*ENGG 1100 CONCEPT REPORT*

*UNMANNED FIRE FIGHTING VEHICLE*

*STRUCTURAL SUBSYSTEM*

*Figure SEQ Figure \\* ARABIC 1 CITATION sv106 \l 1033 (sv1ambo, 2006)*

# Semester 1 2021

# Due Date: Monday 22nd March 2021

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# Executive Summary

Unmanned fire fighting vehicles have the potential to lower the risk of loss of life among aviation fire fighters. For this reason, the Australian Aviation Rescue Fire Fighting Service are interested in design ideas for unmanned firefighting vehicles. The main objective of the structural subsystem of the vehicle prototype is to effectively house the drive and fluid delivery subsystems. More specifically, the structural subsystem must waterproof the electrics of the control system, have an efficient layout of components and have an elevated nozzle platform to allow water to be sprayed further. The design criteria used for decision making were safety, durability, cost, lightweight, efficiency, waterproof, sustainability. Waterproofing and safety were the most important criteria.

Two solutions were evaluated for the waterproofing of the control system. A plastic sealable container, which can hold all components, was chosen over waterproofing each component individually with hot glue. Three solutions were evaluated for the layout of the main body of the vehicle. The chosen design had the nozzle platform and water tank situated above a compartment containing the control system. This solution most effectively waterproofed the control system and allowed the most efficient transfer of water from tank to nozzle. Two solutions were evaluated for the design of a nozzle platform. A design with two motors was chosen as this allowed for the greatest adjustment of spraying direction in both the horizontal plane and the angle of elevation.

Possible improvements to the chosen solution of the structural subsystem include the further stabilisation of the nozzle platform and making the control system more accessible for maintenance.

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# Introduction

## 1.1 Context

The Australian Aviation Rescue Fire Fighting Service (ARFF) are interested in the design of unmanned fire fighting vehicles, as they have great potential for safety and efficiency. The ARFF are responsible for the immediate response to aircraft fires and crashes at 27 of Australia’s largest airports (Aminossadati, Semester 1 2021). The ARFF wish to consider alternative firefighting options which reduce the potential for loss of life by removing officers from the immediate vicinity of the fire. For the unmanned fire fighting vehicle to be successfully considered it would need to be fully functional without an operator, or the immediate presence of one. The full-scale vehicle would also need to be compatible with the existing runway infrastructure and be able to reach fire emergencies, at either end of the runway, within three minutes.

## 1.2 Project Scope

This concept report will detail the specifics of the design process of an unmanned fire fighting vehicle small-scale prototype.

Table 1 lists the objectives, constraints and assumptions that have been taken into consideration throughout the project (Aminossadati, Semester 1 2021).

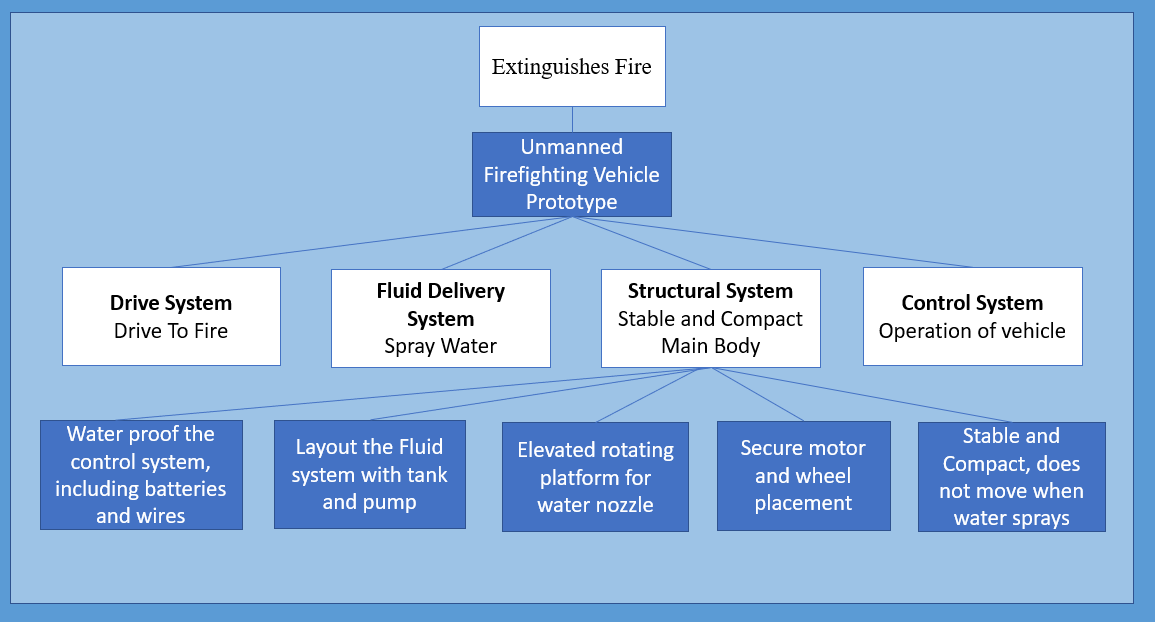
*Table 1 Objectives, Constraints and Assumptions*

|  |  |  |
| --- | --- | --- |
| OBJECTIVES | CONSTRAINTS | ASSUMPTIONS |
| Move forwards and backwards at a controllable speed and in a straight line. | Maximum dimensions:  Length: 300mm  Width: 200mm  Height: 300 mm | Design and process concepts of the prototype can be scaled up. |
| Efficiently put out the fire. | Hold 1L of water | Test space is a controlled environment. |
| Water is successfully sprayed at fires at varying heights and distances. | Batteries <13V to be used for power supply | Fires always at the same temperature and positions in test space. |
| Require no person to operate near the fire. | Maximum weight is 2kg, ideally less than 1.5kg | Runway is flat. |
| To work effectively around fire, water, and high temperatures. | Drive, fluid delivery and structural subsystems must be contained in the main body. | Weather conditions and outside temperature are negligible as test space is inside. |
| Main body is compact and stable enough to allow successful operation of the vehicle. | Prototype should operate for a minimum of 6 minutes. |  |
|  | Control fully/semi-automatic or wired/wireless remote |  |
|  | Budget $150 |  |

## 1.3 System Overview

*Figure SEQ Figure \\* ARABIC 2 Functional Layout*

The functional layout, listing the general functions required of the prototype can be seen in Figure 2.

