UNIVERSITI PUTRA MALAYSIA

POTENTIAL OF NON-SKIN OIL PALM PARTICLEBOARD AS AN ALTERNATIVE BENCH COMPONENT FOR KUALA LUMPUR INTERNATIONAL AIRPORT

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Master Science

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for degree of Master of Science

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December 2006

Chairman : Badrul Azmi Bin Abd. Holed, MSc.

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The design of airport benches plays a significant role in ensuring the comfort of passengers and visitors. In addition, it can portray the local image of the place. Furthermore, based on preliminary research, the current standard airport benches in the Kuala Lumpur International Airport (KLIA) do not give any special local identity that could impress *'first time'* visitors to the country. In addition, the easily damaged cushion part of the existing benches has become a problem to KLIA's maintenance as it is costly and could not be easily replaced. This research proposed the non-skin particleboard made from oil palm

biomass as an alternative material to replace the cushion component of the existing benches. During the period of this research, the use of non-skin particleboard is still in the preliminary stages. The research methods adopted for the study are mixed method; quantitative and qualitative. The method for qualitative research includes interview, direct and participant observation, videotaping of subjects, case studies and document analysis. In this study, qualitative research deems more appropriate since many of the areas to be studied are subjective in nature (comfort, aesthetic and perception). The study found that the new material could solve the current problem faced by KLIA. The study also reveals that although there are different levels of acceptance among respondents from different background and profession, there is a good potential for non-skin particleboard to replace the easily damaged bench components based on its advantage in terms of aesthetic appearance. In addition, it is widely accepted that the new material could portray the Malaysian image. The potential of this material in other type of furniture is also proposed.

Abstrak tesis yang dikemukan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master sains

POTENSI PAPAN SERPAI TANPA KULIT DARI BIO-JISIM KELAPA SAWIT SEBAGAI ALTERNATIF BAGI KOMPONEN BANGKU DI LAPANGAN TERBANG ANTARABANGSA KUALA LUMPUR

Oleh

ASA NAIM BINTI RUSLI

Februari 2007

Pengerusi : Badrul Azmi Bin Abd. Holed,

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Rekabentuk bangku di lapangan terbang diseluruh dunia memainkan peranan penting untuk memastikan keselesaan penumpang dan pelawat. Tambahan pula, ia boleh mencerminkan imej setempat. Bangku di lapangan terbang masa kini tidak dapat memberikan keistimewaan setempat tersebut yang boleh membuatkan pengunjung yang pertama kali sampai ke negara ini boleh merasa kagum. Di samping itu, bahagian berkusyen pada bangku yang sedia ada sekarang amat mudah rosak dan ini menimbulkan masalah bagi pihak penyenggaraan KLIA kerana ia memakan belanja dan tidak mudah digantikan. Kajian ini

mencadangkan papan serpai tanpa kulit dari kelapa sawit sebagai bahan alternatif untuk menggantikan bahagian kusyen bangku yang sedia ada. Semasa kajian, penggunaan papan serpai masih lagi dalam peringkat awal. Kajian in menggunakan gabungan kaedah kuantitatif dan kualitatif. Kaedah kajian bagi kualitatif merangkumi temuduga, pemerhatian secara langsung, rakaman vedio, kajian kes dan analisis dokumen. Dalam kajian ini, penyelidikan kualitatif kelihatan lebih sesuai dengan jenis keselesaan, astetik dan tanggapan pengguna. Kajian mendapati bahawa bahan baru yang dicadankan dapat menyelesaikan masalah penyenggaraan KLIA. Kajian juga mendapati bahawa walaupun terdapat perbezaan tahap penerimaan di antara responden dari pelbagai latarbelakang dan profesion, bahan ini mempunyai potensi yang cerah untuk menggantikan komponen bangku yang mudah rosak. Tambahan lagi, ramai menerima bahan baru ini sebagai boleh mencerminkan imej Malaysia. Potensi penggunaan bahan baru di dalam pembuatan perabut jenis lain juga disarankan.

