

Success Factors of Wood Veneer as an Overlay Material for Panel-based Furniture Manufacturing in Malaysia

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In the first part of this study, the Kelly repertory grid technique was used to determine the most preferred attributes of overlay materials used in wood-based panel furniture in Malaysia. This was followed by a questionnaire survey of 20 large wood-based panel furniture manufacturers to establish the trends in the use of overlay materials and the success factors of their utilization. The results showed that natural wood veneer was the most preferred overlay material, and the common local veneer species used included kembang semangkok, rubberwood, and bintangor. Meanwhile, the predominant imported veneer species were white oak, white ash, and walnut. The factor analysis showed that the properties of the overlay materials and market preferences were the driving factors for their successful utilization. The results clearly showed that natural wood veneer was preferred due to its wood-like, natural, and living attributes, and customers were prepared to pay a price premium for furniture with wood veneers compared to the other types of overlay materials.

Keywords: Wood veneer; Attributes; Value-added wood products; Kelly repertory grid; Natural

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INTRODUCTION

The wood products industry is an important socioeconomic sector in Malaysia, having generated nearly RM23 billion in export earnings, while providing employment to nearly 182,000 workers in 2018 (MTIB 2019). Nevertheless, the sector's contribution to the country's gross domestic product (GDP) has steadily decreased since the 1990s, to approximately 1.8% in 2018. According to the National Timber Industry Policy (NATIP 2009), this decline can be attributed to the rapid growth of the other non-wood sectors in the country, while the decreasing supply of raw materials continues to adversely affect the overall growth and contribution of the sector in recent years.

According to Ratnasingam (2003) and Ratnasingam and Ioras (2005), the growth of the wood industry in the country has been driven primarily by incremental inputs, especially raw materials and labor, assisted by favorable government policies, as stipulated in the various industrial master plans (IMPs). The reports also highlight the stagnating productivity within the industry, which may negatively affect long-term industrial competitiveness.

The first IMP (1986-1995) focused on down-stream activities, while the second IMP (1996-2005) further enhanced the manufacture of value-added products, particularly furniture, builders' joinery and carpentry (BJC), and moldings. The third IMP (2006-2020) emphasized further value addition, creativity, and design enhancement, with the

aim of producing wood products of greater value (Ratnasingam *et al.* 2013).

Nevertheless, as alluded to by Lim *et al.* (2016), the supply of raw materials in the country has steadily declined since the strict enforcement of sustainable forest management (SFM) principles in managing the country's natural forests. From a peak natural forest log production of 18 million m³ per annum, the present volume of saw logs produced stands at approximately 4 million m³ per annum. Although this shortfall in saw log supply from natural forests was expected to be supplemented by the increasing supply of saw logs from the plantation forests established in the country, the overall supply of raw materials in the country remained low (NATIP 2009). Consequently, a net shortage of nearly 2.5 million m³ of raw materials had to be met through imports to meet the demands from the country's wood sector.

The brunt of this shortage in raw materials is being felt by the furniture manufacturing sector, which has emerged as the most dominant subsector within the country's overall wood industry (Ratnasingam *et al.* 2013). Contributing nearly 45% of the country's wood product exports, the furniture industry is increasingly becoming dependent on imported raw materials to meet its demand (Ratnasingam and Lim 2015). In 2018, furniture manufacturers imported nearly 650,000 m³ of raw materials, especially from North America and Europe (MTIB 2019).

The strength of the Malaysian furniture sector is in its wooden furniture products, which account for nearly 80% of its total production (Ratnasingam *et al.* 2013). However, with the greater cost of imported raw materials and a differential MYR-USD exchange rate, many wooden furniture manufacturers are increasing their use of overlaid wood-based panels, especially medium density fiberboard (MDF) and particleboard (PB), to manufacture furniture. The most common overlay materials used by the furniture manufacturers are wood veneer, impregnated paper, and melamine overlay.