The prototype system can be broken down into subsystems based on the functional needs. These subsystems are the Drive System, the Fluid Delivery System, the Structural System and the Control System, see Figure 3. Figure 3 also explores the structural subsystem functions at a component level.

*Figure SEQ Figure \\* ARABIC 3 Function Means Tree*

# Design Criteria

The subsystem of focus in this report is the structural subsystem.

The design criteria for the structural subsystem has been created, in Table 2, based on the functions in Figure 3 and the objectives and constraints outlined in Table 1.

*Table 2 Structural Subsystem Design Criteria*

|  |
| --- |
| Design Criteria |
| Safety – components and overall structure must be safe |
| Durability and waterproof – materials used should be resistant to fire, water and high temperatures, also be strong enough to hold the 1L of water |
| Efficiency – use of space and energy should be efficient |
| Stability – Vehicle should be stable enough to not move when water is sprayed. |
| Lightweight – lightweight materials should be used. |
| Cost – Materials should be inexpensive |
| Main body should contain the drive, fluid delivery subsystems in a compact and organised manor |
| Vehicle must fit within the maximum dimensions (Table 1) |
| Aluminium base plate must be used |

The pairwise comparison decision matrix, in Table 3, aids with the comparison and selection of design options for the prototype.

*Table 3 Pairwise Comparison Decision Matrix*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | SYSTEM CRITERIA | | | SUBSYSTEM CRITERIA | | | | | |
| Criteria | Criteria A: Safety | Criteria B: Durability | Criteria C**: Cost** | Criteria D: Lightweight | Criteria E: Efficiency | Criteria F: Waterproof | Criteria G: Sustainability | Sum Total | Weighting |
| Criteria A: Safety | - | A | A | A | A | F | A | 5 | 0.23 |
| Criteria B: Durability | - | - | B | B | E | F | G | 2 | 0.10 |
| Criteria C: Cost | - | - | - | D | E | C | C | 2 | 0.10 |
| Criteria D: Lightweight | - | - | - | - | D | F | G | 2 | 0.10 |
| Criteria E: Efficiency | - | - | - | - | - | F | E | 3 | 0.14 |
| Criteria F: Waterproof | - | - | - | - | - | - | F | 5 | 0.23 |
| Criteria G: Sustainability | - | - | - | - | - | - | - | 2 | 0.10 |

It is evident from Table 3 that the design of the structural subsystem of the unmanned firefighting vehicle prototype will favour design options which consider safety a priority and are waterproof. Efficiency is the third most important aspect, followed by durability, lightweight, cost and sustainability.

# Design Options

In order to, continue with this report and make insightful decisions, it is necessary to assume the dimensions and style of the other subsystems. Without this assumption the amount of space required for each subsystem would be unknown and there would be too many options for an educated decision.

The design options of these three main areas of the structural subsystem will be discussed:

* Electrics water proofing
* Layout of main body
* Nozzle platform design

## 3.1 Electrics Water Proofing

The electric water proofing needs to be able to protect the control subsystem components, listed below, from water sprayed by the fluid delivery system:

* Arduino
* Batteries
* Plug sensor
* Circuit board

If these components were to contact water they may malfunction, therefore it is important they are protected. Option 1 is hot glue, see Table 4. Option 2 is a plastic container, see Table 5.

*Table 4 Electrics Waterproofing Option 1: Hot Glue Gun*

|  |  |
| --- | --- |
| Electrics Waterproofing Option 1: Hot Glue Gun | |
| Process | Hot glue applied with gun directly to circuit boards of components. When glue is dry the circuits will be waterproof. (Wylie, 2019)  *Figure SEQ Figure \\* ARABIC 4 Hot glue on circuit board* |
| Safety | Hot glue may burn skin. |
| Durability | Unlikely to peal of and expose components. |
| Cost | The cost of the amount of glue required would be a maximum of $0.50. (Bunnings Warehouse, 2021) |
| Lightweight | The glue would weigh approximately 0.02kg. (Bunnings Warehouse, 2021) |
| Efficiency | Human error may result in a not entirely waterproof component. |
| Water Proofing | Waterproofs circuit boards of components but may have difficulty waterproofing an entire component. |
| Sustainability | Hot glue is a plastic with will not easily decompose or be recycled. (Froese, 2019) |

*Table 5 Electrics Waterproofing Option 2: Plastic Container*

|  |  |
| --- | --- |
| Electrics Waterproofing Option 2: Plastic Container | |
| Process | A plastic container with waterproof lid is selected. A hole is drilled into the container for the wires. All components are placed in the container and the wires are run through the hole. The hole is filled with blu-tack. The lid is put on and the components are waterproof. (Robot Room, N/A)  *Figure SEQ Figure \\* ARABIC 5 Components in waterproof container* |
| Safety | The process of drilling may cause injury. |
| Durability | A container could be very sturdy and protect the components from forces as well as water. |
| Cost | $9 for container (Dinga, 2021), $0.50 for amount of Blu-tack needed (Woolworths, 2021). $9.50 total. |
| Lightweight | 0.1kg (Dinga, 2021) |
| Efficiency | Drilled whole may leak. |
| Water Proofing | Waterproofs entire component. Lid has tight seal. Drilled whole may leak. |
| Sustainability | Container is plastic and cannot be decomposed, however, can be repurposed or recycled. |

## 3.2 Layout of Main Body

The configuration of the main body is important in the overall operation of the system. Components of the main body include the water tank, nozzle platform and control system. Below, three configuration designs are evaluated in Table 6, Table 7 and Table 8.

