Timber Defects In Building: A Study of Telapak Naning, Malacca, Malaysia

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ABSTRACT: Timber traditional houses can pose a significant image of Malaysian built environment heritage. It is then crucial for professional to undertake the responsibility in ensuring the timber houses still in a fair condition. In judging the building condition, it is good to have a more concrete evaluation, so that the reliable recommendation can be made within short period of time. The Prioritize Ranking System is deem fit for this purpose. The streamline methodology of the system is using the numerical coding for the survey pro forma. From the prioritize ranking, the data is then used as to foresee the condition of the house; either dilapidated, fair or good. Furthermore, the system enable the surveyor to identify the severity index of each defects and list the element to be repaired in order of priority. The system is tested to the small-scale timber traditional house namely Telapak Naning. The finding of the survey is found true in reflecting the current state of the house.

Key-Words: Building Survey, Prioritise Ranking System, Timber Defects

1 INTRODUCTION

Malaysia, in aiming towards Vision 2020 as a develop country; still have large numbers of timber traditional houses which scattered in the suburban and rural area throughout the country. Some of them age, perhaps a few decades; and a number of them have reached a century. Become old and 'antique' across time, it is indeed requires the evaluation of maintenance, for the purpose of repair and replacement, could be; as to function up to the standard as well as providing safety for the occupants. In addition to that, these traditional houses also have a very significant potential in being gazetted as national heritage. Therefore we have to put an effort in realising this potential, or otherwise it will just be a conservation paradigm.

Moving forward the direction, this research gives focus in establishing the certain criteria to be used in evaluating the timber defects for traditional houses. To date, there is very little in number of published research focusing specifically on rating these traditional houses. Syed Zainal [1995] through Badan Warisan Malaysia (Malaysian Heritage Trust) provides some valuable criteria in assessing the building that should be classify as national heritage. But then, it is more to town building as well as colonial types. A rating criteria was performed by Pitt (1997) and Alani *et al.* (2001), which actually inspired this research. Pitt (1997) and Alani *et al.* (2001) had come out with a rating criteria, that generally acceptable to be applied for any type of building; whereas Syed Zainal (1995) provides the criteria that specifically designated to access the performance of town buildings and colonial houses. With the intention to link the said gap, this research concentrates on the idea of providing the criteria to be used when evaluating the timber defects via a building condition survey work, in which part of it is modified from Pitt (1997) and Alani *et al.* (2001). Apart from descriptive survey, this research tries to develop the Priority Ranking System, with the use of more numerical data for coding and analysing purposes.

Therefore, this paper discussed the said numerical-building-condition-survey based namely 'Timber Defects Prioritizing Ranking

System'. The central approach of the system is to rank the timber defects that are found in one particular building. This will provide some guidance for the owner/care-taker in planning their repair (or replacement) work to be undertaken. After all, it will contemplate the current condition of the house, whether it is fit for occupancy or not. The discussion starts with the brief introduction of the timber house, literary discussion of the system as well as research approach, plus the survey pro forma adapted. It will then follow by the data analysis and discussion of finding, before end up with concluding remarks and future research to be done.

2 BRIEF DESCRIPTON OF TELAPAK NANING

Telapak Naning located at Kampung Sungai Jerneh, Brisu, Malacca, Malaysia, being among the oldest house within the vicinity. Telapak Naning has its own historical significance value. It takes about one hour and half by driving from the capital city of Kuala Lumpur, with estimated travel distance around 170 kilometres. Fig. 1(a) shows an image of Telapak Naning and background information in brief respectively. Telapak Naning was built in the year of 1800 as an arrogance of traditional Malay residential building by the great ancestors of Tuan Haji Nayan Karin. This 206 years house comprises many spaces for resting and welcoming guests (verandah), family occasion (huge main hall) and sleeping (bedroom).

In 1967, the custodian of the house built an annex building to provide shelter for his younger sister. He had also made some replacement to the few building materials. The original portion of Telapak Naning can be seen in Fig. 1(b). Now, the house is not occupied at most of the time. The younger sister of Haji Nayan has been responsible to look after the house since her house is built as an annex to Telapak Naning. The house is raised on stilt which built from timber. According to Hj Nayan, only one big tree was used during the construction. This tree is cut into pieces to adapt the traditional structure of the house, namely column, raised floor, wall framing and roof truss. The joining of the structure is majority based on the type of tongue-and-groof and mortise-and-tenon.

