MECHANICAL RAT REPELLANT DEVICE POWERED BY STEAM BASED WATER TURBINE

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ABSTRACT

Rats are one of the rodent pests of rice plants. Plant damage is characterized by a pattern of rice plant death from the middle of the rice field to the edge of the rice field. Rat eradication, including traps and rat poison, actually causes damage to the rice field ecosystem. This research aims to produce and test a rat repellent device that produces mechanical sound powered by a water turbine by using items that are around. The research method used is the Research and Development (R&D) based on Science, Technology, Engineering, Art, and Mathematics (STEAM). Research by Manohar et al. (2019) stated that after mice were placed in a box equipped with noise of 60 dB-90 dB, the mice left the box to avoid the noise because it was considered to arouse fear and be disturbing. The results of this research are in the form of: 1) The means for expelling mice is a mechanical mouse repellent device powered by a water turbine. 2) The feasibility of a Water Turbine Powered Mechanical Rat Repellent Device is based on the STEAM aspect, namely the science aspect of using water flow to drive a turbine; the technological aspect uses the basic principles of propeller motion on a turbine; engineering aspects of using digital media as a means to create product designs; the art aspect uses idiophones sounds produced from cans; The mathematical aspect uses the basic formula for spindle rotation. Based on research results, a STEAM-based water turbine powered mechanical rat repellent device was declared suitable for use.

Keywords: Repellent, Rats, Mechanics, and Turbines

INTRODUCTION

Plant pests are a problem that never ends. One plant that is often affected by pests is rice. According to Manueke et al. (2020) pests that are often found attacking lowland rice plants include rice stem borers, brown and green planthoppers, grasshoppers, birds and mice. Among several pests that often attack rice, mice are considered to be the pest that has the most significant impact on rice plants. Rice field mice are very detrimental and cause great damage to rice plants compared to planthoppers and other pests (Sudarmaji, 2018). This animal which is considered a nuisance is indeed part of the food chain in the food chain in the rice fields. However,

the increasing population will result in a decrease in crop yields. This is certainly detrimental to farmers considering that the main food source for Indonesian people is rice. If this continues, it is feared that a prolonged food crisis will emerge.

Farmers use various methods to overcome pest problems. One way to do this is to use chemical poisons. However, the use of chemical poisons causes an imbalance in the food chain in the rice fields. Therefore, a means of expelling mice is needed without reducing the population. The rodent with the Latin name rates argentiventer is known to have a sharp sense of hearing. Mice will be disturbed at frequencies of 40 kHz, 50 kHz and 60 kHz at a distance of 2 meters (Ibrahim and Hakim, 2018). This could be an opportunity to create a tool that can help repel mice. However, it is important to know that the solutions offered are in accordance with the problems faced in the rice fields. Therefore, good problem solving skills are required.

According to Nur Ngazizah (2021), generic skills need to be developed to overcome various problems around us. Problem solving in research is carried out deductively. So as a first step in solving the problem, researchers need to move from the general to the specific stage. Based on the description of the problem, the researchers provide an alternative way to repel rats pests, namely by making a rat repellent device that produces mechanical sound by relying on the movement of a water turbine. This tool is inspired by waterwheels used by farmers to circulate water combined with the basic concept of STEAM so that it can add value to the tool.

RESEARCH METHODS

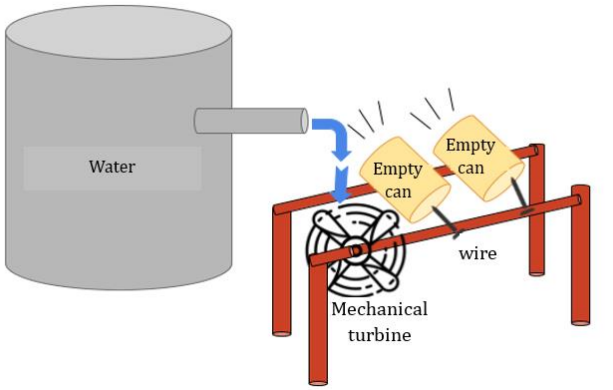
This study used qualitative research methods. The type of research used is the Research and Development (R&D) based on Science, Technology, Engineering, Art, and Mathematics (STEAM). STEAM identification consists of the ask, imagine, plan, create, and improve stages. The initial stage in STEAM is asked, namely conducting observations and interviews with farmers to identify problems. Observations and interviews were carried out with the aim of gathering information regarding the analysis of problems and conditions of rice fields. Based on the results of observations and interviews that have been conducted, researchers have obtained the fact that rat pests have a big influence on rice yields. Efforts to exterminate rats with poison carried out by farmers are deemed ineffective because they damage the balance of the food chain in the rice fields. One of the negative impacts of damaged food chains in rice fields is that many snakes appear in residential areas to look for food.