*Table 6 Layout Option 1*

|  |  |
| --- | --- |
| Layout Option 1 | |
| Layout (front to back) | Nozzle platform (front right)  *Figure SEQ Figure \\* ARABIC 6 Option 1 Layout*  => Control system (front left and middle)  => Water tank  (Nevon Projects, N/A) |
| Safety | Water must pass by control system to get from tank to nozzle. This may result in water leaking onto the control system and cause a system malfunction. |
| Durability | This design looks durable. |
| Cost | Extra cost may be incurred from extra hose length needed to reach between the tank and nozzle. |
| Lightweight | The weight distribution with the tank at the rear may cause the prototype to become unstable. |
| Efficiency | The pump may need to work harder to push the water through the further distance of the hose. Nozzle of centred my not be as efficient as if it was centred. |
| Water Proofing | Water passing the control system may result in a malfunction if the hose leaks. |
| Sustainability | Easy access to all components. |

*Table 7 Layout Option 2*

|  |  |
| --- | --- |
| Layout Option 2 | |
| Layout (front to back) | Nozzle platform and tank combination => Control system  (Raj, 2017)  *Figure SEQ Figure \\* ARABIC 7 Option 2 Layout* |
| Safety | Water does not have to pass the control system. |
| Durability | Design looks durable. |
| Cost | The combination of the tank and nozzle platform may be more expensive as a submersible pump and waterproof cables are needed. |
| Lightweight | The tank being at the front may cause the prototype to be unbalanced and unstable. |
| Efficiency | The combination of pump and nozzle platform means the pump does not have to do much work to move the water. |
| Water Proofing | The water does not have to pass the control system to get from the tank to the nozzle platform. |
| Sustainability | Combination of nozzle platform and tank may restrict access to pump components. |

*Table 8 Layout Option 3*

|  |  |
| --- | --- |
| Layout Option 3 | |
| Layout (front to back) | Nozzle Platform => water tank => control system (underneath)  (Iliadi, et al., N/A)  *Figure SEQ Figure \\* ARABIC 8 Option 3 Layout* |
| Safety | Electrics completely protected from water tank. |
| Durability | Design looks more stable. |
| Cost | Each cost for box materials may be incurred. |
| Lightweight | Extra box materials may add more weight. |
| Efficiency | Tank is directly connected to nozzle. |
| Water Proofing | Control system enclosed in another entire section would help prevent water getting to it. |
| Sustainability | Control components will be hard to access. |

## 3.3 Nozzle Platform Design

The nozzle platform needs to elevate the water nozzle so that water can be sprayed further. The nozzle needs to rotate side to side, angle of elevation angle would also be preferred. Two options for the nozzle platform design are evaluated in Table 9 and Table 10.

*Table 9 Nozzle Platform Option 1*

|  |  |
| --- | --- |
| Nozzle Platform Option 1 | |
| Layout (front to back) | Two motors rotating nozzle side to side and up and down.  (Instructables Circuits, N/A)  *Figure SEQ Figure \\* ARABIC 9 Option 1 Nozzle* |
| Safety | Two motors close to each other may cause some heat problems. |
| Durability | The structure does not look that stable, balancing the motors on top of each other. |
| Cost | Two motors may incur a greater cost. |
| Lightweight | No major weight components are used. |
| Efficiency | Nozzle may not be elevated enough to spray the water far enough. Direction of nozzle could be changed efficiently. |
| Water Proofing | Motors are quite exposed if the water leaked. |
| Sustainability | The nozzle platform is quite compact with motors and pump on top of each other. This would leave not much excess, wasteful material. |

*Table 10 Nozzle Platform Option 2*

|  |  |
| --- | --- |
| Nozzle Platform Option 2 | |
| Layout (front to back) | One motor to adjust elevation angle of nozzle. Large rod elevates nozzle. (El PRO CUS, N/A)  *Figure SEQ Figure \\* ARABIC 10 Option 2 Nozzle* |
| Safety | Water is sprayed far away from electrics. |
| Durability | Rod may fall if not supported properly. |
| Cost | Rod may incur an extra cost. |
| Lightweight | Rod may add extra weight. |
| Efficiency | Pump will have to work harder to push water up the tall rod. |
| Water Proofing | Water sprays away from electrics. |
| Sustainability | Extra material from rod may make more waste. |

# Evaluate and Validate

The design options for the components were compared using the criteria from Table 3. The decision matrix in Table 11 compares the options for waterproofing the electrics.

*Table 11 Electrics Waterproofing Decision Making Matrix*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Electrics Waterproofing Decision Making Matrix** | | | | | | | | |
| **Criteria** | Criteria A: Safety | Criteria B: Durability | Criteria C: Cost | Criteria D: Lightweight | Criteria E: Efficiency | Criteria F: Waterproof | Criteria G: Sustainability | Total |
| **Weight** | 0.23 | 0.10 | 0.10 | 0.10 | 0.14 | 0.23 | 0.10 |  |
| **Option 1: Hot Glue Gun** | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 1.43 |
| **Option 2:** **Plastic Container** | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 1.57 |

Table 11 clearly shows that Option 2 is the better option, with a score of 1.57 compared to 1.47 for Option 1. A sensitivity analysis was conducted, in Appendix 1, by adding and subtracting 10% of the weightings for each criteria. This was done in order to identify any weightings unduly affecting the decision process. In all sensitivity analysis cases Option 2 was the highest ranked and therefore is the chosen option.

