

## PAPER 1: THE GRAMMAR OF TRADITIONAL MALAY LONG-ROOF TYPE HOUSES

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**Abstract.** In this paper, the grammar of the traditional Malay houses (TMH) built in the past century is presented. The basic unit structures that form the shape of the TMH are first derived. Evidences of the basic unit structures or their combinations were documented by previous researchers and are used as a way of explaining the physical, spatial and functional relationships of the built forms of the TMH. The scope of the study is currently limited to the original TMH of the *bumbung panjang* (long roof) type in which the key features of the houses were easily discernible from the side view. The shape addition rules for generating these structures are used to characterize the compositional aspects of TMH style.

Keywords: Shape, Grammar, Traditional Malay Houses, Architecture

### 1. Introduction

The traditional Malay houses (TMH) are located within the peninsular of Malaysia and are a form of local indigenous vernacular architecture from the colonial era. The houses provided a glimpse of the life of the Malays in the 19th century and represent the local cultural heritage. The houses were built by master carpenters and builders. Due to the wooden materials used in the construction of these houses, many are no longer usable and some have been left unattended. Many efforts were made to document these houses by architects and enthusiasts as well as to preserve the houses. The focus in the literature work was concentrated in documenting the built forms of the houses that includes the construction methods, the built-environment analysis, and ordering principles (Kamaruddin, 1983; Nasir, 1985; Yuan, 1987; Gibbs, 1987; Raja Bahrin Shah, 1988; Nasir and Wan Teh, 1994; Syed Iskandar, 2001; Mohd Tajuddin et al. 2004). Recently, a more systematic data collection in the form of cataloguing of photographic collections and measured drawings has been undertaken. Figure 1 shows an example of one of the earliest records of TMH while Figures 2 and 3 show drawings of 2-unit and 3-unit TMH from the eastern region.

The construction of the TMH has been influenced by the iterative adoptions to local conditions such as religion, climate and materials. Within the Peninsular of Malaysia, there exist three distinct regions - northern, central and eastern, in which the TMH differs in styles. However, since the regions are subjected to almost similar local conditions, it is therefore not surprising to find the similarity of shape in most of these houses. This paper attempts to study the form and style of the TMH from the shape grammar approach in order to enable proper coding and compilation of the various built forms in a computing environment. The scope of the study is currently limited to the original TMH of the *bumbung panjang* (long roof) type in which the key features of the houses were easily discernible from the side view.

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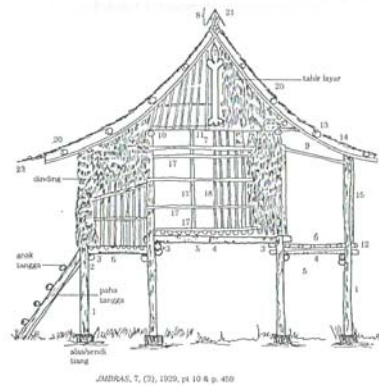


Figure 1. A form of the TMH (adapted from Yaakub, 1996)

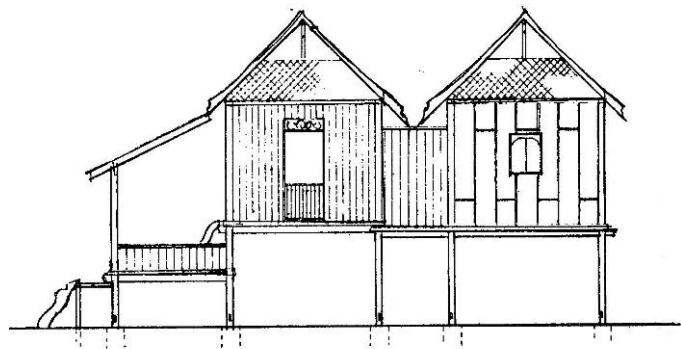


Figure 2. A form of the TMH (adapted from Nasir, 1985)

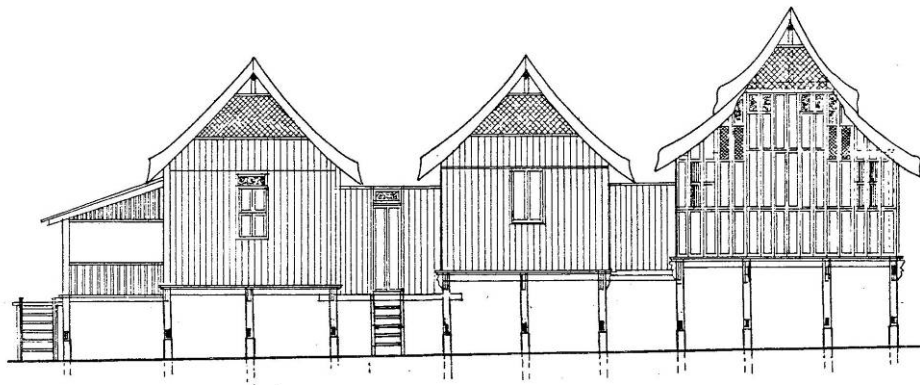


Figure 3. A form of the TMH (adapted from Nasir, 1985)