It is widely acknowledged that the perceived value of and the willingness to pay for furniture depend on its appearance, construction quality, and overall performance (Nicholls and Roos 2006). In this context, furniture appearance attributes (including its aesthetic appeal, color, grain/texture, smoothness, hardness, warmth, and environmental friendliness) are the important determinants for customers' purchase decisions (Ratnasingam *et al.* 2007; Lim *et al.* 2016). The definition of attribute, as given by Brandt and Shook (2005), suggests that it is a feature of the material that differentiates it from other material in the same product category and is strongly associated with the prevailing market opportunities and consumer acceptance.

However, studies of trends in the overlay materials used on wood-based panels for furniture manufacturing in Malaysia are lacking. This study, which employs the Kelly repertory grid (KRG) technique, is the first such study on this subject and should be useful in discerning the peculiarities involved in the consumers' decision-making processes, especially when dealing with overlay materials on wood-based panels. Further, it must be recognized that knowledge about consumers' sensory and emotional associations and reactions toward the choice of overlay material is of particular interest for the design of appropriate marketing and development strategies for furniture (Arowosoge and Tee 2010; Ratnasingam *et al.* 2016). For furniture, the key issue is to find the sensory attributes that distinguish the material from alternatives and that are correlated with people's preferences. The preferred attributes should be enhanced in product development and emphasized in market communication and promotion efforts. Correspondingly, "unpopular" attributes should be reduced, or compensated for, to overcome attitudinal barriers among customers (Solomon 2006). Better knowledge about

perceptions of and attitudes toward materials can also be used for leveraging secondary brand associations in a process of strengthening brand/product type (Keller 2008).

Therefore, this study had three major objectives. First, it aimed to identify attributes and associations that people use to describe and distinguish natural wood veneer, impregnated paper laminate, and melamine overlays on wood-based panels. Second, it aimed to determine the most preferred overlay material for wood-based panel furniture manufacturing and to characterize the attributes that influenced its preference for furniture. Third, it aimed to evaluate the willingness to pay (WTP) for the most preferred overlay material.

EXPERIMENTAL

This study was implemented in two parts. Part I examined the success factors of the three different overlay materials compared to one another using the KRG technique. Part II evaluated the factors that determined the successful application of the three different overlay materials when used on wood-based panels for furniture manufacturing. This part also evaluated the WTP among customers for the wood-based panel furniture with different overlay materials.

Part I

KRG

Because the second part of this study was to analyze the factors that determined the successful application of wood veneer, impregnated paper laminate, and melamine overlay for wood-based panel furniture, the KRG technique (RGT) was chosen as a method (Kelly 1963). The RGT was used to investigate the attributes and constructs that people use for distinguishing among the different overlay materials evaluated in this study. The RGT is a personal interviewing technique used to elicit the constructs by which consumers structure and interpret a product category. Attributes are elicited by repeatedly confronting a respondent with three products drawn from a large set and asking which two products are alike and different from a third (van Kleef *et al.* 2005). The respondents were free to decide which characteristics and attributes they thought were important (Bonebright 2001). In practice, the aim of a RGT study is normally to determine eight to twelve constructs or attributes per interview. The elicited constructs are subsequently presented as scales with which the subject ranks the samples. In this study, participants were individually presented with three samples and asked to describe the attributes in which one of the samples was different from the two others. The process assumes that individuals develop their own personal lists of attributes that they use to organize and conceptualize differences and key features.

Samples

Three samples were chosen to represent natural oak (*Quercus* sp.) wood veneer, impregnated paper laminate with an oak design, and melamine overlay, all of which were overlaid on a 12-mm-thick MDF base. The selection was performed subjectively by the researchers to achieve variation in pattern, contrast, and fabrication process, along with traces, representativeness of wood material, and aesthetic considerations. These samples were chosen on the basis of being the most common overlay materials used within the industry over the last three years. Although other overlay materials were used, the

amounts were limited and inconsistent. Further, the no-overlay option was not considered as a sample board, as industry experts and the Malaysian Furniture Council (MFC) indicated that raw wood-based panel furniture is never produced due to its inconsistency in color.