*Table 12 Layout of Main Body Decision Making Matrix*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Layout of Main Body Decision Making Matrix** | | | | | | | | |
| **Criteria** | Criteria A: Safety | Criteria B: Durability | Criteria C: Cost | Criteria D: Lightweight | Criteria E: Efficiency | Criteria F: Waterproof | Criteria G: Sustainability | Total |
| **Weight** | 0.23 | 0.10 | 0.10 | 0.10 | 0.14 | 0.23 | 0.10 |  |
| **Option 1:** | 1 | 3 | 2 | 3 | 2 | 1 | 3 | 1.84 |
| **Option 2:** | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1.76 |
| **Option 3:** | 3 | 1 | 3 | 1 | 3 | 3 | 1 | 2.4 |

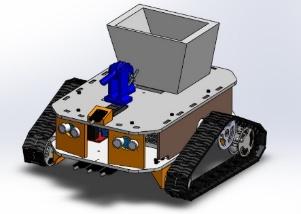
In Table 12, Option 3 is ranked higher (2.4) than Option 1 (1.84) and Option 2 (1.76). The sensitivity analysis, in Appendix 2, supports Option 3 being the best option of choice.

*Table 13 Nozzle Platform Decision Making Matrix*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Nozzle Platform Decision Making Matrix** | | | | | | | | |
| **Criteria** | Criteria A: Safety | Criteria B: Durability | Criteria C: Cost | Criteria D: Lightweight | Criteria E: Efficiency | Criteria F: Waterproof | Criteria G: Sustainability | Total |
| **Weight** | 0.23 | 0.10 | 0.10 | 0.10 | 0.14 | 0.23 | 0.10 |  |
| **Option 1:** | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1.53 |
| **Option 2:** | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1.47 |

In Table 13, Option 1 was the highest ranked (1.53) followed by Option 2 (1.47). The sensitivity analysis, in Appendix 3, shows Option 1 to be constantly ranked highest, therefore Option 1 will be chosen for the design.

The preliminary subsystem design choices are as follows:

* The control system will be cased in a plastic waterproof container to prevent malfunctions from water leakage. Option 2. Figure 11.

*Figure SEQ Figure \\* ARABIC 11 Final Design*

* The layout will have the nozzle platform and tank above an enclosed chassis containing the control system. Option 3. Figure 12.
* The nozzle will be attached to the top of a platform with two motors allowing for horizontal movement and elevation angle adjustment. Option 1. Figure 13.

*Figure SEQ Figure \\* ARABIC 12 Final Design*

# Conclusion

The design of the structural subsystem of an unmanned firefighting vehicle prototype has been investigated in this concept report. The Australian Aviation Rescue Fire Fighting Service are interested in unmanned vehicle options for airport fire emergencies, in order to lower the risk of loss of life among firefighters. The main criteria for the design of the prototype chassis were safety, durability, cost, lightweight, efficiency, waterproof, sustainability. The final chosen design of the structural subsystem allows for efficient flow of water from the tank to the nozzle, which has completely adjustable spraying direction. The electrical control system components are completely protected from water leakage. Possible improvements to this design includes creating the control system more accessible and further stabilising the nozzle platform.