(a) The exterior of Telapak Naning

(b) The original portion of Telapak Naning

Figure 1(a) & 1(b): The house of Telapak Naning

In term of heritage or legacy setting, the special features of Telapak Naning predominantly affects by the historical value (as claimed by the custodian) of the house, which had been used by the Naning warrior named Dol Said as a place to rest, somewhere around 200 years back. This manifestation claimed to be true as it had been mentioned by national digest magazine in Malaysia, Mastika [2006] which stated that this house is a symbol of bravery and independence. As for further clarification, it should be confirmed by the Department of Museum, State of Malacca regarding the historical story line of the house. Until now, the house is proclaim to have some sort of supernatural element, in which it is said to give some sign if there will be anything likely to be happened to the family, or even to the area or *kampong*.

3 THE SYSTEM AND RESEARCH APPROACH

Building condition survey is part and parcel in the wide spectrum of building surveying profession. Traditionally, the condition survey is carried out by using the qualitative approach, particularly descriptive method of assessment. At most of the time, the quantitative is perhaps rarely adopted or not even at all. It is not intended to sentence the condition survey work under the traditional method. Indeed, the traditional descriptive one forms essential information for the condition assessment of one particular building as a whole. The valuable information provided is an essence.

The aim of suggesting quantitative approach in dealing with condition survey is actually not a new paradigm. The work of Pitt (1997) and Alani *et al.* (2001) suggests that the ranking system should be adopted, as one means to prioritize the defects in the building (Hollis, 2000). It forms as supportive documentation as well as essential information, apart from traditional reporting condition survey. By listing the defects in term of priority, the surveyor should be able to have a quick-referencing in getting the idea of the most severe or serious defects occurred. Theoretically, the data in the form of numerical is classified as hard and reliable, thus providing the tangible result of the building condition survey (Hollis, 2000).

The principal of carrying out the condition survey is following the 3-F approach as suggested by Hoxley (2002), namely focus, familiarity and freedom. In dealing with the survey work, it depends on the preference of surveyor, either outside-in or inside-out. Even so, in most cases the surveying work normally commenced from externally rather than internally. To illustrate the preference, Hoxley (2002) did mention about this matter as per quoted below;
"*...In many respects the order of inspection is a matter of the personal preference of the surveyor but what is most important is that the inspection is carried out in a logical sequence with which the surveyor is familiar...*" (Hoxley, 2002; pp. 32).

In completing the system, survey method is more likely towards visual inspection. Lee (1987) stated that in most cases, the method of visual examination is fair enough in identifying the defects causes by the experienced surveyor. In latter suggestion, Lee quoted that the use of survey instrument is much more needed for a more objective diagnosis. Considering this opinion, apart from visual inspection; the surveyor should also need to use some power tools in carrying out the survey. Since the system to be developed is dealing with timber defects, the most suitable instrument, as one to suggest, is moisture meter (we are using Protimeter for this survey). This is because the moisture content (MC) of timber member in building form a very identical mark in verifying the cause of defects i.e. the timber is free from rotting defects if the MC reading is not more than 20%. As suggested by Hoxley (2002) and Johnson (2002), a preliminary inspection is performed by walking around externally and internally, before proceeding with the detailed examination.

This survey used two (2) power tools, namely Laser technology and Protimeter SurveyMaster MM; and the scope of survey as per Fig. 2.

a) Laser technology (Impulse 200)
   Laser technology is use to measure any point of height in the building, particularly from ground level to ridge cap, in which the height cannot be determined by the dimension master because the end-point target for reflection is not parallel to the instrument (dimension master). Height measuring is adapted from a simple geometric concept, namely triangulation formed by the object, i.e. the ridge cap, the ground and the instrument.

b) Protimeter SurveyMaster MM
   A protimeter is used to identify the surface and internal moisture content of the timber element. The work is done in two modes, measure and search; the first indicates the moisture using the digital reading and the latter provides a colour-coded indication, green, yellow or red. Both measure and search mode will refer to the simple diagnosis chart shown in Table 1 to determine whether the timber

member has a condensation defect, rising dampness or no defect at all.

