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Design of Cultivate Fish Grader Machine

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Abstract:- Fish grading is carried out to maintain fish size uniformity being farmed. In general, fish grading is still done traditionally. Traditional fish grading is estimated to have low effectiveness, including long grading times, low accuracy rates, andhigh fish stress levels. The purpose of this research is to design a fish grader machine in a prototype model and determine the effectiveness of the fish grader machine that was designed. Design of fish grader machine includes designing, manufacturing and testing the effectiveness of fish grader machines. The effectiveness of the fish grader machine was observed based on length of time grading and counting, the accuracy of fish size uniformity levels, and accuracy of fish counting levels. The design of the fish grader machine consists of four main components, namely a hopper as a fish motion feeder that was equipped with a door stopper, a rotating conical disc driven by a driving motor as a driving force and directing fish to the grader gap, a grader plate which was made in a circle as a grading breaker, and a container count as a fish count line that was equipped with infrared sensor based on a microcontroller (Arduino). The results of testing the effective fish grader machine obtained that the length of time for grading and counting was 0.54 seconds/fish, the accuracy of fish size uniformity was 94.40%, and the accuracy of fish counting was 94.20%

Keywords:- *Fish Grading; Fish Grader Machine; The Design; Uniformity.*

I. INTRODUCTION

Maintaining the uniformity of fish size is important during the fish farming period. Uniform fish size can optimize growthand prevent cannibalism [4]. The uniformity size of fish being farmed can be achieved by fish grading. Fish grading is still mostly done traditionally by using simple grading tools such asperforated containers or containers with slotted rows [7;8]. Fishgrading is also usually accompanied by counting the number offish based on each fish size.

According to Sapriansyah *et al*. (2018), Traditional fish grading and counting have many weaknesses, among others long grading time, low accuracy levels, and high fish stress levels due to inconvenient treatment for the fish [8]. The traditional fish grading and counting are estimated to have low effectiveness because it is very susceptible to human error, where the human factor greatly determines the results of fish grading and counting [7].

Based on the information above, it is necessary to make an effort to design an effective fish grader machine and be able toovercome traditional grading problems as has been done by fish farmers so far.

II. RESEARCH METHODS

A. Tools and Materials

The tools used in the design of this fish grading machine include electric welding machines, acrylic bending tools, drilling machines, grinding machines, and other technical tools. While the materials used are materials for the manufacturing offish grading machine components with the type of material based on the regulation of the National Standardization Agencyof the Republic of Indonesia number 14 of 2019 concerning the conformity assessment scheme against Indonesian national standards in the agricultural, plantation, livestock and fishery sectors. The materials used are materials that are not dangerous, do not cause physical damage and contamination to fish (non-corrosive), and are easy to clean [1]

The types of materials used include UNP iron (U-Normal Profile) for the manufacture of the frame, stainless steel plate for the manufacture of lanes and the top cover of the frame, acrylic for the manufacture of hoppers, driving fins on the cone plate, grader plates, bulkheads on the top cover of the frame, and counting containers, Fiberglass and resins for the manufacture of cone discs, and aluminium sheet for coating the cone discs.

B. Design

The design of fish grading machine components, including:

1. Design of fish grader component, consisting of hopper design as a container and motion feeder of fish before being graded, design of the rotating conical disc as a component to push and direct fish to grader gap according to its size, and design of grader plate as a fishgrading breaker accordingly with the size.
2. The design of fish counter component, consisting of a counting container, and the design of an automatic counting system, namely the sensorial counting based on a microcontroller (Arduino).

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The design of the fish grader machine was processed by graphic design software, namely Google Sketch-Up. The results of the fish grader machine design were displayed in the form of a three-dimensional image equipped with a descriptionof the image and size.

C. Manufacture

The fish grader machine manufacturing process was carried out in the following stages:

1. Preparation. Consists of the preparation of technicaltools (drilling machines, grinders, welding tools, rulers, pliers, hammers, clamps, etc.) and technical materials such as welding wire, drill bits, grinding bits, and other use consumables materials to support the work.
2. Calculation of material requirements to be used for the manufacture of fish grader machine.
3. Making patterns according to the designs that have been made, including the bending process of iron and acrylic plates.
4. The working process, including the process of cutting, joining, forming, installing, and assembling all components of the grader machine.
5. Functional testing, including testing on each part of the fish grader machine to ensure the functions of these parts work properly according to the calculation.
6. Finishing, includes the process of tidying, painting, and improving the physical appearance of the fish grader machine

D. Fish Grader Machine Effectiveness Testing

The number of fish used was 300 fish per grading trial with 10 (ten) repetitions of the grading trial. The fish used per grading trial were catfish *(Clarias sp.)* consisting of 100 fish 7-8 cm in size, 100 fish in 9-10 cm in size, and 100 fish in 11-12 cm in size.

