

## Kitchen Cabinet Door Material Replacement for Flood-Prone Landed House in Kuala Nerus, Malaysia

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**Abstract:** This paper reveals an analysis of the replacement of raw material for kitchen cabinet doors, which has always been an annual conversation amongst the householders of flood-prone landed houses in the city of Kuala Nerus, Terengganu, Malaysia. The use of existing raw materials in the production of a kitchen cabinet door like plywood, high pressure laminate (HPL), melamine faced chipboard (MFC), or medium density fibreboard (MDF) by the local furniture manufacturers in the state seems to be unable to solve some of the major environmental issues, such as flood-causes damage of the doors, decomposition of the doors due to termites and high humidity factors, and raw materials on the damaged doors are unrecyclable. We compile this study in the applied research category, where there are two types of research procedures have been used, namely quantitative and qualitative methods. In the context of this study, quantitative methods are dominant. Primary data for this study is obtained from a pre-test stage via participant observational technique with time sampling practice and non-random standardised aka a structured interview technique; meanwhile, secondary data of the study is collected from literature review through relevant printed and electronic sources. To make this study a success, we implement six footsteps of the industrial design and development processes, consisting of design ideation for mind map thumbnail, design development for conceptual impression, design refinement for detailing expansion, design software for digital production, workflow for product making, and completion for the outcome of the study that is a full-scale finished model of indoor home kitchen cabinet doors made of polypropylene based honeycomb structure with thick aluminium frame developed from sustainable-and-impressive-design concept, which is the best suited to the 4G type kitchen cabinet that is a long-term trend and gets high demand amongst the householders in the city.

**Keywords:** Environmental studies on furniture raw materials; Polypropylene based honeycomb structure of the 4G type indoor home kitchen cabinet door replacement; Consequences of flood, termites, humidity, and unrecyclable; Flood-prone landed houses in Kuala Nerus, Terengganu, Malaysia; Sustainable-and-impressive-design concept offers at reasonable prices.

## INTRODUCTION

Furniture is a product such as a table, chair, cabinet, sofa, bed, shelf, bench, and so on. It is usually placed in the interior or exterior of a house or office for the convenience and the comfort of human life [1]. The production of a furniture product needs to emphasise the impact on the environment; for example, raw material from a tree to a home or office furniture [2]. There are various types of raw materials used in the production of a furniture product, such as hardwood, softwood [3], and wood scraps or chips of the paperboard [4], rice hush [5], and laminated veneer lumber [6]. Apart from that, there are also plastic and iron based raw materials used in the production of a furniture product like polyethylene, polyethylene

terephthalate, high-density polyethylene, low-density polyethylene [7], polyvinyl chloride, polystyrene, acrylonitrile butadiene styrene [8], polypropylene [9], stainless steel, and aluminium [10].

### Kitchen Cabinet is a Furniture Product

Kitchen cabinet is one of the furniture products. It is used for the purpose of kitchen decoration, storage for kitchenette goods, and cooking activities. It is also capable of producing a sense of serenity to the users [11]. The absence of a kitchen cabinet can cause the kitchen room to become unorganised, unattractive, and uncomfortable [12]. The production of a kitchen cabinet often focuses on several factors like function, aesthetic value, and the durability

of raw materials [13]. A kitchen cabinet available in the market is seen over a lower cabinet, a wall cabinet, a framed cabinet, or a frameless cabinet [14] made of iron based of [15], or plastic based of [16], or wood based of [15] raw materials like plywood, high pressure laminate (HPL), melamine faced chipboard (MFC), and medium density fibreboard (MDF) [17]. The existence of a kitchen cabinet is usually placed in the interior or exterior of a house [18], whether a custom made product [19], a prefabricated product [11], or a commercial product [21] with fog glass [22].

