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Design of i-LOCA (Innovative Lobster Catcher) With Theoriya Resheniya Izobretatelskikh Zadatch (TRIZ) and Business Model Canvas (BMC) (Case Study: Gresik And Lamongan Fisherman Communities)

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Abstract. Indonesia has the potential of marine resources. Efforts are needed to explore and cultivate the existing marine resources appropriately. The problems of fishermen catching technology is one of the main factors causing the lack of competitiveness of nations in the world's fisheries. Lobster has a high sales value, but exploration is still minimal due to the absence of specific fishing gear. Lamongan and Gresik are the coastal areas in Java Sea with the lobster fishing commodities. At the time of the lobster season arrives, limited fishing gear is used in fishing gear such as fish traps and nets that are not a lobster fishing gear. Use the problem-solving process stages: literature studies and field studies. The study of literature used is overall product design, TRIZ and BMC. While field studies conducted in Gresik and Lamongan to seek consumer needs. In this data collection using interviews, FGD and giving questionnaires to fishermen. The design of lobster fishing gear done by TRIZ to resolve the contradiction existing problems and be approached BMC method that lobster fishing gear i-LOCA (Innovative Lobster Catcher) can be commercialized. i-LOCA has detection equipment or towing lobster with optimum fishing capacity to increase the income of fishermen.

Keywords: fishing gear, lobster catcher, lobster, TRIZ, Business Model Canvas

1 Introduction

Indonesia is a maritime nation with a sea area larger than its land area of 5.8 million km2, making up 70% of Indonesia's total land area and home to 17,480 islands (The Embassy of the Republic of Indonesia, Washington, DC, 2015). Squid, shrimp, lobster, fish, seaweed, crabs, pearls, shellfish, and octopus are just a few of the vast potential marine water resources that exist in Indonesia. This potential is furthered by a claim made in the National Industry Roadmap for the 2009–2024 period by the Indonesian Chamber of Commerce and Industry, which claims that one of the key industrial clusters for foreign exchange profits is the processing of marine products. Considering the immense potential, it is also vital to carefully and prudently discover and process Indonesia's existing marine resources by employing available human and technology resources. According to data from the Food and Agriculture Organization (FAO) in 2020, Indonesia is second to China in terms of global fisheries production. One of the key fisheries products, both locally and internationally, is sea lobster. Due to its great economic worth as a popular food item, lobster is much sought after and is fished all over the world. According to FAO statistics on the number of lobsters captures worldwide, the total amount was 205,000 tons in 1988. The amount of lobster caught globally has grown dramatically during a period of 21 years, reaching 25%, or an increase of 51,250 tons. Lobster is one of the extremely promising resources in East Java Province that haven't been properly used. With a price of about IDR 700,000.00 per kilogram, lobster has a very high commercially [1].

The captured commodity that has the highest value is lobster. When compared to other fishing commodities, the value of lobster is around 5-10 times the price of the crab. One source said that one kilogram of medium-sized lobster currently costs around 450 thousand rupiah per kilogram, while crabs range from 50 thousand to 60 thousand rupiah per kilogram. Based on the results of field investigations in Lamongan and Gresik, it was found that being able to get lobsters was more influenced by the luck factor, namely because the lobsters were stuck in nets or trapped in crab traps. Below are pictures of several fishing gears used by Lamongan and Gresik fishermen that are not special fishing gear for lobsters. The condition of the lobster catching equipment on the market is that the majority only have one inlet and the capacity of the fishing gear is small. While lobster fishing gear that has been developed to overcome existing problem still has weaknesses [2]. These weaknesses were obtained from the results of discussions with researchers and fishermen, namely: there was no means of detecting the presence of lobsters, there were no lifting devices/pulleys from lobster fishing gear, they could not be stored and carried easily, there were only 6 holes in the fishing gear and the dimensions of the gear were not suitable including the dimensions for the inlet and outlet.

With the existing weaknesses, an innovative tool was made to improve the existing equipment, namely by providing a detection tool for the presence of lobsters, a lifting device in the form of a pulley to lift the lobster fishing gear when there are already lobsters in it. In addition, there are also holes on each side and easy to fold and carry. These innovations also have the contradictions needed in their manufacture, namely: tools made of strong materials but light, simple tools but can catch various types of lobsters, lifting tools that are light but strong, tools that are strong but can be folded, and tools which is simple but has many functions. Based on the existing contradictions, the Theoriya Resheniya Izobretatelskikh Zadatch (TRIZ) approach is used to solve the contradiction problem [3]. The real condition that exists now is that many innovative products are only in the prototyping stage so that innovators feel that the resulting products are less applicable and need to be commercialized. Products that can be commercialized can of course increase the income of the owner so that the product is not only limited to research. Then a Business Model Canvas (BMC) approach is needed to be able to analyze the business concept of the product, so that the product can be commercialized. This BMC can later be used as a guideline in the product marketing process so that innovative products can continue to be developed and be able to compete with products sold in the market.

The research that will be carried out is carried out using the TRIZ method which is used to bridge trade offs in the field so that a feasible solution is obtained for the existing problems. In addition, an analysis related to BMC was also carried out for the product commercialization process. Thus, the effectiveness and efficiency of lobster catching will increase. It is hoped that in this research a lobster fishing gear with a new design and innovation will be obtained by obtaining solutions to the contradictions that occur and solutions related to business models.

