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Built-in Motion Sensor Bedside Table Inspired by Tangram

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Abstract: With the revolutions of technology, integration of traditional furniture and high-tech upgraded into the new generation of furniture, which is smart furniture able to make our daily activities much easier. Waking up in the middle of the night for a bathroom without sufficient lighting is a distressing thing. It might lead to an avoidable accident due to the dark environment (poor visibility). Therefore, the study aims to design and develop a built-in motion sensor bedside table inspired by tangram. The questionnaire was distributed via Google Form to the respondents aged 20 years old and above in Batu Pahat, Johor, to obtain the design criteria of designing the bedside table. Subsequently, the bedside table's design process started with visual research, thumbnail and ideation sketches, idea development, final design selection, mock-up, and ends with prototype fabrication. The prototype of the built-in motion sensor bedside table was made of plywood and finished with varnish. The findings showed that the built-in motion sensor bedside table was designed with flexible storage boxes that can be arranged or reposition according to the users' preferences. This study was successfully developed a new design of a bedside table with built-in motion sensor light that meets the market demand as a remedy to the aforementioned problem.

Keywords: Smart furniture, Motion sensor light, Bedside table, Furniture design, tangram

1. Introduction

Nowadays, with the development and advancement of science and technology, people's living standard has gradually improved and people have begun to pursue smart furniture. Smart furniture can be defined as furniture that brings added value, functionality, comfort, and elegance to meet every personalized requirement issued by the user (Vaida *et al*., 2014). The core concept of smart furniture can be equipped with information technology capabilities that can allow them to communicate with the devices through sensors and computer networks through the internet (Krejcar *et al*., 2019).

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Additionally, smart furniture in the bedroom is used to cater to users' requirements to make life comfortable and convenient.

The bedside table is a piece of functional and decorative bedroom furniture next to the bed, which provides a place to keep items. Some items usually placed on the top of the bedside tables, such as photographed frames, lamps, and alarm clocks. Additional function and convenience of bedside table with drawers can accommodate space for essential items like wallet, jewellery, keys or documents (Hammonds, 2015). Besides, a bedside table integrates with high technology provides additional functions to make users' life much easier.

Tables built-in with a motion sensor to turn ON the light can provide proper lighting and save time to avoid visual fatigue, control light sensation, postpone lighting off, and conduct a timing switch (Xiao *et al*., 2017). Therefore, a bedside table with a motion sensor light will provide lighting for users without the need for a switch, especially for those who wake up in the middle of the night for the bathroom. Tables with built-in light systems have light sensation controls, ON or OFF light capabilities, and time switching capabilities that allow providing the required amount of light within a short time to help users reduce visual fatigue (Krejcar *et al*., 2019). Apart from that bedside table with built-in motion sensor light may reduce the risks of accidents due to the light bar is motion activated to guide users safely moving around the room in the dark.

Tangram is a 400-year-old Chinese dissection puzzle that can form different shapes by combining the seven flat shapes known as tans (Paul & Ponnam, 2018). Tangram is designed to form a specific shape (give only in outline or silhouette) using all seven tans under the premise with tans do not overlap (Tian, 2012). When all seven pieces are arranged together, they can be formed into various forms, including characters, animals, alphabets, geometric shapes, etc. Although the tangram looks simple, it requires observation and thinking skills to complete certain specified graphics.

Stodart (2017) stated that getting up in the middle of the night for the bathroom brings inconvenience due to the light switch located far from the bed. Users might try to get up in the dark and tripping over everything in the bedroom until they can get the light on. Whether it's a young adult, a middle-aged, or an older adult, it is possible to get up in the middle of the night to go to the bathroom. Nocturia is defined as waking up once or more at night to urinate and most common in adults over the age of 60, but it can occur at any age (Johnson, 2017). The current study looked at men from 19 to 103 years old and suggests that even young people may not be immune to the fall risk associated with this type of sleep disruption (Rapaport, 2017). Some people were lazy to reach the bedside lamp on the bedside table when they are rushing to the bathroom in the middle of the night. This can lead to accidents in a dark environment such as fall injury, step on something, tripped by wire, and so on. A study carried out by Kim *et al*. (2017) found that people who woke just once for the toilet on an average night were 41 percent more likely to experience falls, and the risk of falls at least doubled for people with three or more nightly bathroom trips. Therefore, this study purposes a built-in motion sensor bedside table to remedy the aforementioned problem.