Remarks : October 2006 / Clear weather / Visual and Preliminary Inspection/ Detail Examination			
Scope of Condition Survey (Telapak Naning)	Covers: Exterior Public and Semi-private • Verandah • Living Rooms	Limita-tions	Excluded: Private Area (Bedroom) Attic Space Annex Building

Figure 2: Scope and limitations of condition surveys on site

Table 1: Simple diagnosis chart for Protimeter SurveyMaster MM (Protimeter, nd)

Measure Mode	Search Mode	Interpretation and Comment
Low Reading	Low Reading	Dry surface, dry below the surface – safe
Low Reading	High Reading	Dry surface, damp below the surface. Investigate further using Deep Wall Probes in Measure Mode
High Reading	Low Reading	Damp surface, dry below the surface – probable condensation
High Reading	High Reading	Damp surface, damp below the surface. Trouble. Investigate further with Deep Wall Probes.

Figure of Condition Survey Checklist For Timber Defects

No.	Const. Element	Design & Construction	Building Survey				Prioritise Ranking (Refer TOR)					P.SM		Remarks
			Defect Diagnosis		Defect Prognosis	Proposed Remedial	a	b	c	d	e	Measure Mode	Search Mode	
			Causes	Types										

Guidelines:

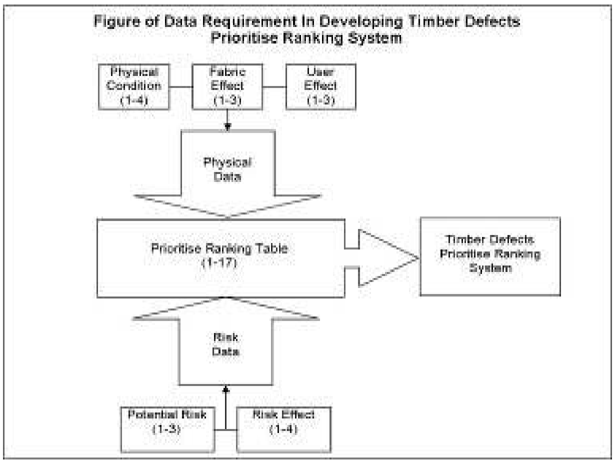
1 "Causes" code: 1 Insects; 2 Fungal; 3 Weathering; 4 Mechanical Failure

2 "Types" code: 1 Termites-Subterranean; 2 Termites-Drywood; 3 Termites-Others; 4 Beetles; 5 Other insect; 6 Wet rot (brown); 7 Wet rot (white); 8 Dry rot; 9 Soft rot; 10 Blue stain; 11 Other rot

3 Prioritise Ranking
a Physical Condition
b Fabric Effect
c User Effect
d Potential Risk
e Risk Effect

4 P.SM (Protimeter SurveyMaster SM)
[Measure=Surface; Search=Below]
L = Low ; H = High

Figure 3: Condition survey checklist for timber defects.



Physical data: Current condition of the building at the time survey conducted.

Risk data: The potential hazard that might be occurred to the building

The physical data and risk data is sub-divide into 5 categories, with 3 types

Figure 4: Data requirement in developing timber defects prioritise ranking system (modified from Pitt, 1997)

Condition survey normally covered the "A to Z" of the building, from structural to non-structural element. Since then, the development of quantitative data for the whole building element according to types of defects is very challenging to produce. It is because in preparing the quantitative data collecting procedure, the surveyor should establish the classification of many types of data such as types of cracks, dampness in building or insect attacks, to name a few. All of the information during the field work should be best coded directly in the form of numerical, or otherwise it will be wasted of time to re-code when coming back from the field. To do this, the possible classification of defects has to be identified in a first place (to form the element of the system), as to speed-up and provide minimum interruption to the flow of the condition survey work.

Data collection is mostly in the form of numerical coding. The checklist is very important as to ensure the report is safely prepared (Hollis and Gibson, 2000). The checklist design (as in Figure 3) covers the type of data required for the timber defects prioritise ranking system. The checklist is divided into 2 main parts namely building survey and timber defects prioritise ranking system. Apart from this, the design and/or construction of one particular element are also recorded. To accommodate with the system, most of the data entry is in the form of numerical, instead of descriptive data.