The second stage is to imagine, namely imagining the problem found and finding a solution to the problem. Based on the problems faced, researchers provided a solution by creating a STEAM-based water turbine-

powered mechanical rat repellent. This tool has a working principle of producing sound from the movement of a water-powered mechanical turbine. This sound is used to chase away mice without disturbing the food chain in the rice fields. This solution is still just an idea that has not been realized. In planning this idea, researchers need to think about all the risks from both the negative and positive sides. So that the tools created can be useful and not detrimental.

The third stage is the plan, namely planning to make a rat repellent device. The aim of preparation is to minimize possible risks while making it easier for researchers to achieve their goals. The initial planning stage is to create a product design using Microsoft Word.

Figure 1.
Design of a STEAM-Based Water Turbine Powered Mechanical Rat Repellent Device



Next is to prepare the necessary tools and materials. Preparing tools and materials is done with the aim of saving time when making a rat repellent tool. The tools and materials needed are:

1. Paralon
2. Medium size turbine
3. Wire
4. Empty can
5. Bamboo
6. Rubber band
7. Wooden plank
8. Glue

The fourth stage is creating, namely making a mouse repellent using the tools and materials that have been prepared.

1. Cut the paralon to the desired size
2. Assemble the paralon to resemble a beam shape using paralon connections
3. Attach the wood and cans according to the position in the design
4. Install the turbine on the paralon at a distance from the can
5. Attach the wire to the turbine shaft made of paralon parallel to the position of the two cans
6. The mouse repellent mechanical turbine is ready for use

The final stage an improvement, namely by testing the feasibility of the product on several respondents to determine the feasibility of the product. The purpose of product testing is to find out errors in the product being made. The tool used is a tachometer to measure the rotation speed of the turbine. The rotation speed rhythm can be calculated using the Spindle Rotation Formula.

$Cs = \pi.d.n$

Cs: Cutting Speed (meters/minute)

π : Constant 3.14

d : Object diameter (mm)

n : Cutting Speed (Rpm)

The data collection techniques used by researchers were observing, interviews and response questionnaires. The interview design used was semi-structured Qualitative Research Methodology (Feny Rita et al, 2022:99). A semi-structured interview design is a design that contains more open questions with the aim of finding problems that are investigated in depth.

The data analysis technique uses an improved technique of the STEAM component, namely by providing an assessment questionnaire on a mechanically powered mouse repellent using a water turbine. This technique will later test the feasibility of a mechanical rat repellent device powered by a water turbine based on aspects of Science, Technology, Engineering, Art, and Mathematics (STEAM).

FINDING AND DISCUSSION

Agricultural land is a place where various animals and plants live side by side. One of them is the event of eating and being eaten in the food chain. However, a fertile environment actually causes the pest population to increase. One of the pests that has a big influence on agricultural yields is rats. It is feared that eradicating the rat population could disrupt the balance of the rice field ecosystem. Therefore, a mechanical mouse repellent powered by a STEAM-based water turbine is presented as a solution to this problem. This research produces a product in the form of a STEAM-based water turbine-powered mechanical rat repellent aimed at rice fields. The following is the design of a STEAM-based water turbine powered mechanical mouse repellent:

Figure 2.
STEAM Based Water Turbine Powered Mechanical Rat Repellent Device

A STEAM-based water turbine powered mechanical rat repellent device is based on the basic concepts of Science, Technology, Engineering, Art, and Mathematics. One of the aspects contained in rat repellent devices is science. The scientific aspect is the aspect where the product made involves natural resources, namely by relying on water energy as mechanical power to drive the propeller. Utilization of water resources was chosen as the most effective solution because researchers consider agricultural products have little benefit. Water as a renewable energy source will be more effective and efficient because farmers do not need to think about product operational costs. Apart from that, the maintenance costs incurred are relatively small because they use used materials. Thus, it is hoped that this STEAM-based water turbine-powered mechanical rat repellent device will not burden farmers.