*Figure SEQ Figure \\* ARABIC 13 Final Design*

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# Appendices

## Appendix 1 Sensitivity Analysis of Electrics Waterproofing Options

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Electrics Waterproofing Decision Making Matrix A + 10%** | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | | Criteria G: Sustainability | | Total |
| **Weight** | 0.21 | 0.10 | | 0.10 | | 0.10 | | 0.14 | | 0.23 | | | 0.10 | |  |
| **Option 1: Hot Glue Gun** | 2 | 1 | | 2 | | 2 | | 1 | | 1 | | | 1 | | 1.39 |
| **Option 2:** **Plastic Container** | 1 | 2 | | 1 | | 1 | | 2 | | 2 | | | 2 | | 1.55 |
| **Electrics Waterproofing Decision Making Matrix B-10%** | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | | Criteria G: Sustainability | | Total |
| **Weight** | 0.23 | 0.09 | | 0.10 | | 0.10 | | 0.14 | | 0.23 | | | 0.10 | |  |
| **Option 1: Hot Glue Gun** | 2 | 1 | | 2 | | 2 | | 1 | | 1 | | | 1 | | 1.42 |
| **Option 2:** **Plastic Container** | 1 | 2 | | 1 | | 1 | | 2 | | 2 | | | 2 | | 1.55 |
| **Electrics Waterproofing Decision Making Matrix C-10%** | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | | Criteria G: Sustainability | | Total |
| **Weight** | 0.23 | 0.10 | | 0.09 | | 0.10 | | 0.14 | | 0.23 | | | 0.10 | |  |
| **Option 1: Hot Glue Gun** | 2 | 1 | | 2 | | 2 | | 1 | | 1 | | | 1 | | 1.41 |
| **Option 2:** **Plastic Container** | 1 | 2 | | 1 | | 1 | | 2 | | 2 | | | 2 | | 1.56 |
| **Electrics Waterproofing Decision Making Matrix D-10%** | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | | Criteria G: Sustainability | | Total |
| **Weight** | 0.23 | 0.10 | | 0.10 | | 0.09 | | 0.14 | | 0.23 | | | 0.10 | |  |
| **Option 1: Hot Glue Gun** | 2 | 1 | | 2 | | 2 | | 1 | | 1 | | | 1 | | 1.41 |
| **Option 2:** **Plastic Container** | 1 | 2 | | 1 | | 1 | | 2 | | 2 | | | 2 | | 1.56 |
| **Electrics Waterproofing Decision Making Matrix E-10%** | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | | Criteria G: Sustainability | | Total |
| **Weight** | 0.23 | 0.10 | | 0.10 | | 0.10 | | 0.13 | | 0.23 | | | 0.10 | |  |
| **Option 1: Hot Glue Gun** | 2 | 1 | | 2 | | 2 | | 1 | | 1 | | | 1 | | 1.42 |
| **Option 2:** **Plastic Container** | 1 | 2 | | 1 | | 1 | | 2 | | 2 | | | 2 | | 1.55 |
| **Electrics Waterproofing Decision Making Matrix F-10%** | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | | Criteria G: Sustainability | | Total |
| **Weight** | 0.23 | 0.10 | | 0.10 | | 0.10 | | 0.14 | | 0.21 | | | 0.10 | |  |
| **Option 1: Hot Glue Gun** | 2 | 1 | | 2 | | 2 | | 1 | | 1 | | | 1 | | 1.41 |
| **Option 2:** **Plastic Container** | 1 | 2 | | 1 | | 1 | | 2 | | 2 | | | 2 | | 1.53 |
| **Electrics Waterproofing Decision Making Matrix G-10%** | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | | Criteria G: Sustainability | | Total |
| **Weight** | 0.23 | 0.10 | | 0.10 | | 0.10 | | 0.14 | | 0.23 | | | 0.90 | |  |
| **Option 1: Hot Glue Gun** | 2 | 1 | | 2 | | 2 | | 1 | | 1 | | | 1 | | 2.23 |
| **Option 2:** **Plastic Container** | 1 | 2 | | 1 | | 1 | | 2 | | 2 | | | 2 | | 3.17 |
| **Electrics Waterproofing Decision Making Matrix A+10%** | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | Criteria G: Sustainability | | Total | |
| **Weight** | 0.25 | | 0.10 | | 0.10 | | 0.10 | | 0.14 | | 0.23 | 0.10 | |  | |
| **Option 1: Hot Glue Gun** | 2 | | 1 | | 2 | | 2 | | 1 | | 1 | 1 | | 1.47 | |
| **Option 2:** **Plastic Container** | 1 | | 2 | | 1 | | 1 | | 2 | | 2 | 2 | | 1.59 | |
| **Electrics Waterproofing Decision Making Matrix B+10%** | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | Criteria G: Sustainability | | Total | |
| **Weight** | 0.23 | | 0.11 | | 0.10 | | 0.10 | | 0.14 | | 0.23 | 0.10 | |  | |
| **Option 1: Hot Glue Gun** | 2 | | 1 | | 2 | | 2 | | 1 | | 1 | 1 | | 1.44 | |
| **Option 2:** **Plastic Container** | 1 | | 2 | | 1 | | 1 | | 2 | | 2 | 2 | | 1.59 | |
| **Electrics Waterproofing Decision Making Matrix C+10%** | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | Criteria G: Sustainability | | Total | |
| **Weight** | 0.23 | | 0.10 | | 0.11 | | 0.10 | | 0.14 | | 0.23 | 0.10 | |  | |
| **Option 1: Hot Glue Gun** | 2 | | 1 | | 2 | | 2 | | 1 | | 1 | 1 | | 1.45 | |
| **Option 2:** **Plastic Container** | 1 | | 2 | | 1 | | 1 | | 2 | | 2 | 2 | | 1.58 | |
| **Electrics Waterproofing Decision Making Matrix D+10%** | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | Criteria G: Sustainability | | Total | |
| **Weight** | 0.23 | | 0.10 | | 0.10 | | 0.11 | | 0.14 | | 0.23 | 0.10 | |  | |
| **Option 1: Hot Glue Gun** | 2 | | 1 | | 2 | | 2 | | 1 | | 1 | 1 | | 1.45 | |
| **Option 2:** **Plastic Container** | 1 | | 2 | | 1 | | 1 | | 2 | | 2 | 2 | | 1.58 | |
| **Electrics Waterproofing Decision Making Matrix E+10%** | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | Criteria G: Sustainability | | Total | |
| **Weight** | 0.23 | | 0.10 | | 0.10 | | 0.10 | | 0.15 | | 0.23 | 0.10 | |  | |
| **Option 1: Hot Glue Gun** | 2 | | 1 | | 2 | | 2 | | 1 | | 1 | 1 | | 1.44 | |
| **Option 2:** **Plastic Container** | 1 | | 2 | | 1 | | 1 | | 2 | | 2 | 2 | | 1.59 | |
| **Electrics Waterproofing Decision Making Matrix F+10%** | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | Criteria G: Sustainability | | Total | |
| **Weight** | 0.23 | | 0.10 | | 0.10 | | 0.10 | | 0.14 | | 0.25 | 0.10 | |  | |
| **Option 1: Hot Glue Gun** | 2 | | 1 | | 2 | | 2 | | 1 | | 1 | 1 | | 1.45 | |
| **Option 2:** **Plastic Container** | 1 | | 2 | | 1 | | 1 | | 2 | | 2 | 2 | | 1.61 | |
| **Electrics Waterproofing Decision Making Matrix G+10%** | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | Criteria G: Sustainability | | Total | |
| **Weight** | 0.23 | | 0.10 | | 0.10 | | 0.10 | | 0.14 | | 0.23 | 0.11 | |  | |
| **Option 1: Hot Glue Gun** | 2 | | 1 | | 2 | | 2 | | 1 | | 1 | 1 | | 1.44 | |
| **Option 2:** **Plastic Container** | 1 | | 2 | | 1 | | 1 | | 2 | | 2 | 2 | | 1.59 | |

