Multidisciplinary Applied Research and Innovation Vol. 3 No. 1 (2022) 555-564

MARI

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/mari
e-ISSN :2773-4773

Shuttlecock Collector Machine

Ahmad Huzaifah Nakharudin[1], Nurul Atiqah Aisyah M. Kamal[1], Nur Mahirah Madihah Ahmad Bakhtiar[1], Hafsa Mohammad Noor[1,2]*, Suhairi Ismail[1,2], Mahmod Abd Hakim Mohamad[1,2]

[1]Department of Mechanical Engineering, Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia (Pagoh Campus), Pagoh Education Hub, KM 1, Jalan Panchor, 84600 Panchor, Johor, MALAYSIA

[2]Sustainable Product Development (S-ProuD), Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia (Pagoh Campus), Pagoh Education Hub, KM 1, Jalan Panchor, 84600 Panchor, Johor, MALAYSIA

*Corresponding Author Designation

DOI: https://doi.org/10.30880/mari.2022.03.01.068
Received 30 September 2021; Accepted 30 November 2021; Available online 15 February 2022

Abstract: Shuttlecock is an essential part of badminton. Usually, the shuttlecock are easily damaged and would be replaced every three to four games, or sometimes sooner if the played with higher intensity. During training, a lot of shuttlecocks were used and burdened the players to pick up all the scattered shuttlecock manually at the end of their training. It requires energy to stack back all the shuttlecock together, but the player is already worn out after the training session. Collecting the shuttlecock manually will sometimes damage the feather on the shuttlecock itself. In this study, a portable and stackable shuttlecock collector machine was fabricated to speed up the time in collecting the shuttlecock and automatically stack in 4 replaceable cylinder tube with diameter 7 cm for 100 shuttlecocks. A barricade was used to make sure that the movement for the shuttlecocks is downward when they enter the cylinder tube and block the shuttlecock if the position is upward. The result for the average time taken of Shuttlecock Collector Machine is 5.1 minutes while the manual method is 8.6 minutes. This shows that Shuttlecock Collector Machine can shorten the process as the manual method require the person that collecting to collect the shuttlecock to bow down as they need to collect the shuttlecock on the floor. The damaged shuttlecock average were only 2 shuttlecocks caused by stuck under the sweeper. From result achieved, this Shuttlecock Collector Machine require 40.7 % less time than manual pick up.

Keywords: Badminton, Stackable Shuttlecock, Shuttlecock Collector Machine

**Corresponding author: hafsa@uthm.edu.my*

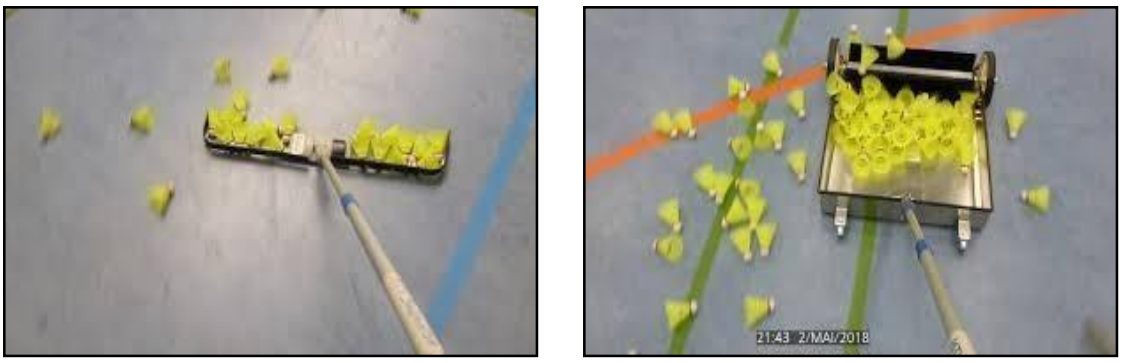
1. Introduction

Sport helps maintain the health of the body. One of the sport choices is playing badminton, but there is a problem that will burden the players because they need to pick up the shuttlecock that scatters on the court floor at the end of the game. During training, a large amount of shuttlecock is fed to players. The training must be stopped before the shuttlecocks can be gathered using a wide mop or broom. Players the need to squat down and pick up the shuttlecock and place into the container. It will require energy to collect and stack the shuttlecock back together, but the player already worn out after the game. That way, it is not only costing a lot of manpower, but it is also delaying the sport time. By using a mop or broom to push and gather the shuttlecock may also damage the shuttlecock.