2. Literature Review

Furniture is a movable and permanent furnishing object serves various function for storage, work, eating, sitting, and sleeping (Smardzewski, 2015b). Furniture seems to have first appeared in Egypt and beginning in the early Dynasty around 3000 BC. Throughout the history of furniture development, the styles of furniture in the world are different in each period, and it has been continuously developed and transformed in its history (Smardzewski, 2015a; Csanády *et al*., 2019). Various furniture styles have formed insignificant differences in shapes, colour, structure, and decorative forms (Husuno & Selimin, 2020). Hence, furniture is constantly evolving and keeps changing its style to cater to people's aesthetics and tastes nowadays.

A bedside table can be defined as a small table next to the bed and designed to keep the bedroom's necessary items. Bedside table usually designed with one or more drawers and shelves or both, relatively rare with a door. The bedside table can be categorized into a built-in bedside table and a movable bedside table. Built-in furniture, once constructed and installed, cannot be moved (Piplani, 2019). In other words, a built-in bedside table is designed to be fixed on the wall or embedding into the headboard of a bed frame, whereas it cannot be moved after installation. As the name suggests, a movable bedside table is a freestanding bedside table that can move around and usually designed with legs. A bedside table is one of the furniture with high demand but low supply in the Malaysian market.

Nowadays, traditional furniture has been difficult to meet people's needs; thus, the furniture industry should be bold and innovative through introduce more innovative furniture that adapts in subtle ways to accommodate technology. The furniture industry remains largely slow-moving and low-tech, but space and furniture have to be mindful of new technology almost instantly. This leads to the furniture industry's need to produce furniture that accommodates technology (Kurutz, 2012). A bedside table with built-in motion sensor light is one of them. A motion sensor is a device that detects moving objects, particularly people, and often applied to security, automated lighting control, home control, energy efficiency, and other useful systems (Olalekan & Toluwani, 2016). Now the motion sensor light is very popular because the light will be activated when sensing human movement in an area. From this, furniture designers should look for furniture value-added space in design aesthetics and new value-added space in technology. With the integration of technology, furniture can immediately rejuvenate and be more easily accepted by the new generation of consumers. Furniture technology helps to provide convenience and make daily tasks more efficient for people. The features of smart furniture are many turns it more distinctive and unique.

Tangram (Figure 1) is one of the oldest Chinese puzzles dating from hundreds of years ago, and it is also called Qiqiaoban in Chinese, literally translating to "seven boards of skill" (Tian, 2012). As its name implies, the tangram consists of seven parts, including five isosceles right triangles, a parallelogram, and a square (Zhou & Wu, 2012). After several rounds of evolution, tangram became popular in Japan and Europe, and the concept of tangram has also been designed into outstanding combination furniture. (Liu & Liu, 2015). Due to the tangram variability, different combinations inspired designers to generate new ideas on furniture design.

Figure 1: Colorful wooden tangram (Tian, 2012)

3. Research Methodology

The combination of methodology reported by Ramli *et al*. (2018) and Selimin *et al*. (2019) was implemented in this study. A questionnaire was used and distributed to 50 respondents between 20 years old and above living in Batu Pahat, Johor, through Google Form. The data collected from the questionnaire was transformed into the design criteria of a built-in motion sensor bedside table

inspired by tangram. The survey questionnaire's design criteria serve as benchmarks for designing and developing the built-in motion sensor bedside table inspired by tangram. There are 6 pieces of visual research produced according to the set elements of visual research. All collected data and visual research were used to generate three thumbnail sketches with 54 ideas, five ideations, five idea developments, and a final design. In this study, thumbnail sketches come out as many ideas as possible. Among five idea developments, only three designs were selected as pre-final designs and proceeded to the final design selection survey. The final design selection survey was conducted through Google Form to identify the final design of the built-in motion sensor bedside table inspired by tangram.

Then, the mock-up was produced at a scale of 1:5 by using a PVC foam board, a manila card, and super glue. The bedside table's technical drawing was prepared by using AutoCAD software with full dimension based on the selected final design as an overview for illustrating concepts on how the bedside table is constructed using appropriate techniques. In this research, the materials used to produce the prototype will depend on the questionnaire's collected data and the suitability of materials with the final design. The prototype fabrication process includes measuring and cutting, assembling, sanding and finishing.

