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The Concept of Raised Floor Innovation for Terrace Housing in Tropical Climate

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Abstract

The ubiquitous terrace house is undeniably the most popular and affordable housing type in Malaysia. It has long been considered as one of the densest forms of property development and has become the common typology of accommodating the masses for this country. However, its design has been plague with various issues for decades. It has been associated, among others with bad design, thermal problems, safety issues and unsightly renovations. In contrary to the traditional tropical architecture that employs sun shading devices, openings with cross ventilation and the use of local material such as timber, terrace houses today have been designed as masonry and reinforced concrete boxes fitted with air conditioner. The modern day terrace house design has perhaps overlooked one of the most important components of a tropical house that is the raised floor. The traditional raised floor design implicated many issues such as ventilation, lighting, thermal comfort, safety and security as well as social aspects. Therefore, this research aims to explore the various issues mentioned above and proposes to uniquely develop a new design for in-house habitation as well as providing for aesthetically pleasing look. The methodology for this paper is a systematic review of existing literature and finds its relation to the raised floor innovation concept. The main finding reveals that the concept of raised floor innovation provides better design solution and gives insight to the existing Malaysian terrace housing design. It suggests a possible and promising way of increasing the livability of terrace housing by the means of a raised floor.

Keywords: *raised floor, safety, security and social aspects, thermal comfort, ventilation.*

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1. Introduction

According to Hutchinson (2002), 'A region can often be clearly recognized by the character of its housing. … House design reflects critical factors such as climate, materials, economics and cultural background'. In Malaysia, the terrace house's rank as the major accommodation for the masses is likely to persist given its priority in the current Ninth Malaysia's Plan. Statistics have also shown that it is still the most sought after type of housing for the average income Malaysian. Authority approval of such houses is also among the highest of all property types and demand is expected to increase. However, little has changed in term of its design innovativeness since the last 25 years. Some housing designs are devoid of basic design principles and are aesthetically offensive. Buildings are built fast and lacking creative design efforts. New and innovative designs are but a mere few. Where there is one, the price would be unreachable to the average Malaysian. The livability index for terrace housing in Malaysia, in this respect, has never been analysed. Mundane design, inflexibility of spaces, ad-hoc renovations, poor ventilation, lighting and thermal comfort have resulted in unacceptable housing living culture in urban and sub urban community areas in Malaysia. Most housing schemes were typically planned in gridiron layout for maximum land use, in single or double storey with an opening of 18 to 24 feet and a depth of 60 to 80 feet. Hence, it has resulted in a habitat unit designed with no sensitivity to the warm and humid tropical climate's requirements as those evident in the traditional buildings in Malaysia such as the traditional Malay houses (*See Figure 1*) and the Chinese shop houses (built as linked buildings).

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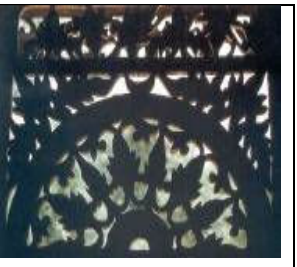

Designed to suit the local climatic requirements using various ventilation and solar control devices, and low thermal capacity building materials.	Steep roof and openings allows for fast water runoffs and facilitates circulation of hot air out of the house to increase natural ventilation.	Openings to exterior walls such as full height operable windows and the use of carved wooden panels and louvers add to effective ventilation devices and promote natural ventilation.

Figure 1: Environmental details of a Malay house

The Malay houses were built from timber and raised on stilts (Hanafi, 1999). The building is well ventilated by having doors and windows with perforated panels or adjustable louvers, and floor board with 1/4 inch gap to let the air to circulate in and out from beneath the building. The traditional Malay house has also been designed to suit the local climatic requirements using various solar control devices and low thermal capacity materials (Hanafi, 1999). Similarly, the traditional Chinese shop houses in the town areas have also strongly considered the need for natural ventilation to cool the building's internal spaces. Courtyard and air well are incorporated with fenestration components on windows, doors and walls. As a result, the residents were able to feel comfortable with the presence of air movement in the building.

Terrace house community however, is seen as lacking the architectural qualities evident in the traditional houses and social integrity as seen in the kampong. The traditional kampong on the other hand reveals sublime architectural qualities that express the way of life, culture and ingenious climatic adaptation of its users (*See Figure 2*). It is not only a physical and geographical entity but also a political and cultural institution (Md. Ali, 1983; Deraman, 2000). Our priority in habitation lies in the relationship of the idea of life, family and community. It is more of a spiritual issue and

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thus requires sensitive intervention. If we fail to acknowledge this, then in the sea of congested modern housing, we will be living separate and individual lives and will forever be plagued with climatic problems and cultural tensions (Mohamad Tajuddin *et al.*, 2005).