## 2. Related work

There has been a recent interest in the reconstruction of ancient or vernacular architecture in a digital environment (Liu et al. 2005, Li et al. 2005, Müller et al. 2005). This interest can be partly attributed to the availability of high computing power at a lower cost as well as the interest in the preservation of a dying culture. Liu et al. 2005 modelled the ancient Chinese timber-structure building in the early *Tang*-Dynasty in Hong Kong. Their research aims to provide effective methods to preservation of ancient timber-structure buildings as well as a way of managing preservation projects. Li et al. 2005 on the other hand modelled the ancient Chinese

architecture based on the construction constraints illuminated in the book *Yinzaofashi*. Müller et al. (2005) combined GIS (Geographical Information Systems) data with shape grammar rules derived from historical information to efficiently create detailed large scale Roman housing architecture.

Another facet to this interest is the development of pictorial generation theory that enables shapes and images to be analysed in a systematic way. An example of this is the shape grammar analysis that can be used to study an existing design and to generate new designs based on the design grammar rules. A shape grammar consists of a vocabulary of shapes (with or without labels), a set of shape rules, and an initial shape. The rules are presented as transformations of a shape or collection of shapes to a new shape or collection of shapes. Applied recursively on an initial shape, the rules produce designs that are said to belong to a language. The benefits of shape grammars over other language mediums when analysing and communicating the design of forms, are that they facilitate exploring the generation of other designs with the same style or convention (Stiny, 1980). Some examples of shape grammars applied to historical built forms are the *Palladian Villa Grammar* (Stiny and Mitchell, 1978), the *Mughul Garden Grammar* (Stiny and Mitchell, 1980), the African homesteads grammar (Herbert et. al 1994), the Taiwanese vernacular dwellings (Chiou and Krishnamurti, 1995), the traditional Turkish houses grammar (Cagdas, 1996) and the *Yingzao fashi* grammar (Li, 2001).

### 3. Descriptions of a Traditional Malay House

The TMH is comprised of the physical, spatial and functional elements. The functional element consists of a list of activities that may take place within the spaces of the houses that include receiving of guests, cooking, dining and sleeping. These activities are closely tied to the spatial elements because of the culture and tradition of the Malays. The inter-relationship of these elements forms rules that determine the hierarchy of spatial importance in the TMH. The spatial element consists of spaces that form the TMH.

A key feature of the TMH is the roof structure which is made up of two timber post and beam structures, supporting a high-pitched, gabled roof called the *bumbung panjang*. The *bumbung panjang* features were accepted by researchers as the original form of the TMH that were not affected by any colonial influence. The *rumah ibu* (mother house) occupies the space under the *bumbung panjang*. The *rumah ibu* is considered as the core area of the house with its floor level being the highest. Most of the activities conducted within this space are performed by the women. These include sleeping, sewing, praying, ironing, studying, and even feasting. Full length windows can be found at the front and back of the *rumah ibu*. The *rumah ibu* may exist entirely by itself and is considered as the most basic form of the traditional Malay house (Figure 4). The built form of this simple house has been documented (Raja Bahrin Shah, 1988). In Figure 4, a simple geometrical shape made up of two lines, a square and a triangle is offered as a representation of the built form.



Figure 4. A simple geometrical representation of the basic TMH (adapted from Nasir, 1985)

Figure 5 and 6 show the common forms of the TMH. The *serambi samanaik* (a verandah attached to the *rumah ibu* on the same floor level and facing backward) could be constructed

together with the *rumah ibu* as part of the nine-post structure and housed under the skillion roof that is attached to the *bumbung panjang*. The *rumah ibu* and the *serambi samanaik* are integrated functionally, spatially and structurally. The *serambi samanaik* is a transitional space between the *rumah ibu* and the *rumah dapur* (kitchen house). The *serambi gantung* (a hanging verandah attached to the *rumah ibu* facing the front of the house) is slightly wider than the *serambi samanaik* and at a lower level to the *rumah ibu* (Gibbs, 1987). This place is used to entertain male guests. It is roofed under skillion roof attached to *bumbung panjang* on the other side of the *rumah ibu*, opposite of the *serambi samanaik* area. The geometrical representation of this built form requires a more complex combination of lines and closed polygons.