As of now, there is some shuttlecock collector has been built by some engineers and researchers. The shuttlecock collector machine an invention to all badminton players. This machine used in training session this machine will help the players to collect all the shuttlecock in shortest time without wasting time and energy to move around the badminton court for collecting the shuttlecock. However, some researchers have focused on the theoretical research on how to pick up the shuttlecock without stack it in their cylinder tube. There are some prototypes for the shuttlecock collector machine but only focused on how to speed up in pick up the shuttlecock. In addition, it still requires energy and time to stack all the shuttlecock manually. The main objective of the project is to fabricate the model that can speed up in collecting the shuttlecock and automatically stack the shuttles in the tube, some innovation has been made and comes with an idea to put the shuttlecock container at the back of the collector and make it easier to move around with the presence of the wheel at the product. This machine also will provide a protection to shuttlecock from damage for recycle used.

2. Literature Review

There are some shuttlecock collector machines that are still under research. The design and mechanism of the machine have been taken as an example to innovate and produce the best product. **Figure 1(a)** is Shuttlecock Collector/Ballsammler (A), it is a sweeper type of shuttlecock collector [1]. This machine has a simple design and one man handling because it is light weight. The user needs to gather the shuttlecock at one place before picking it up manually. Only a small amount of shuttlecock can be collected in one time. **Figure 1(b)** [2] is Shuttlecock Collector/ Ballsammler (B) which upgrade from Shuttlecock Collector/Ballsammler (A) because it has a container that keep the shuttlecock in it. This machine is using the rotation of the wheel that been transfer to the cylinder brush to sweep up the shuttlecocks.



(a) (b)

Figure 1: (a) Shuttlecock Collector/Ballsammler (A) [1] and (b) Shuttlecock Collector/Ballsammler (B) [2]

Figure 2 shows the existing shuttlecock machine collectors fabricated by students from Politeknik Kuching Sarawak. This product is functioning by picking up the shuttlecock using the plastic plate sweeper [3]. The plastic plates push the shuttlecock against the platform to prevent it from falling. The shuttlecock will be collected inside the basket. The shuttlecocks still needed to be stacking manually

inside the shuttlecock container tube. Shuttlecock Collector Machine can collect the shuttlecock in a big amount because this product is using a basket as a place to collect the shuttlecocks. The users of this product still need to stack the shuttlecock together because this product doesn't have the stacking tube. This product is still lacking on the organizing the shuttlecocks. The product is using the plastic plate as a sweeper. The plastic plate will push the shuttlecock against the platform to bring it up and directly into the collector basket. The disadvantage is the plastic plate will cause damage and dent the shuttlecock. The shape of the shuttlecock might not be secure anymore. This machine is using a chain and gear concept to move the product. When the machine is pushed the wheel will move and make the plastic plate sweeper, sweep the shuttlecock up on the platform and move toward the basket.

Figure 2: Shuttlecock Collector Machine made by students from Politeknik Kuching Sarawak [4]

Figure 3(a) shows the roll-in pro collector is the quick way to pick up golf balls from practice nets, practice greens, practice areas and driving ranges. This ingenious hand tool collects up to 70 golf balls in as little as 27 seconds [5]. However, this roll-in pro collector needs a tool to take out the golf ball from the net. This roll-in pro collector does not stack the ball automatically and needs manpower to manually stack the ball. **Figure 3(b)** shows the tennis ball collector mower capable of clearing loose balls off tennis courts within minutes and a perfect for professional tennis facilities such as tennis clubs and sports centers, along with establishments that frequently host official matches or leisurely play. On average, this tennis ball collector mower can gather 150 to 200 balls on a half court in a mere 2 to 3 minutes. The top basket doubles up as a tennis ball hopper if the user desires, holding up to approximately 170 regular size tennis balls. However, the basket can be removed from the machine for easy disposal of balls and storage purposes [6]. The weakness for this collector mower is that the ball is unstack when it's collected and needs manpower to stack the ball manually.

(a) (b)

Figure 3: (a) Roll-in pro collector and (b) tennis ball collector mower

3. Shuttlecock Collector Machine Design

There are several important elements that need to be studied in designing a product so that the production of products works well and is user-friendly. Among the elements that need to be studied is the type of materials and components used, the correct application process, objective analysis products, as well as the cost of each material and component used. Shuttlecock collector machine is shown at

Figure 4. This shuttlecock collector machine is designed with length of 90 cm, height of 60 cm and width of 20 cm. DC motor is used at both shaft where one is used to reel out the thread line and another one to reel in the thread line.