### **The Door for Kitchen Cabinet and Its Environmental Issue**

A kitchen cabinet has its own function for the convenience of the users, such as the doors and its handles, the drawers and its handles, the body and its side panels, the shelves, the table top surfaces, the hinges, and the cornices [11]. In Malaysia, particularly in the state of Terengganu, any activity related to the production of a furniture product, including the making of a kitchen cabinet door is no exception from facing the environmental issues. For example, a plywood production by the local manufacturer in the state is still less concerned with go green manufacturing practices [23] and the existing of raw materials used in the production of a kitchen cabinet door is not lasting due to termites [24] and high humidity factors [25]. In the context of this study, although an indoor home kitchen cabinet door is locally made and produced from plywood, high pressure laminate (HPL), melamine faced chipboard (MFC), or medium density fibreboard (MDF) that furnished with quality finishing and sold at reasonable prices; they are seems to be unable to solve some of the major environmental issues like flood-causes damage of the doors, decomposition of the doors due to termites and high humidity factors, and raw materials on the damaged doors are unrecyclable. It means that indoor home kitchen cabinet doors available in the state market do not serve the needs of the householders in the target places as they are not produced from the solution of sustainable-and-impressive-design concept. This is in line with the hypothesis of the study says that an indoor home kitchen cabinet door made of polypropylene based honeycomb structure with thick aluminium frame is the best suited to the 4G type kitchen cabinet can be offered to the householders of flood-prone landed houses in the city Kuala Nerus, Terengganu, Malaysia. We then state the aims of this study are to replace the existing raw materials of the kitchen cabinet doors to a raw material that has never been used in any production of a kitchen cabinet door locally and nationally, which is polypropylene. Through this effort will be able to create a revolution of the raw material replacement in the production of kitchen cabinet doors in this country to solve the stated problems in total. The outcome of the study is also furnished and completed in the School of Industrial Design of the Universiti Sultan Zainal Abidin, Malaysia. Towards this end, the study aims to

fulfil the following objectives: (i) to produce a full-scale finished model of the 4G type indoor home kitchen cabinet door made of polypropylene based honeycomb structure with thick aluminium frame developed from sustainable-and-impressive-design concept and produced from industrial design and development processes; (ii) to integrate design criteria of ergonomic with safety, aesthetic with creativity and innovativeness, affordability with reasonably-prices, and durability with reliability alongside implementing design practices of design transform and design emotion into the outcome of the study; and (iii) to conduct a pre-test and a post-test around flood-prone landed houses in the stated target places.

### **MATERIALS AND METHODS**

We compile this study in the applied research category, where there are two types of research procedures have been used: quantitative and qualitative methods, where the quantitative is dominant. Applied research is a study involves into a real-world setting to solve the real life problem. It is not a study used to create new knowledge in a specific field [26], but it acquires knowledge for knowledge's sake as contained in fundamental research. It produces a product or service that has creative, innovative, and effective values [28] to enhance community benefits [27]. Apart from that, quantitative method is used to measure the population number [26], or to calculate a number of variables in a study [29], where it begins and concludes either 0 or 1 [30]. Unlike qualitative method requires an observation on a subject or behaviour [29] contained in any document, picture, video, and audio [30].

### **Pre-Test Stage for Primary and Secondary Data Collection**

A pre-test is an initial plan used to test the extent of a study contribution [33], or a prelude way to assess the quality of study journey [34]. It should be carried out before the study began [35] to support and measure any change in the study process [36]. We obtain primary data for this study via participant observational technique with time sampling practice and non-random standardised aka structured interview technique; meanwhile, secondary data of the study is collected from literature review through relevant printed and electronic sources. In other words, primary data collection covers a knowledge gap contained in the literature [32] and defines as indirect data found from first-hand experience, unlike secondary data obtained from books, journals, newspapers, magazines, bulletins, conference data, and others [31].

### **Participant Observational Technique with Time Sampling Practice**

The participant observation means a survey to collect actual behaviour data to enmesh it into a group or subject under study [26], while time sampling is about observing a subject or behaviour in certain extended period [37], or recording behavioural data

systematically through a pre-set interval procedure of 40 minutes within an hour [26]. In the context of meeting the qualitative requirements, we conduct participant observational technique with time sampling practice to identify the existence of the early problem for this study. We enmesh into a group and subject under study where we visit more than 30 units of flood-prone landed houses to record the data according to a pre-set interval procedure of 10 minutes for four times within every hour. At the end of the observations, we confirm the results obtained from this survey say that indoor home kitchen cabinet doors available in the target places are facing the stated environmental problems.