2 Methods

2.1 Early Identification Stage

At the initial identification stage, a field study was carried out. This field study was conducted by making direct observations on the object of research, namely in the areas of Mud and Ujungpangkah, Gresik and Paciran, Lamongan, East Java. This field study was conducted by conducting interviews and Focus Group Discussions with 9 fishermen from Gresik and Lamongan. These fishermen were chosen because they are experienced in the process of catching lobster. In addition, direct observations were also made on the process of catching lobster/crab and the stages of lobster management.

2.2 Data Collection and Processing Stage

2.2.1 Determination of Research Variables

The research variables were obtained before the lobster fishing gear design process, carried out as a comparison of current conditions and after the lobster fishing gear innovation. Determination of the variables of this study was carried out using a questionnaire as a guide to collect data related to the quantity of the catch, the shape of the fishing gear. In addition, it is also determined the number of stakeholders and what stakeholders are involved.

2.2.2 Theory Resheniya Izobretatelskikh Zadatch (TRIZ)

The completion of this TRIZ begins with determining the contradiction of the technical response where this technical response is the result of translating attributes, and these attributes are obtained from the results of the VOC (Voice of Customer) [4]. Furthermore, this contradiction is made into a specific problem and then converted into a general problem. This general problem was obtained from the 39-parameter table and searched for general solutions from the general problem obtained from The 40 Inventive Principles table and finally the last stage in TRIZ is to find the best solution (specific solution) from the alternative solutions given. Fig 4 presents the TRIZ framework employed in this study.

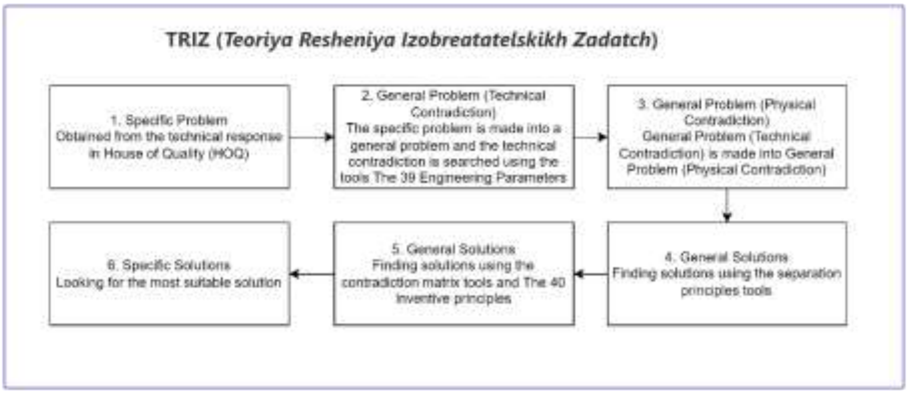


Fig 4. TRIZ framework

2.2.3 Identify Business Model Canvas (BMC)

Identify related business concepts of i-LOCA products that analyze related 9 keys in BMC. This determination is based on the theory of the Business Model Canvas from Alexander Osterwalder and Yves Pigneur, which starts with determining customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partners and cost structure. Thus, the right business solution will be obtained so that the product can be marketed.

2.2.4 Prototyping

In this stage, a product design was carried out based on the alternative concepts that have been selected, based on the references of the previous chapter. The basis for choosing this concept is a design that can improve the work function of the previous system and in the end if the product has been designed the lobster catching system will run more efficiently and more effectively in its implementation [5]. Making this prototype based on the needs of consumers (fishermen). Then we designed the product with software, evaluate and physically design the product.

2.2.5 Product Testing

The purpose of this stage is to obtain the results of lobster fishing gear innovations that can increase lobster fishing capacity so that lobster fishing gear can be utilized optimally. This product test was conducted in Ujungpangkah, Gresik. Testing of this product was carried out 6 times to determine whether the catch from i-LOCA is more effective and optimal or not.

3 Results and Discussions

3.1 Identification of Fishermen's Condition

In carrying out efforts to catch marine products, the tools used by Gresik and Lamongan fishermen have their own specifications to catch marine commodities as needed. Currently, there are seven main tools used to catch commodities, namely shrimp nets, squid nets, fishing nets, fine nets, crab traps, fishing rods and rebon nets. The use of existing fishing gear is adjusted to the season for catching commodities which are in large numbers. In carrying out the fishing process, Lamongan fishermen depart at around three o'clock in the morning using traditional boats they have and bring fishing gear that is considered necessary. Meanwhile, Gresik fishermen usually leave in the afternoon and return at night. The income earned is divided by the number of people who go to sea. In relation to the process of catching lobsters, the fishing gear that is often successful in catching lobsters itself is mostly fishing nets and crab traps. Both tools are tools that are often operated considering the presence of fish and crabs are classified as commodities that often appear. Currently, the main obstacle faced is the uncertain season, so fishing is somewhat hampered.

3.2 TRIZ Results

Based on the results of interviews with fishermen, the voice of the customer is obtained which is then translated into attributes, then these attributes are translated again into technical responses [6].

This technical response is the answer to the attributes where in the translation process this technical response is carried out through Focus Group Discussions with fishermen. Below are the attributes and technical response of i-LOCA. Table 3 presents the attribute and technique response of i-LOCA.

Table 1. Attribute dan Technique Response of i-LOCA.