## Appendix 2 Sensitivity Analysis of Main Body Layout

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Layout of Main Body Decision Making Matrix A-10%** | | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | | | Total |
| **Weight** | 0.21 | | 0.10 | | 0.10 | | 0.10 | | 0.14 | | 0.23 | | 0.10 | | |  |
| **Option 1:** | 1 | | 3 | | 2 | | 3 | | 2 | | 1 | | 3 | | | 1.82 |
| **Option 2:** | 2 | | 2 | | 1 | | 2 | | 1 | | 2 | | 2 | | | 1.72 |
| **Option 3:** | 3 | | 1 | | 3 | | 1 | | 3 | | 3 | | 1 | | | 2.34 |
| **Layout of Main Body Decision Making Matrix B-10%** | | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | | | Total |
| **Weight** | 0.23 | | 0.09 | | 0.10 | | 0.10 | | 0.14 | | 0.23 | | 0.10 | | |  |
| **Option 1:** | 1 | | 3 | | 2 | | 3 | | 2 | | 1 | | 3 | | | 1.81 |
| **Option 2:** | 2 | | 2 | | 1 | | 2 | | 1 | | 2 | | 2 | | | 1.74 |
| **Option 3:** | 3 | | 1 | | 3 | | 1 | | 3 | | 3 | | 1 | | | 2.39 |
| **Layout of Main Body Decision Making Matrix C-10%** | | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | | | Total |
| **Weight** | 0.23 | | 0.10 | | 0.09 | | 0.10 | | 0.14 | | 0.23 | | 0.10 | | |  |
| **Option 1:** | 1 | | 3 | | 2 | | 3 | | 2 | | 1 | | 3 | | | 1.82 |
| **Option 2:** | 2 | | 2 | | 1 | | 2 | | 1 | | 2 | | 2 | | | 1.75 |
| **Option 3:** | 3 | | 1 | | 3 | | 1 | | 3 | | 3 | | 1 | | | 2.37 |
| **Layout of Main Body Decision Making Matrix D-10%** | | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | | | Total |
| **Weight** | 0.23 | | 0.10 | | 0.10 | | 0.09 | | 0.14 | | 0.23 | | 0.10 | | |  |
| **Option 1:** | 1 | | 3 | | 2 | | 3 | | 2 | | 1 | | 3 | | | 1.81 |
| **Option 2:** | 2 | | 2 | | 1 | | 2 | | 1 | | 2 | | 2 | | | 1.74 |
| **Option 3:** | 3 | | 1 | | 3 | | 1 | | 3 | | 3 | | 1 | | | 2.39 |
| **Layout of Main Body Decision Making Matrix E-10%** | | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | | | Total |
| **Weight** | 0.23 | | 0.10 | | 0.10 | | 0.10 | | 0.13 | | 0.23 | | 0.10 | | |  |
| **Option 1:** | 1 | | 3 | | 2 | | 3 | | 2 | | 1 | | 3 | | | 1.82 |
| **Option 2:** | 2 | | 2 | | 1 | | 2 | | 1 | | 2 | | 2 | | | 1.75 |
| **Option 3:** | 3 | | 1 | | 3 | | 1 | | 3 | | 3 | | 1 | | | 2.37 |
| **Layout of Main Body Decision Making Matrix F-10%** | | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | | | Total |
| **Weight** | 0.23 | | 0.10 | | 0.10 | | 0.10 | | 0.14 | | 0.21 | | 0.10 | | |  |
| **Option 1:** | 1 | | 3 | | 2 | | 3 | | 2 | | 1 | | 3 | | | 1.82 |
| **Option 2:** | 2 | | 2 | | 1 | | 2 | | 1 | | 2 | | 2 | | | 1.72 |
| **Option 3:** | 3 | | 1 | | 3 | | 1 | | 3 | | 3 | | 1 | | | 2.34 |
| **Layout of Main Body Decision Making Matrix G-10%** | | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | | | Total |
| **Weight** | 0.23 | | 0.10 | | 0.10 | | 0.10 | | 0.14 | | 0.23 | | 0.09 | | |  |
| **Option 1:** | 1 | | 3 | | 2 | | 3 | | 2 | | 1 | | 3 | | | 1.81 |
| **Option 2:** | 2 | | 2 | | 1 | | 2 | | 1 | | 2 | | 2 | | | 1.74 |
| **Option 3:** | 3 | | 1 | | 3 | | 1 | | 3 | | 3 | | 1 | | | 2.39 |
| **Layout of Main Body Decision Making Matrix A+10%** | | | | | | | | | | | | | | | | |