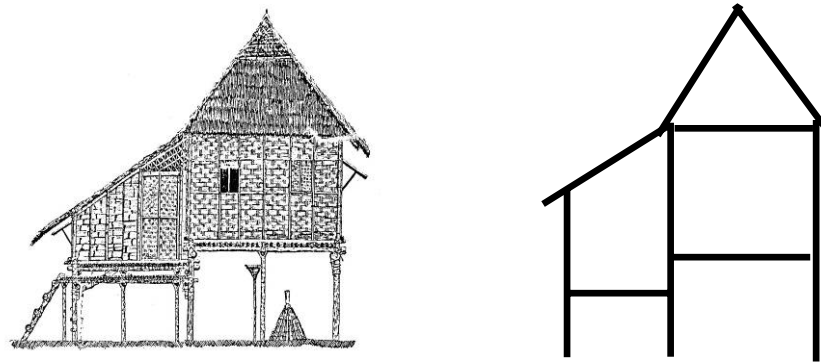


Figure 5. A common form of a TMH and its geometrical representation of the basic TMH (adapted from Nasir, 1985)

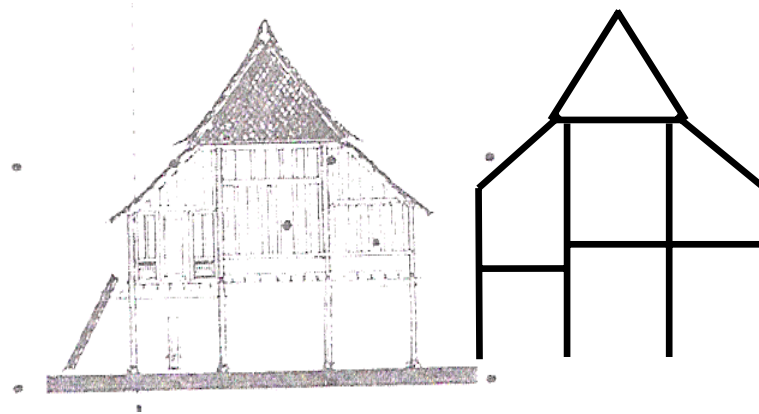


Figure 6. A common form of a TMH and its geometrical representation (adapted from Nasir, 1985)

#### 4. Compositional form of TMH

From the analysis of the documented evidences, we arrive at the general compositional form of the TMH as shown in Figure 7. The form consists of a core space occupying the area under the gable roof above an elevated floor and additional spaces attached to the core space to its left or right. These additional spaces are roofed under the skillion roof and are also above elevated floors. The levels of the floor of the additional spaces could either be below the level of the floor of the core space or at the same level. However, due to social and functional

constraints, the floor levels of the additional spaces are never above the level of the floor of the core space. The various forms of the TMH are due to the presence or absence of the additional spaces as well as the various possible floor level combinations. Figure 8 shows the first four compositional forms that are possible with the addition of one space to the core space.

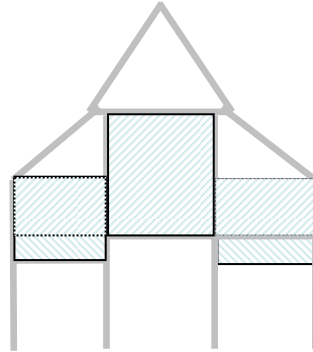


Figure 7. A general compositional form of a TMH

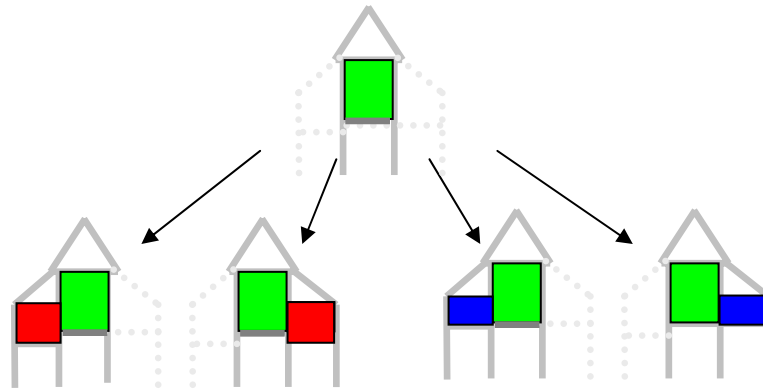


Figure 8. Addition of one space to the core space of a basic TMH

From the resulting forms of one space addition, we could further add another space on the opposite side of the earlier added space and this will result in another four forms of the TMH with three spaces (Figure 9). This addition is purely from the geometrical point-of-view since spaces on the same floor level are not added later but are constructed at the same time as the core space as they share the common floor joist.