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I certify that an Examination Committee has met on 19 December 2006 to conduct the final Examination of Asa Naim Binti Rusli on her Master of Science thesis entitled "Potential of Non-Skin Oil Palm Particleboard as an Alternative Bench Component for Kuala Lumpur International Airport" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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ASA NAIM BINTI RUSLI

Date: 22 MARCH 2007

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LIST OF ABBREVIATIONS

KLIA	Kuala Lumpur International Airport
MAB	Malaysia Airport Berhad
MPOB	Malaysia Palm Oil Board
Mm	Millimeter
M^3	Meter cube
MOR	Modulus of rupture
MOE	Modulus of elasticity
Mpa	Megapascal
m.c	Moisture content
OPF	Oil palm frond
OPT	Oil palm trunk
PP	Product design

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Malaysia has become the world leader of oil palm production. In the year 2005 there are 4.05 million hectares of oil palm plantation (MPOB, 2005). The oil palm tree produces fibrous biomass in the form of trunks, frond and empty fruit bunches. During replanting, oil palm yields five million tonnes of trunks and oil palm fronds estimated at 25 million tonnes annually. It is estimated around 24.93 million tonnes of oil palm fronds will be available in year 2020 (Kong, 2003). With such a big quantum of biomass, the oil palm industry is set to be a major source of raw material to support the wood-based industry on a big scale.

In terms of using oil palm biomass in making furniture component parts, research and development has shown that with the use of the available technologies the industry should capitalize on the availability of these raw materials. One important application of the oil palm biomass is the making of composite boards such as blockboard, chipboard, particleboard and medium density fibreboard (MDF) (Malaysia Timber Bulletin, 2001:10).

Although there is big potential for oil palm biomass as furniture components, there is still lack of interest among local manufacturers to utilize oil palm biomass (Malaysia Timber Bulletin, 2001:10); The Malaysian Furniture Industry, 2002:16). In year 2000 there were 660 large and medium-sized established furniture manufacturers. (The Malaysian Furniture Industry, 2002:22). From this number, only two use oil palm biomass in their manufacturing. In addition, there is lack of promotion in using oil palm biomass as furniture components in local furniture manufacturing. Although the potential of oil palm biomass as furniture components has been proven in research, it has yet to be promoted in the local market (interview with MPOB officer, 2004). Some furniture from oil palm biomass has been manufactured for school and office furniture and some products are mainly for export. According to Jegatheswaran Ratnasingam, (The Malaysian Furniture Industry, 2002 :17) Malaysian furniture should experiment with new materials to reduce pressure on Malaysian resource base and such initiatives will also help towards the development of new designs and stabilize the prices of the conventional furniture raw materials in the market place. Malaysian furniture

Manufacturers are looking aboard at other resource rich countries to obtain their supply of raw materials. Component parts that use imported materials are costly in term of money and time (Jegatheswaran, 2002: 16).

Malaysia's vision is therefore to develop the oil palm biomass industry into a bigger revenue earner compared to the oil products of the palm oil industry and get value from its biomass (Malaysia Timber Bulletin, 2001:10). The use of oil palm biomass as furniture components also can be as alternative to promote plantation forests to replace and save the tropical forests. This vision is parallel with the KLIA concept, "An Airport in a Forest, A Forest in an Airport". The design concept is the most visible of all efforts at greening KLIA. As gateway to the country, an international airport is the first and sometimes lasting, impression of the country. It is has the potential of becoming a landmark evoking national pride in the manner it looks and functions. At the same time, modern-day needs demand that the design of an airport be user-friendly, aesthetically-pleasing and ecologically-sensitive.

To spearhead the quest for quality and active research, this thesis is about "*Potential of Non-Skin Oil Palm Particleboard as an Alternative Bench Component for Kuala Lumpur International Airport"*. This

research is to determine the potential of non-skin particleboard for KLIA bench. The potential of non-skin particleboard is used to replace the broken cushion bench components. Indirectly, the use of non-skin particleboard in KLIA is a preliminary evaluation of this raw material in Malaysian furniture industry.