The interviews in this study were performed with 50 respondents, 25 female furniture buyers and 25 male furniture buyers, who attended the Malaysian International Furniture Fair (MIFF) in Kuala Lumpur, Malaysia, in 2018. All of them were involved in furniture merchandising for at least eight years, and they averaged 39 to 48 years in age. In order to ensure that the responses were representative of the end consumers in the marketplace, the chosen respondents were primarily those with retail outlets or those involved with specialty furniture retailers, rather than agents representing several buying houses or wholesalers. According to the statistics from the fair organizers, almost 90% of all buyers and international visitors to the fair were keen to explore buying opportunities for wood-based furniture, rather than furniture of mixed materials, as Malaysia is still regarded as a leading wood-based furniture producer and exporter in the world. The interviewees were asked to examine (look and touch) the samples, and for each triad, they were asked to state how two of the samples were more similar in one or more characteristics or attributes, in contrast with the third sample. The subject was then asked to rank all three samples with regard to the elicited constructs or attributes on a 5-point scale, in which a score of 5 meant that a sample was perceived to be high in the attribute. During the sessions, no reference was made to any specific application. The assessments were performed at different times and lasted 45 min to 90 min.

Using the data obtained from the interviews, categories were constructed, and the aggregated results were then analyzed *via* principal component analysis (PCA). The preferences were then subjected to a factor analysis, to establish the predominant factors that separated the three samples evaluated. The respondents were also asked to indicate the price premium that they would be willing to pay to the most preferred overlay material chosen.

Part II

To examine the factors that influenced the successful application of these three different overlay materials in wood-based panel furniture, a questionnaire-based survey was conducted in 2019.

Respondents

A questionnaire-based survey of 20 large value-added wood-based panel furniture manufacturing companies in Malaysia was conducted for this study with the assistance of the Malaysian Timber Council (MTC). Thirty-two large wood-based panel furniture companies were initially identified by the MTC as potential respondents for the study, but only 20 consented to participate in this study. Three of the most senior sales personnel from each company were then chosen to participate in the survey, hence, giving a sample size of 60 which was deemed sufficient for statistical analysis.

Questionnaire-based survey

A four-part questionnaire was designed and used to gather the required information. The questionnaire was prepared after discussions with several industrial experts who were suppliers of overlay materials and wood veneers in the country and also by referring to a previous study by Ratnasingam *et al.* (2007). This procedure was to

ensure that the questions represented by the study were relevant and could fulfill the study objectives.

The first part of the questionnaire was related to the background of the responding manufacturer. The second part of the questionnaire required the respondent to reveal the common overlay material used, the quantity, and the origin of the material (*i.e.*, domestic or imported). The third part of the questionnaire evaluated the factors that influenced the choice of overlay material used, including 14 attributes of overlay materials relevant to their selection for wood-based panel furniture applications. These attributes were selected from the 19 attributes highlighted by respondents in the first part of the study, and the selection was performed after consultation with industry experts and academics. These attributes were rated with a five-point Likert scale, from 1 (strongly unimportant) to 5 (strongly important). The fourth part of the questionnaire required the respondents to rank their WTP a premium for the three different types of overlay materials and also to quantify the nominal amount of premium that would be payable for these overlay materials.

Data collection

The questionnaire was initially pre-tested among five randomly selected wood-based panel furniture manufacturers in Selangor, Malaysia, in November 2018. Based on the responses and comments obtained, the questionnaire was modified for greater clarity and ease of implementation. The revised questionnaires were then sent by mail to the 20 selected wood-based panel furniture manufacturers in February 2019. After two weeks, an interview appointment was arranged in each of these mills to facilitate a face-to-face interview with the mill manager, who filled out the questionnaire simultaneously. The mill visits took approximately 4 months to complete. By early July 2019, the questionnaire survey was completed.