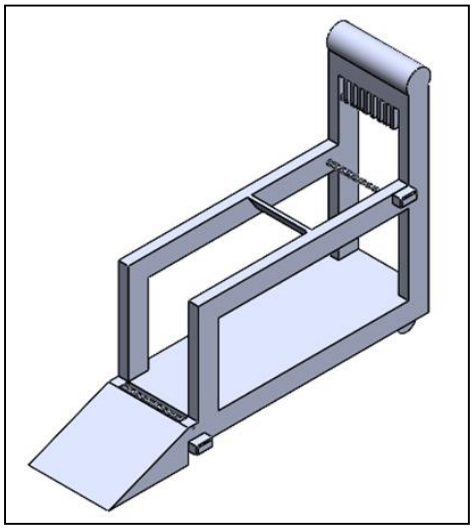


Figure 4: Shuttlecock Collector Machine Solidworks drawing

Figure 5 shows exploded drawing of Shuttlecock Collector Machine. **Figure 5(a)** is the main frame which is made of Aluminium where it is light in weight, durable and non-corrosive. The main frame height is 90 cm where it is average height for human waist level. For the width and length is 20 cm and 60 cm. The main function of the main frame is to maintain the shape and receive push and pull force from the user. **Figure 5(b)** shows the barricade with a dimension of 20 cm of width and height of 5 cm. It is made of polypropylene which is a thermoplastic. It is superlight in weight and suitable to be a barricade that will push the shuttlecock upwards [7]. **Figure 5(c)** is the Aluminium shaft with a diameter of 0.25 cm. The Aluminium is use as it can withstand high tensile strength and will be hard to break. There are two shafts used in the Shuttlecock Collector Machine to perform a belting process. **Figure 5(d)** shows the handle for the Shuttlecock Collector Machine with diameter of 5 cm that made from Aluminium. It is cylindrical in shape and ease the user to hold and push around the Shuttlecock Collector Machine. **Figure 5(e)** is the pulley made from Aluminium and is place between the shafts to reduce the force needed to move the shuttlecock upwards. **Figure 5(f)** is the switch and DC motor (25,000-28,000 rpm). These are two components used to make the belting process move and connected to the shaft. **Figure 5(g)** is the four holes made on the main frame of the Shuttlecock Collector Machine with a diameter of 7 cm as a compartment to put the shuttlecock container. The container can be easily replacing and remove when it is full. **Figure 5(h)** show the caster wheel made from rubber to ease the movement of the Shuttlecock Collector Machine. There are four wheels used on it and it can make the user to turn around the Shuttlecock collector machine easily. The rubber is used to provide floor protection and can be used for a long time. **Figure 5(i)** is the sweeper and made of polypropylene as it is water resistant and will collect the shuttlecock on the floor [8]. **Figure 5(j)** is the flat brush attach to the shaft. The brush is attached to the polypropylene as it will reduce the force needed to spin the shaft. The brush is used to prevent any damage to the shuttlecock. As the flat brush spin, the shuttlecock will be lift and transfer to the belting thread.

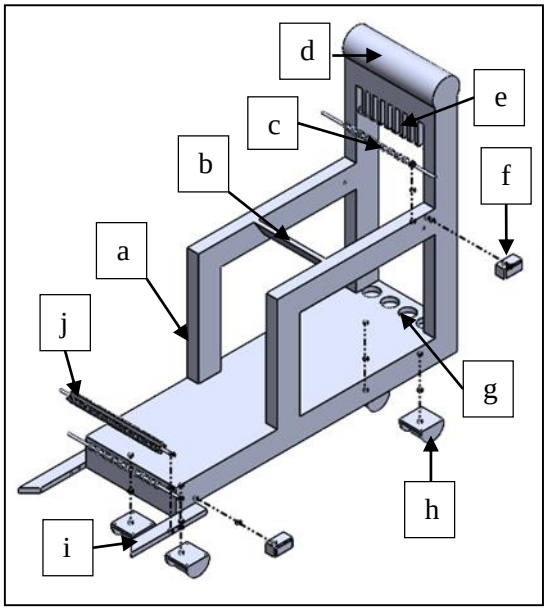


Figure 5: Explode view of Shuttlecock Collector Machine

4. Experimental Setup

Product manufacturing of Shuttlecock Collector Machine is related with the main objective to collect and stack the shuttlecock. For the Shuttlecock Collector Machine to work properly, the following procedure must be done. First, switch on the upper motor and make sure the lower switch is off. Next, put shuttlecock container at it slot and then push the Shuttlecock collector machine around the court. After done collecting, switch off the upper motor and switch on the lower motor to re-reel the thread. During this process there are several objectives that must be done by the Shuttlecock Collector Machine.