➢ *Fish size uniformity accuracy observation*

Observation of the accuracy of fish size uniformity was carried out by utilizing fish of each size being put together in one container. After the fish is completely mixed evenly, then the fish begin to be put into the grader machine gradually until all the fish are completely graded. The number of fish graded in each container of each size should ideally be equal to the number of fish in each size before grading, which is 100 fish per size. If there is a difference, then the number and description of the fish size that does not match are recorded as the grading error rate.

➢ *Fish count accuracy observation*

Observation of the accuracy of counting the number of fishis carried out simultaneously with the observation of the accuracy of fish size uniformity. The number of fish graded at each size ideally should be equal to the number of fish that is shown on the LCD screen for each size. If there is a difference, then the difference in the number of fish between the grading results and the number is shown on the LCD screen is then recorded as the level of calculation error.

➢ *Length of grading time observation*

Observation of the length of grading time is carried out by calculating the effective grading time. The effective grading time is the amount of time used in the grading process using a fish grader machine starting when the first fish enters thegrader machine until the last fish comes out of the grader machine in the grading process. The time is calculated using a stopwatch. The stopwatch starts when the first fish enters the grader machine and is turned off when the last fish enters the reservoir/pond. The time shown on the stopwatch screen is the effective grading time.

E. Data Analysis

➢ *Accuracy of Fish Size Uniformity*

The percentage of uniformity is calculated by the formula[8]:

ES = (Σ IS / IG) x 100%

ES : Percentage of uniformity effectiveness

IS : Uniform number of fish

IG : Number of graded fish

➢ *Accuracy of Fish Counting*

The percentage of the effectiveness of calculating the amount is calculated by the formula [5]:

EJ = (Σ IH / IG) x 100%

EJ : Percentage of the effectiveness of counting thenumber of fish

IH : Number of fish counted by a tool

IG : Number of graded fish

➢ *Length of Fish Grading Time*

The average time needed to grade fish per fish is calculatedby the formula [8]:

RW = WE / IG

RW : Average effective time of each fishWE : Effective time

IG : Number of graded fish

III. RESULT AND DISCUSSION

A. Fish Grader Machine Design

The parts of the fish grader machine are designed to consistof several main parts, including:

1. The hopper uses a stopper door that can open and close mechanically. This stopper door serves to hold the graded fish from falling in groups.

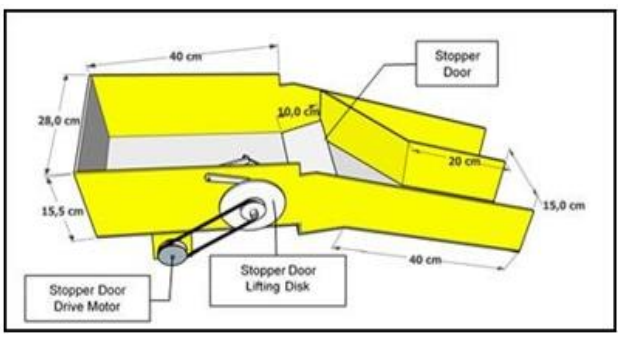

Fig. 1: Hopper.

2. The grading plate uses a circular slit lane system and a grading gap that can be adjusted to the size of the fish. The circular gap line aims to reduce the dimensions of the fish

grading machine which is usually made elongated. In addition, the slit path length on each sizes has the same length/distance.

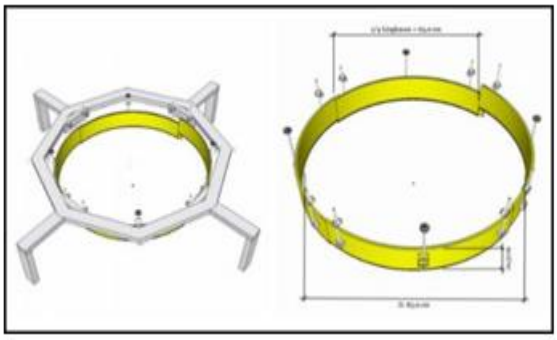

Fig. 2: Grader Plate

3. The conical disk with a pusher fin at the top. This fish pusher is driven by a driving motor and serves to deliver the fish to the appropriate grader gap, just like the conveyor function of an existing fish grader machine.