1.2 Research Problem

Design ordains for purpose, cost and availability on time; the detail of a product's design affects the way in which it can be made. It can be designed to be easy to manufacture in future. The selected bench used for this study was produced by the SARDI Seating System, a programme which is especially designed for airport lounges and the same type of bench as selected for this study has also been placed in others international airports such as Geneva (Switzerland), Lisbon (Portugal), Madrid (Spain), Barcelona (Spain), Havana (Cuba) and Cancun (Mexico) (Lonzano, Diseno, 2002:75). The selected bench design which is produced by SARDI has very excellent bench ergonomic, strong structure and very futuristic design but the use of fabric and padding on the selected bench design placed at KLIA has always caused a problem.

Based on the reason, one of the key features of SARDI furniture is that it avoids the use of fabrics on padding, since fabrics are difficult and expensive to maintain and known to have a shorter life span than other products such as wood components, steel or aluminum, leather, polyurethane padding etc (Lozano, Diseno, 2002:75).

Therefore, the first problem is the need for suitable material to replace damaged airport bench components at KLIA. This is based on the early research and observation done in 2002 on KLIA benches that revealed that many benches were damaged and not easily replaced (refer to Figure 1). It was also learned from some of the staff that cleaning was not easy and replacement could take a long time. (MAB Terminal Manager, 2002).

This research seeks another alternative to solve the problem of the broken cushions on the selected bench components by proposing new material for the benches. This selected component parts include the backrest padding, seat padding, armrest and side table. The non-availability of spare parts for damaged benches is the main issue of the Malaysian Airport Berhad (MAB) maintenance problem. The research will try to satisfy both the users and MAB's need for maximum return. The new prototype is central to determining the bench ergonomic, safety

and the durability of the new replacement bench components**.** Figure1 shows some of the damaged benches found during this initial research.

1

2

3

4

List of Pictures	Name of broken parts	Description	Location
1	Seat cushion	The cushion looked worn out and with holes.	Departure Level, satellite level.
2	Seat cushion	The cushion was full of food and drink stains.	Mezzanine Level.
3	Seat cushion	The cushion was not properly wrapped	Departure Lounge, C12.
4	Seat cushion	Slashed cushion	Mezzanine Level

Figure 1: Examples of damaged cushion at Satellite Terminal Building. (Picture taken: 2002).

The second research problem that prompted this research to be carried out is the waste of oil palm industry byproducts that are abundant and could lead to environmental degradation. Palm oil is generated by only 10 percent of the components while the remaining 90 percent is the byproduct in terms of fibrous biomass in the form of trunks, frond and empty fruit bunches. Underutilization of this existing material will increase the amount of waste produced by palm oil industry.

Thirdly, although there is big potential for oil palm biomass as furniture component, it is still not being fully exploited. One report says that there is still a lack of interest among local manufacturers to utilize oil palm biomass (Malaysia Timber Bulletin, 2001; The Malaysian Furniture Industry, 2002). In addition, there is a lack of promotion in using oil palm biomass as furniture components in local furniture manufacturing. According to MPOB officer (2004), although the potential of oil palm biomass as furniture components has been proven in research it has yet to be promoted aggressively in local market. Using local raw material as furniture resources could reduce our dependency on imported sources and thus could save our economy.