The causes of defects primarily fall within 2 categories, namely insects damaged or fungal infestation. Weathering is classified as secondary cause since its have close relation with the ageing factor and 'wear and tear' scenario, which sometimes cannot be claimed as building defects. Further, mechanical failure is likely to occur in the event of no repair or maintenance work carried out during the initial stage of defects. Therefore if the mechanical failure is highly rated, perhaps the particular building has possibility to highly prioritise for repaired.

Apart from causes in defects diagnosis section, the survey is required to have data on the types of defects, which form the details of diagnosis part. The first five types of defects as depicted in Figure 3 (under guideline no. 2) belong to the insects damaged category, whereas the rest up to eleven describe the details of fungal infestation. The surveyors' knowledge and experience give great influence in completing this section accurately.

Description of defects provides room for surveyor to jot down any relevant explanation in describing the defects, or perhaps simple sketches in doing so. This section is much more useful if defects recorded are to be found not fall within any category in the guidelines. Furthermore, it is advisable during the course of survey to record each defects identified on its own basis. This will give clear identification of the frequency or number of defects occurrence, which form an integral data to be used in determining the severity index of one particular defect.

By referring to Fig. 3, the latter section of survey pro forma indicates the information required for calculating the sum of timber defects in determining its priority. Two types of data have to be collected, which are the physical data and risk data as per Fig. 4.

From the survey checklist described above, the data on the latter part form integral information in developing the system. Two types of data have to be collected, namely the physical data and risk data. Physical data deals with the current condition of the building at the time survey conducted. For risk data, it associated with the potential hazard that might be occurred to the building, particularly the risk that gives effect to structural damage, which in turn lead to safety and health problem to the occupant (if the building is occupy).

The physical data and risk data is sub-divide into 5 categories, with 3 types and 2 types respectively as per Figure 4. The scale, chronology and linguistic value are provided in Table 2. The total score is 17, with reflects the lower is the higher priority. Both of the data is then sum-up as to get ranking of defects priority. Towards the end, one particular building that being surveyed is rated out of 3 conditions in term of building stability, namely Condition 1: Dilapidated; Condition 2: Fair and Condition 3: Good. The linguistic value and average marks of these 3 conditions is given in Table 3.

Table 2: Term of reference for timber defects prioritise ranking system

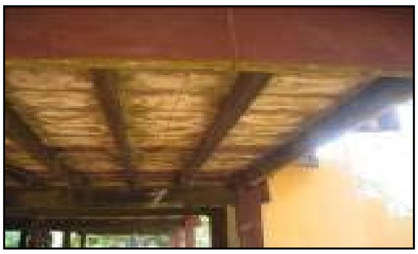
No.	Type of Data	Scale Value	Chronology Value	Linguistic Value
1	Physical Condition	0	Repair or replacement is needed within the period of 1 month	Element/structure not functional at all
		1	Repair or replacement is needed within the period of 1-6 month(s)	Serious defect, cannot functional to an acceptable standard
		2	Repair or replacement is needed within the period of 6-12 months	Functional sound, but need an urgency repair or replacement
		3	Repair or replacement is needed within the period of 1-2 year(s)	Structurally functional, only minor Defects
		4	No need for repair or replacement	Free from any visible defects
2	Fabric Effect	1	Significant effect	If one particular element/structure is malfunction, what is the possible effect to the other element/structure member
		2	Have effect	
		3	Minor or no effect at all	
3	User Effect	1	Significant effect	If one particular element/structure is malfunction, what is the possible effect to the other element/structure member
		2	Have effect	
		3	Minor or no effect at all	
4	Potential Risk	1	Most possible	Risk for structural damage, which in turn can lead to death or injury (if the scale value is 3, the "risk effect" should have the score value of "4")
		2	Possible	
		3	Not possible	
5	Risk Effect	1	Death or serious injury	Risk for structural damage, which in turn can lead to death or injury
		2	Injury	
		3	Minor injury	
		4	No risk associated	

Table 3: Condition assessment of the building

Condition	Linguistic Value	Average Total Marks
Condition 1: Dilapidated	✓ Not safe for occupancy	04-05
Condition 2: Fair	✓ Sign of defect in secondary structural member (not give effect to the building stability) ✓ Need repair or replacement	06-10
Condition 3: Good	✓ Main structural member is strong and stable ✓ Defects which influence aesthetic value only	11-17