Data analysis

The data from the questionnaires were compiled and tabulated using Microsoft Excel Version 2013 (Microsoft, Redmond, WA, USA) to facilitate analysis. The data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) software Version 2015 (IBM, Armonk, NY, USA). The effects of the overlay materials' attributes and origins on wood-based panel furniture were analyzed. The comparison of means among the test factors was performed using the non-parametric statistical method, *i.e.*, the Mann-Whitney U test, as the data in this study were ordinal (Ho 2006). This was followed by a factor analysis of the 14 attributes of overlay materials, to simplify them into smaller groups of several attributes that determined the factors of success of overlay materials used for furniture (Nicholls and Roos 2006).

RESULTS AND DISCUSSION

The results of the evaluation of overlay materials' attributes that determined their application to furniture are presented in the first part, while the factors driving the successful application of these overlay materials to furniture are presented in the second part.

Part I

Based on the interviews conducted, 19 categories of attributes were elicited, as shown in Table 1. The PCA conducted on the aggregate results from Table 1 revealed three factors with eigenvalues greater than 3.

The first factor represented the natural aspects of the material, while the second factor represented solidity and homogeneity, and the third factor represented smoothness, sleekness, and irregularity of pattern. A summary of the correlations between attributes and preference ratings is shown in Table 2.

Table 1. Content Analysis from Interviews with Respondents

Characteristic	Definition	Interpretative Core Category	Total Score	
			N	%
Wood-like	Wood-feeling	Material	48	86.9
Natural	Real, not plastic		48	86.9
Living	Living material		48	86.5
Pleasant	Cozy, safe		45	72.9
Processed	Man-made, machined	Processed	35	61.1
Stable	Durable material		32	58.4
Homogenous	Uniform feel		32	58.1
Patterned	Much variation	Visual	41	70.3
Irregular pattern	Organic, no order		38	63.2
Calm	Soothing		33	53.3
Bright color	Light and appealing color		37	59.9
In fashion	Trendy	Tactile	44	72.0
Warm	Expressively warm		41	68.9
Solid	Bulky		23	37.1
Hard / High Weight	Compact		20	36.3
Smooth	Smooth feel		20	36.3
Sleek	Slippery, shiny		17	26.1

N = number of interviewees who chose this attribute; % = average score accorded to the attribute

Table 2. Principal Component Analysis and Factor Loadings

Characteristic	Factor 1: Material	Factor 2: Homogeneity	Factor 3: Smoothness
Wood-like	0.928	0.643	-0.343
Natural	-0.987	0.344	-0.338
Living	-0.811	-0.328	-0.316
Pleasant	0.791	-0.379	0.299
Processed	-0.416	-0.551	0.458
Stable	-0.569	0.781	-0.565
Homogenous	0.344	0.899	0.616
Patterned	0.461	0.711	0.313
Irregular pattern	0.817	0.559	-0.326
Calm	0.701	0.526	0.445
Bright Color	-0.565	-0.631	0.803
In fashion	0.881	-0.648	-0.328
Warm	-0.736	-0.549	-0.317
Solid	-0.444	0.733	0.316
Hard / High Weight	0.469	-0.553	0.705
Smooth	0.389	-0.617	-0.771
Sleek	-0.671	-0.433	0.802

The results clearly indicated that preferences correlated most positively with the attributes “natural,” “wood-like,” and “pleasant.” Meanwhile, the correlations were negative with attributes such as “hard,” “processed,” “homogenous,” and “high weight,” which were typical features of melamine overlay. Impregnated paper laminates lacked the warmth, stability, and wood-like feeling offered by the natural wood veneer. Hence, wood veneer was confirmed to be highly appreciated as an overlay material for furniture, due to its naturalness and wood-specific properties offering harmony without disturbing natural irregularities (Nyrud *et al.* 2008). These attributes separated the wood veneer from the impregnated paper laminates and melamine overlays, suggesting that, even within the latter two types, there were large discerning differences with some implications for customer preferences.