| **Criteria** | | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | Total | |
| **Weight** | | 0.25 | | 0.10 | | 0.10 | | 0.10 | | 0.14 | | 0.23 | | 0.10 |  | |
| **Option 1:** | | 1 | | 3 | | 2 | | 3 | | 2 | | 1 | | 3 | 1.86 | |
| **Option 2:** | | 2 | | 2 | | 1 | | 2 | | 1 | | 2 | | 2 | 1.8 | |
| **Option 3:** | | 3 | | 1 | | 3 | | 1 | | 3 | | 3 | | 1 | 2.46 | |
| **Layout of Main Body Decision Making Matrix B+10%** | | | | | | | | | | | | | | | | |
| **Criteria** | | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | Total | |
| **Weight** | | 0.23 | | 0.11 | | 0.10 | | 0.10 | | 0.14 | | 0.23 | | 0.10 |  | |
| **Option 1:** | | 1 | | 3 | | 2 | | 3 | | 2 | | 1 | | 3 | 1.87 | |
| **Option 2:** | | 2 | | 2 | | 1 | | 2 | | 1 | | 2 | | 2 | 1.78 | |
| **Option 3:** | | 3 | | 1 | | 3 | | 1 | | 3 | | 3 | | 1 | 2.41 | |
| **Layout of Main Body Decision Making Matrix C+10%** | | | | | | | | | | | | | | | | |
| **Criteria** | | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | Total | |
| **Weight** | | 0.23 | | 0.10 | | 0.11 | | 0.10 | | 0.14 | | 0.23 | | 0.10 |  | |
| **Option 1:** | | 1 | | 3 | | 2 | | 3 | | 2 | | 1 | | 3 | 1.86 | |
| **Option 2:** | | 2 | | 2 | | 1 | | 2 | | 1 | | 2 | | 2 | 1.77 | |
| **Option 3:** | | 3 | | 1 | | 3 | | 1 | | 3 | | 3 | | 1 | 2.43 | |
| **Layout of Main Body Decision Making Matrix D+10%** | | | | | | | | | | | | | | | | |
| **Criteria** | | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | Total | |
| **Weight** | | 0.23 | | 0.10 | | 0.10 | | 0.11 | | 0.14 | | 0.23 | | 0.10 |  | |
| **Option 1:** | | 1 | | 3 | | 2 | | 3 | | 2 | | 1 | | 3 | 1.87 | |
| **Option 2:** | | 2 | | 2 | | 1 | | 2 | | 1 | | 2 | | 2 | 1.78 | |
| **Option 3:** | | 3 | | 1 | | 3 | | 1 | | 3 | | 3 | | 1 | 2.41 | |
| **Layout of Main Body Decision Making Matrix E+10%** | | | | | | | | | | | | | | | | |
| **Criteria** | | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | Total | |
| **Weight** | | 0.23 | | 0.10 | | 0.10 | | 0.10 | | 0.15 | | 0.23 | | 0.10 |  | |
| **Option 1:** | | 1 | | 3 | | 2 | | 3 | | 2 | | 1 | | 3 | 1.86 | |
| **Option 2:** | | 2 | | 2 | | 1 | | 2 | | 1 | | 2 | | 2 | 1.77 | |
| **Option 3:** | | 3 | | 1 | | 3 | | 1 | | 3 | | 3 | | 1 | 2.43 | |
| **Layout of Main Body Decision Making Matrix F+10%** | | | | | | | | | | | | | | | | |
| **Criteria** | | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | Total | |
| **Weight** | | 0.23 | | 0.10 | | 0.10 | | 0.10 | | 0.14 | | 0.25 | | 0.10 |  | |
| **Option 1:** | | 1 | | 3 | | 2 | | 3 | | 2 | | 1 | | 3 | 1.86 | |
| **Option 2:** | | 2 | | 2 | | 1 | | 2 | | 1 | | 2 | | 2 | 1.8 | |
| **Option 3:** | | 3 | | 1 | | 3 | | 1 | | 3 | | 3 | | 1 | 2.46 | |
| **Layout of Main Body Decision Making Matrix G+10%** | | | | | | | | | | | | | | | | |
| **Criteria** | | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | Total | |
| **Weight** | | 0.23 | | 0.10 | | 0.10 | | 0.10 | | 0.14 | | 0.23 | | 0.11 |  | |
| **Option 1:** | | 1 | | 3 | | 2 | | 3 | | 2 | | 1 | | 3 | 1.87 | |
| **Option 2:** | | 2 | | 2 | | 1 | | 2 | | 1 | | 2 | | 2 | 1.78 | |
| **Option 3:** | | 3 | | 1 | | 3 | | 1 | | 3 | | 3 | | 1 | 2.41 | |