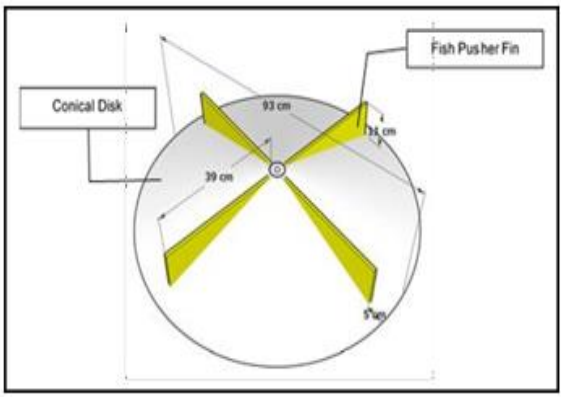

Fig. 3: Conical Disc

4. The fish counter uses an infrared sensor which is controlledby the Arduino microcontroller. Fish counting with this sensory system aims to speed up and improve the accuracyof counting the number of fish.

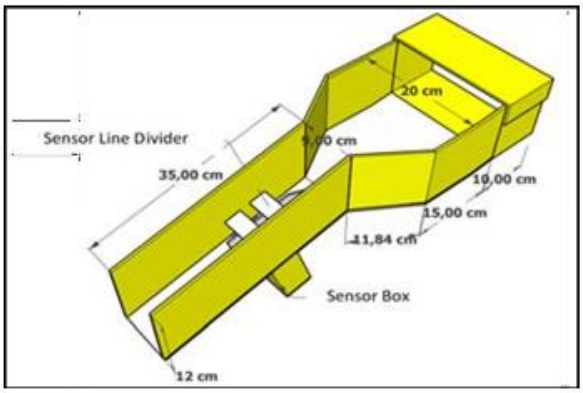

Fig. 4: Counting Container

From the four main parts, the design of the fish grader machine as a whole are carried out, while the results of the design of the fish grader are as follows:

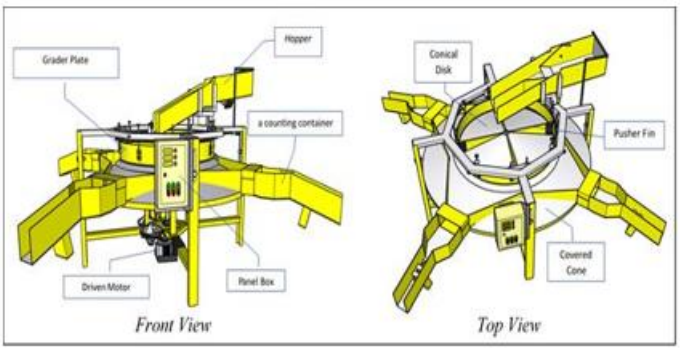

Fig. 5: Design of Fish Grader Machine

➢ *Fish Grader Machine Effectiveness*

B. Length of Grading and Counting time

Based on observations of the effective time of fish grading and counting, the data obtained for the effective time of grading and counting of the fish grader machine are as follows:

Rep	Fish Graded (fish)	GradingEffective Time (second)	Time Per Fish (second/fish)
1	300	175	0,58
2	300	141	0,47
3	300	150	0,50
4	300	133	0,44
5	300	190	0,63
6	300	163	0,54
7	300	185	0,62
8	300	171	0,57
9	300	170	0,57
10	300	140	0,47
Average (%)		**161,80**	**0,54**

Table. 1: Effective Time of Fish Grading and Counting

From the table above, the longest effective time of 10 repetitions was 190 seconds and the fastest time was 133 seconds. The average effective time used to grade and count 300 fish is 161.8 seconds so that the average time to grade and count 1 (one) fish is 0.54 seconds/fish. The results of the effective time observation carried out have an effective time range that is almost the same as the study of Sapriansyah *et al.* (2018) which states that the time used for grading and counting fish using a grading and counter system is 0.55 seconds/fish [8]

➢ *Accuracy of Fish Size Uniformity*

Observation of the accuracy of fish size uniformity is carried out by observing how much the fish grading machine can separate/grouping the graded fish according to their size. The level of uniformity accuracy is obtained by comparing the number of fish that are uniform in each size with the total number of fish graded. Accuracy of fish size uniformity is expressed in percent (%). Based on the results of the fish grader machine trials carried out, the following data were obtained:

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Rep.	Fish Graded (fish)	Not Uniform (fish)	Uniform (fish)	Accuracy (%)
1	300	20	280	93,33
2	300	20	280	93,33
3	300	14	286	95,33
4	300	18	282	94,00
5	300	21	279	93,00
6	300	15	285	95,00
7	300	13	287	95,67
8	300	19	281	93,67
9	300	16	284	94,67
10	300	12	288	96,00
	Average (%)			**94,40**

Table. 2: Accuracy of Fish Size Uniformity

The data table above informs that, out of 10 repeated trials,the highest uniformity accuracy rate was 96% and the lowest was 93%. While the average level of uniformity accuracyobtained is 94.4%. The average uniformity accuracy rate of 94.4% is slightly higher than the uniformity accuracy level of the fish grader machine designed by Badruzzaman *et al*. (2020)in his research entitled Analysis of the Fish Grading Machine Performance Testing Process for Grading Catfish with a Capacity of 5 Kg, with an average uniformity accuracy rate of 93% [2].