Next is the technological aspect, where the products made contain technological elements. The technology used in this product is the basic principle of propeller motion using water power connected by a wire. Next, the propeller connected to the wire around the paralon will rotate so that the wire hits the bamboo on the can. Bamboo connected with rubber causes repetitive movements when touched by the wire. Collisions between cans and bamboo in a certain rhythm will produce a sound with a frequency of 55 Hz which can scare mice from approaching agricultural areas.

Engineering is the design aspect of the product, namely the design of a mechanical mouse repellent powered by a water turbine. This design was created using the Microsoft Word application, namely by arranging spatial and flat shapes to form a product design. Figure 1 explains how the design and working principle of a water turbine powered mouse repellent device produces a sound that disturbs mice's hearing.

From an artistic perspective, this product is more prominent in that the resulting rhythmic art is always consistent because the wires have been arranged in such a way that they are at a certain degree to produce a rhythm

that can be enjoyed while also producing a loud sound. Apart from that, this media combine used items that have been decorated to add artistic value. According to Nur Ngazizah (2018:31) states that: Items that were previously unused become useful. Reusing used goods in the surrounding environment can reduce the risk of flooding, reduce water and environmental pollution, and help maximize the performance of rat repellent devices. On the other hand, the use of used goods can reduce production costs so that it does not burden farmers.

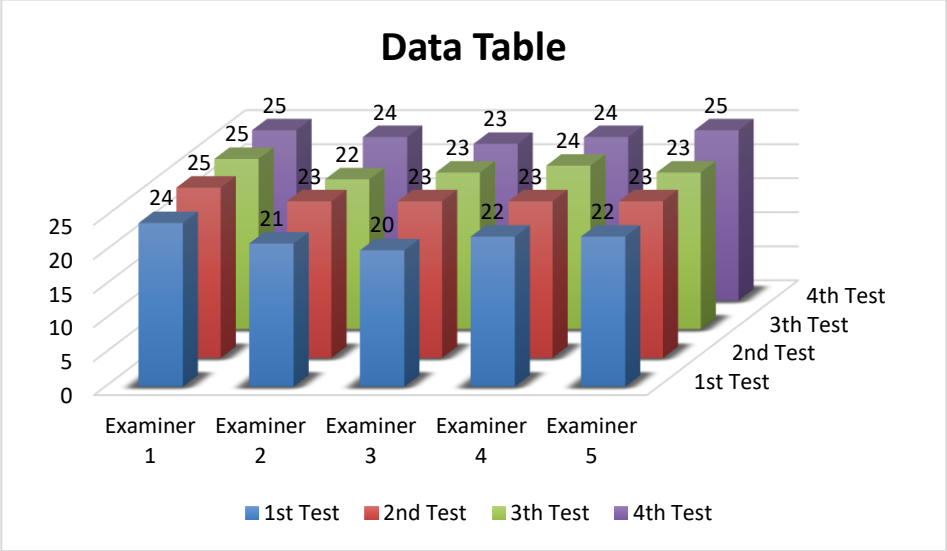
The last aspect is mathematics, namely determining the mathematical elements in the product. This tool can run according to the fast flow of water. The faster the rhythm produced, the faster the volume of water flowing. The water discharge hitting the turbine affects the loudness of the sound produced. Therefore, the water discharge is related to the rotation speed of the turbine. The turbine rotation speed can be calculated using the spindle rotation formula. Based on the measurement results, the spindle rotation meets the criteria so that it produces sound with the desired frequency.