## Appendix 3 Sensitivity Analysis Nozzle Platform

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Nozzle Platform Decision Making Matrix A-10%** | | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | | | Total |
| **Weight** | 0.21 | | 0.10 | | 0.10 | | 0.10 | | 0.14 | | 0.23 | | 0.10 | | |  |
| **Option 1:** | 1 | | 1 | | 2 | | 2 | | 1 | | 2 | | 2 | | | 1.51 |
| **Option 2:** | 2 | | 2 | | 1 | | 1 | | 2 | | 1 | | 1 | | | 1.43 |
| **Nozzle Platform Decision Making Matrix B-10%** | | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | | | Total |
| **Weight** | 0.23 | | 0.09 | | 0.10 | | 0.10 | | 0.14 | | 0.23 | | 0.10 | | |  |
| **Option 1:** | 1 | | 1 | | 2 | | 2 | | 1 | | 2 | | 2 | | | 1.52 |
| **Option 2:** | 2 | | 2 | | 1 | | 1 | | 2 | | 1 | | 1 | | | 1.45 |
| **Nozzle Platform Decision Making Matrix C-10%** | | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | | | Total |
| **Weight** | 0.23 | | 0.10 | | 0.09 | | 0.10 | | 0.14 | | 0.23 | | 0.10 | | |  |
| **Option 1:** | 1 | | 1 | | 2 | | 2 | | 1 | | 2 | | 2 | | | 1.51 |
| **Option 2:** | 2 | | 2 | | 1 | | 1 | | 2 | | 1 | | 1 | | | 1.46 |
| **Nozzle Platform Decision Making Matrix D-10%** | | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | | | Total |
| **Weight** | 0.23 | | 0.10 | | 0.10 | | 0.09 | | 0.14 | | 0.23 | | 0.10 | | |  |
| **Option 1:** | 1 | | 1 | | 2 | | 2 | | 1 | | 2 | | 2 | | | 1.51 |
| **Option 2:** | 2 | | 2 | | 1 | | 1 | | 2 | | 1 | | 1 | | | 1.46 |
| **Nozzle Platform Decision Making Matrix E-10%** | | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | | | Total |
| **Weight** | 0.23 | | 0.10 | | 0.10 | | 0.10 | | 0.13 | | 0.23 | | 0.10 | | |  |
| **Option 1:** | 1 | | 1 | | 2 | | 2 | | 1 | | 2 | | 2 | | | 1.52 |
| **Option 2:** | 2 | | 2 | | 1 | | 1 | | 2 | | 1 | | 1 | | | 1.45 |
| **Nozzle Platform Decision Making Matrix F-10%** | | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | | | Total |
| **Weight** | 0.23 | | 0.10 | | 0.10 | | 0.10 | | 0.14 | | 0.21 | | 0.10 | | |  |
| **Option 1:** | 1 | | 1 | | 2 | | 2 | | 1 | | 2 | | 2 | | | 1.49 |
| **Option 2:** | 2 | | 2 | | 1 | | 1 | | 2 | | 1 | | 1 | | | 1.45 |
| **Nozzle Platform Decision Making Matrix G-10%** | | | | | | | | | | | | | | | | |
| **Criteria** | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | | | Total |
| **Weight** | 0.23 | | 0.10 | | 0.10 | | 0.10 | | 0.14 | | 0.23 | | 0.09 | | |  |
| **Option 1:** | 1 | | 1 | | 2 | | 2 | | 1 | | 2 | | 2 | | | 1.51 |
| **Option 2:** | 2 | | 2 | | 1 | | 1 | | 2 | | 1 | | 1 | | | 1.46 |
| **Nozzle Platform Decision Making Matrix A+10%** | | | | | | | | | | | | | | | | |
| **Criteria** | | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | Total | |
| **Weight** | | 0.25 | | 0.10 | | 0.10 | | 0.10 | | 0.14 | | 0.23 | | 0.10 |  | |
| **Option 1:** | | 1 | | 1 | | 2 | | 2 | | 1 | | 2 | | 2 | 1.55 | |
| **Option 2:** | | 2 | | 2 | | 1 | | 1 | | 2 | | 1 | | 1 | 1.51 | |
| **Nozzle Platform Decision Making Matrix B+10%** | | | | | | | | | | | | | | | | |
| **Criteria** | | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | Total | |
| **Weight** | | 0.23 | | 0.11 | | 0.10 | | 0.10 | | 0.14 | | 0.23 | | 0.10 |  | |
| **Option 1:** | | 1 | | 1 | | 2 | | 2 | | 1 | | 2 | | 2 | 1.54 | |
| **Option 2:** | | 2 | | 2 | | 1 | | 1 | | 2 | | 1 | | 1 | 1.49 | |
| **Nozzle Platform Decision Making Matrix C+10%** | | | | | | | | | | | | | | | | |
| **Criteria** | | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | Total | |
| **Weight** | | 0.23 | | 0.10 | | 0.11 | | 0.10 | | 0.14 | | 0.23 | | 0.10 |  | |
| **Option 1:** | | 1 | | 1 | | 2 | | 2 | | 1 | | 2 | | 2 | 1.55 | |
| **Option 2:** | | 2 | | 2 | | 1 | | 1 | | 2 | | 1 | | 1 | 1.48 | |
| **Nozzle Platform Decision Making Matrix D+10%** | | | | | | | | | | | | | | | | |
| **Criteria** | | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | Total | |
| **Weight** | | 0.23 | | 0.10 | | 0.10 | | 0.11 | | 0.14 | | 0.23 | | 0.10 |  | |
| **Option 1:** | | 1 | | 1 | | 2 | | 2 | | 1 | | 2 | | 2 | 1.55 | |
| **Option 2:** | | 2 | | 2 | | 1 | | 1 | | 2 | | 1 | | 1 | 1.48 | |
| **Nozzle Platform Decision Making Matrix E+10%** | | | | | | | | | | | | | | | | |
| **Criteria** | | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | Total | |
| **Weight** | | 0.23 | | 0.10 | | 0.10 | | 0.10 | | 0.15 | | 0.23 | | 0.10 |  | |
| **Option 1:** | | 1 | | 1 | | 2 | | 2 | | 1 | | 2 | | 2 | 1.54 | |
| **Option 2:** | | 2 | | 2 | | 1 | | 1 | | 2 | | 1 | | 1 | 1.49 | |
| **Nozzle Platform Decision Making Matrix F+10%** | | | | | | | | | | | | | | | | |
| **Criteria** | | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | Total | |
| **Weight** | | 0.23 | | 0.10 | | 0.10 | | 0.10 | | 0.14 | | 0.25 | | 0.10 |  | |
| **Option 1:** | | 1 | | 1 | | 2 | | 2 | | 1 | | 2 | | 2 | 1.57 | |
| **Option 2:** | | 2 | | 2 | | 1 | | 1 | | 2 | | 1 | | 1 | 1.49 | |
| **Nozzle Platform Decision Making Matrix G+10%** | | | | | | | | | | | | | | | | |
| **Criteria** | | Criteria A: Safety | | Criteria B: Durability | | Criteria C: Cost | | Criteria D: Lightweight | | Criteria E: Efficiency | | Criteria F: Waterproof | | Criteria G: Sustainability | Total | |
| **Weight** | | 0.23 | | 0.10 | | 0.10 | | 0.10 | | 0.14 | | 0.23 | | 0.11 |  | |
| **Option 1:** | | 1 | | 1 | | 2 | | 2 | | 1 | | 2 | | 2 | 1.55 | |
| **Option 2:** | | 2 | | 2 | | 1 | | 1 | | 2 | | 1 | | 1 | 1.48 | |