

Modern Study Table for Small Houses Inspired by Origami

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DOI: <https://doi.org/10.30880/rmtb.2022.03.01.020>

Received 31 March 2022; Accepted 30 April 2022; Available online 25 June 2022

Abstract: Nowadays, the newest tiny-size apartments have floorspaces as little as 10 to 15 meters square. When compared to 30 years ago, a tiny flat has gotten smaller over time. This may cause people who live in small, congested, and cluttered spaces to feel worried, imprisoned, and claustrophobic. This will indirectly increase the degree of contentment with the lodging. Therefore, the purpose of this research is to identify design criteria, design, and develop a prototype of a modern study table with multifunctional features for users who live in small size houses. This study began with an online questionnaire survey distributed via Google Form to 50 respondents in Pagoh, Johor. This obtained data was converted into design criteria for the design process. The survey yielded design criteria such as pinewood as a material, closed storage, stainless steel table legs, natural colour, and a flip-top mirror. Following that, the design process began with the drawing of 30 thumbnails, 6 ideations, and 4 concept developments. Three idea development sketches were utilized as candidates for this study's final design selection that was done via a simple survey. A new prototype of a modern study table made of rubberwood and coated with wood lacquer was successfully produced. Finally, by wisely utilising the limited space of tiny homes, this innovative design study table is able to solve the mentioned problem.

Keywords: Modern Design, Study Table, Small Houses, Origami

1. Introduction

In recent years, the price of real estate property has risen dramatically. Small flats 30 years ago had a floor space of about 55 square metres. In Malaysia, the Ministry of Housing and Local Government has a regulation that states that the floor space of flats must be between 45 and 56 metres square, and terrace houses must be between 48 and 60 metres square (Ishak et al., 2016). The newest tiny-size apartments on the market nowadays have floorspaces as little as 10 to 15 metres square. We can see that the modest flat has shrunk with time, compared to 30 years ago. A person who lives in a tiny house

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must think carefully about what to buy, how to decorate, and how to use the available floor space. This will make the individuals who reside in the house more comfortable. Furthermore, Urist & Beriot (2013) asserted that the cramped quarters will result in psychological issues. People who live in a congested and cluttered environment will experience tension, confined feelings, and claustrophobic sensations. As a consequence, it will have an impact on our everyday lives or activities, as well as our degree of satisfaction with the lodging. Using multifunctional furniture is one option for avoiding crowded and limited space as one multifunctional furniture can serve more than one function.

Furniture is an essential object that may help us in our everyday lives by allowing us to use it for storage, work, dining, sitting, and sleeping. Furniture may be created from a range of materials, including wood, metal, glass, polymer, and ceramics. Tables have existed since 2500 BC when the Ancient Egyptians developed some of the oldest tables made of wood and alabaster, which are still in use today. The Greeks and Romans, who developed the use of tables, are credited with starting the diversity of tables.

A study table is a piece of furniture having a flat top surface and one or more legs that serve as work, reading, or studying surface. Typically, a study table is supported by four legs. However, there are rare exceptions, such as certain study tables that have three legs, a single hefty pedestal, and are linked to a wall. There are several table design concepts available, including modern, rustic, minimalist, and many more. Some of the bespoke table designs were inspired by flowers, architecture, culture or fashion.

Origami is the Japanese art of paper folding. Paper was invented in China in the first and second centuries and introduced to Japan later in the sixth century. Because of the expensive cost and limited amount of paper, origami was once classified as a luxury item or for ceremonial purposes. The advancement of technology has enhanced papermaking procedures. Paper has grown more widespread, and origami has gained popularity in society.

Thus, the objectives of this work are to design and develop a prototype of a modern study table for tiny houses inspired by origami. The design criteria gathered from the visual research and questionnaire will be used to design and fabricate the prototype of this study table.

2. Literature Review

According to Beardmore (1971), living in a small space is not new. People have been living in small apartments for many years owing to the enormous population of major cities and the movement of people from rural to urban regions such as China, Asia, and other parts of the world. In an apartment, a bedroom should be at least 6 to 9 metres square. However, as a result of being divided into small units, the bulk of flats have fallen in size. As a result, an open-plan structure apartment will be an excellent choice for tiny apartment design (Georgoulas *et al.*, 2012).