Testing the usability of a STEAM-based water turbine-powered rat repellent also takes into account the spindle rotation speed of the turbine. The test was carried out four times by five media experts by distributing instruments containing media expert assessments. Based on the tests that have been carried out, the average score from the response questionnaire results is 92.2%, while the steam analysis test is stated to be good. The following are the average results of the percentage gains from these four aspects:

Table 1.
Questionnaire Response Table

Examiner	1st Test		2nd Test		3th Test		4th Test		Total
	yes	no	yes	no	yes	no	yes	no	
Examiner 1	24	1	25	0	25	0	25	0	100
Examiner 2	21	4	23	2	22	3	24	1	90
Examiner 3	20	5	23	2	23	2	23	2	89
Examiner 4	22	3	23	2	24	1	24	1	93
Examiner 5	22	3	23	2	23	2	25	0	93
Persentase (%)	87,2		93,6		93,6		96.8		92,2

Figure 3:
Response Questionnaire Diagram



Testing of the STEAM-based mechanical rat repellent device powered by a water turbine was carried out four times with five media validators. In the first test, the test results showed a quite satisfactory value, namely 87.2%. It's just that there are several components of the rat repellent device that are not sturdy enough and need to be repaired. The testers gave advice on using glue that has stronger adhesive power so that it can maintain the durability of the rat repellent device in various conditions.

Figure 4:
Trial 1

After making improvements to the product, a second trial was carried out again on five media validators. In the second trial, the score was 93.6%. During testing, there was an obstacle, namely the rotating wire was entangled in the grass around the water flow so it could not rotate. The examiner provided input to place the tool in a more spacious place to avoid a similar thing.

Figure 5:
Trial 2

In subsequent tests, the tool's performance worked well. However, testers still have not found evidence that the device can repel mice. The value obtained in the third test was 93.6%. Testers recommend installing rat repellent devices within 1 week or until the rice harvest is finished so that they can compare the effectiveness of the rat repellent devices.

Figure 6:
Trial 3

In the final test, the examiner tested the rat repellent device. Based on the data obtained, the tool can work well until the rice harvest is complete. After recording the rice harvest data, it was discovered that there had been an increase in yields of 20 kilograms of rice on 700 square meters of rice fields. Initially, the harvest before the rat repellent was installed produced 250 kilograms. After rat repellent devices were installed around the rice fields, the harvest increased to 270 kilograms. The score obtained by the examiners was 96.8%. So this research is relevant to previous research which stated that mice can be driven away by using noise with a frequency of 40Hz to 60Hz. Thus, a STEAM-based mechanical rat repellent device powered by a water turbine is declared to be very suitable for application in rice fields.

The results of the data that have been collected are also in line with the good response from farmers in the rice fields. They think that this innovation is very useful for increasing crop yields. After several weeks the rat repellent device was installed and it showed satisfactory results. Many farmers feel helped by having this tool in the fields. Apart from that, other farmers are also motivated to install this equipment in their fields.

Apart from being able to chase away mice with the mechanical sound produced by the movement of the water turbine, this tool is also able to channel water throughout the rice fields using a water turbine. The water collected in the water turbine will slowly begin to flow to flood the rice fields so that soil fertility can be optimal and comprehensive. This is certainly very helpful for farmers to increase the fertility of rice plants so that crop yields can increase.

CONCLUSION

This research produces a mechanical rat repellent device powered by a water turbine based on STEAM. The results of research from testers stated that the rat repellent device was declared very good and effective in repelling rats. The feasibility of a Water Turbine Powered Mechanical Rat Repellent Device is based on the STEAM aspect, namely the science aspect of using water flow to drive a turbine; technological aspects using the basic principles of propeller motion on a turbine; engineering aspects of using digital media as a means to create product designs; the art aspect uses idiophone sounds produced from cans; The mathematical aspect uses the basic formula for spindle rotation. In tests that have been carried out, mechanical rat repellent devices have been proven to increase rice yields by up to 20 kilograms. In developing this rat repellent device, used goods can be used according to the resources in the surrounding environment. Apart from that, farmers are advised to keep water sources free of rubbish so that rat repellent devices can work optimally.