4.1 Shuttlecock Collecting Speed

This experiment is to find the difference in time and speed of collecting the shuttlecock. To differentiate, 100 shuttlecocks is spread randomly across the court and will be pick manually and Shuttlecock Collector Machine. Time is recorded for the collecting duration. The experiment will be done 3 times to get the average time of collecting time.

4.2 Stacking Ability

After done doing the collecting experiment, the shuttlecock that collected by the Shuttlecock Collector Machine will be pass to the eight threads where will divide into four section and will be stack into four-cylinder tube. One cylinder tube can load 12 number of shuttlecocks and the tube will be replace manually once it is full. During this process the transferring pattern need to be known either it is random or sequence. In the transferring process a barricade will prevent the shuttlecock to stack upwards and maintain the stacking in downwards position.

4.3 Shuttlecock condition

After the previous two experiment is done, all the shuttlecock that collected in the shuttlecock container will be check its condition to make sure the shuttlecock is in good condition. For the three set of experiment each set of shuttlecocks will be mark with different color to make sure there is no shuttlecock used more than once for the experiment.

5. Result and Discussion

The user will push around the Shuttlecock Collector Machine around the court three times to do the experiment. The first phase of the experiment is the difference in collecting speed between manually by hand and using Shuttlecock Collector Machine. The second phase is to determine the stacking ability of the Shuttlecock Collector Machine into the shuttlecock container and to learn the pattern for the shuttlecock stacking between random or sequence. The last phase of the experiment is to know the shuttlecock is in a good condition to use again after being collected by the Shuttlecock Collector Machine.

5.1 Working Principle of Shuttlecock Collector Machine

Figure 6 shows the Shuttlecock Collector Machine model. **Figure 6(a)** shows the sweeper that will sweep the shuttlecock on the court and collect it. As the Shuttlecock Collector Machine moves around the court, the sweeper will sweep the shuttlecock and trap it in between before the shuttlecock is move up by the thread. **Figure 6(b)** is the shaft that will hold the thread as thread is reeling in and out. **Figure 6(c)** show the thread that will move the shuttlecock upward to the shuttlecock container. The thread will be reeled in by the upper shaft and as the thread is reeling in the shuttlecock that stuck between the two threads will be moving upwards. **Figure 6(d)** show the handle for the Shuttlecock Collector Machine. The handle is convenient and suitable for the user. Lastly the **Figure 6(e)** is the caster wheel that will ease the movement of the Shuttlecock Collector Machine when there is force applied onto it.

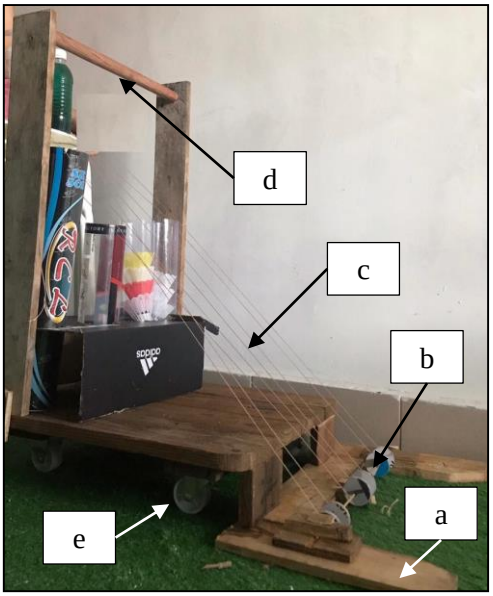


Figure 6: Shuttlecock Collector Machine model

Figure 7 shows the step of how the Shuttlecock Collector Machine stacked the shuttlecock inside the tube. The Shuttlecock Collector Machine was pushed towards the shuttlecock as shown in **Figure 7(a)**. The shuttlecock collected by sweeper and will be passed to the thread by the spinning flat brush as shown in **Figure 7(b)** and **Figure 7(c)**. **Figure 7(d)** and **Figure 7(e)** shows the thread bring the shuttlecock moved upward into the cylinder tube. The shuttlecock reaches the drop point above the cylinder tube and drop into the cylinder tube as shown in **Figure 7(f)**.