Attribute	Technical Response
Catch capacity	Product dimensions are large
	Pull strength
	Catch mechanism
Use safety	Mechanism of use
Environmental friendliness	Catch mechanism
	Tool material
Ease of carry	Tool weight
Size	Product dimensions are large
	Mechanism of use
Selectivity	Catch mechanism
Durable	Tool material
Ease of making	Design complexity
	Material price
Ease of repair	Design complexity
Live catch conditions	Catch mechanism

After identifying the needs of consumers (voice of customer), then at this stage the design of lobster fishing gear with the TRIZ method is carried out, which concentrates on solving the problem of contradictions that occur. The i-LOCA is expected to be able to improve the lobster catching process and increase the lobster catching capacity. The contradiction that will be solved using TRIZ is a contradiction that is obtained based on consumer demand or needs. This can be seen from interviews with several fishermen. Based on the results of interviews with in-depth interviews with several fishermen, namely fishermen from the Weru area, Paciran District, Lamongan and Lumpur, Gresik. Interviews were conducted with several fishermen, namely Mr. Salih, Muhaimin, Samsul Ma'arif, Ikhwan, Mukhid, Nawar, Ridho, Sodikon, and Darlim. Meanwhile, the fisherman who is active in providing answers is named Mr. Sholih who has now changed his profession to being a collector and Mr. Samsul Maarif as a fisherman. These fishermen were chosen because they understand the manufacture of fishing gear, understand the conditions of the sea and marine resources. In addition, this fisherman has also worked as a lobster catcher for many years (at least 2 years). Based on the results of the interview, it was found that the needs of fishermen (voice of customers) about lobster fishing gear, namely tools made of strong but light materials, simple tools but can catch various types of lobsters, lifting equipment that is light but strong, strong but foldable tools, and a simple tool but has many functions. The consumer demand will be used as a specific problem which is then used as a general problem. The flow of TRIZ implementation starts from identifying the existing contradictory problems. Furthermore, these problems are divided into two, namely useful features and harmful features. This definition is followed by the use of a table of 39 technical parameters (The 39 Engineering Parameters) which is then found a solution from the table of 40 innovative principles (The 40 Inventive Principle).

3.2.1 Specific Problem – General Problem

The specific problem created in this TRIZ is a technical response that has a negative relationship with other technical responses. The technical response that has a negative relationship is obtained from the results of interviews with several fishermen (based on consumer desires), then converted into general problems using table 39 technical parameters. The first step is the determination of contradictory technical responses, where at this stage an explanation of the contradictions between technical responses is explained and classified into the categories of useful features and harmful features. A useful feature is a technical thing that you want to fix but causes other problems, while a harmful feature is a technique that will get worse when the problem is solved. Where contradictory technical responses are made into specific problems which will then be converted into general problems.

Product Design versus Materials Used

The technical response that contradicts is the product design and the materials used. Below are the results of the general problem from the specific problem (see Table 4):

Table 2. Product Design versus Materials Used.

	Useful Feature	Harmful Feature
Specific Problem	Product Design	Material is used
Description	Catch capacity is optimal	Light material
General Problem	Volume of nonmoving object (8)	Weight of non-moving object (2)
Description	Catch capacity is low	Heavy equipment

The product design referred to here is the design of the existing lobster fishing gear that is small and complicated or difficult to understand while the material used is made of material that is not sturdy so that when used in the fishing process it is not optimal. So we need a tool that has a simple design with lightweight but strong materials. The technical response of the product design contradicts the technical response of the material used. The expected improvement is optimal fishing gear capacity but using lightweight materials for easy lifting. Thus, the technical response of the product design is generalized into a volume of non-moving object. The product design here describes the shape of the existing lobster fishing gear which has a small (slight) fishing capacity. Meanwhile, the technical response of the material used is generalized into a weight of non-moving object. The material used here is a strong but light material.

Traction versus Tool Weight

The contradictory technical response is the traction and weight of the tool. Below are the results of the general problem from the specific problem (see Table 5):

Table 3. Traction versus Tool Weight.

	Useful Feature	Harmful Feature
Specific Problem	Pull strength	Tool weight
Description	Powerful lifting device	Light material
General Problem	Strength (14)	Weight of nonmoving object (2)
Description	No lifting equipment	Heavy equipment

The pull strength that is meant here is the ability to pull fishing gear that is difficult and heavy so that it is possible to fall into the sea or be dangerous where i-LOCA has a large enough weight when the catch is large so that a strong lifting equipment is needed that is able to lift the fishing gear. the big one. The technical response of traction contradicts the technical response of the weight of the tool. The expected improvement is a strong but light lifting device. Thus the product lifter will be strong but still light when you have to lift heavy loads. Thus, the technical response of traction is generalized to strength. The traction here explains how strong the lifting equipment is when lifting the lobster catch. Meanwhile, the weight of the tool is generalized to be the weight of non-moving object. This relates to the material used for fishing gear so that the fishing gear is able to catch the maximum lobster capacity.

Product Design versus Mechanism of Use

The contradictory technical response is product design and use mechanism. Below are the results of the general problem from the specific problem (see Table 6):

Table 4. Product Design versus Mechanism of Use.

	Useful Feature	Harmful Feature
Specific Problem Description	Product Design Simple and easy to under-stand	Mechanism of use Easy to use and store
General Problem Description	Shape (12) Intricate design	Convenience of use (33) Cannot be folded (stored)

The product design referred to here is a design that is initially complicated so that it is difficult to use especially in storage, which also has a difficult mechanism of use where it is hoped that this lobster fishing gear will have an easy mechanism both in use and storage so that the catch becomes optimal because fast process. The technical response of product design contradicts the technical response of the use mechanism. The desired improvement is that the product is easy to use included in its storage with a simple design. Thus the product will be easier and safer when stored. This results in easy use of the product when it comes to tool catch and storage. Then, the technical response of product design is generalized into shape. Product design here describes a simple product form. Meanwhile, the technical response of the use mechanism is generalized into convenience of use. This relates to the ease of the tool to use and store.