REFERENCES

Purnama, A. C., Hantoro, R., & Nugroho, G. (2019). Rancang bangun turbin air sungai poros vertikal tipe Savonius dengan menggunakan pemandu arah aliran. *Jurnal Teknik ITS*, *2*(2), B278-B282.

Rahman, A., & Kimin, K. (2018). Pengaruh Debit Air Terhadap Kinerja Kincir Air. *DINAMIS*, *2*(12), 76-79.

Nurfauzan, A. (2023). Pengembangan Alat Pengusir Hama Tikus di Lahan Persawahan Menggunakan Sensor PIR dan Penguatan Ultrasonik untuk Petani. *Information Technology Education Journal*, *2*(3), 12-19.

Nurhikmayati, I. (2019). Implementasi STEAM dalam pembelajaran matematika. *Jurnal Didactical Mathematics*, *1*(2), 41-50.

Mariana, N., Julianto, J., Subrata, H., Balqis, K. I., Rachmadina, C. D., Anindya, V. H. K., & Sholihah, S. A. (2023). Desain Pembelajaran STEAM

dengan Media Selasi untuk Peserta Didik Kelas II SD. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *7*(1), 240-250.

Manueke, J., Assa, B. H., & Pelealu, E. A. (2018). Hama-hama pada tanaman padi sawah (oryza sativa l.) di Kelurahan Makalonsow Kecamatan Tondano Timur Kabupaten Minahasa. *Eugenia*, *23*(3).

Sudarmaji, S., Jumanta, J., Tran Quang Tan, TQT, & Nguyen Quy Hung, NQH (1999). 8. Pengendalian fisik tikus di negara berkembang.

Ngazizah, N., Saputri, D. R., Prahastiwi, F. A., Maulannisa, D., & Safitri, D. (2021). Pengembangan perangkat pembelajaran berbasis keterampilan generik sains terintegrasi karakter tema 6 Kelas III Sekolah Dasar. *Jurnal Cakrawala Pendas*, *7*(1).

Pambudi, B., Efendi, R. B., Novianti, L. A., Novitasari, D., & Ngazizah, N. (2019). Pengembangan alat peraga IPA dari barang bekas untuk meningkatkan motivasi belajar dan pemahaman siswa sekolah dasar. *Indonesian Journal of Primary Education*, *2*(2), 28.

Bana, M. S., Rahmawati, D., Joni, K., & Ulum, M. (2020). Rancang Bangun Alat Pengusir Tikus dan Burung pada Tanaman Padi. *J-Eltrik*, *2*(1), 53-53.

Inke, R. (2023). DESAIN ALAT PENGUSIR TIKUS SAWAH YANG MENGHASILKAN BUNYI SECARA MEKANIS DENGAN PENGGERAK TURBIN AIR.

Choifin, M., Afifah, Y. N., Lestari, L. P., & Prastio, A. Y. (2023). RANCANG BANGUN PANEL SURYA SEBAGAI ALAT PENGUSIR TIKUS BERBASIS ULTRASONIC. *Mechonversio: Mechanical Engineering Journal*, *6*(2), 65-70.

Aiyub, S. (2024). Turbin Angin menggunakan Pipa PVC sebagai Pembangkit Tenaga Listrik dan Pengusir Hama Burung Pipit. *Jurnal Serambi Engineering*, *9*(2), 8851-8859.

Febrian, R. (2024). *RANCANG BANGUN PROTOTIPE PENGUSIR HAMA BURUNG DAN TIKUS SAWAH BERBASIS IOT TERINTEGRASI APLIKASI ANDROID* (Doctoral dissertation, Universitas Mataram).

Ruspandy, R. (2022). *Perancangan Produk Pengusir Hama Sebagai Alat Bantu Petani Memaksimalkan Hasil Panen Padi* (Doctoral dissertation, Institut Seni Indonesia Yogyakarta).

Ariprihata, A., Erfandy, E., Susilo, S. W., & Sujito, S. (2023). Rancang Bangun Panel Surya Off-Grid Untuk Catu Daya Alat Pengusir Hama Tikus. *Jurnal Energi Baru dan Terbarukan*, *4*(3), 80-101.