4. Results and Discussion

4.1 Questionnaire

The survey questionnaire is distributed to identify the design criteria of the built-in motion sensor bedside table inspired by tangram and determine the end customer demand. The questionnaire consists of three parts which are Section A (demographic information), Section B (design criteria), and Section C (opinion of respondents). The result shows that majority of respondents interested in owning a built-in motion sensor bedside table. The built-in motion sensor bedside table's design criteria inspired by tangram are to have combination storage, made of wood and wood-based products, natural wood colour, and wireless charging as additional features. Most of the respondents agreed that the design concept of the built-in motion sensor bedside table brings benefits to solve the problem in a dark bedroom. The significant result of the questionnaire was presented in Table 1.

Table 1: Summary of the questionnaire result

Element	Percentage (%)	Description
Demographic information	60	Female respondent
	88	Respondents between 20 to 30 years old
	74	Chinese respondents
	90	Single
Design criteria of built-in motion sensor bedside table	60	Owned a bedside table
	50	Familiar with Tangram
	88	Preferred a bedside table with built-in motion sensor light
	46	Preferred combination storage
	58	Preferred bedside table made from wood and wood-based products
	82	Preferred natural wood colour
	52	Wireless charging as additional features that add to a bedside table
	88	Place phone on the bedside table
	76	Wake up in the middle of the night to go to the bathroom
Opinion of respondents	86	Built-in motion sensor light bedside table helps to locate the items easily in the dark environment
	82	Built-in motion sensor bedside table provides illumination and guides users safely moving around the room in the dark
	84	Built-in motion sensor bedside table may reduce the risks of an accident in the dark bedroom

4.2 Visual Research

Figure 2 shows the visual research on a bedside table. The visual research selection covers the shape of the bedside table, bedside table with legs, built-in light bedside table, bedside table with combination storage, bedside table with drawer, and bedside table with door.

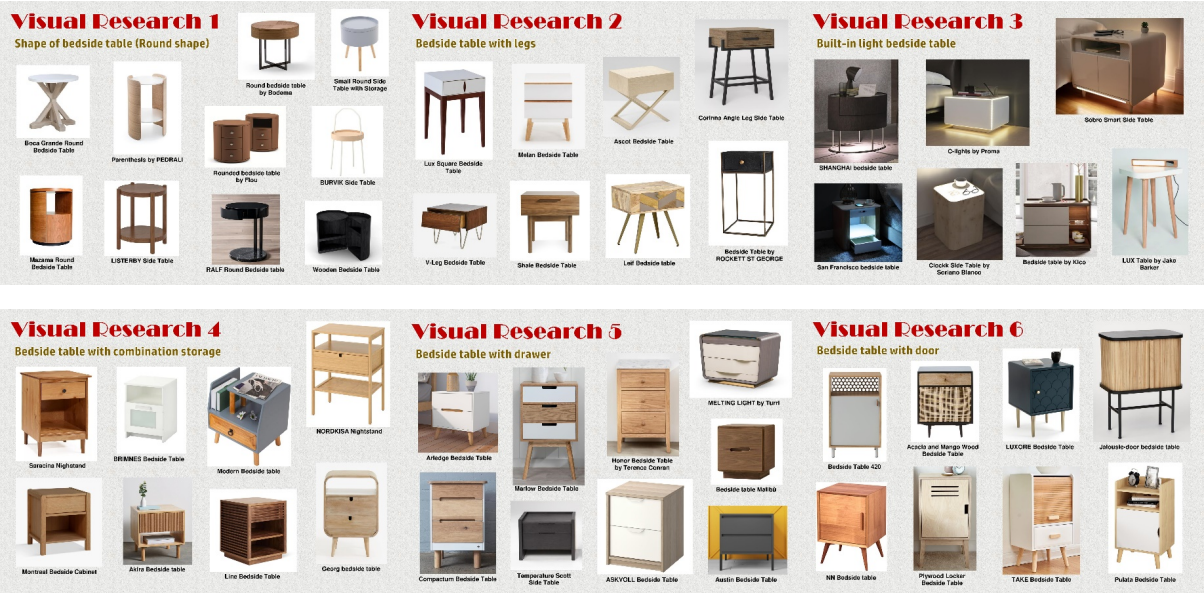

Figure 2: Visual research

4.3 Thumbnails Sketches and Ideation

Thumbnail is a vital preparatory step in drawing, and it helps to visually plan out the simple design concept and ideas of the bedside table. A thumbnail's goal is to conceive different basic ideas to design various styles of the bedside table. The thumbnail sketches were presented in a 2D form with different shapes, geometries, and appearances. Figure 3 shows a total of 54 ideas of built-in motion sensor bedside table were done in 3 thumbnail sketches.

