

DESIGN AND FABRICATION OF KAYAK WASHING AID DEVICE

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ABSTRACT

This study discussed the process of the design of a kayak-washing helper device. Thru observation, the UiTM Cawangan Terengganu Kampus Bukit Besi students need to manually hold and turn the kayak for washing and cleaning purposes. This results in higher human energy used to wash and clean the kayak. Therefore, there is a need to produce a kayak washing aid device for the students. This project includes the problem definition, concept generation and selection, embodiment, detail design, and prototype fabrication. At the end of the project, it was found that the kayak washing helper device was able to fulfill the product design specifications with the advantage of saving human energy usage and time.

Keywords: Kayak Washing Aid Device, Mechanical Engineering Design Process

1.0 INTRODUCTION

Kayak is a kind of canoe-like boat known as a transporting vehicle that moves across the water. Kayak that has a small and slim structured body is propelled usually by one or two passengers at a time where it moves front-to-back and rotational navigation [1,2]. In a kayak, the paddler seated is facing forward with the legs placed inside the cockpit and extended to the frontal position [3,4]. At UiTM Cawangan Terengganu, Kampus Bukit Besi, kayaking is one of the most popular recreational outdoor activities among the students due to its location near the Tasik Puteri Bukit Besi. Figure 1 shows an example of kayaking activity by UiTM students.



Figure 1: Example of kayak activities in Tasik Puteri by UiTM students [2]

At UiTM Cawangan Terengganu, Kampus Bukit Besi, kayaking is one of the most popular recreational outdoor activities among the students due to its location near the Tasik Puteri Bukit Besi. After the kayaking activities, the students need to return the kayak to the sports store in a clean condition. However, from the observation, it is hard to clean the kayak without a proper wash station, as the kayak becomes dirty again after washing it on the ground. The weight of the kayak increased as a result of the removal of

stagnant water inside the body due to its unchanged rotational position. Therefore, to overcome this problem, a proper type of device is needed for lifting the kayak as it also works as a frame for cleaning purposes. In addition, this kayak-washing helper device aims to save human energy usage and consume time.

The engineering design process is important in the problem-solving process. It is a repetitive step that engineers use along the process [5]. According to Khandani [6], there are five steps in the basic design processes including gathering information, solutions generation, analyzing the solution selection and product testing. He stated that these step-by-step processes are more efficient and effective in problem-solving work.

Hence, in this study, the prototype of the kayak station was developed using Three-Dimensional (3D) software with engineering design processes where it started with conceptual design followed by the embodiment design process. Details of these design processes were discussed in the next section.

2.0 METHODOLOGY

This section discusses the design principles carried out throughout the kayak washing aid device design. The flowchart of the design activities is shown in Figure 2 below.