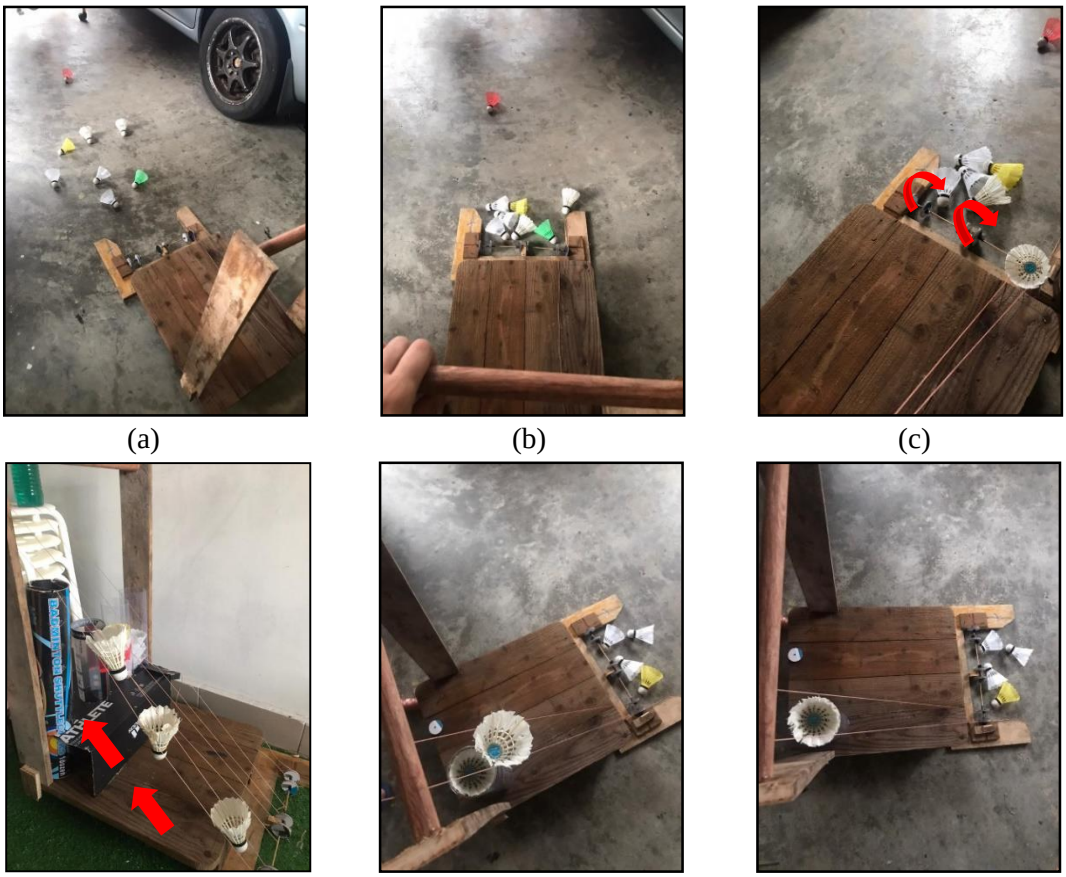


Figure 7: Process of collecting shuttlecock using Shuttlecock Collector Machine

Figure 8 shows the process of transferring the shuttlecock from sweeper to the thread by spinning flat brush. This Shuttlecock Machine Collector manage to hold the thread by its cork because the cork diameter is smaller than the feather diameter. The distance between two thread that hold the shuttlecock is 3 cm and the cork diameter is 2.8 cm while the feather diameter is 6.8 diameter. The thread is moved upward by reeling the upper shaft and the shuttlecock is also pull along as the thread is reeling in. as the thread move upward the distance will be increase until 6.5 diameter. The thread will be 6.5 cm at the top of the shuttlecock container tube. It is possible to drop the shuttlecock downward as the feather is smooth surface and the cork is the heaviest part of the shuttlecock and the shuttlecock will be pull by the gravity.