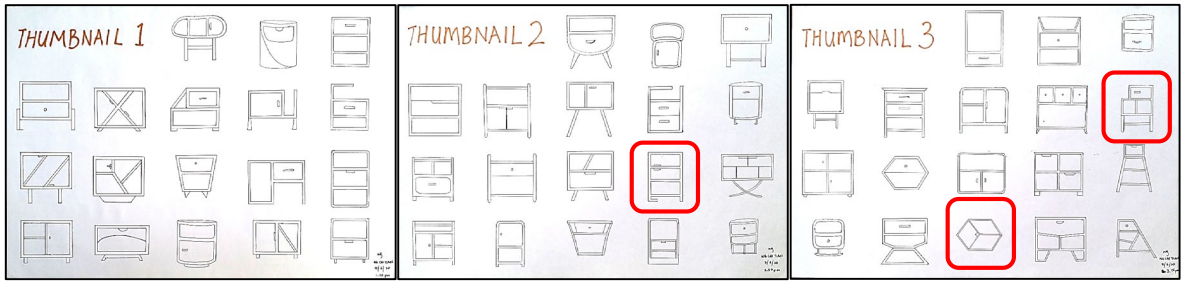

Figure 3: Thumbnail sketches

Meanwhile, Figure 4 shows five ideations of the bedside table. Three ideas from thumbnail sketches (marking with a red box in Figure 3) were chosen as basic ideas for creating the bedside table's ideation. These three selected ideas have a simple shape and interesting appearance that rarely used in bedside table design, so they can be used as a reference to design the mainframe of the bedside table. The ideation mainly focuses on the tangram concept, which can transform into various forms. In this study, the pattern and shapes of tangram were used to design the bedside table included

bowl and Olympic flame. Ideation 3 was selected as a potential design for further development due to this design can meet the design criteria and more distinctive out of all ideations.

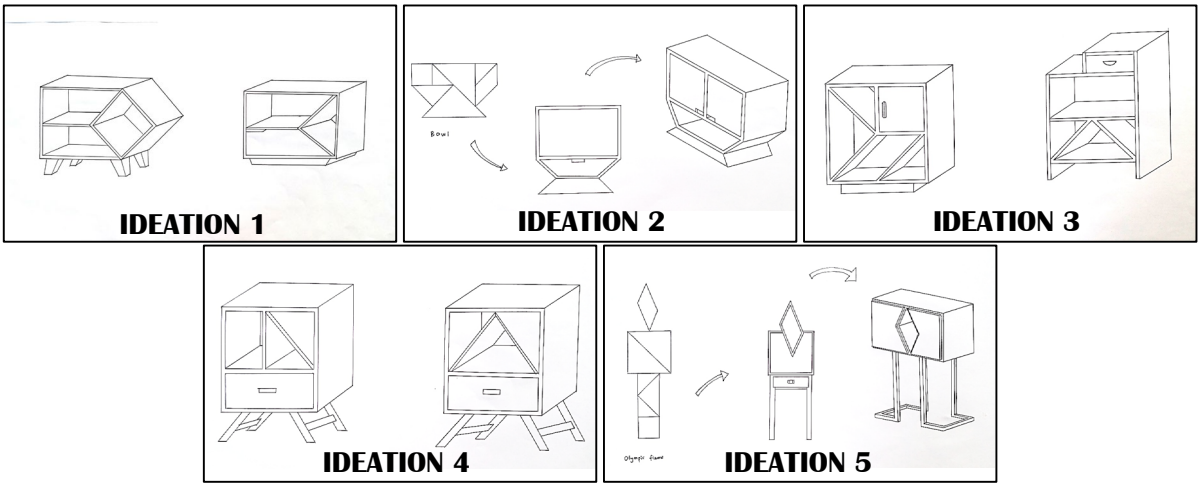

Figure 4: Ideation of the bedside table

4.4 Idea Development

The five idea developments were made based on ideation 3 as a basic design of the built-in motion sensor bedside table, as shown in Figure 5. The idea developments were designed with motion sensor light as illustrated and more focused on the storage part's layout design combined with the tangram feature. The closed storage was considered to design in two patterns which is door and drawer. Additionally, the idea development was more attractive to coloured. Based on observation, idea development 1 and idea development 4 have drawers with specific shapes that are not commonly used in bedside table design, limiting the type and size of items stored on the bedside table. Therefore, the design survey scope was narrowed down to three designs, including idea development 2, idea development 3, and idea development 5 as pre-final designs.