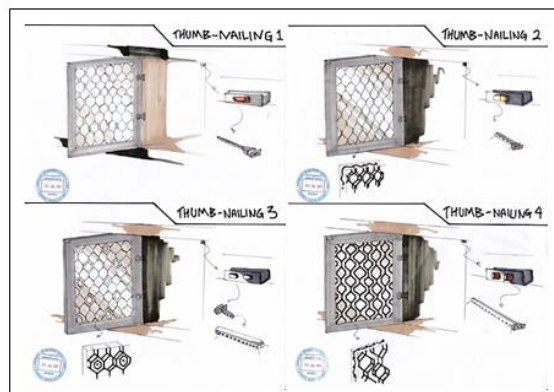
**Non-Random standardised aka a Structured Interview Technique**

An interview is a process to engage two-way conversation to focus on a specific issue related to a study. It gains the thought, opinion, perspective, or description about a particular set of phenomena based on expertise and knowledge of the participants who are familiar with the topic and can provide comment and constructive feedback on their specific experience [39]. There are three types of interview techniques: standardised aka a structured interview, semi-standardised aka a semi-structured interview, and un-standardised aka an un-structured interview, which can be done randomly or non-randomly [38]. In the context of this section, non-random participant means a selected group of people based on their characters and

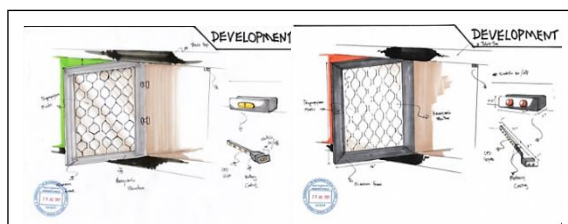
availability for the interviews, while standardised aka a structured interview is an official dialogue done in a formal meeting, unlike to the other two types [26]. In the context of meeting the quantitative requirements, we verify the results of the observations by preparing the list of questions as we have had solid idea about a specific issue to be uncovered. We then ask the questions (to more than 10 participants, comprising of the householders and the furniture industrialists) exactly as written and worded in the list of questions. We focus on the answers since reordering them are not allowed. We are also not clarifying to answer the replies of the participants, not altering the level of the languages, and not deviating the flow of sequence of the questions. At the end of the interviews, we verify the results obtained that indoor home kitchen cabinet doors available in flood-prone landed houses are needed to be replaced altogether.

**Industrial Design and Development Processes**

To make the study a success, we implement six footsteps of the industrial design and development processes, consisting of design ideation for mind map thumbnail (see Fig-1), design development for conceptual impression (see Fig-2), design refinement for detailing expansion (see Fig-3), design software for digital production (see Fig-4), workflow for product making (see Fig-5), and completion for the outcome of the study (see Fig-6), which can be referred to as follows:



**Fig-1 : Design Ideation for Mind Map Thumbnail**



**Fig-2 : Design Development for Conceptual Impression**

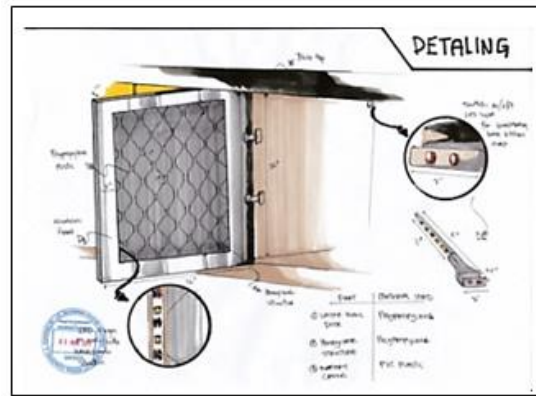


Fig-3 : Design Refinement for Detailing Expansion

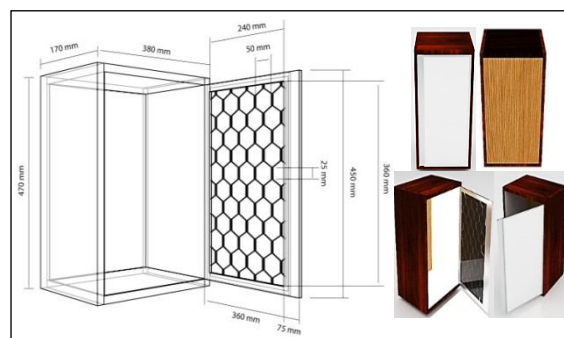


Fig-4: Design Software for Digital Production

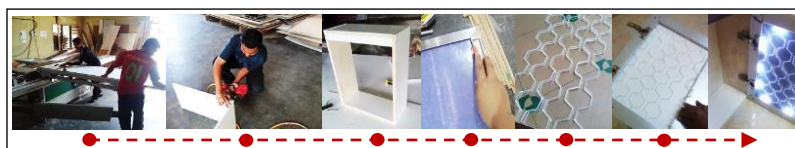


Fig-5: Workflow for Product Making



Fig-6: Completion for the Outcome of the Study

### Post-Test Analysis Stage for the Outcome of the Study

Of the four product benchmark categories; cash cow, dog, star, and question mark that include in the analysis of growth-share matrix for product benchmarking, we agree to place the outcome of the study into the cash cow category, where it is easy-to-sell, ease-to-earn profits, confident to gain annual returns, and able to dominate the local and national markets. Unlike the other benchmarks that are hard to sell, earn less profits, and low sales margin (the dog); or

high market share due to the strong brand but sales unlike the cash cow (the star); or big investments for unpredictable sales and profits (the question mark).

We then conduct the analysis of crossed-map for product positioning to find out the price comparison and product resilience between the outcome of the study and the existing of indoor home kitchen cabinet doors available in Kuala Nerus and Terengganu markets. We use two variables (prices factor vs. material durability) on one crossed map, where there are four kitchen



cabinet door manufacturers available in the state that explain the Company A offers inexpensive prices but the materials used are not durable and easily damaged, the Company B offers a slightly expensive price and uses the materials similar to the Company A, the Company C offers costly prices amongst all due to the use of high quality materials, and the Company D offers cheap prices with moderate material quality. For the outcome of the study, we agree to place it at inexpensive prices with high quality and durable materials as it has a price differential of 18 per cent reduction (including goods and services tax) compared to the other raw materials like plywood, high pressure laminate (HPL), melamine faced chipboard (MFC), or medium density fibreboard (MDF).

The outcome of the study is also brought into the analysis of product SWOT in which the strengths for the outcome of the study are academic based research solution, ease-to-get raw material supply, having sales relationships with a panel company, innovative contribution for the local furniture industry, low cost production, reasonable retail prices, high quality and durable products, and equipped with LED lighting accessories. The weaknesses for the outcome of the study are a new brand and lack of skilled manpower, while the opportunities for the outcome of the study are a new change in the furniture business as the government is fully supported to easily penetrate the

local, regional, and international markets. The threats for the outcome of the study are currency wavering and volatility in world oil prices that may affect the cost of purchasing the raw materials, increasing the overhead costs, or rising the logistics costs.

We also conduct the analysis of product compression, tensile, and impact for the outcome of the study to examine durability of the material when facing the major environmental problems that are flood-causes damage of the doors and decomposition of the doors due to termites and high humidity factors. For the compression test, we set a reading of 10 KN (kilo newton) between 223 N (Newton) and 1022 N. The results of the test show that (Fig-7) the compressive pressure graph is increasing for the samples are proven strong with the final reading of 0.04821 MPa (Megapascal) in 0.7324 mm (millimetre). For the tensile test, we set a reading of 30 KN at a temperature of 70°C to 250°C. The results of the test show that (Fig-8) the tensile pressure graph is increasing for the samples are proven strong with the final of break-sample reading is at 162 per second in 10 mm with maximum load of 539.9 N. For the impact test, we set a reading of 407.95 J (Joule), where the sample is divided into six parts and cut to size 55 mm x 10 mm (Fig-9). The results of the test have shown that the final average reading for each sample is 1.4234 J.