Catch Mechanism versus Design Complexity

The contradictory technical response is the catch mechanism and the complexity of the design. Below are the results of the general problem from the specific problem (see Table 7):

Table 5. Product Design versus Mechanism of Use.

	Useful Feature	Harmful Feature
Specific Problem Description	Catch Mechanism Easy catch process	Design Complexity Simple design
General Problem Description	Level of automation (38) No lobster detection device	Complexity of device (36) Complicated fishing gear

The fishing mechanism referred to here is a long fishing process because it has a complicated design so that it does not attract lobsters to enter the fishing gear. Existing fishing gear is difficult to repair and manufacture. It is expected to form fishing gear that has an effective process so that the catch is optimal, environmentally friendly and the catch is in the form of lobster with a tool design that is easy to repair and manufacture. The technical response of the catch mechanism contradicts the technical response of the complexity of the design. The desired improvement is that the product has an easy fishing mechanism with a simple design so that fishermen can easily carry out the fishing process.

Then, the technical response of the catch mechanism is generalized to a level of automation. The fishing mechanism here describes a product that is equipped with a lobster detection device so that the fishing process becomes easier. Meanwhile, the technical response of design complexity is generalized to complexity of device. This is related to the design of lobster fishing gear.

3.2.2 General Problem – General Solution

After knowing what contradictions occur and generalizing, the next step is to find solutions to existing contradictions and generalize the solutions obtained, according to the TRIZ principle, which is to generate new and creative ideas. Based on the generalization of the existing problems, several solutions were found to the existing contradiction problems. From the available alternative solutions, one of the most feasible solutions is then selected, to be used as a specific solution. In order to obtain the alternatives above, a tool is used in the form of the TRIZ site, which contains a data input section and results, called the interactive matrix. What is used as input is a generalization of the technical response in the previous section. After that, finding the alternative solutions from technique response in each contradictions.

3.2.3 General Solution - Specific Solution

The solution principles that have been offered above, which were obtained from The 40 Inventive Problem Solving, are specified as the most appropriate solution to be applied to the design of i-LOCA (Lobster Catcher).

Product design versus materials used

In the explanation of the previous sub-chapter, the solution idea was obtained, namely principle 35, parameter changes at point C which reads "Change the degree of flexibility". The above principles provide ideas for making lobster fishing gear that is flexible and easy to use. Principle 35 was chosen because it is based on consumer needs, namely ease of use, easy to fold, carry and repair so that a solution is formulated based on this principle 35. While principle 10 was not chosen because it was not possible with the existing technical conditions (not in accordance with the voice of consumers). Principle 19 was not chosen because it takes a long time in the process so it is not relevant during the tool manufacturing process. While principle 14 was not chosen because the shape of the ball did not match the conditions of the ocean waves, thus allowing the tool to be overturned.

Traction versus tool weight

In the explanation of the previous sub-chapter, the solution idea was obtained, namely principle 1, segmentation, at point B which reads "Make an object easy to disassemble". The above principles provide an idea for making lobster fishing gear that is easy to assemble and disassemble so that it is easy to use and store. Principle 1 was chosen because it is based on consumer needs, namely ease of use, easy to fold and store. This is also related to the solution of the contradiction in product design versus the material used in the form of the level of flexibility. While principle 40 was not chosen because it would cost production. Principle 26 was not chosen because it is not technically relevant if using infrared so that the tool does not function in real terms. Principle 27 was also not chosen because it is technically impossible to do because the price of the material is the same so it is difficult to replace it with a cheaper one.

Product design versus use mechanism

In the explanation of the previous sub-chapter, the solution idea was obtained, namely principle 15, dynamics, at point A which reads "Allow (or design) the characteristics of an object, external environment, or process to change to be optimal or to find an optimal operating condition. " The above principles provide an idea to make lobster fishing gear with an optimal design by providing i-LOCA lifting equipment so that the product can be moved and lifted easily. Principle 15 was chosen based on consumer needs, namely the existence of supporting tools to increase the level of safety of fishermen during the fishing process so that a comfortable, safe, healthy and efficient lifting tool is needed. Meanwhile, principle 32 was not chosen because it is technically impossible to change the object's color. Principle 26 was also not chosen because it is not technically relevant if using infrared so that the tool does not function in real terms.

Catch mechanism versus design complexity

In the explanation of the previous sub-chapter, the solution idea was obtained, namely principle 10, preliminary action, at point B which reads "Pre-arrange objects such that they can come into action from the most convenient place and without losing time for their delivery". The above principles provide ideas for making lobster fishing gear with different shapes with a simple process and lobster detection so that the fishing process becomes effective. Principle 10 was chosen because it answers the needs of consumers in terms of an easy and fast catching process by providing a lobster detection device or a lobster puller. Principle 15 was not chosen because it did not respond to consumer needs for an easy fishing mechanism. In addition, principle 24 was also not chosen because it is technically impossible to combine tool parts because of the flexible tool concept.