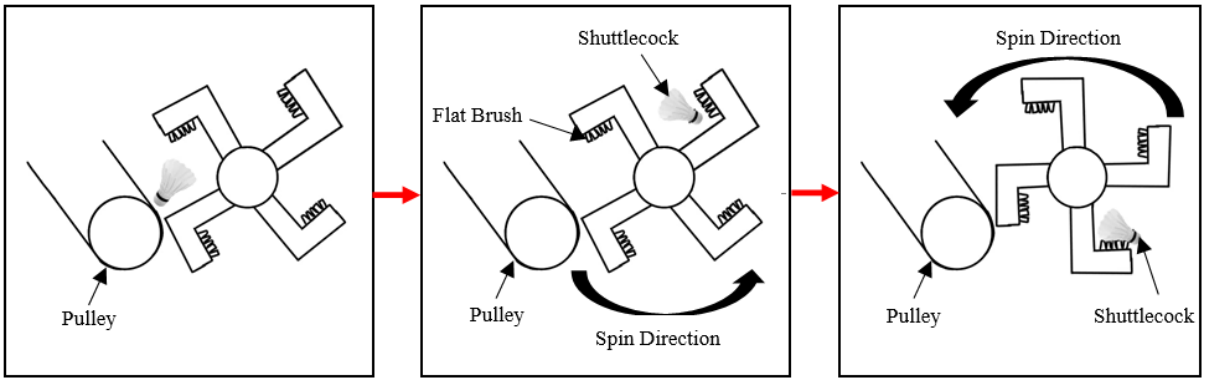


Figure 8: Process of transferring the shuttlecock from sweeper to the thread by spinning flat brush

5.2 Analysis on Shuttlecock Collector Machine

The analysis towards Shuttlecock Collector Machine is made to approve the objective of time saving when collecting the shuttlecock. **Figure 9** shows the result of time taken to collect 100 shuttlecocks around the court by manual and by Shuttlecock Collector Machine. From the graph, it shows that the average time for the Shuttlecock Collector Machine to collect 100 shuttlecocks is shorter than manual method. For the average time taken of Shuttlecock Collector Machine is 5.1 minutes while the manual method is 8.6 minutes. This shows that Shuttlecock Collector Machine can fasten the process as the manual method require the person that collecting to collect the shuttlecock to bow down as they need to collect the shuttlecock on the floor. The Shuttlecock Collector Machine able to reduce 40.7 % of the time needed to collect the shuttlecock.

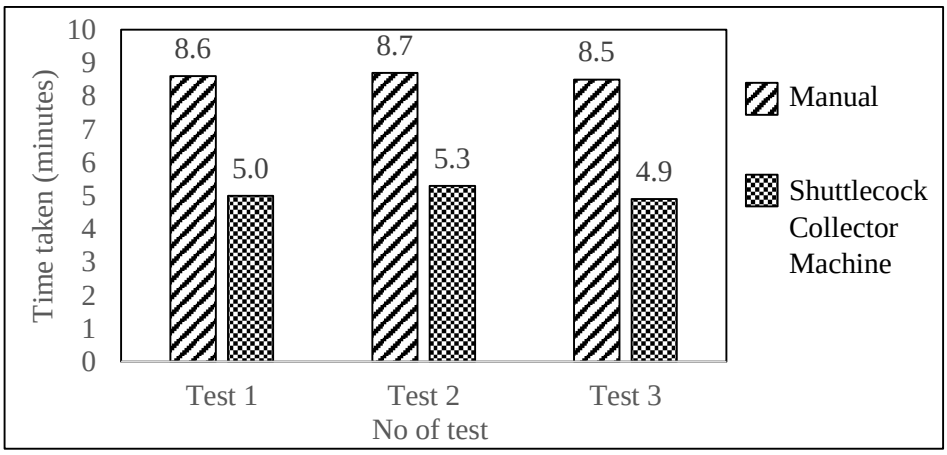


Figure 9: Time taken to collect 100 shuttlecocks

Figure 10 shows the total of shuttlecock that successfully being stack into the shuttlecock tube. Test 1, Test 2, and Test 3 successful collected 94, 96 and 93 stack shuttlecocks, respectively. It seems like the average successful rate to stack the shuttlecock is 96 % and the rest 4 % of the shuttlecock failed to stack due to some shaking effect while pushing around the Shuttlecock Collector Machine too fast that made the shuttlecock to fall before reaching the container tube. The unsuccessful shuttlecocks will be remains outside and need to be manually stack by the user at the end of the process. The shuttlecock is stacked downwards as the thread that transferring the shuttlecock is fit for the cork. Even though there are some that will be facing upward there will be a barricade in the middle and will push the shuttlecock to be downwards. The pattern for stacking is random as all the four pair of thread is moving at the same time and the shuttlecock position also cannot be control during the collecting process. **Figure 11** shows how the shuttlecocks will be stack downward.