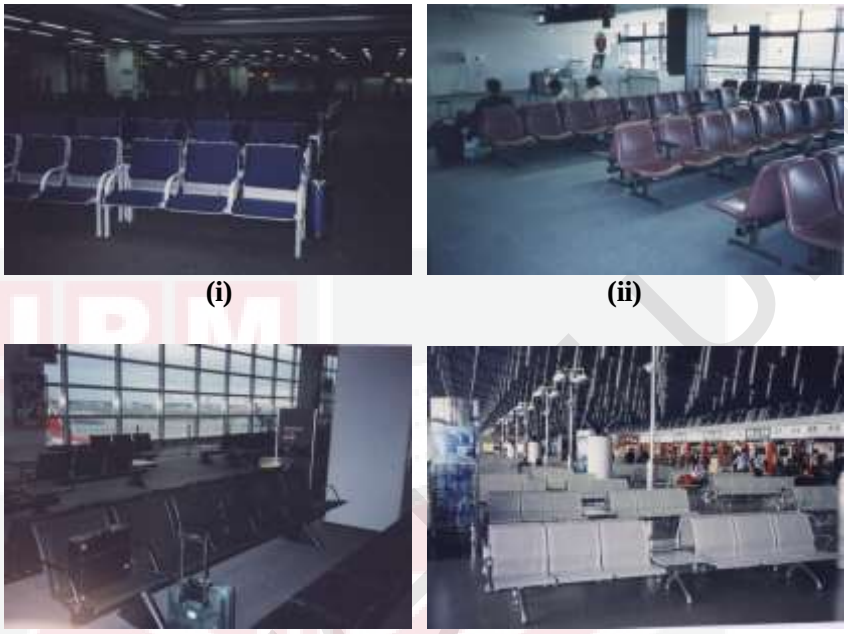
According to Jegatheswaran Ratnasingam, (2002:17) Malaysian furniture should experiment with new materials to reduce pressure on

Malaysian resource base and such initiatives will also help towards the development of new designs and stabilize the prices of the conventional furniture raw materials in the market place.

In addition, he writes, "Malaysian furniture manufacturers are looking aboard at other resource rich countries to obtain their supply of raw materials" (Ratnasingam, 2002:16). The use of oil palm biomass could help our local economy as we don't need to rely on imported products. In addition, the use of oil palm biomass could also reduce pressure on our local timber as a source for furniture making. Component parts that use imported materials are costly in term of money and time.

Fourth, early investigation and literature review on bench study around the world reveals that the typical look of airport benches in major international airports makes KLIA does not have any significant identity to portray Malaysia. New material could provide new image and identity thus create unique experience to travelers. It was also found that some of the benches in other international airports do not have cushions thus benches need not necessarily use cushion to provide comfort to users. Figure 2 shows benches at several international major airports.

The photos below show benches at several international major airports.



(i) **(ii)**

(iii) **(iv)**

Figure 2: Photos of benches at other international airports starting from left: (i) Bombay International Airport, (ii) Narita International Airport, (iii) Frankfurt International Airport and (iv)Pudong-Shanghai International Airport.

This research was undertaken based on the need to give Kuala Lumpur International Airport (KLIA) a new image and character in terms of its bench material and design. It is proposed that local material that portrays Malaysia be employed to provide fresh new look to airport benches. This research was also prompted based on initial observation done in 2001 that revealed the material used for airport benches have been poorly maintained and damaged. The used of oil palm biomass as furniture components also can be as alternative to promote plantation forests to replace and save the tropical forests. This vision is parallel

with the KLIA concept, "An Airport in a Forest, A Forest in an Airport".

1.3 Research questions

In conducting this research, two research questions are developed:

1. How can the oil palm biomass particleboard replace the existing cushion for benches at KLIA?

2. What are the perceptions of users and professional on the new material for benches of KLIA?

1.3 Objectives of Study

1. To study the potential of oil palm biomass particleboard as a replacement to the existing cushion for benches in KLIA.

2. To study users' and professionals perception of the new bench.

1.5 Research Contribution

This research is to benefit many departments. Literature review shows that not many researches have been carried out in this area especially on the benches at airport. It can also be assumed that research on design aspects of furniture made from oil palm biomass, especially in Malaysia, is not found in the literature. This is a first attempt to explore the potential of oil palm biomass in a new type of furniture apart from the existing usage in office and school furniture. User perception study could provide insights on what users from other countries think about Malaysian products. Therefore this research could provide new information for students, practitioners and researchers in industrial design field as well as other related fields such as furniture industry, oil palm industry, airport service and maintenance and tourism industry.