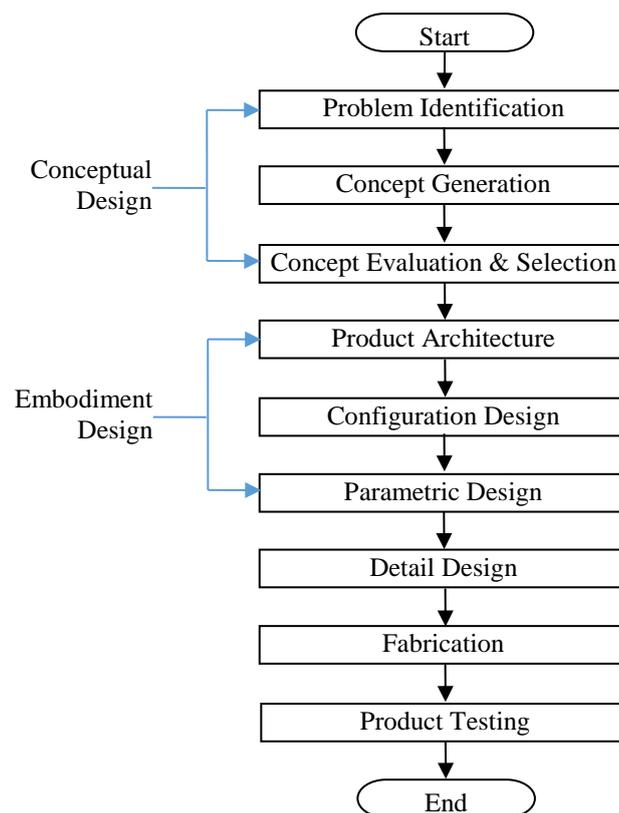


Figure 2: Flowchart of the design process

2.1 Problem Identification

The design activities started with observation and interview of the students in terms of the process of washing and cleaning the kayak which are done by the recreation clubs in UiTM Cawangan Terengganu Kampus Bukit Besi. As a result, the identified problem related to washing and cleaning of kayak is shown in Table 1 below. Therefore, it indicates that there is a need to develop a kayak washing aid device to solve the identified problem.

Table 1: Problem-related to Washing and Cleaning of Kayak in by Recreational Clubs in UiTM Cawangan Terengganu Kampus Bukit Besi

No	Problem
1	The current method of washing and cleaning the kayak is done by students manually which is involve lifting and turning the kayak
2	Kayak is heavy to lift and to turn for washing and cleaning purposes
3	It takes more energy and time to wash and clean the kayak

2.2 Product Design Specification

The Product Design Specification (PDS) of the kayak washing aid device is shown in Table 2 below. The PDS highlights the parameters used in the development of the device. There are 9 parameters were used in the PDS.

Table 2: Product Design Specification of Kayak Washing Aid Device

Parameter	Description
Function	To aid with the kayak washing and cleaning activities which can save human energy and time usage
Performance	Able to hold and rotate the kayak Able to shower from top
Economy	The cost of production is not more than RM500
Customer	This device focuses on the usage of recreational clubs in UiTM Cawangan Terengganu Kampus Bukit Besi
Environment	This device is subjected to outdoor usage
Size	The machine will be suitable design to support different sizes of kayak. The overall size will be approximately height 1400 cm, width of 800 cm, and length 1700 cm.
Material	The main frame is made of hollow steel for its durability
Ergonomics	The device should be made as the kayak washing and cleaning activities would be easy and comfortable to handle for the user
Safety	The device should have all relevant safety features

3.0 RESULT AND DISCUSSION

3.1 Concept Generation and Selection

Table 3 shows the morphological chart for the kayak washing aid device. The chart is characterized by its identified list of device sub-function which is located on the left side of the chart. The possible option-solution for each sub-function then is placed on the right side of the chart. There are six sub-functions, and each sub-function has at least three option solutions. Later, five concepts are made through the possible combinations of option solutions for each sub-function. A total of six concepts are produced from the morphological charts. The details of the configuration of the concept are as follows:

Concept 1 = A1 + B3 + C1+ D1 + E2 + F1 Concept 4 = A5 + B5 + C3 + D3 + E1 + F2
 Concept 2 = A2 + B1 + C5 + D2 + E1 + F1 Concept 5 = A2 + B3 + C3 + D3 + E5 + F2
 Concept 3 = A5 + B3 + C3 + D1 + E5 + F4 Concept 6 = A5 + B5 + C3 + D3 + E1 + F3

Figure 3 shows the sketches for each concept. For the first concept, the kayak is placed on a horizontal plate and is secured by a spring strap. The hose pipe is used to wash and clean the kayak and the kayak is rotated by using the paddle. For the second concept, the kayak is placed on a full V-shape plate and is secured by using rope and rotated by belting. For the third, fourth, fifth and sixth concepts, all use the beam V-shape kayak holder which paddle and steering are used to rotate the kayak. Concept 5 used the piping system and concepts 3, 4 and 6 use the sprinkler watering systems. All concepts except concept 3 are moveable with the use of a tyre.