In providing solutions that are generated based on the existing contradiction problems, one of the most feasible solutions is chosen which will be applied to the design of the i-LOCA product. The proposed solutions were discussed between researchers, fishermen and i-LOCA producers. The first contradiction is the contradiction between the product design and the materials used. The solutions offered are principles 35, 10, 19 and 14. From these principles the principle of parameter changes (35) is chosen at point C which reads "change the degree of flexibility". The purpose of this principle is to change the level of flexibility of the tool. These principles provide ideas for making lobster fishing gear that is flexible and easy to use. This principle was chosen because it is based on consumer demand where fishermen have been struggling with tools that take up a lot of space on the boat so that fishermen want tools that are easy to fold, carry and store. This can be solved by the solution in principle 35 by changing the level of flexibility in which the tool is made easy to fold, carry and store.

Furthermore, for the second contradiction, namely the contradiction between the attraction and the weight of the tool. The solutions offered are 40, 26, 27 and 1. Based on the solutions offered, the chosen solution is principle 1, segmentation, at point B which reads "Make an object easy to disassemble". The purpose of this principle is to divide the object into several parts or make the object easy to disassemble. This principle gives the idea to make lobster fishing gear that is easy to disassemble so that it is easy to use and store. This principle was chosen compared to others because it is the solution that best suits the conditions of the existing lobster fishing gear. In addition, this solution also supports the first contradiction where a tool that is flexible and easy to disassemble is required. With the ease of disassembling the tools, it is easy for fishermen to use i-LOCA.

3.3 Product Design

After obtaining alternative solutions that have been carried out in TRIZ methodology, making alternative product design which includes physical design and choose the best design

Physical Product Design

During the design of this product, there are several alternative designs obtained from the general solution from TRIZ, namely as follows:

Design 1: obtained from principle 10, namely changing the shape of the tool from the existing bubu so that it has a different number of inlet holes or a barrier is made for each square area. Design 1 emerged from the modification of existing tools by increasing the fishing capacity of the gear.

Design 2 : obtained from principle 14, namely using a spherical or curved shape in the design of the tool that is made so that it is cylindrical. In addition, these 2 designs arise from modifications to existing tools.

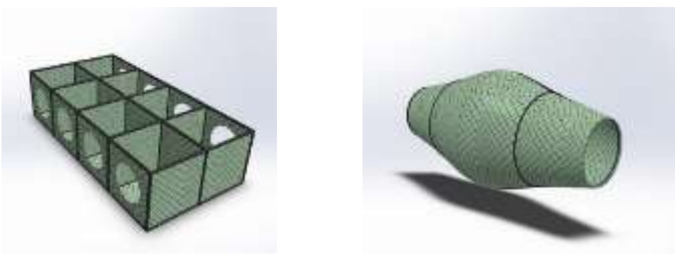
Desain 3 :

obtained from the solution on principle 19 which is to perform different actions or different processes in the manufacture periodically so that it takes the form of a baby hood. Design 3 emerged from the modification of the existing tool design.

Design 4 :

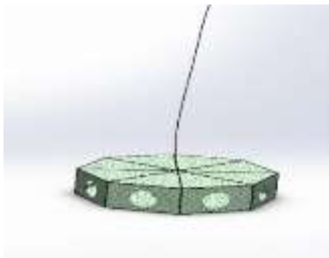
obtained from the solution on principle 35, namely by changing the level of flexibility of the tool so that it is made an octagon with optimal catch and easy to fold. In addition, these 4 designs emerged based on consumer needs.

Fig. 5 illustrates the alternative designs of fishing gear.



(a) (b)

(c)



(d)

Fig. 5. Alternative designs of fishing gear. (a) Fishing Gear Design-1, (b) Fishing Gear Design-2, (c) Fishing Gear Design-3, (d) Fishing Gear Design-4.

Of the 4 alternative designs available, the fishing gear design 4 was chosen as the i-LOCA (Innovative Lobster Catcher) design because it is in accordance with consumer demand and in accordance with TRIZ solutions. After processing the data using the TRIZ method, the next step is to design the product according to the selected solutions. In this physical product design explanation, the product is explained with the help of 3D's Max software and SolidWorks software. The shape of this octagonal product is a modification of an existing tool. i-LOCA is an improvement from the tool by Muhammad Ali Akbar Felayati which still has some shortcomings. This form is also the result of a Focus Group Discussion with several fishermen from the Mud area, Gresik. Among them are Mr. Samsul Ma'arif and Mr. Ikhwan who stated that the octagonal design is the right design because so far there is no fishing gear specifically for lobster. So far, lobster catches are still not optimal. Lobster caught is only limited to being trapped by accident. This octagonal shape is considered appropriate because it has an optimal fishing capacity, a good level of strength so that it is stable during the fishing process at sea, has a practical design because it is easy to carry, fold and store. The i-LOCA design is also safe and easy to use and uses environmentally friendly, lightweight and strong materials. The design of i-LOCA is different from existing tools. The criteria that distinguish i-LOCA from existing tools are adjusted to the attributes of the voice of customers and fishermen. Below is a comparison table for lobster fishing gear (see Table 8):

Table 6. Lobster Catcher Comparison.