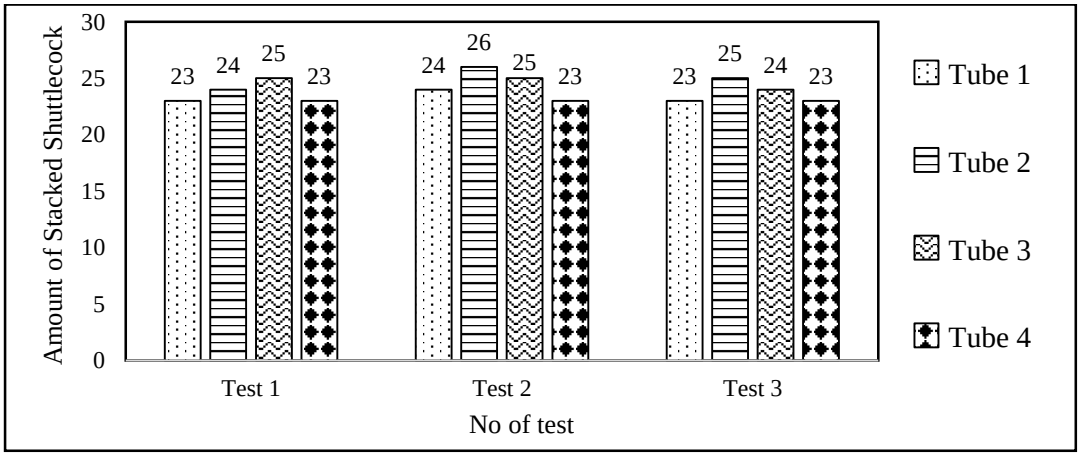


Figure 10: Amount of successfully shuttlecock stacked

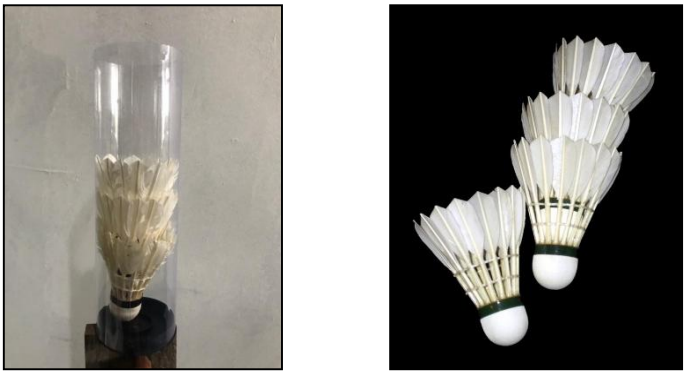


Figure 11: Downward stacked shuttlecock

Figure 12 shows the percentage of the damaged shuttlecock that has been completely stack into the cylinder tube. The shuttlecock that had been damaged has a similarity where the feather is slightly distorted and it because the shuttlecock hit the sweeper and stuck between the sweeper and the floor. **Figure 13** and **Figure 14** shows how the shuttlecock is stuck between the sweeper and the condition of the shuttlecock after stuck.