It is easier to totally dismiss the terrace housing designs as inappropriate and unsuitable for the warm-humid tropical climate of the country. However, there could perhaps be a simple and yet effective solution to the terrace housing design woes and the answer lies close with us. In the traditional Malay house, there is a clear definition of architectural elements and can be categorized into three main zones. The top zone, which covers the roof element, the middle zone for wall and the bottom zone which is the floor. The bottom zone however, is not evident in our modern design of buildings. Therefore, the purpose of this paper is thus to discuss the significance of the proposed raised floor element for terrace houses to achieve livability, namely the architectural and climatic qualities as well as social integrity. Fair to also note, that in recent years, several other mass housing design schemes have been researched upon and as yet still experimental. This paper does not make any comparison but merely taking cues from the past and exploring the potentials yet to be harnessed in the form of the terrace-housing scheme**.**

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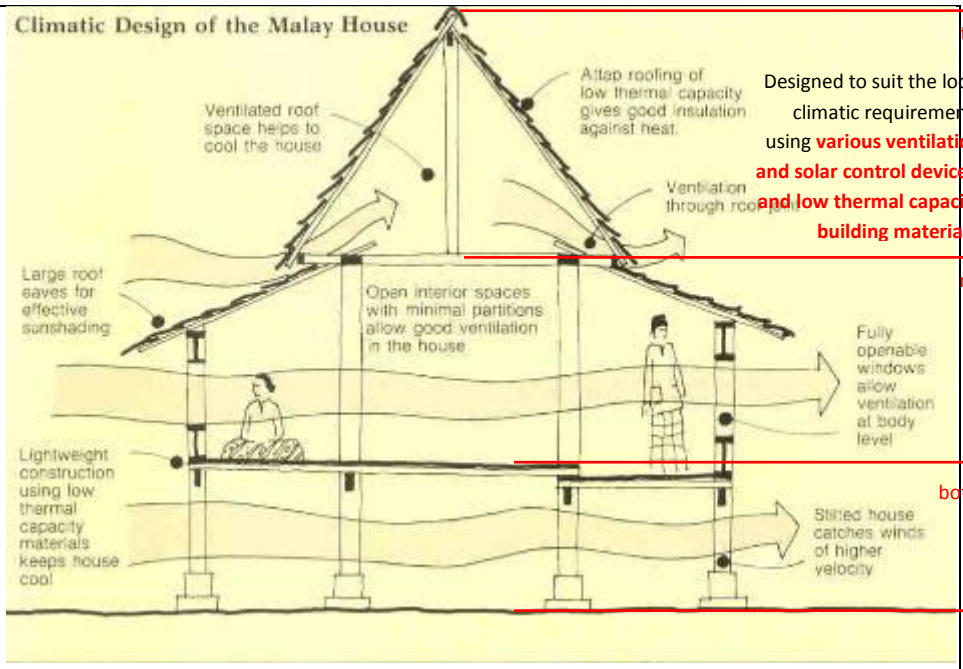

Reference: Yuan, L. J.: The Malay House: Rediscovering Malaysia's Indigenous Shelter System, Institut Masyarakat, 1987

Figure 2: Climatic Design of the Malay House

2. Problems of Livability In Terrace Housing

Since 1981 several researches have determined that terraced houses are poorly designed to achieve various climatic comfort and social requirements. The buildings are not designed in response to the country's inclement climate which characterized by three main features; seasonal uniformity, low wind velocities ranging in average of 1m/s to 1.2 m/s and small diurnal temperature range (Takahashi,1981) and high humidity and high dry-bulb temperature in the afternoon. The buildings are also not designed to cater to the diverse social and cultural community. The problems of livability in terrace housing in Malaysia can thus be looked from a few different aspects as elaborated below.

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2.1 Ventilation

The mass housing programs resulted in dwelling units which are not designed suitable for the warm-humid tropical climate of the country. House features and components which can generate ventilation include air well (Rajeh, 1994), doors and windows, ventilation panels and fenestration walls. However, most of the houses built today are devoid of true natural ventilation for house-cooling purposes. The insufficient openings and low wind velocity have caused the air velocity in the terraced houses to be less than 1.0m/s. Rajeh (1994) has recommended that an air movement of 1.0 m/s would provide a satisfactory relief for most of the time. The air velocity helps to increase the efficiency of sweat evaporation, and thus avoid discomfort due to moisture on the skin. Climatic analysis for Kuala Lumpur has suggested openings in the range of 50% to 80% of the walls to facilitate ventilation comfort (Rajeh, 1994). Due to this discomfort, the favorite solution is to install an air-conditioning unit to the particular space that needs cooling. It is, at best, only a temporary solution, works only for those who have a high income and completely disregards health issues.

