial to ensure that it is feasible to be developed in urban areas for future uses.

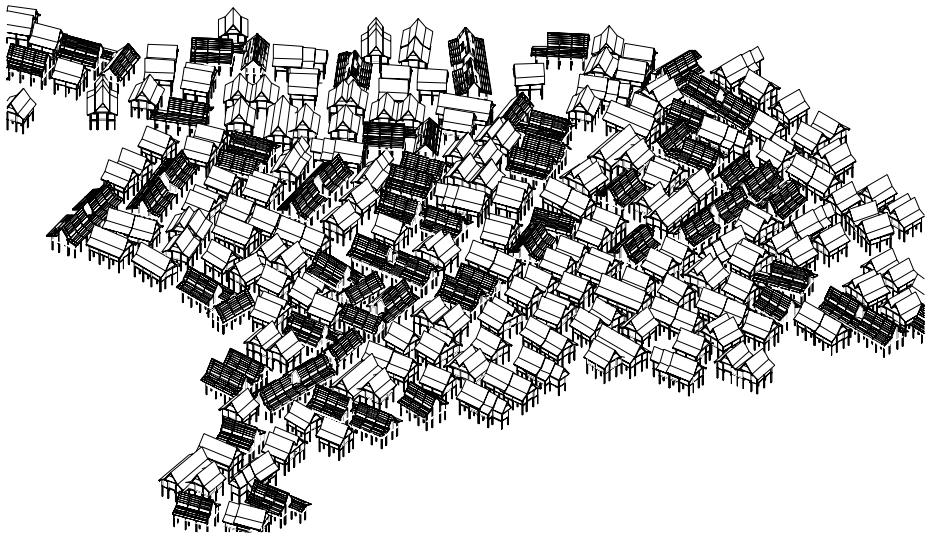


Figure 11: Inland Water Village at Kuala Perlis, northern part of western coastal area of Peninsular Malaysia.

The other reason is the application of building codes and planning concepts from Western countries introduced during the colonial period. Its application continues to influence the Southeast Asian building industry after the countries became independent under new local government. This regulation impacts greatly on the selection of the type of housing landscape in Southeast Asia. It favours development of terraced houses across the regions because these type of houses are most suited to the codes and regulations like building setback, minimum size of the house plot, building's materials and type of street and road. In Malaysia, the practice of traditional planning methods and construction systems are forbidden since major fires occurred in 1826 and 1881 in Penang and Kuala Lumpur respectively. Regulations promote the development of heavy weight construction, using brick and concrete as primary materials, instead of development of traditional lightweight construction to dominate the urban landscape.

Turner describes the advantages of the modern regulations as the control of housing development and prevention of urban sprawl. The system, however, has made it 'minimally feasible' for the poor. The regulations should provide opportunity rather than restriction in order to "encourage the discovery of new solutions without endangering people's safety and health, so that social and economic performance standards could liberate us from the tyranny of socio-economic homogenisation".[42] Traditional patterns offer a variation of house size for all income groups while the grouping arrangements encourage social interaction. Various house sizes are located in one group incorporating all income levels. The size of the house accords to the owner's means and avoids segregation of income levels.

5. New Technologies

Methods of construction in the building industry are not based on environmental concern as a primary factor in contemporary practices. The method is outdated, derived from systems used since the 1700s The Industrial Revolution in Europe reflected that this method was a solution to architecture and planning developments in those centuries, based on the understanding and available technology of that time. During this period, many concepts of city planning like the Garden City, Radiant City, Suburban City and Broadacre city, were introduced by Western planners and architects to solve problems of city planning and housing development, and to codify with the advance of industrial character of the machine movement, which they have not experienced before. The concept is based on mass-production, manufactured by using single-purposed machines, and the same technique was adopted by the building industry. This mass-production technology has influenced methods of construction. The components were bricks, floor and staircase units, and pre-cast concrete structural frames. The ability of the industry to offer components of regular sizes and dimensions indeed helps to speed up housing construction at an economic cost. But the system constricts design and planning to a limited pattern. As Scoffham argued, the system has standardised design as a complete 'design-and-build' package which promoted uniformity in housing landscape.[43]

Today, the technology has developed with the application of a computer-based approach, and as a result; has created technologies which are far more flexible in terms of an eco-friendly design concept while mass-industry's technology is very limited to the contemporary needs in sustaining the environment. This technology was applied during the period where the communities concerned with industrial development were insensitive towards sustaining the environment. The radical transformation from manual system to computer control gives flexibility to the design. It is now possible to create a flexible and versatile multi-purpose factory, which can produce a variety of building components or batch products as opposed to a single product. Bookchin argues, "The changes required to use these machines in a cybernated industrial facility would generally be in circuitry and programming rather than in machine form and structure."[44] In a multi-purpose industry; however, a computer monitors all the robotic machines, which can manufacture custom-made components suiting a single project at economic cost.