4 ANALYSIS AND DISCUSSION OF FINDINGS

By the time survey is conducted, the ventilation meter indicates the surrounding temperature is 27 degree Celsius, with the air velocity of 2.5 m/s. This shows the possibility of low moisture content and providing the dry surface for the whole site. Proceed with the analysis, the result of condition survey is shown in Table 4. According to the number of appearances, rotting is the highest number of occurrence, followed by termites attack and beetles. Therefore, insect attacks and fungal infestation remain as the main causes of timber defects, since more than half of the number of defects recorded fall within these two categories of causes. The location of defects is mostly found in the exterior part of the house. The defects can be seen in Fig. 5.



(a)

(b)

(c)

(d)

Figure 5 (a), (b), (c) and **(d):** Defects which occurred at the surface of the timber at the site.

For the analysis of timber defect prioritise ranking, the lowest total marks is 5, whereas the highest score recorded is 16. The indication for marking system is the priority should be given to the lowest score. In this condition survey, the element of roof beam at staircase area is found to have the serious defects cause by fungal infestation, with the type of defect is dry rot. The score for this defected roof beam is 5 with the occurrence number is 1. The second serious defect with total mark of 10 is still cause by the fungal infestation, and located behind the area of defected roof beam. Total mark of 16 is recorded as the highest with prioritise ranking number 6; and 4 number of defects occurrence. The defects which classified as the least priority defects are caused mostly by the insect attacks.

The result of moisture content for defected timber element is depicted in Table 4, which shown under column of P.SM. A particular attention should be given to H (high) score, regardless whether the score is under measure mode or surface mode. Based on the survey result, the dampness defects could be raising dampness, since the characteristic of the reading is dry at the surface and damp below the surface. Thus eliminates the possibility of condensation defects. The roof beam which is the serious defects among 12 has the reading of low and high for the surface and below surface measurement respectively. As to confirm whether raising dampness is occur, a further testing should be done using Deep Wall Probes, which is not carried out since the custodian did not allow for any destructive testing.

After prioritising each and every single timber defects found, it is important to deliberate about the overall condition assessment of the house; whether it is dilapidated, fair or good. Furthermore, this finding is much more useful for the occupants of the house for the sake of safety. According to the rated score of 5 types of data in determining timber defects prioritise ranking system; this research has extended the calculation in getting the total average marks for rating of condition assessment. The analysis reveals the average score is 13, thus indicates the condition of good (as refer to classification in Table 3). The level of severity for each timber defects is determined by the calculation of severity index.

Two types of data is required, namely the frequency and the average score of risk effect for each particular defect. The frequency is determined when the survey completed by referring to the number of defects occurrence in “defect diagnosis-types section” (as per Table 4). At first, the frequency is translated into percentage form. Then, the average score of risk effect is matched with the cross-reference table to get the accumulate multiplier. The accumulate multiplier is used as weight-age for average score of risk effect, with 0.25 is assign for each score. The formulation of severity index is shown below. In interpreting the result, the highest percentage indicates the most severe defect.

Severity Index *= Frequency (%) x Accumulate Multiplier of Risk Effect*

From this finding, suffice to mention that all timber defects found in Telapak Naning is classified as not very much severe, since no severity index above 50% is recorded. Termites attack found to be the lowest index (below 10%) and considered not severe to the house. The finding of severity index is then confirmed and supported the score of condition assessment, which good with no severe defects found. From the research conducted, the main finding can be drawn as below:-

a. Element to be repaired (in order of priority) – details to be refer from Table 4 and 5

1) Roof beam; 4) Either floor (timber joist) or ceiling board;
2) Ceiling joist 5) Floor joist (header); and
3) Fascia board; 6) Either beam, window, column or wall board

b. Overall Condition Assessment – Condition 3: Good

c. Severity Index – Wet rot (brown) with almost 43%

5 CONCLUSION

Telapak Naning gives significant remarks to Kampong Sungai Brisu, Malacca, Malaysia. Major renovation which carried out around 1967 gives quite a lot of changes, especially for finishing materials. This is found to be the main cause in which the occurrence of timber defects in term of numbers is very minimal to the house nowadays.