2.2 Natural lighting

The deep design of the typical units often resulted in a lack of adequate daylight in the inner space. Most houses depend on windows or glass door for natural light either from the front or the rear of the house. Various regulations were imposed under the 1984 Uniform Building By-laws (UBBL) to ensure the incorporation of clerestory windows to avoid this inadequacy. Others feature the central courtyard design. Unsightly renovations to the front porch and rear kitchen area however have rendered the light penetration especially to the centre space, minimal.

2.3 Thermal comfort

According to Yuan (1987), the main causes of climatic stress in Malaysia are high temperatures, solar radiation, humidity and glare. In order to achieve climatic comfort in the Malaysian home, these factors must be controlled besides the control of rain, floods and occasional strong winds. Yuan also noted that to achieve thermal comfort in the warm humid Malaysian climate, solar heat gain by the building and human body

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must be minimized while heat dissipation from the body must be maximized by ventilation and evaporative cooling.

In most terrace houses today, comfort equals round the clock air-conditioning. Various features and components are not considered in the thermal comfort of a house. Roofs for example are not designed with ventilation louver to disperse trapped heat. Thus, house owners would rather close all doors and windows and to turn on the air-conditioner in order to achieve coolness.

2.4 Privacy violation

Built on ground, terrace houses are renovated to the boundary lines incorporating high defense walls and security to secure privacy from not only passerby and strangers but also pesky neighbors. To add to those layers of visual defense, clothes are hung to dry on rows of movable drying units at the front porch where the cars are missing during the day. Gone are the social and community values as seen in the kampong.

It is difficult to differentiate and demarcate the territories of public and private spaces in the village. Due to the preference for community intimacy over personal privacy, house compounds are often open and unfenced, making private spaces undefined and merges with the public spaces. As discussed later, this leads to a well-integrated spatial environment which promotes close community ties in the village.

2.5 Social and security

There are no definitive areas for social interaction and activities. The front porches are renovated to accommodate a row of cars and the children most often scattered away to play on the street where they are exposed to constant threat of accidents and mishaps. During times of social function such as *khenduri* or a wedding, the street transformed to cater to welcoming guests an audience. Community living in the urban areas is significantly different than that of the rural villages. As urbanization rate increases, there is a pressing need to improve community living in today's neighborhoods as "neighborhood is seen as the most important urban element that establishes the social and economic sustainability of the area, providing the community ties which hold it together..." (Neal, 2003: 8). Efforts to improve neighborliness in today's urban community must be taken seriously because the social values in the urban areas are characteristically different than the rural community. Yahya (1995: 45-40) highlighted

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that in the urban areas, there are less cohesive relationships, greater individual freedom, breakdown of traditional values, problems of adjustment, differences in family relationship and increase in social distance.

2.6 Environmental

As recently, even the terrace-housing scheme has not been spared the wrath of Mother Nature. Constant flash floods have wrecked havoc to the nation with incurred losses in the amount of millions. Our forefathers were aware of that but not many of us have taken cues.

3. The Missing Element - The Raised Floor Of The Traditional Malay House

The essence of modernism and its subsequent philosophical and aesthetic development have often not been understood by many architects in Asian countries. At the same time, a respect for tradition and our own architectural heritage is widely acceptable. They provide the basic foundations toward developing an exciting contemporary reinterpretation of the vernacular. The manifestation of the traditional Malay house can easily be identified by the three basic elements of architectural studies. They are the elements of floor, wall and roof. The traditional Malay house clearly shows a distinctive separation as evident in its zoning of the elements (*refer to Figure 2*). Many a research has been done to dissect and look at various components and elements of the traditional Malay house but the raised element has not been considered to a great length.

The raised floor of the traditional Malay house has often presented itself with many possibilities. In an environment which is characterized by heavy, tropical rain accompanied by the now frequently heavy flash flood, the raised floor tradition is perhaps the most ideal and immediate solution to the problem. This is a vital design element, which has been overlooked for years and which design could possibly bear a significant impact on our housing system. It is the reflection of the society's accumulated wisdom and collective images. The traditional raised floor not only allows for easy passage of air into and through the house but the area beneath the house is also comfortable for children to play and venue for various daily activities (*as depicted in Figure 5 and Figure 8*).