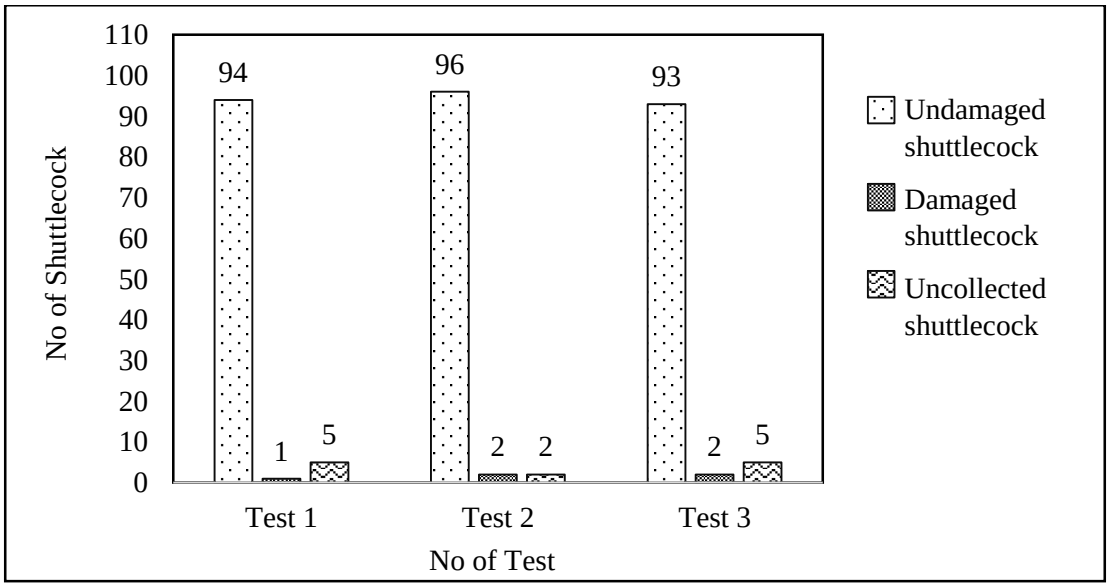


Figure 12: Amount of Undamaged and Damaged Shuttlecock

Figure 13: Shuttlecock stuck under sweeper

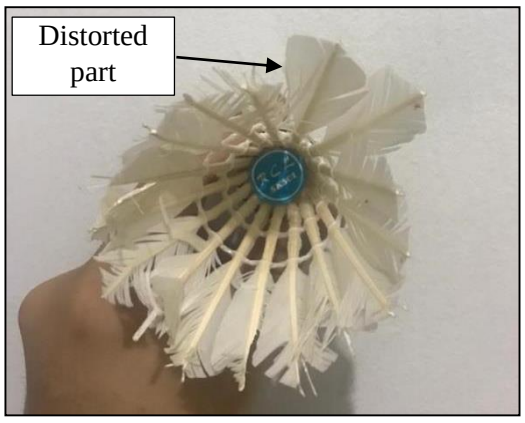


Figure 14: Distorted shuttlecock

6. Conclusions and Recommendations

The Shuttlecock Collector Machine is able to perform its intended purpose. It helps reduce 40.7% of the time picking up shuttlecocks on the floor while also arrange it accordingly. This shuttlecock collector machine will not damage the shuttlecock's feathers and will save the players' time because it does not need to manually stack the shuttlecock as it is already stacked when it is collected by the machine. The machine pulley concept will take care of the feathers and the wheel will help to move the machine easily. Moreover, this collector machine will greatly help the players as they do not require a lot of manpower to operate this machine.

The suggestion for the user will be the user need to push the shuttlecock collector machine slowly to prevent shaking that will make the shuttlecock fall and failed to stack into the container. Using more lightweight material to reduce the weight of 25 kg Shuttlecock Collector Machine can help the user to move the machine from one place to another. Make the Shuttlecock Collector Machine operate fully automatic to ease the user more by moving itself around the court without using any human power.

Acknowledgement

The authors would also like to thank the Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia for its support.

References

[1] S. Helmut, "Shuttlecock collector / ballsammer," in Youtube, September 5, 2018. [Online]. Available: https://www.youtube.com/watch?v=HqgUuEGae3k. [Accessed July 5, 2021]

[2] S. Helmut, "Shuttlecock collector / ballsammer," in Youtube, May 3, 2018. [Online]. Available: https://www.youtube.com/watch?v=4hODzsYsZ7A. [Accessed July 5, 2021]

[3] Rhizobium Inside, "Shuttlecock collector machine (SCM) POLIKU," in Youtube, October 3, 2014. [Online]. Available: https://www.youtube.com/watch?v=X5Di1ocYQfY. [Accessed July 5, 2021]

[4] F. N. M. F. Muhammad and B. Surendran, "JKM borang inventori shuttlecock collector machine," 2020. [Online]. Available: http://www.pmm.edu.my/zxc/2020/upick/remo/JKM/Borang %20Inventori%20Projek_JKM(37).pdf. [Accessed June 29, 2021]

[5] Golf Business News, "Introducing the new roll-in pro collector," February 14, 2014. [Online]. Available: https://golfbusinessnews.com/news/new-products/introducing-the-new-roll-in-pro-collector/. [Accessed July 5, 2021]

[6] Net World Sports, "Tennis ball collector, tennis ball pick up machine, tennis ball hopper," 2021. [Online]. Available: https://www.networldsports.co.za/tennis-ball-collector-mower. [Accessed July 5, 2021]

[7] A. Polymers, "Polypropylene (PP) lightest thermoplastic," in Amco Polymers. [Online]. Available:https://www.amcopolymers.com/resin-families/polypropylenepp#:%7E:text=Polypropylene%20is%20known%20for%20its,and%20has%20excellent%20moisture%20resistance. [Accessed July 5, 2021]

[8] Marlin Steel Wire Products, "7 need-to-know polypropylene material properties" January 16, 2020. [Online]. Available: https://www.marlinwire.com/blog/7-need-to-know-polypropylene-material-properties#:%7E:text=Polypropylene%20is%20highly%20impermeable%20to,from%20exposure%20to%20various%20chemicals. [Accessed July 3, 2021]