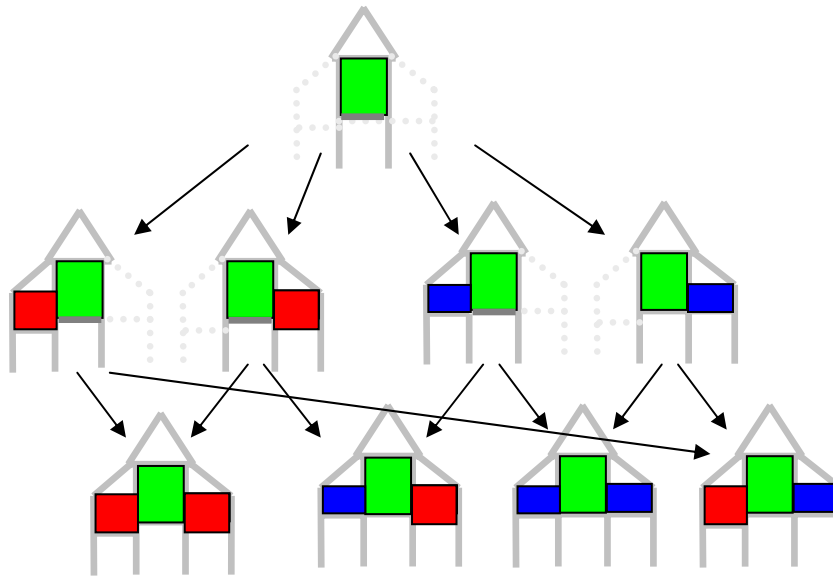


Figure 9. Addition of a second space to the core space of a basic TMH

The above process yielded the nine possible basic shapes of TMH with one, two and three spaces under one high-pitched gabled roof. Each of these shapes could form a house unit completely by itself. The shapes in Figure 9 can be rearranged as shown in Figure 10 to show the space development process with the central figure being the most basic shape of TMH.

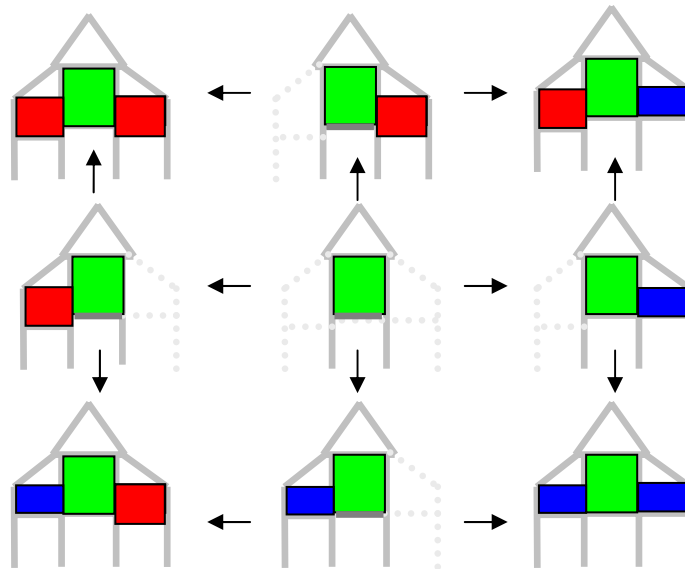


Figure 10. The nine basic shapes of TMH

Other forms of the TMH are as a consequence of combining two or three of the basic shapes. Figure 11, 12 and 13 show examples of the addition of two basic shapes or units to form a new TMH. The added shape is called *rumah dapur* and it has the same form as the basic shape called *rumah bujang*. A key feature of this addition process is the presence of the space separating the two shapes, called the *selang* or *pelantar*. The *selang* is typically an open space platform with or without an entrance on its side. The *selang* may be formed by a separate floor joist or by extending the floor joist of the space to be added.