Table 3: Morphological Chart for Kayak Washing Aid Device

Sub-function	Option-solution
Watering system	A1 Water hose
	A2 Piping system
	A3 Water pail
	A4 Water jet
	A5 Water sprinkler
Rotary mechanism	B1 Belt
	B2 Gear and chain
	B3 Crank Arm
	B4 Motor
	B5 Steering handle
Kayak placement base	C1 Horizontal plate
	C2 Rope
	C3 Beam V-shape
	C4 Hole plate
	C5 Full plate V-shape
Kayak placement base securing	D1 Spring
	D2 Rope
	D3 Lashing strap
Device mover handle	E1 U-shape
	E2 L-shape
	E3 T-shape
	E4 Rope
	E5 None
Tyre configuration	F1 Single cylindrical tyre
	F2 Double cylindrical tyre
	F3 Spherical tyre
	F4 Non-tyre

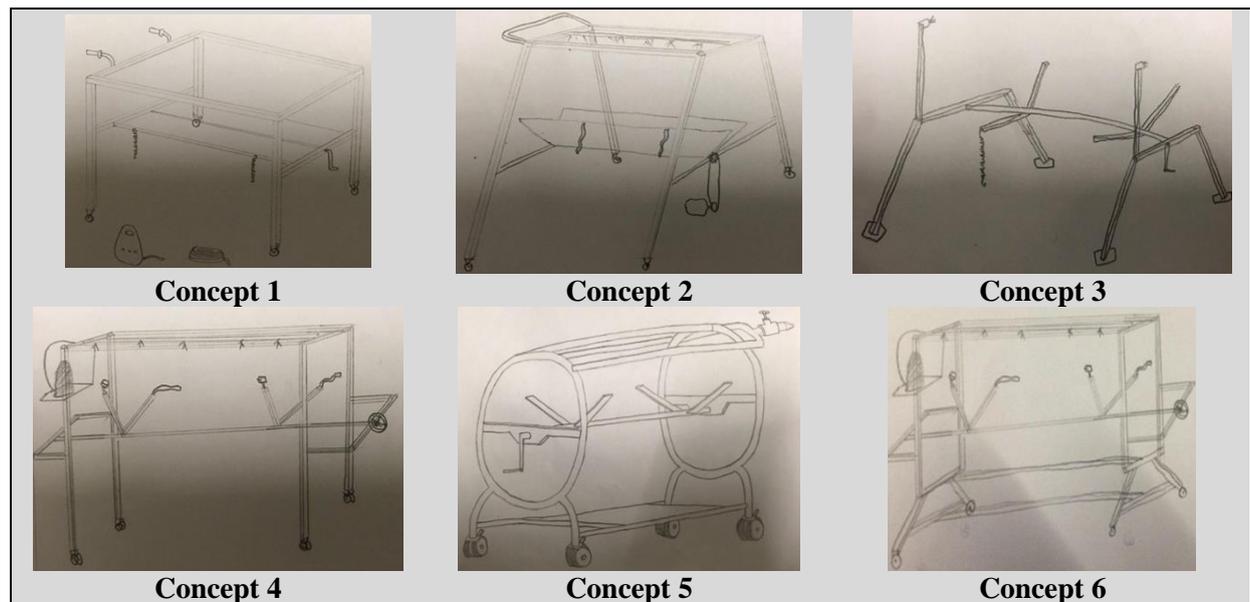


Figure 3: Sketches of Each Concepts

Later, these six concepts are evaluated to determine the final concept to be used as the proposed product design by using the Pugh analysis. These concepts are compared to the datum which is the manual method used by the recreational club for washing and cleaning the kayak activities. The Pugh analysis results are shown in Table 4 below.