1.6 Research Design

The research design of this study is divided into four phase:

i. Literature Review and early investigation,

ii. Preparation of material (new bench and questionnaire),

iii. Site survey and data collection

iv. Data analysis and writing.

Therefore, the research design for this study was conducted in four distinct phases. The chart in Figure 3 shows the flow of research activities for this study.

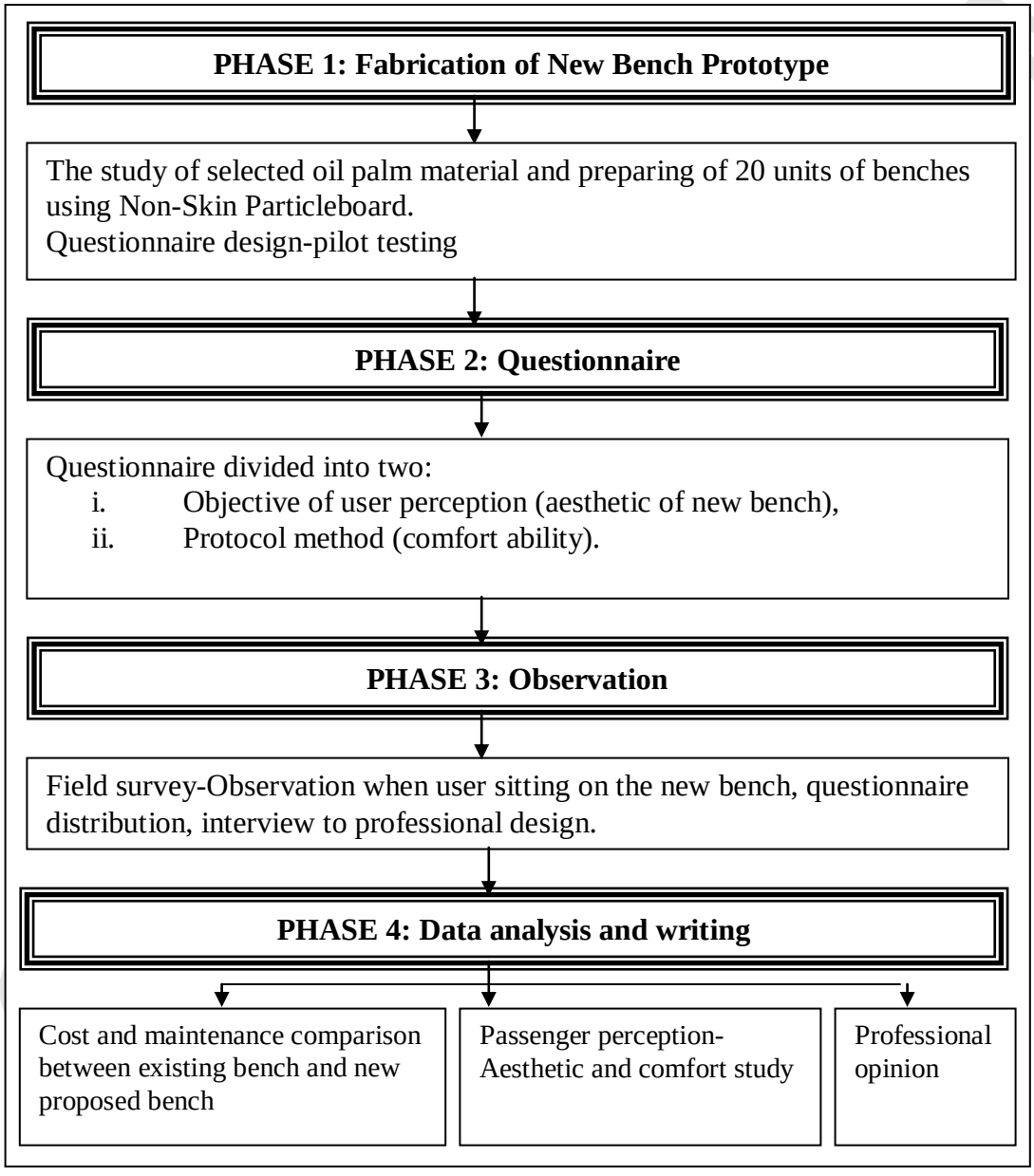


Figure 3: Research framework.