The outcome of this study provides indications for the development of wood-based panel manufacturing in Malaysia. Manufacturers should highlight the natural origin of the product, *i.e.*, wood veneer. Thus, they should present the positive aspects of unprocessed wood: its living structure, its color, and the naturalness of the material (Brandt and Shook 2005).

Part II

Choice of overlay material

The selection of overlay materials showed significant differences among the wood-based panel furniture manufacturers. This result was in line with the study of Brandt and Shook (2005), who reported that consumers have different perceptions of different materials, and these perceptions can be leveraged for marketing and new product development. It was apparent that natural wood veneer was the preferred overlay material compared to impregnated paper laminates and melamine overlay (Fig. 1).

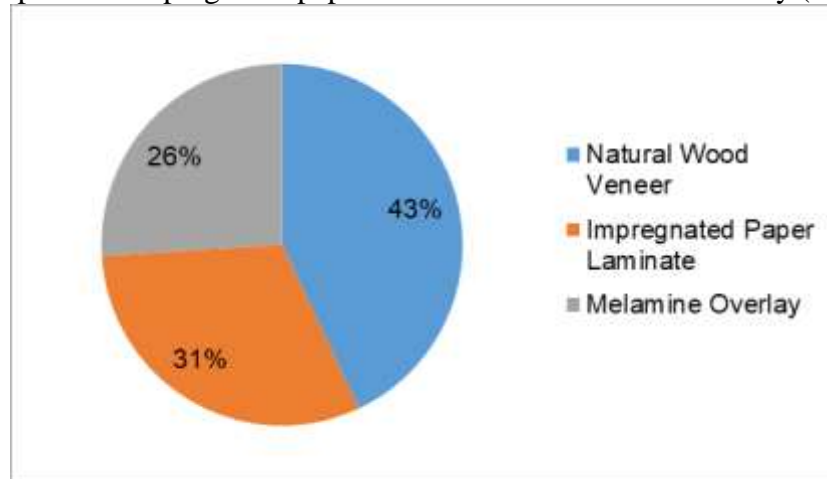


Fig. 1. Proportional use of different overlay materials

For natural wood veneers, the most preferred imported wood veneer species were white oak (*Quercus* spp.), white ash (*Fraxinus* sp.), walnut (*Juglans regia*), beech (*Fagus* sp.), and poplar (*Populus* sp.). Figure 2 shows the most common imported wood veneer species used by wood-based panel furniture manufacturers. The most common local wood veneers include kembang semangkok (*Scaphium* sp.), rubberwood (*Hevea brasiliensis*), bintangor (*Calophyllum* sp.), Nyatoh (*Palaquium* sp.), and meranti (*Shorea* sp.), as shown in Fig. 3.

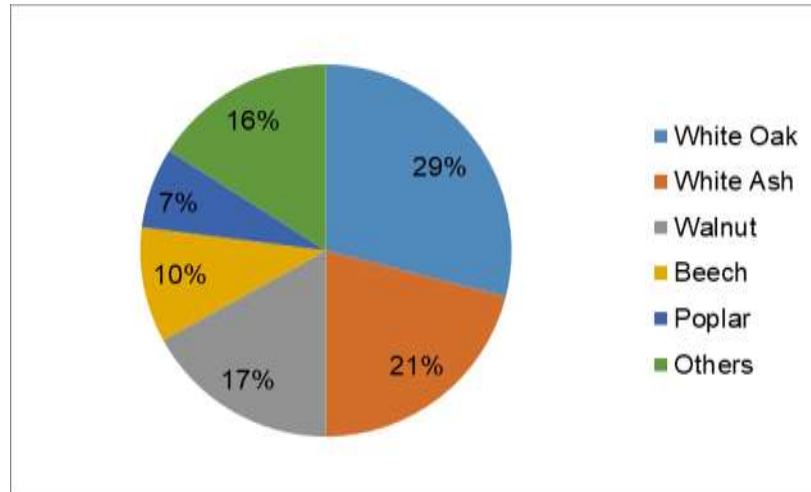


Fig. 2. The most common imported wood veneer species used by manufacturers of value-added wood products

