Jake Milroy
David Huang
Hussein Khodor
Ivan Herrera Moreno
Team #12

**Make a Decision!**

Posture Pad Microcontroller Selection - Design Matrix

| | Weight | ESP32 Feather | Arduino Nano 33 IoT | Raspberry Pi Pico |
|---|---|---|---|---|
| Cost | 2 | 4 | 3 | 5 |
| Available Analog Inputs | 3 | 4 | 5 | 2 |
| ADC Resolution | 4 | 4 | 4 | 4 |
| Ease of Interfacing and Familiarity | 3 | 5 | 4 | 3 |
| Total Score | 12 | 51 | 49 | 41 |

Posture Pad Microcontroller Selection - Analytical Hierarchy Process (same matrix with normalized weights)

| | Weight | ESP32 Feather | Arduino Nano 33 IoT | Raspberry Pi Pico |
|---|---|---|---|---|
| Cost | 0.15 | 0.333 | 0.267 | 0.400 |
| Available Analog Inputs | 0.25 | 0.353 | 0.471 | 0.176 |
| ADC Resolution | 0.4 | 0.333 | 0.333 | 0.333 |
| Ease of Interfacing and Familiarity | 0.2 | 0.435 | 0.304 | 0.261 |
| Total Score | 1 | 0.359 | 0.352 | 0.290 |

1. Cost ($)
    a. **Basis:** The retail price of each board from Adafruit or Arduino's official site.
    b. **Calculation:** The lower the cost, the higher the score.
    c. **Example:** ESP32 Feather scored highest costing $20, followed by Raspberry Pi Pico costing $15, then Arduino Nano 33 IoT costing $25.
    d. **Interpretation:** Cheaper boards are preferred since this is a prototype and cost efficiency is desirable.

2. Available Analog Inputs
    a. **Basis:** Number of usable analog input pins per board.
    b. **Calculation:** Higher number of analog inputs received higher scores.
    c. **Example:** Arduino Nano 33 IoT with 8 inputs scored the highest, followed by ESP32 Feather at 6 inputs, then Raspberry Pi Pico at 3 inputs.
    d. **Interpretation:** More inputs allow more sensors (FSRs) to be read directly without multiplexing, which simplifies circuit design.

3. ADC Resolution
    a. **Basis:** Bit resolution and stability of the onboard ADC.
    b. **Calculation:** The higher the bit resolution, the higher the score.
    c. **Example:** All three of the boards scored the same as they all had the same bit resolution at 12 bits.
    d. **Interpretation:** Higher resolution and cleaner ADC readings enable smoother and more consistent sensor data.

4. Ease of Programming
    a. **Basis:** Subjective but based on familiarity, documentation quality, and software ecosystem.
    b. **Calculation:** Subjective rating system with 1 being the hardest and 10 being the easiest. The higher the rating, the higher the score.
    **c. Example:** ESP32 Feather with a rating of 10 scored the highest, followed by Arduino Nano 33 IoT with a rating of 7, then Raspberry Pi Pico with a rating of 6.
    d. **Interpretation:** Since this is a 'mini' project, development speed and ease are critical for prototyping.

After entering the raw scores for each criterion (listed in rows) and each alternative (listed in columns), we normalized the AHP matrix so that the total of each row (each criterion) equaled 1.

The general normalization formula is:

$$a'_{ij} = a_{ij} \div \sum_{j=1}^{m} a_{ij}$$

Where:

- $a_{ij}$ is the raw score for criterion i and alternative j.
- $a'_{ij}$ is the normalized score for that criterion and alternative.
- $\sum_{j=1}^{m} a_{ij}$ is the sum of all alternative scores under that same criterion.

After normalization, the overall weighted score for each alternative was computed by multiplying each criterion's normalized value by its corresponding criterion weight and summing the results:

$$S_j = \sum_{i=1}^{n} (w_i \times a'_{ij})$$

Where:

- $S_j$ is the total weighted score for alternative j.
- $w_i$ is the weight of criterion i.
- $a'_{ij}$ is the normalized value from that criterion's row.

This produced the final weighted scores and overall ranking of the three microcontrollers.

As a group, we have decided to use the ESP32 Feather as our chosen microcontroller. Based on our AHP analysis and overall project goals, it proved to be the most balanced and practical option. For our posture pad prototype, we require multiple analog inputs to read data from the force-sensitive resistors, which the ESP32 provides in sufficient quantity.

Additionally, our team already has the most experience working with the ESP32 platform, allowing greater flexibility and efficiency during development. The board also offered the most favorable overall score across our evaluation criteria, including cost, available analog I/O, ADC resolution, and ease of programming.

According to our AHP matrix results, the ESP32 Feather achieved the highest total weighted score of 0.359, outperforming both the Arduino Nano 33 IoT and Raspberry Pi Pico.

In summary, the ESP32 Feather best meets our project's technical needs and aligns with our team's existing skills, making it the most suitable choice for our project implementation.