1.7 Research Methodology

This research is conducted using both quantitative and qualitative methods. The first phase includes literature review, observation and informal interview with Malaysia Airport Berhad (MAB) staff and visitors of KLIA. It also includes identification of materials that can be easily damaged and bench design suitable for the propose replacement material.

The first phase comprises of designing and producing prototype benches to be used for site study. This was followed by questionnaire design on user perception and user comfort, questionnaire for interview of MAB staff and professional on the practically, suitability and aesthetic value on the new benches. Questionnaire survey on passengers was done in month of May 2006. Result form site study was analyzed using average of positive and negative statement and content analysis.

REFERENCES

Ashby M. and Johnson K., (2003) The art of materials selection, *Material Study* December 2003. pp. 24-35

Ashby M. and Johnson K., (2002) Materials and Design: The Art and Science of Material Selection in Product Design. Oxford Butterworth-Heinemann

Asian Timber, Forestry, Panel, Woodworking and Furniture Industries: July/August 2005, Status of Technology in the Malaysian Wood Industry.

Ck Siew, Wood-based Panels: Improvement in particleboard manufacturing, *Asian Timber*, Vol. 22.No. 3. March 2002, pp. 24-25.

Corlett E. N. (1999) Are You Sitting Comfortably? *International Journal of Industrial Ergonomics* **24** (1999) pp 7-12

Crilly, N., Moultrie, J., and Clarkson, P.J.(2004) Seeing Things: Consumer Response to the Visual Domain in Product Design. *Design Studies* **25** (2004) pp. 547-577

David Gasull, Figueras International Seating, Spain, Waiting game, *Passenger Terminal* 2002, pp. 48-50.

David Inwood and Jean Hammond, 1993, Product Development: An Integrated Approach.

Design Through Education Programmed 1997, Malaysia Design

Dr. Jegatheswaran Ratnasingam and Dr. Lim Meng Tsai, Variability in wood resources- It Implications on Processing, *Asian Timber: Forestry, Panel, Woodworking and Furniture Industries*, November/December 2005, pp. 28-29.

Dr. Kamarudzaman Md. Isa, Why Design?, *Design Magazine of Innovation Malaysian Design*, (1996), pp. 48-49.

Edward Martin Stevens, JR., Design Guidelines and Evaluation of an Ergonomic Chair Feature Capable of Providing Support to

Forward-Leaning Postures, Doctor of Philosophy of Texas A&M University, December (2004).

Edward Martin Stevens, JR., December 2004, Design Guidelines and Evaluation of An Ergonomic Chair Feature Capable of Providing Support to Forward-Leaning Postures.

Elizebeth Hill, Catherine O'Sullivan and Terry O'Sullivan1995 Creative Arts Marketing, 1995.

Fenety P. A., Putnam C. and Walker J.M (2000) In Chair Movement: Validity, Reliability and Implications for Measuring Discomfort *Applied Ergonomics* **31** (2000) pp. 383-393

Fernando Redriguez-Lonzano, IMAT Mobiliario y Diseno, S.A., Spain, Comfort and Versatility, *Passenger Terminal World*, Annual Technology Showcase Issue 2002, pp 72-75.

Fernando Caldeira Jorge. 22-24 September 2004. 1st International Conference of Environmentally- Compatible Forest Products. Proceeding of International Conference of Compatible Forest of Product.

Hammond, S. (1995). Using psychometric tests. In G.M.Breakwell, S. Hammond and C. Fife-Schaw (Eds.), Research Methods in Psychology. London, UK: Sage Publications.