Kriteria	Existing Tool (Bubu)	Tool from Felayati (2011)	i-LOCA
Shape	Rectangle	Hexagon	Octagonal
Entrance	1-2	6	8
Lobster Detection	No	No	Yes
Lifting Equipment	No	No	Yes
Easy to fold	Yes	No	Yes
Catch capacity	1-3 lobster	3-6 lobster	6-10 lobster
Safety of Use	No	No	Yes
Environmentally Friendly	Yes	Yes	Yes
Easy to bring	Yes	No	Yes
Size	40x30x20 (cm3)	60x60x30 (cm3)	70x60x42 (cm3)
Selectivity	Yes	Yes	Yes
Durable	No	Yes	Yes
Easy to make	Yes	Yes	Yes
Easy to repair	Yes	No	Yes
Live catch conditions	Good	Good	Good

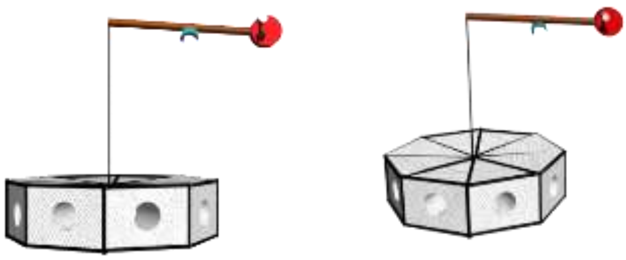
Furthermore, product specifications are determined based on consumer needs obtained through interviews, which consist of parts for fishing gear, lifting equipment, support and detection equipment or lobster pullers. Below are the specifications of the i-LOCA tool (see Table 9).

Table 7. Lobster Catcher Comparison.

Part	Size/Spesification	Material
Catch Tool	70 x 60 x 42 (cm3)	Iron & Net
Lifting Tool	200 (cm)	Iron
Cantilever	100 (cm)	Iron
Lobster Detection		
LED	48,8 %	Plastic
Buzzer	150 Hz	Plastic
Driver	4x4 (cm2)	PCB
Board Control Arduino Nano	Nano	

Design of i-LOCA (Innovative Lobster Catcher)

Based on the solution of the TRIZ principle, the i-LOCA (Innovative Lobster Catcher) design suggests that the fishing gear has an optimal fishing capacity, can be folded and stored (flexible), a strong but lightweight lifting device, and a lobster detection device. It has also been adapted to the needs of consumers (fishermen) so that i-LOCA is easy to use. This lobster detection tool or lobster puller uses a microcontroller in which there is a driver where this driver controls the intensity of the red LED light and the frequency on the buzzer. The type of controller used in this tool is the Arduino nano control board package. How to activate this LED and buzzer by setting the variable resistor. In addition, the i-LOCA design is also obtained based on consumer needs.



(a) (b)

Fig. 6. i-LOCA design: (a) side view, (b) top view

i-LOCA lifting equipment

Based on the existing TRIZ solution, it is recommended to make a strong but lightweight lifting device so that fishermen can easily lift the i-LOCA and do not fall into the sea because this lifting equipment prioritizes the element of safety.

Fig. 7. i-LOCA lifting equipment

i-LOCA Material

The material used in the design of this i-LOCA is iron where the original material is stainless steel. This iron was chosen in the manufacture because of its low price. While the original material is stainless steel because the material is strong, lightweight and corrosion resistant according to consumer demand.

Prototyping of i-LOCA

After designing the physical design of i-LOCA, the next step is to make an i-LOCA prototype. In the 3-dimensional illustration of i-LOCA, it was carried out with the help of 3D's Max software and SolidWorks software and the physical design was carried out in a tool workshop. Making a real prototype is intended so that the tool can be tested directly so that the shortcomings of the tool can be identified. The following is an image of the i-LOCA prototype:

Fig. 8. i-LOCA prototype.

3.4 Prototype Testing

The prototype that has been made is then tested to prove whether the planned concept is as expected or not. In testing the i-LOCA prototype, it is carried out in the following stages:

- The prototype is tested at sea by fishermen.
- The trial was carried out 3 times a day, namely morning, afternoon/evening and night.
- The trial is carried out by comparing the new tools and existing tools (bubu).
- The catches of the two tools are compared, which tool is more optimal.
- In the trial process, overall the tool was successful in catching lobsters, but there were several weaknesses. These weaknesses include weaknesses in timing and test points that are less likely to be tested continuously. The trials carried out with the tools made produced several catches which are described in Table:

Table 8. Tool catch.

Test-	Lobster Catch	
	Existing (Bubu)	*i-LOCA*
1 (1 day)	1	2
2 (3 hours)	0	0
3 (3 hours)	0	0
4 (3 hours)	1	2
5 (1 day)	0	0
6 (1 day)	0	0

In the trials carried out, several lobster shrimp were obtained but could not show optimal results. From a physical design concept, the existing tools have fulfilled several main aspects in the principle of passive fishing gear, namely the ease of entry and difficulty of exiting for lobsters. Both of these aspects have been well supported in the tools that are made to allow the existing lobsters to be trapped in large numbers. In the process of testing the tool, intense communication with fishermen is the key to whether this tool can be used or not. Fig. 9 shows the prototype testing process.


(a)


(b)


(c)


(d)

Fig. 9. Prototype testing: (a) Tool Trial in Ujungpangkah, (b) The i-LOCA device was put into the sea, (c) i-LOCA lifting Process, (d) i-LOCA testing.