Modern design is an interior design style that originated in the early twentieth century and continues to inspire modern designers today. A monochromatic colour palette, clean lines, simplicity, natural materials, and enough natural light describe modern interior design (MasterClass, 2021). Modern design, according to Asaff (2021), is difficult to describe owing to its diversity. Modern interior design, in its most basic form, represents the modern art movement within the house. Modern design, on the other hand, is defined by a number of important characteristics and design concepts.

According to Smardzewski (2015), furniture is an item of applying arts that serves as movable and permanent furnishing of home spaces. Furniture may be used for a variety of purposes, including storage, work, dining, sitting, lying down, sleeping, and resting. Furniture helps to a more convenient and pleasant way of life for humans (Astonkar & Kherde, 2015). Throughout the years, furniture has

been created to fulfil a specific purpose. Sofas and mattresses, for example, are used for relaxing, while closets and cupboards are used for storing, and tables and chairs are used for dining.

A table is a piece of furniture that has a flat top surface and one or more legs and serves as a work surface, dining area, or storage surface. Trestles, legs, or a pillar support the tabletop, which is made of stone, metal, wood, or glass. The dining table, which is used for meals, is the most popular type of table. Following that is the coffee table, which is a low table used in living areas to display objects or serve beverages. The bedside table is where you put your alarm clock and lamp. While there are more types of tables besides the ones mentioned above, such as drafting tables and sewing tables. Table is a type of furniture that is well-known and widely utilised in the Western world since 7th century BCE.

Meanwhile, dressing tables began as a little portable cosmetic box that held perfume flasks, combs, nail files, and tiny scissors (Adlin, 2013). There are several varieties of dressing tables available on the market today, including fixed dressing tables, extensible dressing tables, and multifunctional dressing tables. Each of these dressing tables is available in a variety of sizes and designs. According to Adlin (2013), the dressing table is still a unique and traditional type of furniture that may suit both our practical daily requirements and our innermost emotional and psychological needs.

According to Canepa (2017), multifunctional furniture is also known as space-saving furniture, transformable furniture, or multipurpose furniture. Multifunctional furniture is intended to serve several activities and functions at the same time. Despite the fact that multifunctional furniture has been around for a long time, its usefulness has not been fully appreciated.

Multifunctional furniture designs are the newest trend, and they can be seen everywhere. Since a few years ago, the demand for multifunctional furniture with stylish designs, maximum storage capacity, and creative space-saving designs has been increasing, and the furniture industry in Asia-Pacific is expanding (Karthek, 2019). Due to the space available for interior spaces in modern city tiny houses and apartments being limited, the furniture must be innovative.

The ancient art of paper folding is known as origami. The term "Origami" is derived from the Japanese terms "oru" (to fold) and "kami" (paper). Traditionally, most origami was made up of straight folds on a piece of paper with identical dimensions on both sides. Origami does not allow ripping, cutting, or glueing. When finished, the origami provides a developable surface that can be unfolded into a flat plane equal in length to the design (Dureisseix, 2012).

Although the key objective of origami is entertainment and aesthetics, engineers may still use it to construct self-folding structures. NASA researchers, for example, have merged origami principles into massive star shades and put them on spacecraft to deploy small plates onto bigger structures as presented in Figure 1 (Peraza et al., 2014).

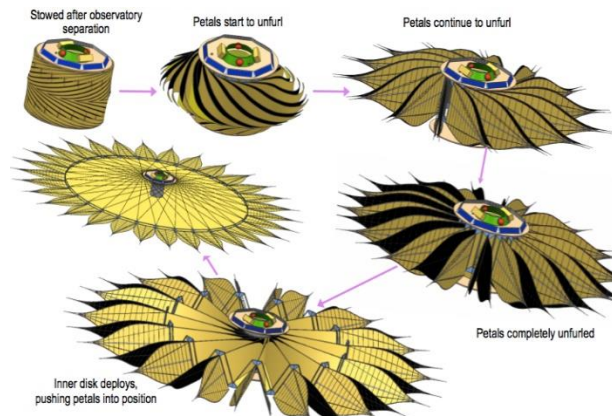


Figure 1: The deployment of NASA starshade (Peraza et al., 2014)

3. Research Methodology

This study used the same procedure as other studies that have been published (Ramli *et al.*, 2018; Selimin *et al.*, 2019; Husuno & Selimin, 2020). In this study, a questionnaire with 22 questions was used, divided into three sections: section A for demographic information, section B for design criteria of modern study table for tiny homes inspired by origami, and section C for user feedback. Following that, 50 thumbnails were freehand drawn on A3 paper using a pen. After that, 10 ideation sketches were generated based on the existing thumbnail that most likely met the design criteria of the study table. Six ideation sketches were examined and appraised, and the best ones that met the design criteria were gathered. These ideations were developed further during the idea development process. Three concept development sketches were used as candidates for the final design.