Figure 5: Idea development of bedside table

4.5 Final Design

A simple design survey was distributed and 60 respondents chose the final design through Google form. Among the three idea developments, idea development 5 has obtained the highest percentage with 55%. Besides, 28.3% of respondents prefer idea development 3 and only 16.7% of respondents prefer idea development 2. Accordingly, idea development 5 was selected as the final design of the built-in motion sensor bedside table inspired by tangram.

The final design (Figure 6) was made based on idea development 5 and some amendments can be made to the design to increase the aesthetic value and practicability of the design. The storage box designed in three shapes derived from tangram, which includes two triangles, a square with a door, and a parallelogram. The wireless charging is an additional feature for this bedside table. It will be installed under the top board to provide a phone charging area. In addition, the motion sensor light was designed at a low position under the bottom of the bedside table and closer to the floor. This led to the motion sensor's ability to detect users' feet on the floor effectively, and the light will automatically turn on the light. The final design was fully complying with the design criteria to enrich the bedside table design in functionality, user-friendly, and contemporary concept.

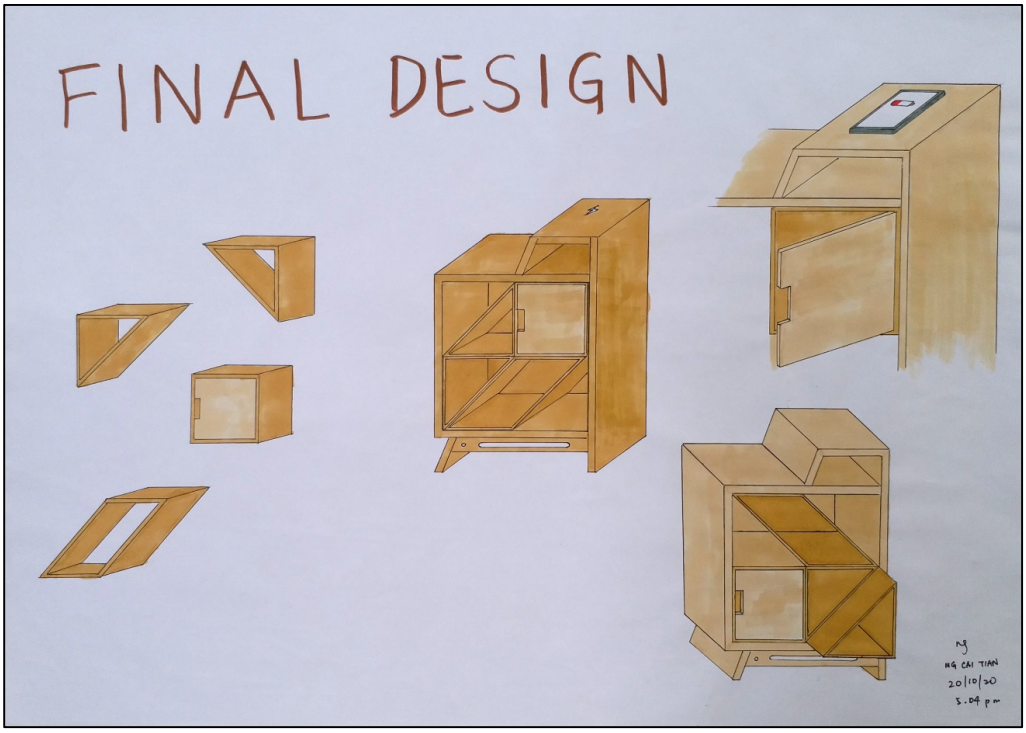

Figure 6: Final design of the bedside table

4.6 Mock-up

In this study, the mock-up was made from PVC foam board as the core part at the scale of 1:5. All of the joints were attached by using super glue. The mock-up will also be surface finish using a manila card to make the bedside table resemble the wood pattern, except the storage boxes. The white object at the bottom of the bedside table represents the light bar, while the black object represents the motion detector. The bedside table's final design can be visualized through this mock-up and amendments can be made further to improve the design before producing the prototype. The mock-up of the built-in motion sensor bedside table is presented in Figure 7.