We are also considering about Tool Usability:

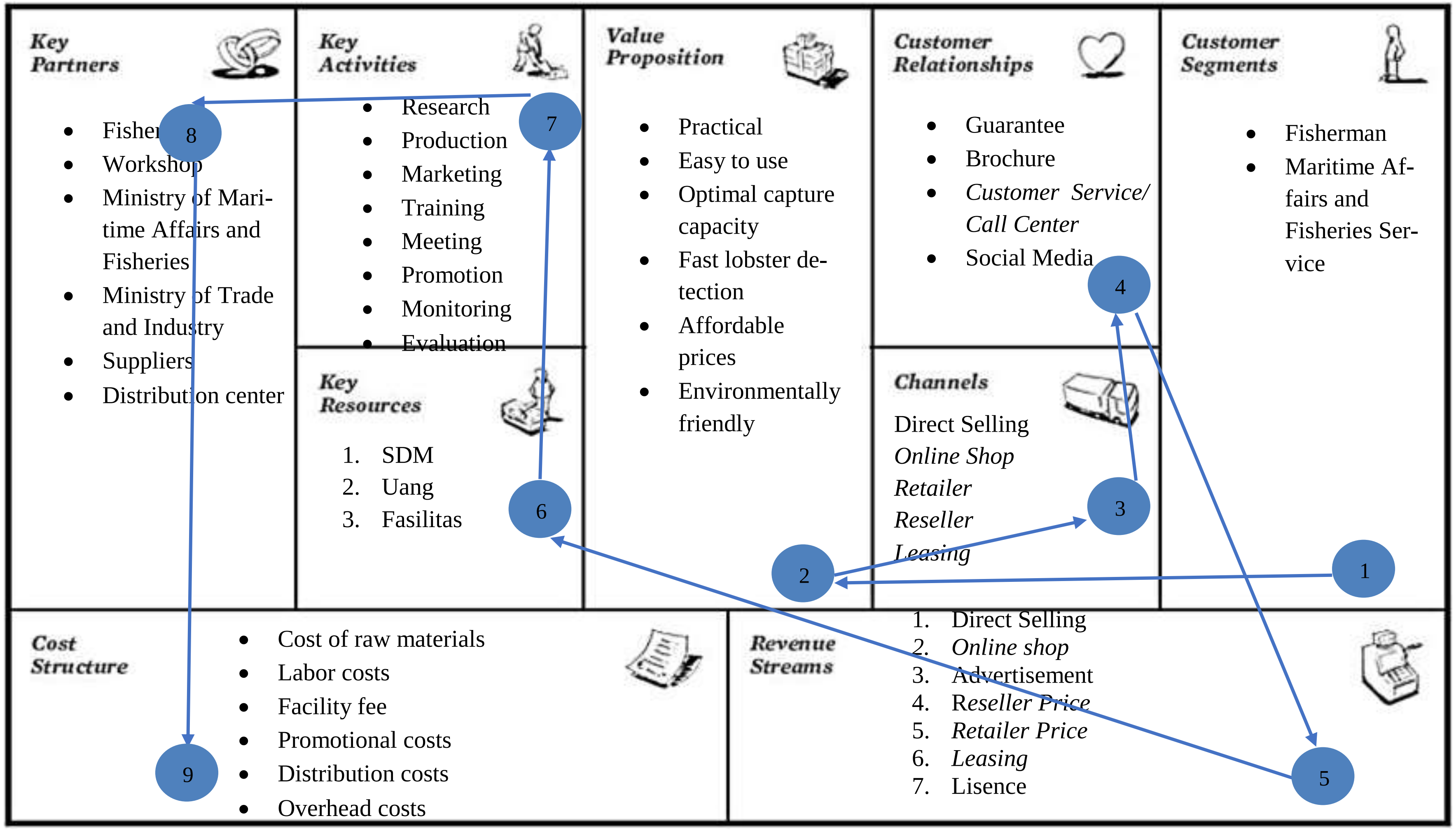
a. Learnability, is the ability of users to understand what they see first, to make it easier for users, the right packaging system is used, starting from assembling or preparing tools to using tools for the lobster catching process to storing fishing gear by providing user manuals.
b. Efficiency, is how quickly users solve problems. In i-LOCA there is a lobster presence detection device in the form of a buzzer and LED to speed up the lobster catching process and there is a lifting device to lift the lobster fishing gear when there is a catch.
c. Memorability, is the ability of users to remember and reuse what has been used before. i-LOCA covers this from the ease of use of the tool by providing pictures and descriptions of the use of the tool.
d. Errors, is how many errors are made in using a tool. i-LOCA covers this with the presence of a lobster detector or puller and automatic rollers to lift the iLOCA.
e. Satisfaction, is how comfortable the user is using the i-LOCA lobster fishing gear. Satisfaction in using i-LOCA is satisfaction in the fast lobster catching process so that the catch is optimal and has a comfortable tool design

3.5 Business Model Canvas (BMC)

In making the Business Model Canvas for this i-LOCA product, it starts with determining the customer segments because the first thing to determine is the selection of the target market. profit. Then determine the value proposition, namely the advantages of i-LOCA products compared to others because when marketing a product, you must be able to show product superiority [5]. The thing that was chosen by the customer segments was not the value proposition or the overall order of the BMC work because it was based on the Business Model Canvas concept from Alexander Osterwalder and Yves Pigneur [6]. In running the i-LOCA business, what is determined first is the target market and then determines the superiority of the product to be marketed. Where the advantages of this i-LOCA product are practical, easy to use, affordable price, optimal catching capacity, fast and environmentally friendly lobster detection. This product is practical because it is easy to carry, fold and store. The price of this product is affordable because it is equipped with an automatic lobster detection device. The i-LOCA lobster detection tool is made simple so it is different from the tools sold in the market where the lobster detection tools on the market are quite expensive.