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4. Lessons From Modern Architecture – Le Corbusier And The 5 Points of A New Architecture

The theory of Le Corbusier is multi-faceted and defies simple explanation. A fundamental aspect of his theory is that architecture relates to a fixed world-order. From Vers une Architecture:

Architecture is a thing of art, a phenomenon of the emotions, lying outside questions of construction and beyond them. The purpose of construction is to make things hold together; of architecture to move us. Architectural emotion exists when the work rings within us in tune with a universe whose laws we obey, recognize and respect. When certain harmonies have been attained, the work captures us. Architecture is a matter of "harmonies," it is a "pure creation of the spirit." (Vers une Architecture, p 23)

Another aspect of Le Corbusier's philosophy was his concern for a new architecture relative to current times. Each era or period should create its own works of architecture. He has an inherent belief that forward progress is good. *"If a man does not move forward he becomes bankrupt." (Vers une Architecture, p 101).* Vers une architecture contains many images of airplanes, motorcars, and ocean liners – examples of modern technology and progress. Other strands of modernism current at that time felt that a clean break from the past was necessary, by virtually starting with a blank slate. Le Corbusier is different in this regard as he maintains links with the past. The most obvious, as noted above, is a belief in an absolute. In addition, Le Corbusier draws selectively from the past of Western architecture. He uses examples of Greece, Rome, and other periods to amplify his various arguments. Le Corbusier was a man to whom ideas were fundamental. It is therefore interesting to see some of the results of his thought processes, even if the underlying rationale is not made clear.

The five points can be summarized as 1) Supports or Pilotis 2) Roof gardens; 3) Free design of the ground plan; 4) Horizontal windows; and 5) The free design of the façade. It was Le Corbusier's Villa Savoye (1929-1931) that most concisely summed up his five points of architecture that he had elucidated in the journal *L'Esprit Nouveau* and his book *Vers une architecture*, and which he had been developing throughout the 1920s.

By supports, Le Corbusier states the ground level of buildings should be raised 3 to 6 metres above existing grade, so that "*the rooms are thereby removed from the*

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dampness of the soil; [and]they have light and air." (Le Corbusier and Jeanneret, P., Five points towards and new architecture, in Programs and manifestoes on 20th-century architecture, Conrads, U. - Editor, (MIT Press 1975) p 99). The main floor of Villa Savoye is set one level above grade. With the exception of bedrooms for the servants (who apparently are not covered by this manifesto), there are no primary rooms at grade level.

What this does is literally and figuratively separates the house from the ground (*Figure 3*). It is an interesting contrast to other design philosophies that seek to merge the dwelling with the earth, and to incorporate the experience of a tactile terra firma or ground in a design. However, the disassociating of the house with the ground does allow the perception and experience of the house to be more cerebral. It allows one to fully appreciate the absolute harmonies to which the composition is attuned.

Figure 3: Villa Savoye – Main building mass is raised on columns

5. The Modern Concept Of Raised Floor Housing

The concept of terrace raised floor housing as shown in *Figure* 4. Based on its main component, the floor system of traditional Malay house has often presented itself with a multifaceted usage, be it technically, environmentally or socially (*See Figure 5*). Its characteristics can be considered when designing with the modern concept of raised floor.

The raised floor can be designed to allow for:

- Ventilation (good air flow movement);

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- Lighting (good light filtering in from the floor);
- Thermal Comfort (retardant from direct heat from the ground);
- Safety and Security (space for children as well as hindrance to thief);
- Privacy (visual and social);
- Functionality (multifunction of usage); and
- Economy (low energy usage, cost effective);

Figure 4: Raised Floor Terrace Housing Concept

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The raised floor presented solution to social responsibilities such as bathing the physically challenged elderly and also bathing the deceased.

Gaps between the floorboards solved problems of house cleaning, ventilation and also lighting.

Gaps between the floorboards under kitchen shelves for ventilation purposes.

Figure 5: Floor functions of a traditional house

5.1 Advantages of the new design

As with the raised floor of the traditional house, the new raised floor design presents us with several possibilities.

- Better ventilation (houses are cooler);
- Natural lighting quality (a more radiant house);
- Saves energy (less lighting needed);
- Adjustable mechanism for improved thermal comfort, ventilation and lighting; and
- Ample community space.