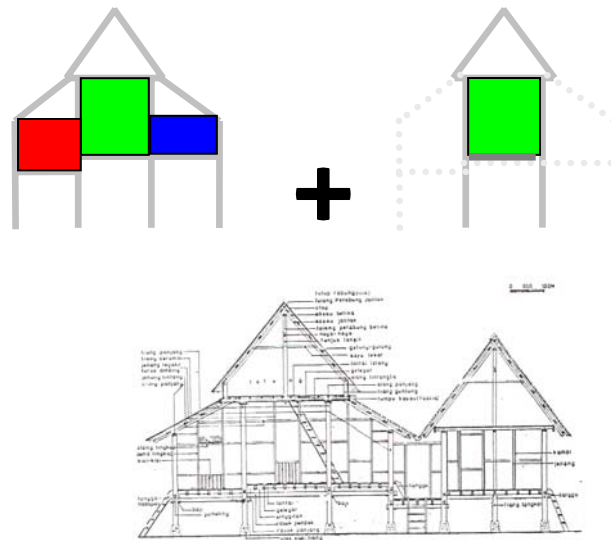


Figure 11. The addition of two basic shapes to form a new TMH (adapted from Nasir, 1985)

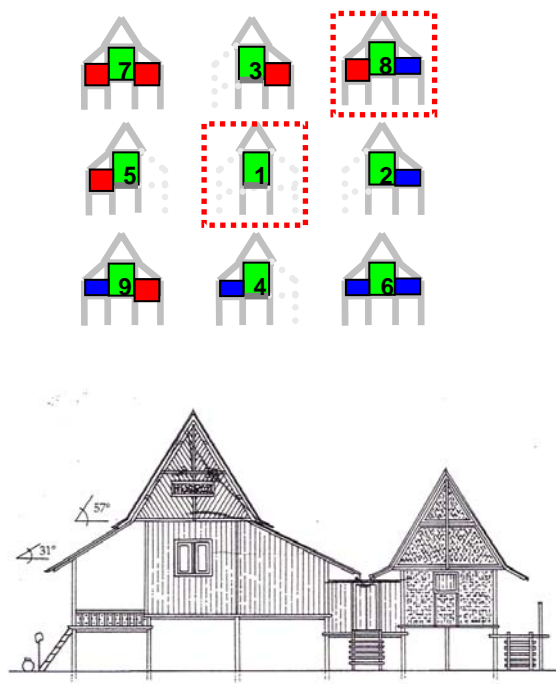


Figure 12. The addition of two basic shapes to form a new TMH (adapted from Nasir, 1985)

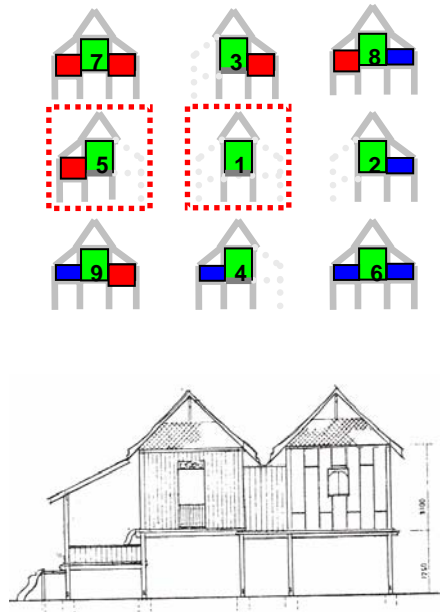


Figure 13. The addition of two basic shapes to form a new TMH (adapted from Nasir, 1985)

A more complex addition would involve three basic shapes, as shown in Figures 14 and 15. The *selang* between the core shape on the left and the middle shape (*rumah tengah*) is formed by extending the floor joist of the middle shape, while the *selang* between the middle shape and the end shape (*rumah dapur*) is formed by its own floor joist.

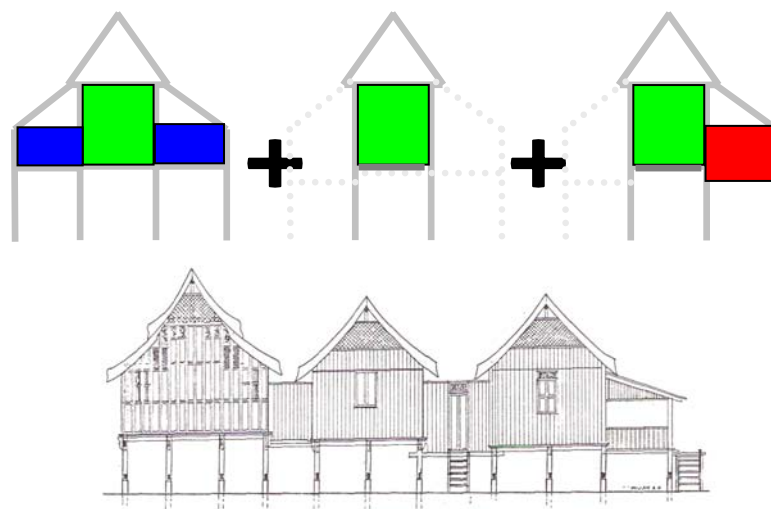


Figure 14. The addition of three basic shapes to form a new TMH (adapted from Nasir, 1985)