Han, S. H. and Kim J. (2003) A Comparison of Screening methods: Selecting Important Design Variables for Modeling Product Usability. *International Journal of Industrial Ergonomics* **32** (2003) pp 189-198

Ilse Van Kesteren, Pieter Jan Stappers and Prabhu Kandachar (2001). Representing Product Personality in Relation to Materials in a Product Design Problem.

Jegatheswaran Ratnasingam, (2002) The Malaysian Furniture Industry, Asian Timber Pocket Guide.

John R. Lindbeck, Product Design and Manufacturing, (1995)

Jungchul Park, Sung H. Han (2004) A fuzzy rule-based approach to modeling affective user satisfaction towards office chair design,

International Journal of Industrial Ergonomics **34** (2004), pp31-47.

Kees J. Overbeeke, Peter Vink and Fai K. Cheung, The emotion-aware office chair, *Proceedings of the International Conference on Affective Human Factors Design Asean Academic Press, London*, 2001, pp. 262-266.

Keiji Sato. January 28,199.Design Promotion Cooperating Program Color Planning(workshop paperwork).

Kujit-Evers L.F.M, Groenesteijn L. de Looze M.P and Vink, P. Identifying Factors of Comfort in Using Hand Tools *Applied Ergonomics* (2004) pp. 453-458

Latest Development and Commercialisation of Oil Palm Biomass at MPOB : From Waste to Wealth, Malaysian palm Oil Board, Ministry of Primary Industries.

Malaysia Timber Bulletin, 2001, pp10.

Malaysia Timber Bulletin, 2001; The Malaysian Furniture Industry, (2002)

Malaysian Timber Council, Toward Responsible Forest Management, *Furniture Industry of Malaysia*, pp. 6-7.

Malaysian Timber Forum, 2004

Manuel Rebollar, Rose Perez and Rosario Vidal (2005), Comparison between orientated strand boards and other wood-based panels for the manufacture of furniture, *Materials & Design*, 2005, pp. 1-7.

Marco Squarcini, Terminal seating: Search for reassurance, *Passenger Terminal World March 2002*, pp. 122-124.

Marco Squarcini, Tecno Spa, Italy, Safe seat, *Passenger Terminal World*, Annual Technology Showcase Issue 2002, pp. 81-84.

Matteo Anselmi, Emmegi Spa, Italy, Seating style, *Passenger Terminal* 2002, pp. 56-57.

Mike Baxter (1995) Product Design: Practical methods for the systematic development of new products.

Ministry of Primary Industries, Malaysia, 2001, Report on Malaysia's Primary Commodities.

Mohamed Ali Hasan and Sharakbah Yakob, Palm Oil Industry, 2006

Oil Palm Tree Utilization Committee Malaysia, 4-5 March 1991, Seminar Proceeding, Seminar Proceedings Oil Palm trunk and other Palmwood Utilization.

Oil Palm Tree Utilization Committee (OPTUC), December 2000, Utilization of Oil Palm Tree, Oil Palm Biomass Opportunities and Challenges in Commercial Exploitation.

Oil Palm Tree Utilization Committee (OPTUC), 15-17 December 2003, 6th National Seminar on Oil Palm Tree Utilization, Development of Oil Palm Biomass Industry.

Paul Allie, Doug Kokot, Choosing a Chair Based on Fit, Comfort and Adjustable Features 2.1, February 2005, steelcase Inc., pp. 1-9.

Perangkaan Perdagangan Juar Negeri Bulanan Monthly Eternal trade statistics, Jabatan Perangkaan Malaysia, Januari to April (2003)

Premilla Mohanlall, KLIA International Airport Berhad (KLIAB), 1998, *The Making of KLIA (KL International Airport).*

Prentice-Hall, Inc., Englewood Cliffs, N.J. Harry N. Abrams, Inc., New York, 1981, Varieties of Visual Experience.