The question that truly begs at this juncture is that can the raised floor design increases livability as well as providing functionality and aesthetics to the modern Malaysian home. An innovative design is hereby proposed. It is also fair to reason out that the comparison made between the traditional Malay house and the modern terrace house is in the architectural elements or better yet the missing element. The traditional Malay house is selected as compared to the perhaps traditional Chinese shop houses or the Sarawak longhouse as it is the most prevalent traditional architecture in the country.

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6. Solutions Presented By The Raised Floor Innovation

6.1 Ventilation

Ibnu Khaldun in his magnum opus 'Muqaddimah' stated that the most important aspect of city planning is the presence of moving air. There should be maximum air movement. The rows and rows of terrace housing somehow pose a tricky problem for air movement. Yet there is a potential to increase the air movement in terrace housing design. The traditional Malay house with its raised floor design captured wind of higher velocity. It provides for cross air ventilation, which is an important aspect of passive design. The terrace housing with the raised floor innovation could provide with air movements throughout the housing scheme (*See Figure 6*). In addition, it could also provide an alternative floor construction with the inclusion of the adjustable floor louvers (*See Figure 7*). This would therefore helps the floor 'breathes' naturally. The adjustable floor louvers could assist in diverting some of the cross air from under the floor into the house and through to the rear.

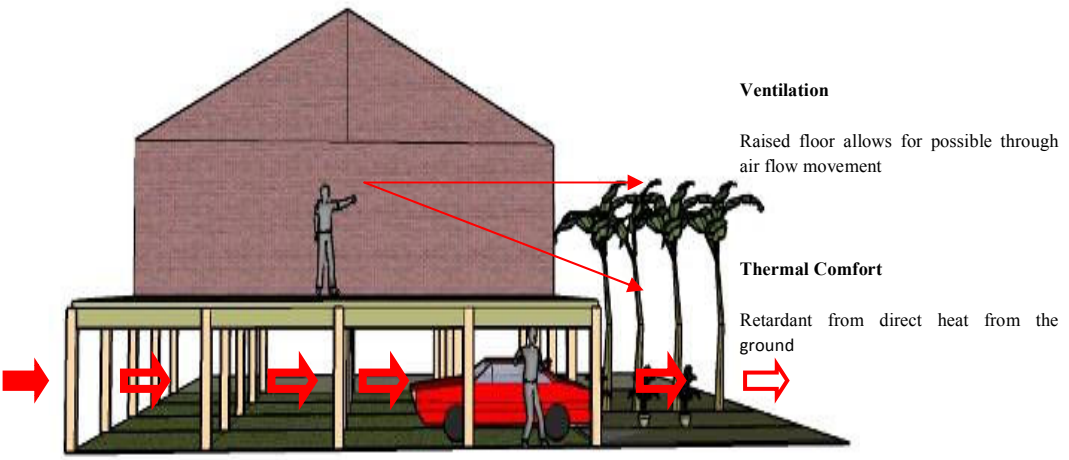

Figure 6: Cross Section of proposed raised floor innovation

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6.2 Lighting

The long and narrow orientation of the terrace house limits the amount of natural lighting penetration. Most terrace houses rely on mainly the openings of windows from the front and rear of the house to bring light in. The raised floor innovation could enhance the light qualities into the house with the use of floor openings. Such openings can be incorporated in any suitable part of the house. The whole construction of the house could also be integrated with Industrialized Building System (IBS) and the openings be in modular form and added or subtracted according to the home owners' preference (*See Figure 7*).

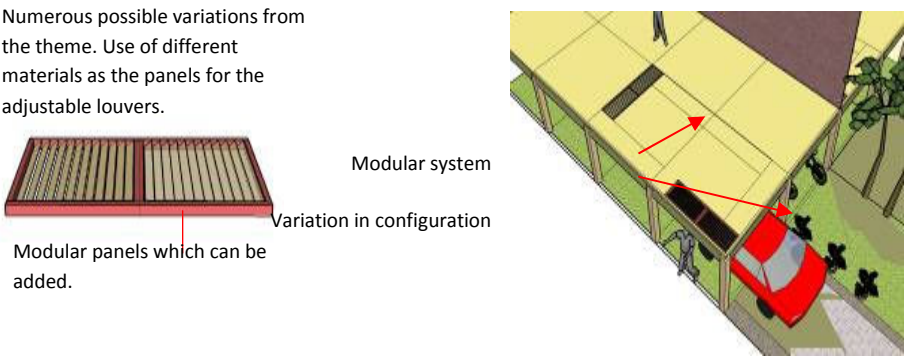

Figure 7: Adjustable Floor Louver

6.3 Thermal comfort

Another important strategy with the raised floor innovation is the consideration of various construction materials for its floor component. Our modern terrace housing is designed incorporating reinforced concrete floor. Concrete has heat retention and radiating property. In the daytime it soaks up heat and radiates it back in the evening and at nights. The raised floor innovation allows for the use of timber as its floor system. The combination of timber flooring and reinforced concrete construction will eliminate much of the problems of thermal comfort. In addition to that, the floor openings could incorporate devices as the adjustable floor louvers to divert air in and through the house for better air circulation and the floor boards could also have gaps to allow for air.