However most local authorities, architects and urban planners are not fully aware of the flexibility of the new technology to influence their design and planning schemes. They continue using a construction system from western countries which they consider to be conventional. The system is outdated because it deals with building components, which have a standardised form and monotonous design manufactured based on mass production system in single purpose industries. The practice negatively impacts the existing landscape as pinpointed by Abel as the outcome of 'mass-produced building methods', depicts the 'worst effects' of the place-form factors.[45] This application ignores the surrounding regional identity since all places are regarded as the same in design strategy by exploiting mass-produced components to cater for the construction technique. The outcome is a homogenous building identity, which tends to erode the existing landscape, The approach disregards the essence of the place, culture and tradition, and existing geography.

The introduction of computer applications in electronic-based technology has changed the traditional method of the production system in manufacturing industries, gearing manufacturing systems towards a batch production technique. The machines do not function as single purpose production but they have multi-purpose functions, producing variations of designated components in the same factory based on computer control. This multimedia technology is reprogrammable, downloaded to computers to gain access and control to the robotic machines

which also have multiple axial movement. All commands from specific programmes (custom-made) in computers are interpreted by the machines to generate their tasks. Advances in IT technology are able to manage variations of different building regulations and laws possible from one place to another. The most typical problem of building regulations is that the regulations are standardised, regardless of the location in Southeast Asia. Application of IT makes information accessible to the users, architects and urban planners, and those involved in the construction industry, from any place in the world. This system creates positive developments in changes of building regulations regarding specific locations and climates. The new technology makes the traditional concept of tailor-made prefabricated components in building construction possible, which underlies a new challenge in blending the traditional system integrated with contemporary building materials with the needs of innovative design.

The concept of assembled components can thus be applied to the housing industry. Instead of being produced manually by traditional builders, the components can be fabricated at the factory. These batch-produced materials will help to cope with the demands of the housing industry. The positive aspect of batch-produced components is that they are available at reasonable prices according to individual requirements. The system needs a social mechanism. Users and builders stimulate participation through control and feedback. The practice thus secures not only environmental aspects; responses to the climate, surrounding and ecology, but also cultural, social and financial traditions.[46]

Application of modern bricklaying construction of terraced houses and conventional building regulation ignores the importance of traditional timber craftsmanship. Numbers of local traditional craftsmen are decreasing and today there are only a few craftsmen left, as there are no jobs for them in the modern construction industry. The application of construction methods based on a combination of traditional techniques and computer technology in manufacturing industry preserves the professions of traditional craftsmen. Compared to early traditional craftsmen, the new generation are professionals who graduate from university, doing research, inventing prefabricated components at various forms, sizes, designs and styles to ensure that the manufactured computer based products meet the quality standard and client's satisfaction. A large number of workers are still needed in the construction process, and homeowners as well as surrounding communities are encouraged to participate.

Timber is the primary material used in traditional construction. To ensure the success of sustainable logging systems, the government has permitted commercial logging based on a rotational cycle system where only mature and fully grown trees are harvested at a rate between 7 and 12 trees per hectare. The potential is however confounded, because the local timber industry is targeted to supply processed hardwood for overseas, not for local development.[47] Timber export in 1993 for example, contributed a total of RM12.2 billion (US$4.7 billion) to the economy.[48] The other problem is that insurance for houses built with timber is relatively high compared to that of houses built with brick, because timber presents a fire risk. This makes timber a less popular material for house construction, especially for middle and low-income groups. Alternative materials like plastics, pre-cast reinforce concrete, aluminium and steel or new materials based on combination of the existing construction materials like plastics and steel, and plastics and timber, which are fire resistant but have similar functions and characters to timber, are feasible as long as the materials are capable of allowing construction based on the prefabrication technique.

Development, however, cannot be successful by simply copying a prototype of the traditional house because the existing prototype is obsolete in a contemporary context. The regionalist approach, as mentioned earlier, is not a development of architecture, which symbolises a lost vernacular; it must adhere to the context of contemporary technology, tropical adaptation and cultural responses. The traditional house, however, can be utilised as a springboard for research. Immediate action for research should be:

- Further research of construction techniques not based on site reclamation and clearing.
- Batch production technology – a combination of traditional techniques and computer (multimedia) technology in manufacturing a system of prefabricated components to replace the mass production concept of the bricklaying system.
- New materials for the contemporary prefabricated components, which have similar capabilities, functions and characters to timber, but are fire resistant.

6. Conclusion

Socio-economic activities of indigenous people in Southeast Asia are closely related to the surrounding environment. Being located in wetland topography, these have given them a unique and distinct culture compared to other tropical regions in the world. The environment has also dictated planning patterns and construction methods with unique forms of house-on-stilts architecture. However, the shift of socio-economic pattern to monetary based agriculture and later to manufacturing industry has changed the Southeast Asian landscape. The adoption of new socio-economic patterns impacts significantly on the planning pattern and construction system. Planning laws, building codes and regulations borrowed from the West have forbidden traditional housing developments because the laws promote heavy weight construction using bricks and reinforced concrete as the main materials. As a result, the development lends itself to land erosion and results in an increase in flood-prone areas, which in turn causes millions of dollars in property damages due to continuous land clearing and reclamation activities. The advance of new technology has made it possible for traditional construction systems to be applied to contemporary urban housing. The technology is able to produce variations of designated custom-made components at regular cost that mass production system is unable to offer. The change can promote the use of traditional concepts as an alternative, for the purpose of sustainable urban development in Southeast Asia.

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