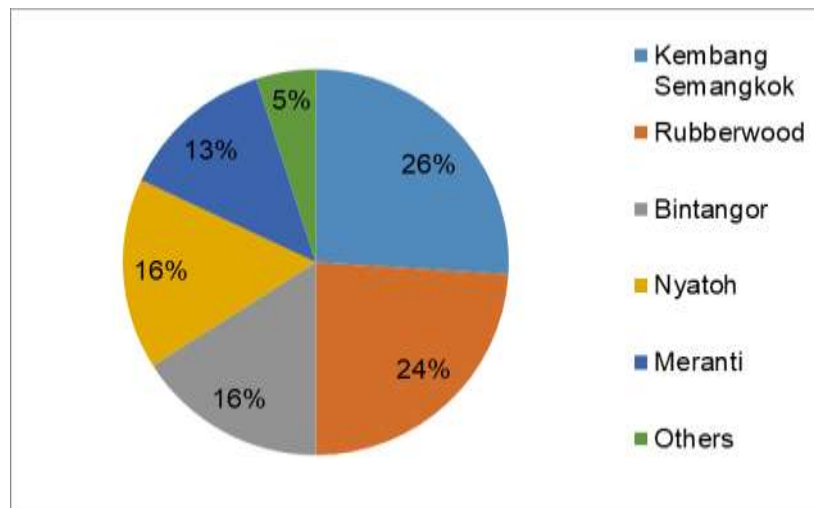


Fig. 3. The most common local wood veneer species used by manufacturers of value-added wood products

The manufacturers of wood-based panel furniture appeared to have resorted to the use of wood veneer primarily to reduce product cost and to produce furniture with natural wood appearances. The application of wood veneer enables solid wood features to be maintained without sacrificing product performance, while improving product pricing (Tsoumis 1991).

The study also examined the attributes of overlay materials according to the source of the wood veneer (*i.e.*, local or imported), as shown in Table 3. Similar to the study on the preferences for solid wood materials for value-added wood products, as reported by Ratnasingam *et al.* (2016), it was apparent that cost, market preferences, supply, aesthetic quality, and product specifications were the primary factors that encouraged wood-based panel furniture manufacturers to use either local or imported wood veneer.

Table 3. Mean Rating of Attributes According to Origin of Wood Veneer

Attribute	Local (n = 20)	Imported (n = 20)
Cost	4.79	4.87
Market preference	4.89	4.94
Aesthetic quality	4.33	4.48
Warm	3.86	3.71
Natural wood-like	3.44	3.51
Working properties	3.03	3.07
Supply / Availability	3.43	3.21
Trendy	3.19	3.31
Environmentally friendly	2.96	3.27
Product specifications	4.43	4.41
Durability	2.47	2.61
Solid	2.33	2.41
Strength and hardness	2.13	2.26
Price premium for finished goods	3.67	3.91
Figures in bold represent the highest ranking of attributes important for each category of origin of wood veneer.		

The Mann-Whitney U test was applied to determine whether there were any significant differences in cost, market preference, or supply between the local and imported natural wood veneers. No significant differences were observed between the local and imported wood veneers for these attributes, as the p-values were greater than 0.05. Thus, differences in cost, market preference, product specification, aesthetic value, and supply did not influence the choice of using either local or imported wood veneer as the overlay on wood-based panel furniture.

Contrary to solid wood species, for which the source or origin of the species influenced the preferences for a particular wood species (Ratnasingam *et al.* 2016), this did not appear to be the case with natural wood veneer. This rather unique finding suggests that natural wood veneer may have an advantage in terms of its aesthetic appeal but cannot offer other differentiating factors when comparing materials of local origin and imports.