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6.4 Privacy

One of the planning elements that cause privacy violation in terrace housing design is the direct visual connection from outside to inside. This has never been a major problem in the traditional Malay house design as a direct eye level visual is never possible. In the traditional Malay house, the privacy gradient begins at the house lawn and increases in level to the *serambi* and finally to the *rumah ibu* or mother house. The *rumah ibu* or mother house is separated by units and doors from the *anjung* or *serambi* which form the front part of the house. The *rumah ibu* presents the innermost sanctum of the family and only relatives and family members are allowed. In our modern culture, the *rumah ibu* is located on the upper floor and is disconnected from the formal male dominated front portion of the house. Children when exiting the house can often disrupt the conversation of elders in the living room without respect. The raised floor innovation could therefore provide an alternative exit from the uppermost level onto the ground level without even passing through the living room.

6.5 Social Aspects

In contrary to the use of the front porch or the *serambi* of the terrace house, the *anjung* or the *serambi depan* of the traditional Malay architecture presents us with many social functions. It can be used by the men for conversation area, siesta and *khenduri* or function. The *dapur* or kitchen at the rear of the traditional Malay house would then be used in support of the *khenduri* by preparing food for the occasion. The modern terrace house on the contrary, would undergo massive transformation as soon as it is available for occupation. When house owners renovate their porch into a *serambi depan*, they have forgone not only the privacy distance but also the potentially social aspect of the house. The raised floor innovation would thus assist in recreating the many social aspects long been missing in our community. It could be designed to accommodate a space with many functions. The space could be designed for social function gatherings, food preparation area, playing area for children, place for gardening and even the drying of clothes or parking. (*See Figure 8*).

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The area could be use as extended space for social functions such as 'khenduri'.

The area beneath the house is comfortable for children to play and various daily activities.

The raised floor of the traditional Malay house is an effective counter measures from flood, wild animals and etc. It allows easy passage of air into and through the house.

Figure 8: Raised Floor functions of a traditional house

6.6 Environmental

The most important aspect of the raised floor innovation, however, would be the immediate solution to the severe flash flood that has hit Malaysia in the recent years (*See Figure 9*). The traditional Malay house has acknowledged the problem of flood and has adjusted the raised floor level accordingly. Therefore it is wise that we give it a serious consideration for our future development. It could very well be Malaysia's architecture identity.

Constructing buildings on stilts and turning the Environment Friendly Manual (Masma) into law are among the proposals made by the Permanent Commission to Control Floods to check floods whenever there is a heavy downpour. The previous Natural Resources and Environment Minister (Datuk Seri Azmi Khalid) mentioned that the commission has been tasked with looking into solutions for flood woes, which cost the Government almost RM1bil yearly in aid, relief and other forms of assistance.

Datuk Seri Azmi had also agreed to look into the possibility of having buildings raised above ground so that there would "be room for water to flow, especially when it rains heavily." He further noted that, "It is time to look into the traditional ways of

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construction. In the old days, houses were built on stilts, not only to prevent wild animals from entering the house but also to avoid flooding. It is not impossible for buildings to be built this way today?"

Figure 9: Flood causing havoc to daily activities

7. Conclusion

Sometimes it requires Mother Nature to indicate to us what we have opt to neglect. The 'raised floor design" incorporates exciting features that addresses issues such as thermal comfort, ventilation, lighting, aesthetics, comfort and social. Furthermore, this design can be immediately used in Malaysian housing due to its adherence to standard measurements.

Research in this area could provide a better design solution, flexibility for a current and new scenario of terrace housing or for what matters even more, any building design in Malaysia, which satisfies both private and public spaces. The design scheme will enhance local and existing culture, integrates into public facilities and activities and can be stretched into a new community lifestyle. This can be tested on in new residential areas, urban as well as suburban areas. The design could incorporate low energy design in order to build a sustainable mass housing architecture.

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