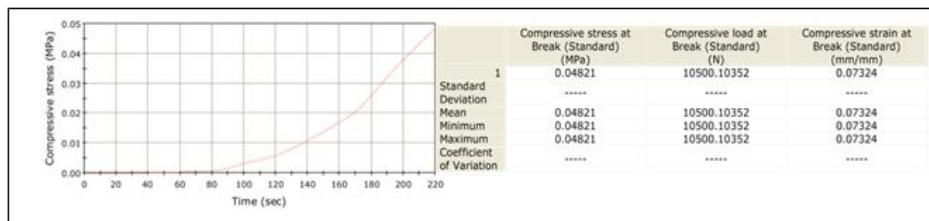


Fig-7: Compression Test for the Outcome of the Study

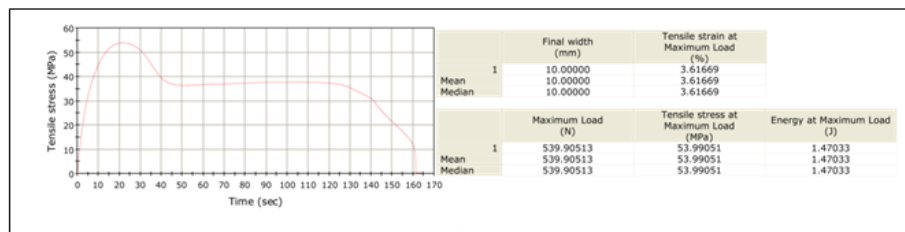
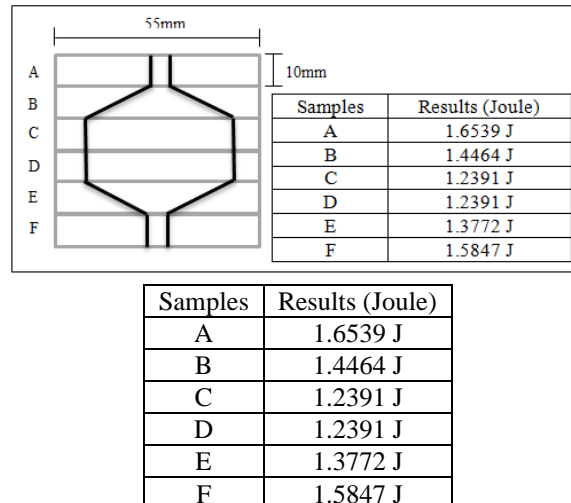


Fig-8: Tensile Test for the Outcome of the Study



**Fig-9: Impact Test for the Outcome of the Study**

A random participant questionnaire technique defines a participant has an equal chance of being chosen to participate in a survey. A participant can be picked whether from a simple random participant of any place related to the study, or a group random participant of any club membership related to the study [26]. Apart from that, a questionnaire is one of the techniques used in a survey study that has four categories of questions, namely opened-ended questions, closed-ended questions, dichotomous questions, and multi-response questions [40]. An opened-ended question begins with what, why and how, while a closed-ended question initiates with which, who, when, is or are, do or did, will or would, was or were, and has or have [41]. Unlike a dichotomous question requires two possible answers that only need to be answered one, whereas a multi-response question provides a variety of answers that can be answered one or more [40]. In the context of this section, we conduct the analysis of random participant questionnaire technique to validate some key points for the outcome of the study, which are design criteria, design practices, design elements, and design principles. We choose a simple random participant that picks around the state of Terengganu and a group random participant that picks amongst the householders of flood-prone landed houses in the city of Kuala Nerus. We apply all of four categories of the questions to be set in our survey forms. We then distribute hundreds of questionnaires to the participants who have experience and knowledge on the issues related to indoor home kitchen cabinet doors and its surrounding problems. At the end of the questionnaires, we confirm the results obtained from this test say that the outcome of the study is perfectly fitted with design criteria, design practices, design elements, and design principles.