Factor analysis

According to statistical theory, the factor analysis technique is based on the assumption that all variables are correlated to some degree (Ho 2006), and the degree of correlation among the variables was examined using the Kaiser-Meyer-Olkin method. The analysis showed a low index value of 0.306 of the correlation among the variables. Further, Bartlett's test of sphericity yielded a value of 84.13, with a level of significance less than 0.001. Therefore, there were significant correlations among some of the variables, which in turn indicated that the factor analysis was an appropriate test for this data set.

The factor analysis grouped the 14 variables associated with the three different overlay materials into three main groups of attributes: overlay properties, sustainability, and market determinants. The factor analysis resulted in the consolidation of the many variables into these three distinct groups, as shown in Table 4.

Table 4. Three Factor Solutions from Factor Analysis

Attribute	Group 1: Overlay Properties	Group 2: Sustainability	Group 3: Market Determinants
Working properties	0.881	-0.126	0.101
Aesthetic quality	0.738	-0.131	-0.113
Durability	0.647	0.414	-0.044
Solid	0.411	-0.369	-0.441
Warm	0.539	0.455	-0.436
Strength and hardness	0.593	-0.426	-0.026
Environmentally friendly	0.452	0.583	0.055
Natural wood-like	0.699	0.433	0.313
Supply	-0.143	0.599	0.554
Price premium for finished goods	-0.153	0.441	0.741
Product specifications	0.074	-0.152	0.707
Cost	0.346	-0.186	0.741
Market preference	0.418	-0.041	0.783
Trendy	0.389	0.349	0.616

Group 1 included variables such as working properties, aesthetic quality, durability, warmth, natural wood likeness, and strength and hardness. Group 2 included environmental friendliness and supply. Group 3 included product specifications, cost, supply, price premium for finished goods, trendiness, and market preferences. The explained variances accounted for 26.5%, 12.1%, and 19.3%, respectively, of the total variance observed. Thus, in the manufacture of wood-based panel furniture, the overlay properties and market determinants were more important than the sustainability for determining the choice of overlay material used in furniture.

It was apparent that overlay materials can be used as a value-adding strategy for the manufacture of furniture. They should be further employed to ensure that manufacturers derive product competitiveness from its application, to replace the steadily decreasing supply of solid wood resources.

WTP for overlay materials

In the questionnaire survey, all respondents indicated a greater WTP a price premium, of up to 10% on average, for natural wood veneer compared to the other two types of overlay materials. It appeared that naturalness, environmental friendliness, and wood-like feeling were highly desirable attributes of furniture, as reported by Pakarinen and Asikainen (2001). When the desired attributes were found in the product, it often led to greater selling prices (Scholz and Decker 2007). Overall, the use of natural wood veneer, whether local or imported, appears to be a good strategy that can be employed by wood-based panel furniture manufacturers to enhance their products and to serve as a desired product marketing feature.

CONCLUSIONS

1. The RGT showed that natural wood veneer was preferred, compared to impregnated paper laminates and melamine overlay, for furniture application. The natural, wood-like and pleasant attributes of the wood veneer were highly preferred by the respondents.

2. The factor analysis revealed that overlay properties and market preferences were the important determinants in choosing overlay materials for applications in furniture.
3. The common imported wood veneers used by furniture manufacturers in Malaysia were white oak, white ash, and walnut, while the preferred local wood veneer species included kembang semangkok, rubberwood, and bintangor.
4. The respondents' WTP for natural wood veneers was greater compared to the other two overlay materials, and a price premium of nearly 10% was likely for wood veneer overlay materials.
5. The naturalness, environmental friendliness, warmth, and trendiness of natural wood veneer make it the ideal overlay material for wood-based panel furniture in Malaysia.
6. Wood veneering can be regarded as a useful strategy to add value in wood-based panel furniture manufacturing.

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