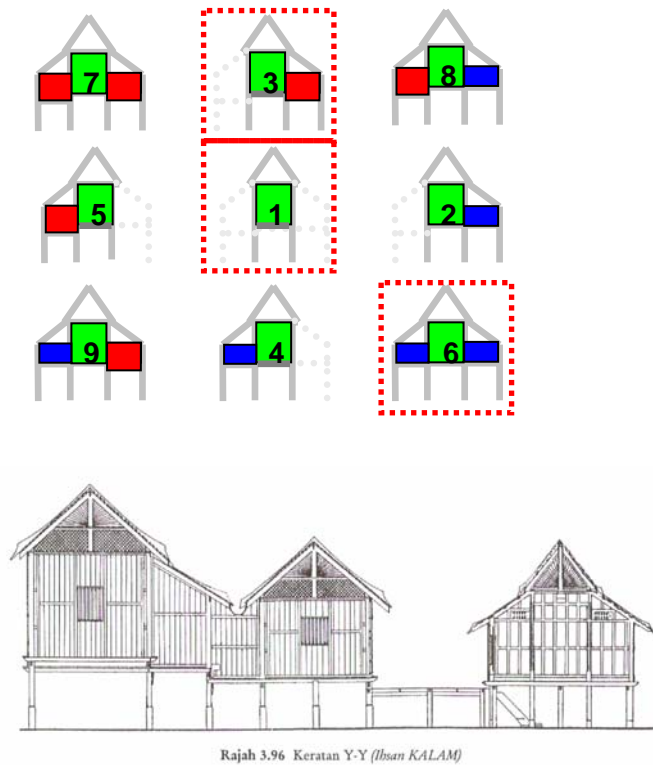


Figure 15. The addition of three basic shapes to form a new TMH (adapted from Mohd Tajuddin et al. 2004)

#### 4. Construction Elements of Traditional Malay Houses

To enable fast generation of the skeleton of the TMH, a construction grammar is used. The construction grammar follows the approach of shape grammar. The details of the construction grammar for the TMH are presented in Said and Embi, 2007a. A shape grammar approach is used due to the fact that the shapes of TMH can be easily described using geometry. This approach resulted in the 9 basic shapes and the addition rules to generate all the possible styles of the *bumbung panjang* TMH.

The key elements used in the construction grammar are given in Table 1. Some of the key elements are illustrated in Figures 16 and 17. To create a 3-dimensional unit of the house, the generated structure is duplicated along the z-axis to make up the 2 x 3-, 3 x 3-, 4 x 3-, or 4 x 4-post structures.

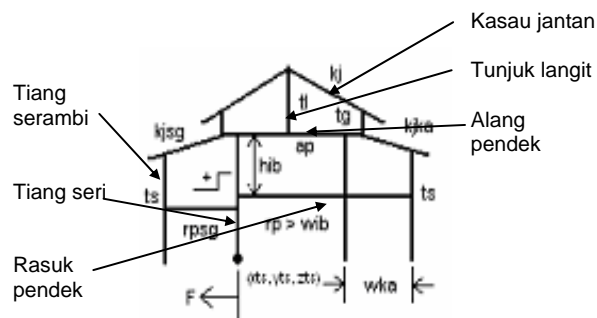


Figure 16. Primary construction elements of the TMH

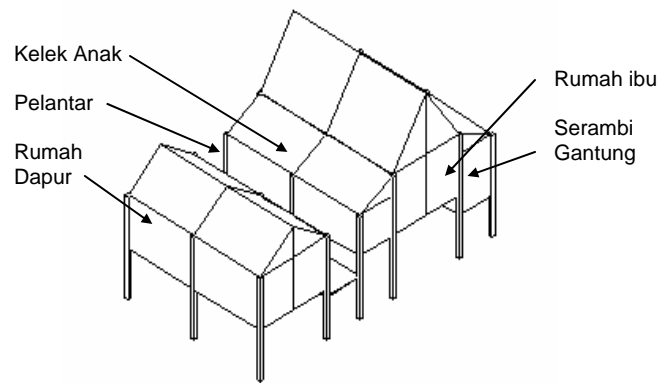


Figure 17. Primary spatial elements of the TMH

The space developments of the basic TMH are shown in Figure 18. The increase in spaces from left to right in Figure 18 typically depicts the need for the additional spaces. However, the phases of addition of spaces would be dictated by the form constructed in the initial phase. Unit [IB] is the simplest form of the traditional Malay house and is sometime called the *rumah bujang* (bachelor house) while unit [SG+IB+KA] is the most common form of a single-unit traditional Malay house and is fully capable to function as a family house. Examples of multi-unit traditional Malay house formed by the combinations of the basic single units are shown in Figure 18. The unit addition rules are as follows:

- i. The more popular main units with additional units are units [SG+IB+KA], [S+IB+KA] or [SG+IB]. However, in principle, any of the nine basic units could serve as the main unit.
- ii. All middle and end-units typically comprised of units [RT], [RT+KA], [RT+SL], [DP], [DP+KA], and [DP+SL]. The forms of [RT+KA/SL] and [DP+KA/SL] are similar to [IB+KA/SL] shown in Figure 14.
- iii. For middle and end-units, additional simple structure such as *jemuran* (a flat un-roofed structure) and/or stair may be added to allow for entrance and exit.
- iv. The floor level of the *selang* or *pelantar* (enclosed walkway connecting two units) can be at the same level of the additional units or at a lower level. Stairs may be added at the side of the *selang* to allow for entrance and exit.
- v. The floor level from the main unit to the end unit (facing backward) must be in a descending mode.

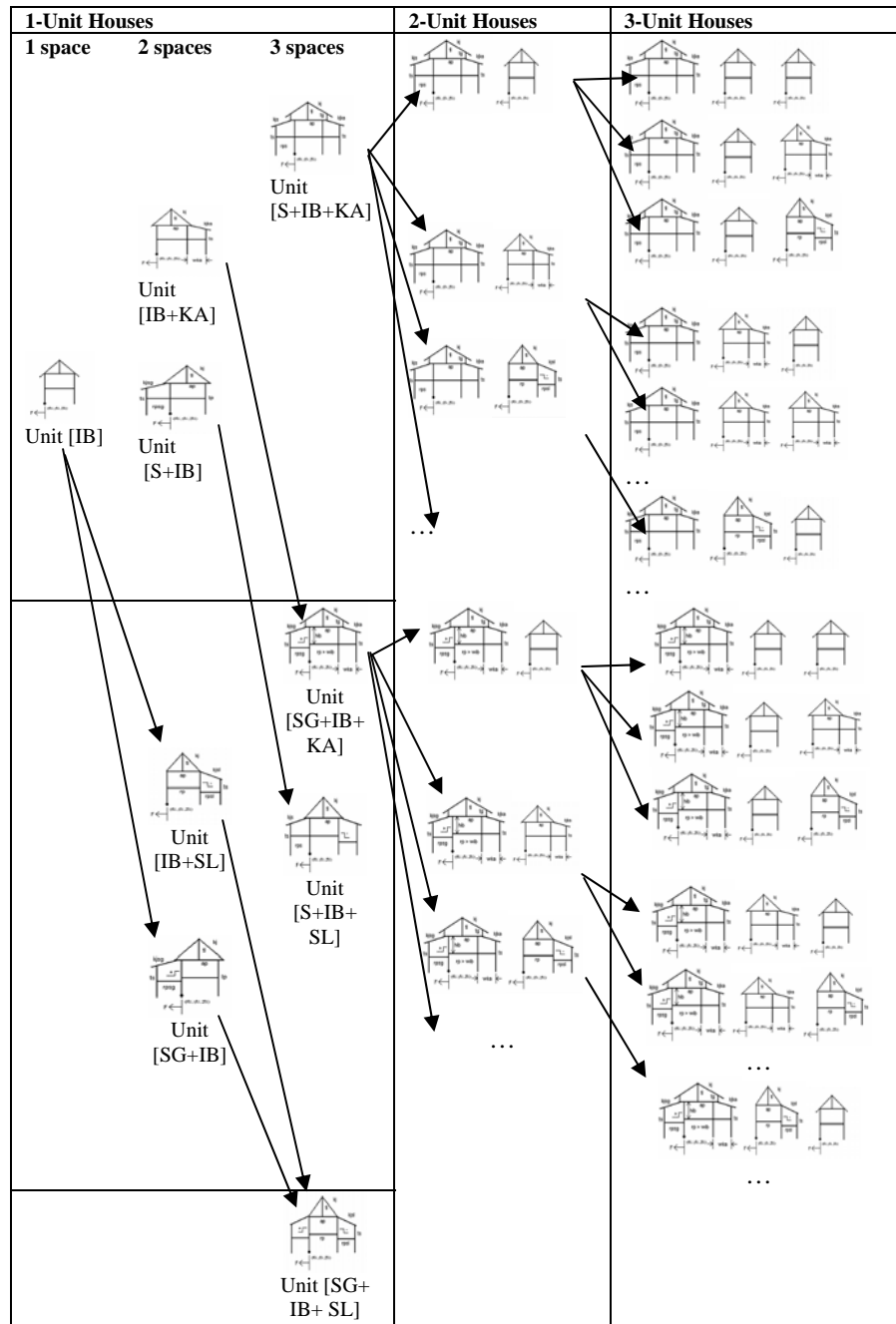


Figure 18. Some examples of 1-, 2- and 3-unit traditional Malay houses.