Based on observations, the error rate of uniformity accuracy that occurs is caused by several things, including:

1. There is still an accumulation of fish when the fish fall There is still an accumulation of fish when the fish fall from the outlet of the feeder container (hopper) into the grading gap. This build-up causes some small fish to not pass through the appropriate size gap because they are blocked by larger fish. The accumulation of fish also sometimes still occurs in the next lane so that even smaller fish cannot escape through the grading gap.
2. The cross-sectional shape of the upper conical disc, especially in the 5 cm section along the lip of the conical disc, still has a rudimentary level of precision. This causes the size of the grading gap to be slightly unstable so that fish that should not pass can pass through the grading gap or vice versa.
3. The rotational speed of the conical disc for the size of the fish tested (7-12 cm) is estimated to be too fast. This causes when the sorted fish have not had time to pass through the appropriate grading gap due to accumulation, the fish have been swept into the grading gap in the next lane.
4. There is a movement of fish after escaping from the appropriate grading gap to the previous lane. This is because there is a gap between the bulkhead and the lip of the disc, so that fish with active movement can pass through the gap.

➢ *Accuracy of Fish Counting*

Observation of the accuracy of counting the number of fish is to determine the ability of the counting component on the fish grader machine in calculating the number of graded fish at each size. The level of accuracy in calculating the number of fish is obtained by comparing the initial number of fish calculated with the number of fish calculated on the LCD screen for each size. The level of calculation accuracy is expressed in percent. Based on the results of observations made, data on the accuracy of calculating the number of fish were obtained as follows:

No	Fish Graded (fish)	Number of Fish Counted (fish)				Accuracy (%)
		Line 1	Line 2	Line 3	Total	
1	300	85	93	105	283	94,33
2	300	90	91	98	279	93,00
3	300	94	87	105	286	95,33
4	300	89	90	100	279	93,00
5	300	90	89	100	279	93,00
6	300	92	92	100	284	94,67
7	300	91	92	100	283	94,33
8	300	92	88	106	286	95,33
9	300	90	91	101	282	94,00
10	300	94	91	100	285	95,00
		Average (%)				**94,20**

Table. 3: Accuracy of Fish Counting

Based on the table above, the accuracy level of fish counting by the counting component on the fish grader machine designed to build the highest is 95.33% and the lowest is 93% with an average accuracy rate of 94.2%. From 10 repetitions of testing the performance of the counting component on this fish grader machine, in general, the counting component on this fish grader machine has worked well. However, calculation errors still occur with an average error rate of 5.8%. According to Purwanto dan Achlison (2016), fish counters with an error rate of less than 10% are acceptable for use by fish farmers [6].

The error rate that occurs is caused by several things, including:

1. There is overlapping of the fish's body when the fish passes through the counter aisle. This causes two fish to simultaneously pass through the counter passage and the count sensor detects the two fish are only one count or one tail. This also happened to the fish counter designedby Purbowaskito dan Handoyo (2017); Hendrawan *et al*. (2021) which uses a pipe as a fish counting tunnel, where the error rate in the calculation of the designed fish counter is due to overlapping fish bodies, namely two or more fish simultaneously passing through the counting sensor so that the counting sensor detects one fish only [3;5]
2. There is a fish jump with a very active movement through the top of the counting aisle so that the fish is not counted or not detected by the counting sensor. Thisalso happened to the fish counter designed by Yutanto *et al*. (2018) which uses funnels and pipes as the counting passage, where the error rate occurs due to fishjumping out of the funnel and fish stuck in the funnel sothat the fish do not move into the counting passage [9].

IV. CONCLUSION

1. The design of the fish grader machine consists of four maincomponents, namely a hopper as a fish feeder that was equipped with a stopper door, a rotating conical disc drivenby a driving motor as a driving force and directing fish to the grading gap, a grader plate which is made into a circle as a grading breaker, and a counting container as a fish counting lane that was equipped infrared sensor based on an Arduino microcontroller.
2. The results of fish grader machine effectiveness testing arethe length of grading and counting time was 0.54 seconds/fish, the accuracy of size uniformity levels was 94.40%, and the accuracy of fish counting levels was 94.20%.

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