A final design survey was carried out in order to select the best design of idea developments in terms of usefulness, user-friendliness, user preference, and design concept. Based on the images and design criteria supplied, three concepts from idea development drawings will be included in the final design survey. The design with the most votes will be chosen as the final design and built as a prototype.

Afterwards, the mock-up was developed at a scale of 1:6 of its original size. Mounting board, ruler, cutter, pencil, hot glue, super glue, UHU glue, and wood adhesive wallpaper were used to build the mock-up. The technical drawing in this study was created using Computer-Aided Design software, AutoCAD. The software was used to sketch the exact dimensions of the study table design. The design was plotted in 2D and 3D views with multiple perspectives in terms of size and colour.

Subsequently, a full-scale prototype of a modern study table inspired by Origami was fabricated. The prototype was manufactured in accordance with the real dimension, design, and material specified in the final design. Identifying and preparing raw materials, measuring, cutting, drilling, welding and jointing, sanding and polishing, and final assembly were all part of the prototype manufacturing process. The selected final design might be altered during the prototype fabrication process owing to a variety of circumstances such as material availability, difficulties in fabricating using current machines and equipment, and other considerations.

4. Results and Discussion

4.1 Questionnaire Analysis

Table 1 displays the questionnaire data summaries, which contain demographic information, modern study table design criteria, and user feedback. As listed in Table 1, there were 50 respondents who participated in this survey, with 56 % were male, 98 % aged between 20 and 30 years old, and 60 % were Chinese. 76 % fall under the B40 household income group, with an annual income of less than RM 4,360 and 64 % of respondents live in terrace houses.

Meanwhile, the design criteria section reveals that the majority of respondents (88%) possess a study table, with 68% placing it in the bedroom, 28% in the living area, and others in a special study room. Furthermore, the survey discovered that 76 % had a single function of study table, which is just for study purposes. Additionally, 64 % of the respondents possessed a dressing table, with 72% preferring combination furniture (study table and dressing table). Moreover, the majority of respondents are well-versed in origami. In terms of study table design features, the majority of respondents prefer closed storage (54%) over open storage (24%) or no storage (22%), a flip-flop mirror (62%) over a fixed mirror (38%), stainless steel table legs (76%) instead of wood (24%), and natural wood colour (46%) as surface finish.

According to the respondent feedback section, the majority of respondents (59%) had a problem with cramped living space since most of the space was taken by furniture, and 72% classified their home

as a small-size residence. 90% of respondents suggested incorporating a dressing table into the design of a study table, and they (52%) also agreed to replace their existing traditional single-function furniture (study table and dressing table) with multifunctional furniture in order to have more free floor space. Therefore, from the questionnaire results, it can be summarised that the design criteria for this study are pinewood as a material, closed storage, stainless steel table legs, natural colour, and a flip-top mirror.

Table 1: Summary of questionnaire results

Section	Percentage (%)	Description
Demographic information	56	Male respondents
	98	Ages between 21 and 30
	60	Chinese respondents
	80	Household income group – B40
	64	Reside terrace house
Design criteria	88	Own study table
	68	Place the study table in the bedroom
	76	Own study table with single function
	64	Own dressing table
	72	Prefer multifunctional furniture
	90	Know about origami
	54	Prefer closed storage
	62	Prefer flip-flop mirror feature
	76	Prefer table legs made of stainless steel
	46	Prefer study table with natural wood finishing
Respondent feedback	59	Most of their living space occupied by furniture
	72	Reside at limited space/small house
	90	Agreed that multifunctional furniture will give more free space to their living area
	52	Prefer to replace their existing study table and dressing table with multifunctional furniture

4.2 Design Process

Figure 2 presents the thumbnail sketches of a modern study table inspired by origami for small households. A minimum of 30 thumbnail sketches were produced using a pen. Each thumbnail was intended to depict a modern study table with a variety of tones, places, sizes, and features. As a result, five thumbnails in red box (Figure 2) were selected for further refinement. The choice was chosen based on which thumbnail best fit the design criteria established from the questionnaire survey.