Building condition survey reveals that the house is still in a good condition and classified as good. For maintenance purpose, the custodian should give priority for replacement of the roof beam element at the staircase area (the lean-to-roof structure). In term of severity level, frankly to quote that no element had seriously damaged. This is because all the timber defects are recorded to be below of 50% severity index. Keep in mind that only one portion of the house namely roof beam at the staircase area that need to be replace urgently, otherwise the severity level reflects the number of defects occurrence for the whole structure. The limitation of the research is the reliability of the system developed for the purpose of rating criterion namely Timber Defects Prioritise Ranking System. Telapak Naning form as pilot project for the system and it is likely to be found that the findings reflect the current state of the house. More and more building should be surveyed using this system in evaluating the system reliability.

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Table 4 : Analysis of building survey and timber defects prioritising for Telapak Naning, Malacca, Malaysia

No.	Construction Element	Design and/or Construction	Building Survey Defect Diagnosis		Timber Defects Prioritise Ranking System							P.SM		References	Remarks
			Causes	Types	a	b	c	D	e	Total Marks	Prioritise Ranking	Measure Mode	Search Mode	Photo/ Drawing no.	
1	Beam	Tongue & groove	1	4	3	3	3	3	4	16	6	L	L	(As Fig.5)	External
2	Window frame	Double leave window with green glass door, side hung	1	4	3	3	3	3	4	16	6	L	L		External
3	Floor	Timber joist	2	6	2	2	3	2	4	13	4	L	L	A	External
4	Floor	Timber joist	2	6	2	2	3	2	4	13	4	L	L	A	External
5	Column (under house)	Square in shape	1	4	3	3	3	3	4	16	6	L	H	B	External
6	Fascia board (at both sides)	Decorative with air Space	3	2	2	1	2	3	4	12	3	L	L		External
7	Floor joist (header)	Square in shape	1	1	3	2	3	3	4	15	5	L	L	C	External
8	Roof beam	Lean-to-roof	2	8	0	1	1	1	2	5	1	L	H	D	Staircase
9	Ceiling joist	Lean-to-roof	2	8	2	1	2	2	3	10	2	L	H	D	Staircase
10	Ceiling board	Lean-to-roof	2	8	2	1	3	3	4	13	4	L	H	D	Staircase
11	Wall board	Plywood	4	3	3	3	3	3	4	16	6	L	L		*Serambi*
12	Ceiling board	Plywood	2	6	1	2	3	3	4	13	4	L	L		Living room
								Total		158					

Condition Assessment

Average Total Marks = 158/12

13 (Condition 3: Good)

(continued from Table 4)

Guidelines:

1 "Causes" code
1 Insects
2 Fungal
3 Weathering
4 Mechanical Failure

2 "Types" code
1 Termites-Subterranean
2 Termites-Drywood
3 Termites-Others
4 Beetles
5 Other insect
6 Wet rot (brown)
7 Wet rot (white)
8 Dry rot
9 Soft rot
10 Blue stain
11 Other rot

3 Prioritise Ranking
a Physical Condition
b Fabric Effect
c User Effect
d Potential Risk
e Risk Effect

4 P.SM (Protimeter SurveyMaster SM)
[Measure=Surface; Search=Below]
L = Low ; H=High

Table 5: Analysis of severity index for Telapak Naning, Malacca, Malaysia

Types of Defects	"Types" Code	Frequency	Frequency (%)	Average Score of Risk Effect	Accumulate Multiplier*	Severity Index	Severity Index (%)
Termites-subterranean	1	1	8.33	4	0.25	2.08	4.76
Termites-drywood	2	1	8.33	4	0.25	2.08	4.76
Termites-other	3	1	8.33	4	0.25	2.08	4.76
Beetles	4	3	25.00	4	0.25	6.25	14.29
Wet rot (brown)	6	3	25.00	2	0.75	18.75	42.86
Dry rot	8	3	25.00	3	0.50	12.50	28.57
TOTAL		12	100.00			43.75	100.00

* cross-reference

Risk Effect	Score	Multiplier	Accumulate Multiplier
	1	0.25	1.00
	2	0.25	0.75
	3	0.25	0.50
	4	0.25	0.25