Table 4: Pugh Chart of Kayak Washing Aid Device

Parameter	Weightage	Datum	Concept					
			1	2	3	4	5	6
Safety	3	0	0	+	0	+	+	+
Durability	2	0	+	+	0	+	+	++
Load capability	2	0	+	+	+	+	+	++
Stability	1	0	+	++	0	+	+	+
Ergonomics	2	0	0	+	0	+	++	++
Affordable	1	0	-	-	-	-	-	-
Easy to use	1	0	+	+	+	+	+	+
Comfortable	2	0	+	+	+	+	+	+
Performance	1	0	+	+	0	+	+	+
Net Score		0	8	14	4	13	15	19

Based on the Pugh analysis, the net score for each concept for Concepts 1, 2, 3, 4, 5 and 6 are 8, 14, 4, 13, 15 and 19 respectively. As a result, concept 6 is chosen to be the final concept due to its highest score. This concept utilizes less material for frame construction but with more durable features and stability. Besides that, it uses the water sprinkler system to wash and clean the kayak.

3.2 Embodiment Design

There are three activities involved in embodiment design which are product architecture, configuration design and parametric design. Embodiment design is important and must be established before detailed design is done.

In product architecture, the physical arrangement product is determined and identified to meet the specified functions. Figure 4 and Figure 5 show the schematic diagram and the rough geometry layout of the product respectively.