Meanwhile, the sketches from the selected thumbnails were used to generate the ideation. This process's ideation produces a variety of patterns and design styles. Six pieces of ideations were formed together with the inspiration, which was inspired by origami as illustrated in Figure 3. However, ideation 5 was chosen for the idea development process because it meets the design criteria of closed storage, flip-flop mirror feature, suitable for legs made from stainless steel, and natural colour.

Figure 4 depicts four idea developments of the modern study table for small houses inspired by Origami. There were four idea developments that were drawn in different design and practical concepts. Idea development 1 has a hinged lift-top mirror countertop, hidden and locked storages, and origami-form hardwood table legs. When compared to the drawer, the hidden storage has a larger storage area. The idea Development 2 has a lift-top mirror countertop with a hinge, hidden and locked storage, and stainless steel table legs. Meanwhile, idea development 3 has a hinged lift top mirror countertop, hidden and closed storages, and stainless-steel table legs with an origami structure. The hidden storage was designed behind the lift mirror countertop.

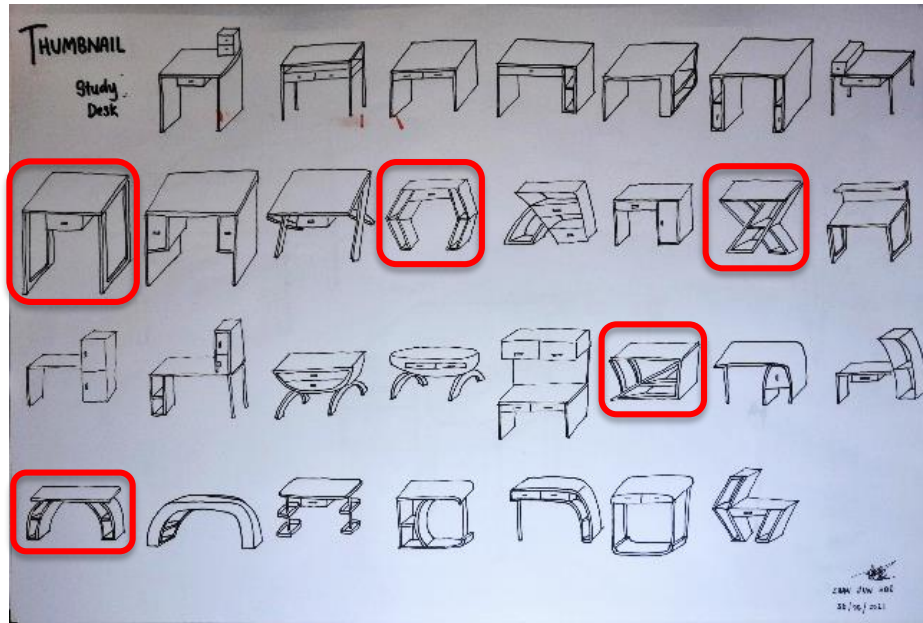


Figure 2: Thumbnail sketches of modern study table for small houses inspired by origami