The customer segments of i-LOCA are fishermen and the Department of Maritime Affairs and Fisheries. The Maritime Affairs and Fisheries Service was chosen because this service also accommodates fishermen and supports the DKP program for the welfare of fishermen. In addition, DKP was also chosen as a key partner because the fishing community is still not aware of technology, so the government must explain it so that fishermen are serious and willing to use the product. Then determine the channel or channels to find the right channel in marketing the product. The i-LOCA sales channel is in the form of direct sales or direct approaches with fishermen, either through exhibitions or tool demonstrations so that fishermen are interested in buying. An online shop is also carried out in the form of collaboration with the Ministry of Trade and Industry so that i-LOCA products are included in the e-catalogue which will later be purchased by government agencies or companies. In addition, sales are also carried out through retailers or resellers so that i-LOCA can be sold in all areas of East Java. Furthermore, customer relationships are determined to determine the right relationship with customers so that products can be easily marketed and prevent complaints from customers. This relationship with customers can be forged through guarantees, brochures, social media and call centers or customer service. Next is determining revenue streams, key resources and key activities, key partners, cost structure. This is because in running a business you have to know where the source of income comes from, the key supporting resources, the key supporting activities and the cost structure consisting of any costs so that the business can run smoothly. Sources of income are obtained from direct sales: income is obtained from the sales of i-LOCA which are sold directly to consumers. In addition, it also uses advertisements managed by the Maritime Affairs and Fisheries Service. Revenue is also generated from prices for resellers and retailers. Revenue is also obtained from selling i-LOCA products online, namely through the results of an e-catalogue in collaboration with the Ministry of Trade and Industry. In addition, income is also obtained from the results of copyrights from i-LOCA which are marketed (licences) and i-LOCA leasing proceeds to consumers because not all fishermen can afford to buy i-LOCA equipment in cash.

While in running this business using resources in the form of human resources, facilities and money. While the key activities in running this business start from research, production, marketing, training, meetings, promotions, monitoring and evaluation. In running this business, partnerships are carried out with the Ministry of Maritime Affairs and Fisheries, the Ministry of Trade and Industry, fishermen, raw material suppliers, distribution centers and craftsmen (workshops) for making lobster fishing gear. The cost structure of the i-LOCA business is raw material costs, labor costs, facility costs, promotion costs, distribution costs and overhead costs.



Gambar 4. 1 *Business Model Canvas*

4 Conclusions

The design of lobster fishing gear produced with the TRIZ approach has been able to meet productive criteria in the form of the ability to catch equipment in quantities that exceed the previous fishing **gear**, user friendly in its use with minimal application of mechanical systems, environmentally friendly with a passive fishing system (trap) and able to be commercialized which can increase the income of fishermen.

Furthermore, the design of the resulting lobster fishing gear has been able to resolve the existing contradictions, namely product design versus the material used, pull strength versus tool weight, product design versus use mechanism and catching mechanism versus design complexity so that lobster fishing gear is made according to the existing criteria. namely tools made of strong but light materials, simple tools but can catch various types/sizes of lobster, lifting tools that are light but strong, strong but foldable tools, and simple tools but have many functions.

The contradictory solutions obtained from the TRIZ approach are: making lobster fishing gear in the shape of an octagon that forms a circle, making lobster fishing gear that is easy to disassemble so that it is easy to use and store, making lobster fishing gear with an optimal design by providing lifting equipment on i-LOCA so that the product can be moved and lifted easily and makes lobster fishing gear with different shapes with a simple process and the presence of lobster detection so that the fishing process becomes effective.

Some suggestions that can be given for further research related to the design of lobster fishing gear are as follows. The overall design of lobster fishing gear is adjusted to the needs of consumers, in this case fishermen. Testing of the tool should be carried out during the existing lobster catching season, which is carried out in the months of the lobster catching season. Trial activities are carried out optimally with the same conditions and treatment by comparing fishing gear that have the same function. Prototype work should actually use actual materials so that the tool functions optimally. Assembling electronic components should pay attention to the design and shape of the packaging so that it is safe when used at sea.

References

[1] K. R. Tanaka, J. Cao, B. V. Shank, S. B. Truesdell, M. D. Mazur, L. Xu and Y. Chen, "A model-based approach to incorporate environmental variability into assessment of a commercial fishery: a case study with the

American lobster fishery in the Gulf of Maine and Georges Bank," *ICES Journal of Marine Science,* vol. 76, p. 884–896, 2019.

[2] S. G. Partiwi, M. A. A. Felayati and A. Sudiarno, "Design of lobster fishing equipment and its contribution to fishery industrial cluster performance: Case study: East Java, Indonesia," in *2012 Southeast Asian Network of Ergonomics Societies Conference (SEANES)*, 2012.

[3] C. Uzoka and R. Mishra, "Integration of TRIZ and CFD to New Product Development process," *International Journal of Computational Fluid Dynamics,* vol. 34, p. 418–437, 2020.

[4] S. Mi Dahlgaard-Park, "Inventive thinking through TRIZ: a practical guide," *The TQM Magazine,* vol. 18, p. 312–314, 2006.

[5] S. Curcic and S. Milunovic, "Product development using quality function deployment (QFD)," *International Journal for Quality Research,* vol. 1, p. 243–247, 2007.

[6] S. E. a. M. C. Y. Karl Ulrich, Product Design and Development, 7th Edition, Mc Graw Hill, 2020.

[7] Y. Jin, S. Ji, L. Liu and W. Wang, "Business model innovation canvas: a visual business model innovation model," *European Journal of Innovation Management,* vol. 25, p. 1469–1493, 2022.

[8] A. Osterwalder and Y. Pigneur, Business model generation: a handbook for visionaries, game changers, and challengers, vol. 1, John Wiley & Sons, 2010.