Original Proposal with Analysis

1. Project Goals (Original Proposal)

The initial goals of our project were straightforward:

- **Complete a fully functional robotic car** using ESP32 and Dualshock 4

- Gain practical experience in **problem-solving** and troubleshooting

- Improve our ability to build both **hardware and software** systems

- Strengthen our **teamwork**, including dividing responsibilities effectively

- And finally, **have fun** while learning something new

We did not expect to create something extremely advanced; instead, our focus was on growth, experience, and finishing a working prototype.

2. Analysis of Outcomes

Goals Achieved

We successfully met the main objectives of the project:

- Built and tested a **working robotic car** with Bluetooth control

- Implemented a **police light system** and **dual-tone siren**

- Improved our **problem-solving skills** by constantly dealing with unexpected issues

- Gained real experience in **electronics, wiring, coding, and system integration**

- Strengthened our **teamwork**, learning how to share tasks and support each other

- Had fun throughout the process, which was one of our goals

- Grew significantly compared to our starting point — technically and personally

Despite all difficulties, we ended up with a system that works, and we understood much more than when we started.

Goals Not Fully Achieved and Why

Some goals were not accomplished due to unexpected obstacles:

- We originally planned to use an **ESP board** and control the car using a **PlayStation 4 controller**

  - However, the ESP board **burned out**, which forced us to switch to Arduino

- We faced **faulty components**, defective boards, and burned circuits

- Stores with electronic parts were often **closed on weekends**, slowing progress

- Wiring and debugging took more time than expected due to repeated hardware issues

Because of these setbacks, we had to simplify some parts of the project and focus on stability rather than complexity.

3. Improvements With More Time and Resources

If we had additional time or better hardware availability, we would implement:

- **Servo-based steering** for realistic wheel turning instead of tank-style turning

- **Front and rear lights** (headlights and taillights) to improve realism

- **PWM speed control** for smooth acceleration

- **Battery monitoring** via an analog input for safety and diagnostics

- **Ultrasonic sensor** for obstacle avoidance

- A command to **toggle police lights and siren** on/off

- Returning to the original idea of **ESP + PS4 controller** once reliable hardware is available

These enhancements would significantly expand the functionality and realism of the robotic car.

4. Conclusion

Although the project took a very different path from what we initially planned, the changes and challenges ultimately helped us grow. We dealt with burned boards, broken components, wiring bugs, and constant troubleshooting — but each problem taught us something valuable.

We achieved our biggest goals:
 we finished the project, gained real engineering experience, improved teamwork, and had fun doing it.

Most importantly, we realized that we are no longer the same beginners we were at the start — the project changed us and made us better.