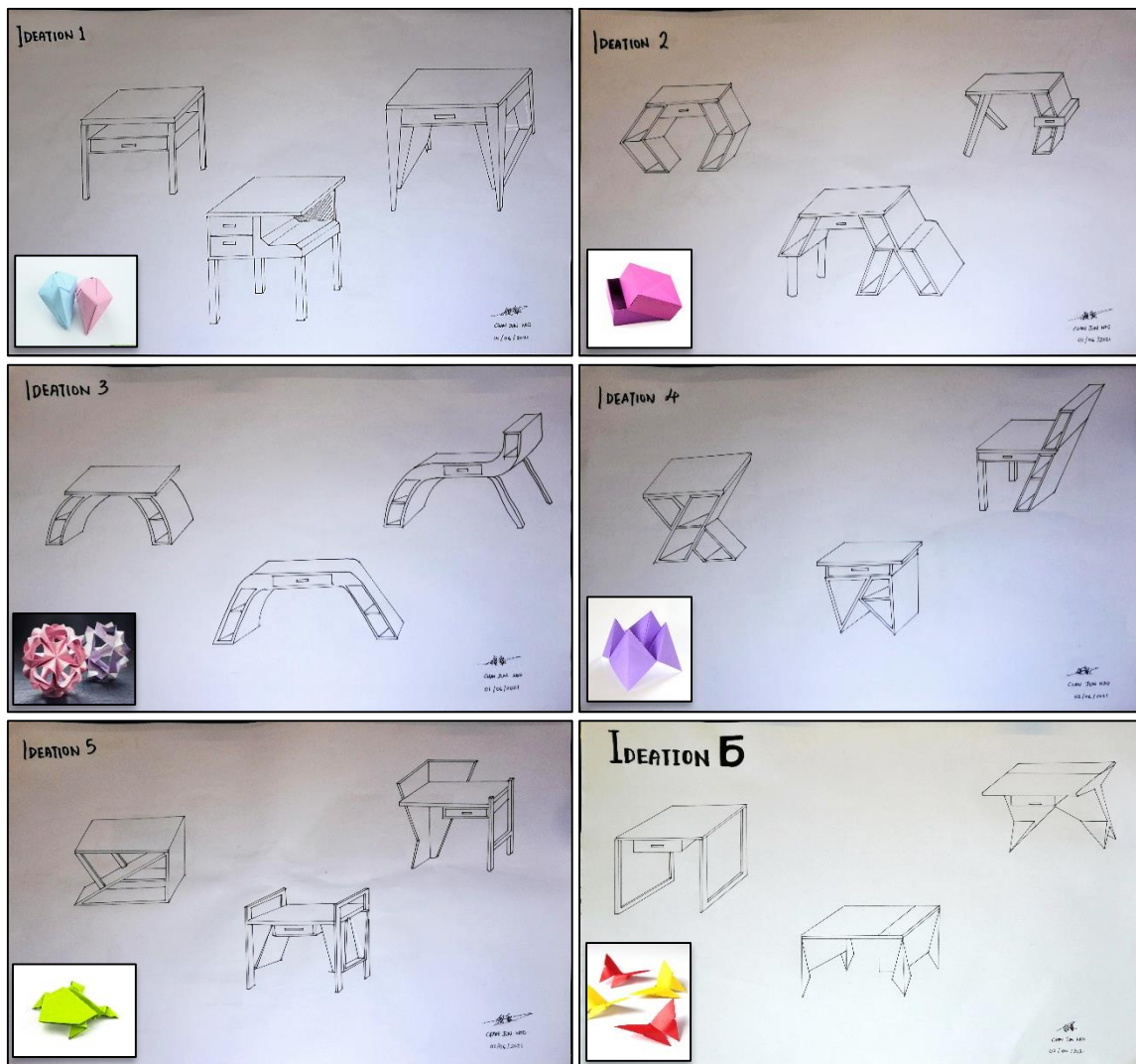


Figure 3: Ideation sketches of modern study table for small houses inspired by origami

Idea development 4 includes a lift top mirror countertop with hinge, hidden and closed storage, an origami-shaped frame, and stainless steel table legs on both sides. The middle section of the table can be used for additional storage of books, magazines, and stationery. Cosmetics can be stored in the hidden storage behind the lift top mirror countertop. From these idea development sketches, idea development 1, 3, and 4 were nominated as final design candidates since they meet the design criteria obtained earlier.