## 5. Digital modelling of TMH

Digital modelling of the TMH begins with generation of the basic forms using the construction grammar. A total of 9 basic structures representing the 9 basic units can be built as well as 27 seven 2-unit structures representing the combinations of the 9 basic units with three of the basic units that serve as the second unit. Up to 81 different 3-unit TMH can be built at the same time by the combinations of the basic units following the addition rules. Thus, a total of 117 unique different skeleton structures of TMH can be generated at any particular time. This represents the

more popular forms of the TMH out of the 819 possible forms generated from the combinations of 1-unit, 2-unit and 3-unit structures (Said and Embi, 2007b).

## 6. Conclusions

The grammars for constructing the forms of the long-roof typed traditional Malay houses based on the side elevations have been presented. The rules take advantages of the fact that the predominant features of the houses are the single *bumbung panjang* unit and the combinations of this unit or its variants. Nine basic units have been generated and the combination of these units has been validated with the documented built forms. Further work is to developed plan grammar.

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Table 1. Primary construction elements of TMH.

Elements	Name	Symbol	Data	Notes*
Point	<i>tiang seri</i> location (main post)	lts	$(x_{ts}, y_{ts}, z_{ts})$	Ground level
	direction of the house	hdr	[i, j, k]	To front
	Posts' arrangement of each unit	par	$[n_w \times n_b]_{MN}$	Re. spatial elements
Linear-physical	<i>tiang seri</i> (main post)	tp	length, size start/end pt.	Size= 1 <i>ketak</i> <sup>2</sup>
	<i>rasuk pendek</i> (short floor joist)	rp	as above	Size=1/3 <i>ketak</i> <sup>2</sup>
	<i>alang pendek</i> (roof tie girt)	ap	as above	as above
	<i>tiang serambi</i> (verandah post)	ts	as above	Size= 1 <i>ketak</i> <sup>2</sup>
	<i>tiang gantung</i> (hanging post)	tg	as above	Size=1/9 <i>ketak</i> <sup>2</sup>
	<i>tunjuk langit</i> (kingpost)	tl	as above	as above
	<i>kasau jantan</i> (rafter)	kj	as above	1/15 <i>ktk</i> <sup>2</sup>
	angle of the main roof	$\square$ (deg)	45-57	
	angle of skillion roof	$\square$ (deg)	30-40	
	<i>alang panjang</i> (girt)	ag	length, size start/end pt.	Size=1/3 <i>ketak</i> <sup>2</sup>
	<i>rasuk panjang</i> (floor beam)	rg	as above	as above
	<i>tulang bumbung</i> (roof ridge)	tb	as above	Size=1/9 <i>ketak</i> <sup>2</sup>
Planar-physical	<i>dinding</i> (walls) with <i>tingkap</i> (windows) and <i>pintu</i> (doors)	di	Tiles arrangement	Re. tile elements
	<i>tebar layar</i> (gables ends)	ty	as above	as above
	<i>atap</i> (roofs)	at	as above	as above
Spatial	<i>rumah ibu</i> (mother house)	IB	Y/N	Re. style generated
	<i>kelek anak</i> or <i>serambi samanaik</i> (verandah)	KA	Y/N	as above
	<i>serambi gantung</i> (hanging verandah)	SG	Y/N	as above
	<i>selasar</i> (rear hanging verandah)	SL	Y/N	as above
	<i>loteng</i> (attic)	LG	Y/N	as above
	<i>kolong</i> (space beneath the floor)	KG	Y/N	as above
	<i>selang/pelantar</i> (intermediary spaces)	SG/PL	Y/N	as above
	courtyard	CT	Y/N	as above
	<i>anjung</i> (verandah addition)	AJ	Y/N	as above
	<i>rumah dapur</i> (kitchen)	DP	Y/N	as above
	<i>rumah tengah</i> (middle house)	RT	Y/N	as above
	<i>rumah tangga</i> (stair house)	RG	Y/N	as above
	<i>tangga</i> (stairs)	TG	Y/N	as above
	<i>jemuran</i> (flat unroofed structure)	JR	Y/N	as above

\* *Ketak* (or *ktk*) is the length between the first knuckle of the first finger and the tip of the thumb of an adult person