Product Design and the Manufacturing Industry": held on December 5, (1995)

Rashid A. Mac Donald B.J. and Hashmi M.S.J. Evaluation of the Aesthetics of Products and Integration of the Findings in a Proposed Intelligent Design System *Journal of Material Processing Technology* **153-154** (2004) pp 380-385

Rodriguez-Lozano F. (2002) Comfort and Versality *Passenger Terminal* pp. 72-75 IMAT Mobiliario y Diseno, S.A., Spain,

Sarah Gaventa, The Role of Ergonomics, Home *Design Workbooks: Home Office,* 1998, pp. 8.

The Malaysian Furniture Industry, 2002, pp16

V.K. Raj, Interior Design: The Heart of the *Matter, Malaysia Design Magazine*, 1996, pp.44-45.

Wan Hasamudin Wan Hassan; Mohamad Husin; Anis Mokhtar and Atimar Abdul Aziz (2003), NoSkin Moulded Particleboard from Oil Palm Biomass, *MPOB Information Series*, MPOB TT No. 207, July 2003.

Wesley E. Wood on, Barry Tillman, Peggy Tillman, Second Edition, Human Factors Design Handbook, (1992).

Wong King Wai, Marisa Misron, Malaysia Airport Berhad, *KLIA Magazine*, Issue 3 November 1998, NavigatingKlia, pp 78.

Woon Weng Chuen, Economic perspective of oil palm trunk utilization, *Seminar Proceeding: Oil Palm Trunk and Other Palmwood Utilization*, 4-5 March (1991), Organised by Oil Palm Tree Utilization Committee Malaysia, pp. 292-297.

Webpages

www.greenplywood.com/oilpalm.htm,Business Esprit, 2001.

http://encyclopedia.thefreedictionary.com/Ergonomic, Ergonomic, (2004), pp.1-2.

http://encyclopedia.thefreedictionary.com/design, Design, 2004, pp.1-2.

http://encyclopedia.thefreedictionary.com/chair, Chair, 2004, pp.1-13.

http://www.essaybank.co.uk/free_coursework/1535.html, Specification,(2002), pp. 1-4.

http://www.essaybank.co.uk/free_coursework/2467.html, Technology Factor Analysis, 2002, pp. 1-6.

http://www.mvcuk.com/products/airport_public_seating/airport_public_seating.html, Global Airport & Public Seating, pp.1-2.

http://www.copybook.com/publications/article.asp?pubID=14&catID+346&artID+550, Airport International: Airport Seating: Comfort and Versatility, 2002, pp.1-3.

htp://www.aiportseatingalliance.com/rex.htm, AIRPORTSEATINGALLIANCE: Rex, pp. 1-2.

htp://www.aiportseatingalliance.com/citizen.htm, AIRPORTSEATINGALLIANCE: Citizen/800, pp. 1.

htp://www.aiportseatingalliance.com/scp.htm, AIRPORTSEATINGALLIANCE: SCP. pp.1.

http://www.airportseatingalliance.com/baja.htm, AIRPORTSEATINGALLIANCE: Baja, pp.1.

http//www.airportseatingalliance.com/alta.htm, AIRPORTSEATINGALLIANCE: Alta, pp.1.

http://www.grammerdesign.com/Airport_Seating/Italia_pages/Italia.htm , Italia, pp.1-2.

http://www.mida.gov.my/beta/view.php?cat=5&scat=9&pg=111 Malaysian Industrial Development Authority

www.ihknordwestfalen.de/marktkontakt/bindata/AHKStudieTimber2005.pdf, "Market Watch 2005"Sector Timber in Malaysia

http://www.mtc.com.my/statstic/stat04/5-11.html, Export of Chipboard by Peninsular Malaysia (By Major Destinatios).

http//www.fao.org/docrep/003/Y0153E/Y0153E03.htm The Utilization, Processing and Demand for Rubberwood as a Source of Wood Supply

http://www.mtc.com.my/news/pr217.htm Inculcating A Design Culture in the Malaysian Furniture Industry.

http://www.mtc.com.my/news/pr94.htm Malaysia Successful in Diversifying Downstream.