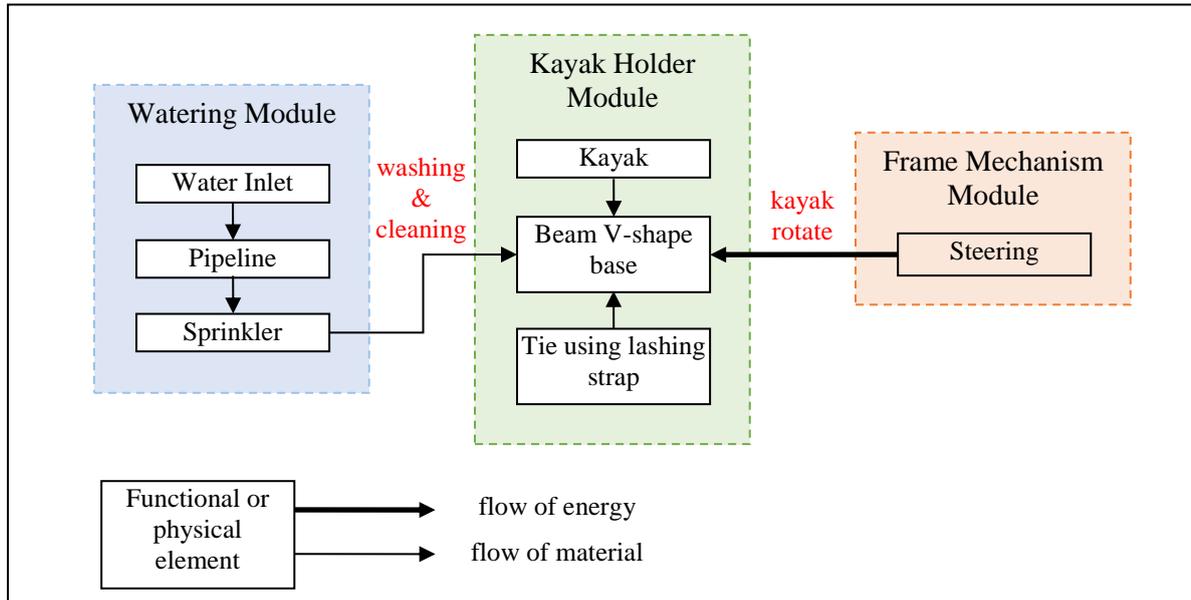


Figure 4: Schematic Diagram of Kayak Washing Aid Device

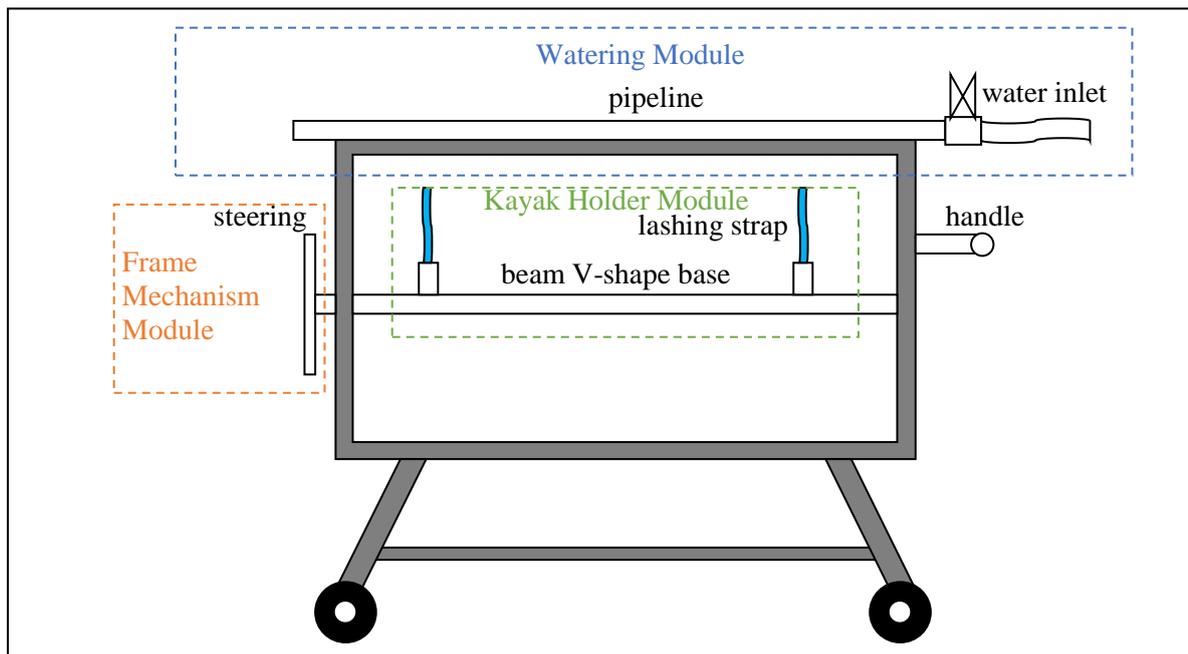


Figure 5: Rough Geometric Layout of Kayak Washing Aid Device

There are three modules in the kayak washing aid device: watering module, frame mechanism module and kayak holder module. The watering module is placed at the top to ensure water will flow out thru the sprinkler to the kayak below with the aid of gravitational force. The kayak holder module is placed at the centre height of the overall height device to ensure the kayak can be easily reached and operated for washing and cleaning purposes by the student. The frame mechanism is located at the outside frame device to ensure ease of rotation of steering by the student.

3.3 Detail Design

Figure 6 shows the three-dimensional (3-D) modelling of the Kayak Washing Aid Devices. The design is made in Solidwork. The overall dimension are shown in Table 5 below.