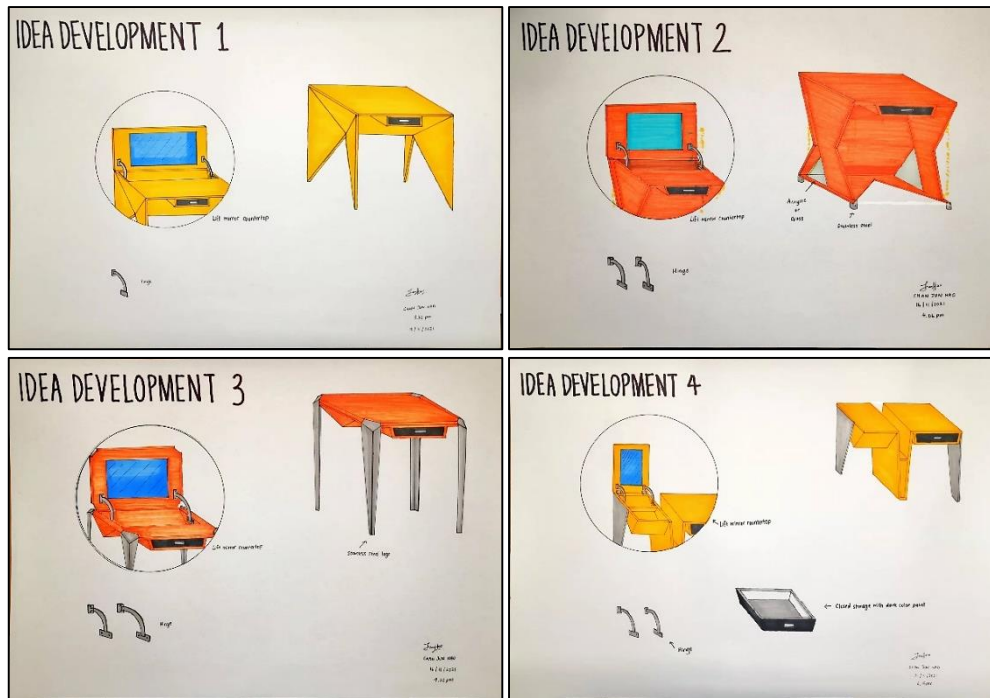


Figure 4: Idea development of modern study table for small houses inspired by origami

A simple final design selection survey was carried out in this study by disseminating a questionnaire utilizing Google Form. This design selection survey has three parts: demographic information, design selection, and respondents' recommendations on the selected design, where idea development 1, 2, and 3 are referred to as design 1, 2 and 3 correspondingly. This survey has a total of 40 respondents. According to the survey, 55% of respondents preferred design 3, 32.5% preferred design 2, and others preferred design 1. Furthermore, 60% of them picked pinewood as the primary material for the study table, followed by rubberwood (22%), and medium-density fibreboard (18%). Table 2 summarises the total results of the final design survey.

Table 2: Summary of final design survey

Item	Percentage (%)	Description
Demographic information		
Gender	58.0	Female
	42.0	Male
Age	85.0	16-25 years old
	15.0	25-35 years old
Design selection		
Which design you prefer?	12.5	Design 1
	55.0	Design 2
	32.5	Design 3
What material you prefer?	60.0	Pinewood
	22.0	Rubberwood
	18.0	Medium-density fibreboard

In addition, respondents 9 and 10 proposed in the respondent recommendation section, "Maybe the middle spaces between the mirror table and the study table can be designed an additional storage" and "Wider left part of the table," respectively. Thus, design 2 is the chosen final design for this study. Figure 5 shows the final design of an origami-inspired modern study table for small houses. This final design drawing expanded on the previous idea development 4 by adding dimension and a distinct viewport.

4.3 Prototyping Process

Mock-up creation was the first step in this process. Figure 5 shows a 1:6 scaled mock-up model of a modern study table for small houses influenced by origami. Mounting board, wood wallpaper, cutter, ruler, and UHU adhesive are among the materials and tools used in the mock-up development process.



Figure 5: Mock-up of modern study table for small houses inspired by origami

Following that, several viewpoints of the modern study table for small houses inspired by origami are generated in 2D and 3D using the AutoCAD software. The dimensions of this modern study table inspired by origami are 113 cm (length) x 75 cm (height) x 55 cm (width). Figure 6 and Figure 7 depict 2D and rendered technical drawings of an origami-inspired modern study table for small houses. The 2D technical drawing shows the dimensions of the desk as well as a perspective view. To mimic the actual prototype, the study table was applied and rendered with the material to be used in the fabrication process.

