**Ethical and Environmental Analysis**

**Year:** 2021 **Semester:** Fall **Team:** 8 **Project:** Sink or be Sunk

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**Assignment Evaluation:**

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| **Item** | **Score (0-5)** | **Weight** | **Points** | **Notes** |
| **Assignment-Specific Items** |  |  |  |  |
| **Environmental Impact** | 5 | x6 |  |  |
| **Ethical Challenges** | 5 | x6 |  |  |
| **Writing-Specific Items** |  |  |  |  |
| **Spelling and Grammar** | 5 | x2 |  |  |
| **Formatting and Citations** | 5 | x1 |  |  |
| **Figures and Graphs** | 5 | x2 |  |  |
| **Technical Writing Style** | 5 | x3 |  |  |
| **Total Score** | 100 |  |  |  |

**5: Excellent 4: Good 3: Acceptable 2: Poor 1: Very Poor 0: Not attempted**

**Comments:**

*Great analysis!*

**1.0 Environmental Impact Analysis**

Overall, our product does not have major environmental impacts outside of production and end of life disposal. During use we are not concerned other than power draw. The product is enclosed within a plastic briefcase and includes PCB, 3D printed plastic boats, a battery, and other components soldered onto the PCB.

In terms of production, we are not using any highly sensitive materials with respect to the environment. We produce very little waste in the production of our product as well. We used lead free solder and lead-free PCB mainly because it was what was available to us in lab as well as online, but also due to environmental concerns. According to the EPA, lead can cause damage to environments such as “decreased growth and reproduction in plants and animals.” [1] The production of the PCB itself also has its own environmental concerns. PCBs are generally made from copper, but some of the processes can be harmful to the environment. A solution like an alkaline solution is used to remove unwanted copper. While we do not know exactly what this solution is, a common solution that is used is made of chloride copper, hydrochloride, hydrogen peroxide, and water. [2] Copper chloride is toxic to aquatic organisms and could cause long-term effects in aquatic environments according to its SDS [3]. Hydrochloride is also very dangerous and can be corrosive to soil and organisms if they are exposure to it [4]. Hydrogen peroxide and dihydrogen monoxide are common solutions and will cause very little harm to the environment. It is important that companies producing PCBs are taking case to dispose of their alkaline solution in a safe manner.

Our lead-free solder paste, SAC305, that we used for our grid PCB boards are mainly tin (over 90%) but contain small amounts of silver and copper according to the safety data sheet [5]. It also states that there are “no specific hazards” with respect to environmental precautions. These elements themselves are not usually found to be harmful to the environment. For personal protection, care will be taken by making sure to turn on the exhaust fan when soldering as well as keeping the workspace clean and washing of the hands after soldering to ensure the solder is not spread around the environment or on ourselves.

We use LEDs on our board for light displays and we picked WS2812C because this specific model was a lower power and has a longer life than other possible models like WS2812B or WS21811. [6]

During normal use, there are very little environmental concerns. This is a standalone board game that is battery powered and charged through micro-USB. The game only lasts around 30 minutes and therefore will not draw much power from its charger when plugged in. Theoretically, one could also be concerned about the potential Wi-Fi signals interfering with other signals, but this is more of an ethical concern rather than an environmental concern.

Our product currently includes a lithium-ion battery for power and this needs to be considered for normal use and end of life. Eventually this battery will either degrade and not hold a good charge anymore or it will need to be disposed of when the user no longer wants to keep the game. We also need to be concerned about potential damages to the battery which could cause it to catch on fire and damage the game itself as well as cause harm to the people using it. Lithiumion batteries contain materials like cobalt, graphite, and lithium and should be recycled properly. In our user manual we will include a web address to earth911.com which allows you to look up the nearest site at which you can recycle these batteries. While lithium and graphite are not toxic, cobalt is. Although it is nowhere near as toxic as lead, it is still important to make sure it is disposed of properly. [7]

Our board is encased in a plastic enclosure which is well known to cause harm to the environment. We chose this packaging because it was easy to obtain and fit our product well. However, we still need to acknowledge the potential environmental issues in production and end of life. At end of life, it is fair to assume that the user will just throw this game away, even though there are batteries, circuits, and plastics inside of it. The plastics itself will not ever break down in our lifetime and if thrown away will sit in a landfill essentially for forever [8]. The production of the plastic is also very harmful to the environment as they are made from all common fossil fuels and release emissions into the environment during refinement and production [9].

In our user manual, we will provide instructions to the user on ways to dispose of the materials properly. However, at the end of the day, it is fair to assume that the common user will not follow these instructions which is why it is important to analyze the environmental impact of our product.

**2.0 Ethical Challenges**

Ethically, there are not any major challenges are obstacles with our product. It is a game designed for all ages but targeted to kids who want to be able to play with their friends when they aren’t physically located near each other. If the product is being used as intended and not broken into, there would be no major ethical issues with our design.

One ethical issue that could arise is that our game is trivializing a wartime game. While our game is designed from attacking another person’s ships, this issue is very similar to the fears that people have regarding video games causing kids to become violent. Studies have shown that this is not a legitimate concern and does it have actual effects on children [10]. We feel it is safe to assume that this logic can be similarly applied to our game.

If a user does break apart the game board, they would have access to the internal parts which could create ethical concerns due to the safety of messing with power controls or the battery. First, we would make sure to include warnings in the user manual that instructs the users to not open the board. We can also place warning labels on the bottom of the game board itself. The board will also be constructed in such a way that it will not fall apart easily. The durability will hopefully eliminate any unintentional destruction of the board.

We will also make sure the user knows to turn off the power when they are not playing as to disable the Wi-Fi module. Theoretically, a user could clog up the bandwidth of where they are playing if they have a very limited Wi-Fi connection. However, the bandwidth necessary to play this game is so small and limited that this is not a concern whatsoever. A user could also hijack the ESP32 for malicious purposes, however, there is not much that can be done about that. If the user truly wants to reprogram the ESP32 for their own use, we will have no control over that.

One benefit our game has over existing Battleship games and other games targeted for kids is that we don’t have any small pieces. Our ships themselves are large enough that they would not be choking hazards. We also do not have the hit or miss pegs like traditional Battleship which are a large choking hazard due to their small size.

**3.0 Sources Cited**

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