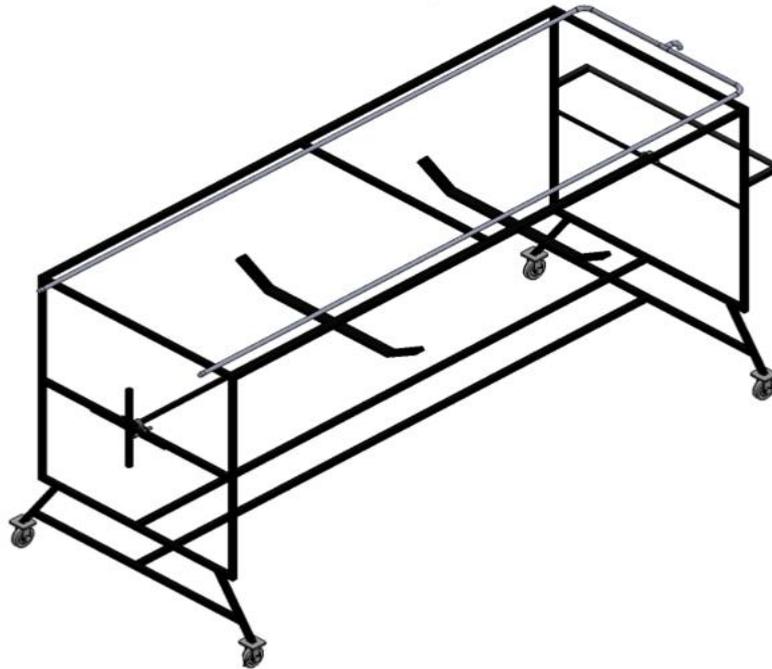


Figure 6: Drawing of Kayak Washing Aid Devices

Table 6: Overall Dimension of Kayak Aid Washers Devices

Parameter	Dimension (meter)
Height	1.55
Length	3.352
Width	1.381

3.4 Prototyping

Figure 7 shows the fabrication model of Kayak Aid Washing Devices. For safety reasons, the cable is used to tied the kayak to its positions and the rotation of kayak also can hold for cleaning purposes.

The operation manual are as follows;

- i. The user must lift a kayak on kayak holder .
- ii. Then tied a kayak to avoid it fall.
- iii. Close a sliding and lock it.
- iv. Start a water system inlet .
- v. Rotate a kayak holder on every 180°.
- vi. Stop a water system flow and wash a kayak with detergent.
- vii. Restart a water system and rotate a kayak holder to every angle till its clean



Figure 7: The prototype of Kayak Washing Aid Devices

3.5 Product Testing

Table 7 below shows the comparisons of product testing for the kayak washing activities. It shows that the time taken for washing and handling the kayak is 3.04 minutes. It takes 3 persons for washing the kayak manually. 2 persons to hold the kayak and rotate the kayak while rinsing the kayak, and 1 person to rinse the kayak. As for the Kayak Washing Aid Devices, the time taken for washing and handle the kayak is 2.43 minutes. It was take 2 persons for washing kayak used kayak station. 2 persons that needed for lift up the kayak to place on the kayak. As for the result, for manually cleaning, the kayak is not fully clean and still have impurities. As for the Kayak Washing Aid Device, the kayak is clean and the surface is in good condition.

Table 7: Product Testing

Washing Type		Manually	Kayak Washing Aid Device
Comparisons	Time	5 Minutes	3 Minutes
	Manpower	3 person	2 person
	Result	Not fully clean and still have impurities	Clean and kayak surface in good condition

4. CONCLUSION

This study has shown that concept 6 is the best concept for the kayak washing aid device in terms of load capability, durability, and ergonomics. These parameters improve the activities of kayak washing in the UiTM Cawangan Terengganu Kampus Bukit Besi. From the product testing, the device helps in improving the timr taken to clean the kayak and improving the quality of kayak cleaning. For future improvements, the water sprinkler can be made so that the water can clean thoroughly the kayak and the mechanism of kayak rotations can run through motor aid.

REFERENCES

- [1] Renuka Patil and D. S. S. Sudhakar, “Automated storage system for Kayak”, International Research Journal of Engineering and Technology (IRJET), Vol: 04, Issue: 04, Apr.2017.
- [2] H Ghazali, N H Mas’aud and N A Rahman, “Design and Fabrication of Kayak Carrier”, IOP Conf. Series: Materials Science and Engineering (ICECTIII 2021), doi:10.1088/1757-899X/1176/1/012022.
- [3] Simon Hudson and Paul Beedie, Chapter 9, “Kayaking”, Water-based Tourism, Sport, Leisure, and Recreation Experiences, 2007.
- [4] Jan Willem (AJW) Teunissen, Stijn (SEW) ter Wellea, Sebastiaan (SWJ) Platvoeta, Irene Faberc, Johan Piona, and Matthieu Lenoir, “Similarities and differences between sports subserving systematic talent transfer and development: The case of paddle sports”, Journal of Science and Medicine in Sport (JSAMS), 24 (2021) 200–205
- [5] Sergio Andrés Rubio, “Design and development of a kayak trailer”, Universidad De Valladolid, Valladolid, marzo, 2018.
- [6] Seyyed Khandani, “Engineering Design Process”, IISME, Solectron, 2005.