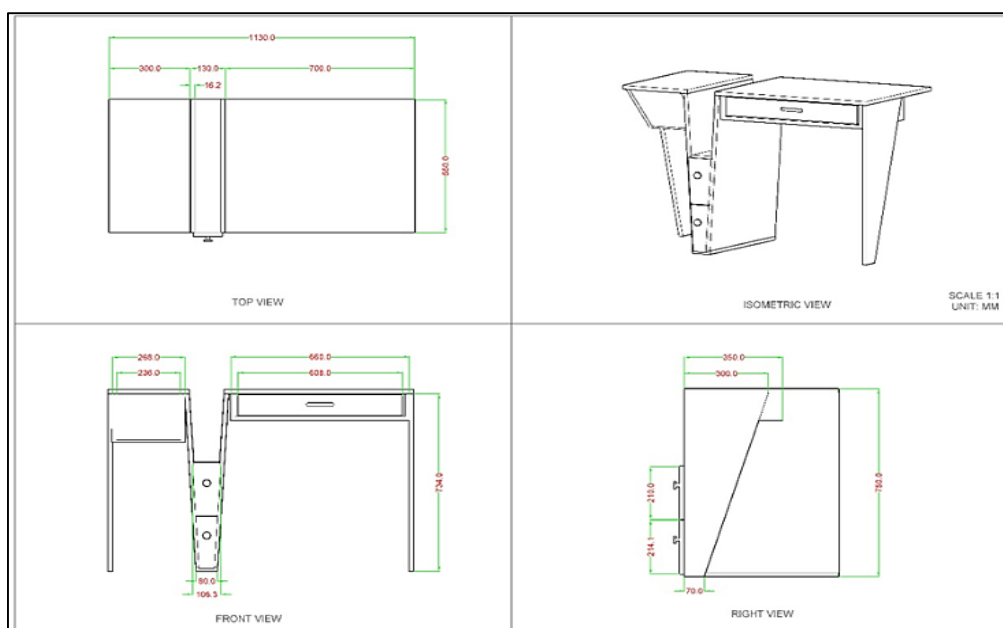


Figure 6: A 2D technical drawing of modern study table for small houses inspired by origami

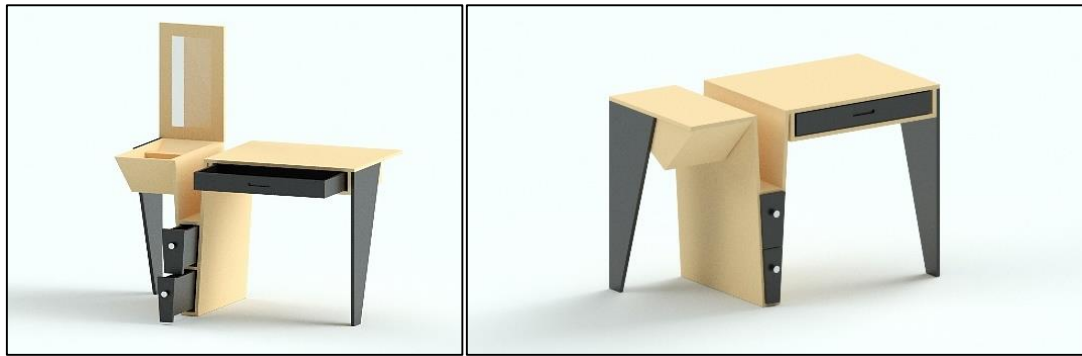


Figure 7: Rendered technical drawing of modern study table for small houses inspired by origami

Meanwhile, Figure 8 depicts a finished prototype of a modern study table for small houses inspired by origami. Rubberwood was used to create the prototype. The study desk has closed storage, a drawer, and a lift mirror countertop. The prototype manufacturing process includes the process of identifying and preparing raw materials, measuring and cutting, initial assembly, sanding and polishing, and final assembly process.

There are some changes between the prototype and the final design. First and foremost, the final design was supposedly developed using pinewood as the material, however, in the prototype fabrication process, rubberwood was utilised as the main material due to the availability of pinewood in the selected manufacturing company. Second, the closed storage with lift mirror countertop in triangular-shape design was changed because the storage was too tiny, limiting the number of objects that users could store indirectly. Third, the size of the table legs was increased in comparison to the drawn final design in order to provide more stability to the study table. Also, the table legs in the final design concept were changed to wood due to a lack of skills and machines to fabricate the designed table legs using stainless steel.



Figure 8: Prototype of modern study table for small houses inspired by origami

5. Conclusion

In conclusion, the objectives of the study were achieved successfully. A new design was created to fulfil the current study table demands for small houses. The design criteria for the modern study table for small houses inspired by origami are closed storage, pinewood, stainless steel table legs, natural

colour, and flip-top mirror countertop. Throughout the study, six ideations and four idea developments were sketched. The study's final design was decided via a final design survey. Design 2 or idea development 4 was chosen as the final design and developed into a prototype. The final design has been modified to increase the appearance, quality, and stability of the study table. Overall, by using rubberwood and wood lacquer, a prototype of a modern study table inspired by origami was manufactured.

Some ideas were made to enhance the design of a modern study table with a multifunctional feature in the future. To fulfil the specific demands of target consumers, a future study should develop a modern study table with multifunctional features. Multifunctional furniture design might be possible if the designers can collaborate with architects and engineers. Its designs may then be coupled with building structures and layouts to optimise the utility of both furniture and buildings.

Acknowledgement

The author thanked the reviewers for their valuable comments and useful suggestion. All those who contributed directly or indirectly are thanked.

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