Figure 7: Mock-up of a bedside table

4.7 Technical Drawing

The technical drawing of the bedside table was illustrated with full dimension by using AutoCAD software. The technical drawing is defined as an overview for illustrating how the bedside table is constructed in suitable techniques. The bedside table's technical drawing was presented in an orthographic view consisting of four different views are shown in Figure 8.

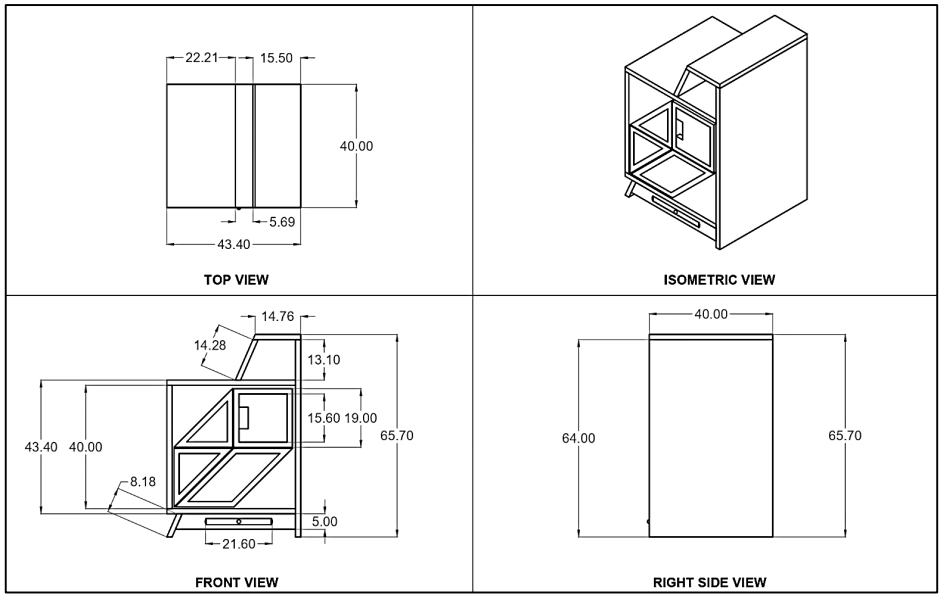

Figure 8: Technical drawing of a bedside table

4.8 Prototype Fabrication

Next, the prototype was made of plywood as the main material and finishing with varnish to enhance the bedside table's appearance (Figure 9). The prototype has five open storages, a closed storage with a door, and a built-in motion sensor light installed on the bottom. This bedside table's uniqueness is the four storage boxes are flexible and can be rearranged according to users' preferences. The built-in motion sensor light can detect about 3 to 5 meters, 120-degree, and the light will automatically turn OFF after 20 seconds.

Figure 9: Prototype of a bedside table

5. Conclusion

In conclusion, this study has been achieved in the aforementioned research objectives. The built-in motion sensor bedside table inspired by tangram was designed and developed according to the data obtained from the survey questionnaire. Consequently, the built-in motion sensor bedside table's design criteria inspired by tangram consist of combination storage, wood and wood-based products like material, and natural wood colour appearance. Ideation 3 was chosen for further development and idea development 5 was selected as the final design through design survey. The bedside table prototype was made from plywood as the main material, finishing with varnish as coating material, and embedded a motion sensor light below the bedside table. Additionally, the bedside table can illuminate users who wake up in the middle of the night and avoid accidents in a dim environment.

Thus, there are some recommendations for improving this research and future work. Future research is suggested to design a bedside table with no more than three storage compartments. It is recommended to design the storage box of the bedside table to be square or rectangular. Both designs increase its storage space and greatly enhance the overall value and practicality of the bedside table. Moreover, the bedside table can add extra light on the rear side to provide users with more light in the dim environment. For future study, the bedside table can also be designed with additional features, such as Bluetooth speakers, USB ports, and more, thereby increasing the bedside table's functionality and commercial value.