**RESULTS AND DISCUSSION**

A full-scale finished model of indoor home kitchen cabinet door made of polypropylene based honeycomb structure with thick aluminium frame (see

Fig-6) developed from sustainable-and-impressive-design concept and produced from industrial design and development processes is the best suited to the 4G type kitchen cabinet that is a long-term trend and gets high demand amongst the householders of flood-prone landed houses in the city of Kuala Nerus, Terengganu, Malaysia. In the context of this section, the outcome of the study is fitted with four design criteria, two design practices, five design elements, and four design principles, which can be referred to as follows:

**Design Criteria**

We confirm the criterion of ergonomic with safety for the outcome of the study has a smooth surface and is not harmful, injurious, or threatening to the user’s hands and body when doing any touching, opening, and closing activities. It also has an illumination effect of a battery type LED light that is not hurt the human eye as the nature of polypropylene is translucent and reduces the occurrence of more light exposure. This LED light is served as a notification that the door is being opened and it can make easier for the users to view the storage items in the dark or at night. Apart from that, we affirm the criterion of aesthetic with creativity and innovativeness for the outcome of the study is a contribution from sustainable-and-impressive-design concept done by manual hand expertise and design software of the Rhinoceros, 3D Studio Max, and Adobe Photoshop to make it looks more attractive, versatile, and is possible to be reproduced by another furniture maker. It is able to create a revolution of raw material replacement in the production of indoor home kitchen cabinet door locally and nationally to solve the stated environmental problems in total. We consider the criterion of affordability with reasonably-prices on the purchase price of polypropylene is much cheaper than the price of the other raw materials like plywood, high pressure laminate (HPL), melamine faced chipboard (MFC), and medium density fibreboard (MDF). The estimate current market price for polypropylene is MYR5.40 per

kilogram. It means that polypropylene based solution offers low cost production, engages in a simple manufacturing process with the use of existing machinery and equipment, be recyclable to avoid open burning activities, and offers affordable retail prices to consumers. We also believe that the criterion of durability with reliability for the outcome of the study is proven to be a hard and strong material.

### Design Practices

We describe the meaning of design transform for the outcome of the study is a replacement of the existing raw materials; from plywood, high pressure laminate (HPL), melamine faced chipboard (MFC), or medium density fibreboard (MDF) to the polypropylene (PP) based solution to create new breath for furniture industry. We also define the importance of design emotion for the outcome of the study is the existence of a battery type LED lights are successfully elevating the user mode to be more cheerful and energetic.

### Design Elements and Principles

We confirm that there are 10 types of lines available on the outcome of the study, such as broken lines, curved lines, diagonal lines, dotted lines, horizontal lines, straight lines, thick lines, thin lines, vertical lines, and zigzag lines. Apart from that, there are three types of shapes available on the outcome of the study that are two-dimensional geometrical rectangle, hexagon, and circle, as well as two types of forms that are three-dimensional geometrical hexagon and cuboid, and also four types of textures that are tactile textures, visual textures, natural textures, and artificial textures. We also confirm that there are five types of colour theory available on the outcome of the study, which consist of greyish tone; all cool colours; yellow-and-red-and-blue of the primary colour; violet-and-green-and-orange of the secondary colour; and violet-and-greenish-and-bluish-and-orange-brownish of the tertiary colour; meanwhile, four types of design principles can be clearly seen over a balance and equalise, harmony and tranquillity, pattern and motif, and rhythm and movement.

### CONCLUSION

This study highlights the initiative of knowledge-based transfer through the solution of sustainable-and-impressive-design concept embedded into the state-of-the-art polypropylene based honeycomb structure with thick aluminium frame of kitchen cabinet door, which is the best suited to the 4G type indoor home kitchen cabinet that is a long-term trend and gets high demand amongst the householders of flood-prone landed houses in the city of Kuala Nerus particularly and to those in the other cities in Malaysia generally. This study has successfully resolved the major environmental problems in total, which are flood-causes damage of the door, decomposition of the door due to termites and high humidity factors, and avoiding open burning activities to dispose the damaged door

that are unrecyclable. The study also generates human capital for and increasing domestic economy percentage for Kuala Nerus district authorities and the state government of Terengganu through contribution of the local industry boards and players in the sectors of furniture, furnishings, and fittings, especially in the manufacturing of indoor home kitchen cabinet doors, such as manufacturers, wholesalers, retailers, contractors, consultants, suppliers, marketers, vendors, investors, inventors, designers, engineers, and scientists.

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