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References

Csanády, E., Kovács, Z., Magoss, E., & Ratnasingam, J. (2019). Furniture production processes: Theory to practice. Optimum Design and Manufacture of Wood Products. Switzerland: Springer, Cham. 367-421.

Hammonds, O. (2015). Benefits of a bedside table. Retrieved on April 30, 2020, from https://www.3benefitsof.com

Husuno, N., & Selimin, M.A. (2020). Meja kopi moden pelbagai fungsi diinspirasikan oleh Palmanova, Itali. Research in Management of Technology and Business, 1, 326-336.

Johnson, J. (2017). How to treat an overactive bladder at night. Retrieved on April 30, 2020 from https://www.medicalnewstoday.com

Kim, S.Y., Bang, W., Kim, M.S., Park, B., Kim, J.H., & Choi, H.G. (2017). Nocturia is associated with slipping and falling. PLoS ONE, 12(1), 1–12.

Krejcar, O., Maresova, P., Selamat, A., Melero, F.J., Barakovic, S., Husic, J.B., Herra-Viedma, E., Frischer, R., & Kuca, K. (2019). Smart furniture as a component of a smart city - Definition based on key technologies specification. Special Section on Urban Computing and Well-Being in Smart Cities: Services, Applications, Policymaking Considerations, 7, 94822-94839.

Kurutz, S. (2012). Furniture meets the digital age. The New York Times. Retrieved on May 16, 2020, from https://www.nytimes.com

Liu, Z., & Liu, W. (2015). Research on the design of combination furniture based on toy brick style concept. Proceedings of the 5th International Conference on Civil Engineering and Transportation (ICCET). Atlantis Press. 1712–1717.

Olalekan, B.O., & Toluwani, O.V. (2016). Automated home security system: A review. Journal of Electrical and Computer Engineering, 1, 7-16.

Paul, R., & Ponnam, A. (2018). Teaching customer experience quality and its significance in retail management: A role playing game using chinese puzzle ‘Tangram’. Decision Sciences Journal of Innovative Education, 16(2), 126-139.

Piplani, G. (2019). Built-in v/s movable furniture: Here’s what you should choose. Retrieved May 2, 2020, from: https://www.makaan.com

Ramli, N.A.M., Selimin, M.A., Ab Hamid, A.A.A., Bon, A.T., Rahim, W.N., & Halip, J.A. (2018). Conceptual design of modern minimalist dining table inspired by British military uniform. Proc. of the Int. Conf. on Industrial Eng. and Operations Management, Bandung, Indonesia.

Rapaport, L. (2017). Frequent nighttime bathroom trips tied to higher risk of falls at all ages. Retrieved on April 30, 2020, from https://www.reuters.com

Selimin, M.A., Hasanuddin, S., Halip, J.A., Ab Hamid, A.A.A., & Bon, A.T. (2019). Contemporary modular study table for small minimalist residence in Malaysia. Proc. of the Int. Conf. on Industrial Eng. and Operations Management, Bangkok, Thailand.

Smardzewski, J. (2015a). The history of furniture construction. Furniture Design. Australia: Springer, Cham. 1-45.

Smardzewski, J. (2015b). Classification and characteristics of furniture. Furniture Design. Australia: Springer, Cham. 47-95.

Stodart, L. (2017). Under the bed motion sensor lights are genius. Retrieved on November 11, 2020 from https://mashable.com

Tian, X. (2012). The art and mathematics of Tangrams. Bridges, 553-556.

Vaida, C., Gherman, B., Dragomir, M., Iamandi, O., & Banyai, D. (2014). Smart Furniture - Quo Vadis. Proceedings of the International Conference on Production Research - Regional Conference Africa, Europe and the Middle East and 3rd International Conference on Quality and Innovation in Engineering and Management. 493-498.

Xiao, W., Gao, Y., & Bai, X.F. (2017). Study on design of intelligent furniture and application of smart material. Proceedings of the 2017 International Conference on Manufacturing Engineering and Intelligent Materials (ICMEIM). Atlantis Press. 521-524.

Zhou, Z., & Wu, L. (2012). The study of principles of puzzle game design. Proceedings of 2012 International Symposium on Information Technologies in Medicine and Education (ITME). IEEE Access. 1079–1083.