Hardware
ESP32 Development Board

- **Rationale**: Serves as the central control-brain for sensor data processing, controlling the system, and managing the wireless communication (Wi-Fi or Bluetooth) of the system.
- **Availability**: Available in our inventory.
- **Notes**: It is the appropriate controller for an IoT-based project-the data processing and communication tasks are efficiently executed.

Ultrasonic Distance Sensor (HC-SR04)

- **Rationale**: To measure the distance to identify that it is occupied by a vehicle.
- **Availability**: Available in our inventory.
- **Notes**: Calibration and proper timing are required to have the right distance measured.

IR Sensor (Infrared Sensor Module)

- **Rationale**: It detects cars using reflected infrared light.
- **Availability**: Available in the classroom so borrowed 6 of them.
- **Notes**: It is a simple-to-deploy, reliable occupancy sensing device under a variety of lighting environments for detecting the occupancy of parking space.

LCD Display (16x2 LCD with I2C Interface)

- **Rationale**: Displays parking states and whether it is empty or filled, as well as simple system messages, in real-time.
- **Availability**: Available in our inventory.
- **Notes**: I2C wiring would be simpler and have less wires for communication with the ESP32.

Software Libraries
Paho MQTT Client Library

- **Rationale**: Support the MQTT protocol for communication between the parking sensor, cloud, and mobile apps.
- **Availability**: Open-source and free download from Eclipse Paho.
- **Notes**: Work compatible with ESP32 and is fitted for real-time messages and data transfers.

LiquidCrystal_I2C Library

- **Rationale**: It is used for interfacing with an I2C LCD display; it will help in controlling the display of parking status and other data.
- **Availability**: Open-source, installable through Arduino Library Manager.
- **Notes**: the I2c saves GPIO number needed to connect to the ESP32; thus, it is more comfortable in small embedded applications.

Software tools
Arduino IDE

- **Rationale**: Most common development environment for programming microcontrollers, especially useful for the work of the ESP32 and sensors such as HC-SR04 and IR sensors.
- **Availability**: Free to download. Cross-platform.
- **Notes**: Very simple and easy user interface and is very compatible with ESP32, best both for novice and expert users, yet it supports a wide variety of libraries for sensor integration

Visual Studio Code

- **Rationale**: Provides the IDE for code editing, debugging, and managing versions.
- **Availability**: For free download and cross-platform.
- **Notes**: Adjustably extensible for python, arduino, and esp32 development.

GitHub Desktop

- **Rationale**: GUI Tool to manage Git repositories, commits, and collaborative version control.
- **Availability**: Free to download from GitHub.
- **Notes**: Best for team collaboration but not very useful for users unaware of how to use the command line interface for Git.

Additional
Testing/Prototyping Materials

- **Rationale**: Breadboards, jumper wires, resistors, and other components needed for prototype construction.
- **Availability**: Available in our inventory.
- **Notes**: Keep track of quantities used to avoid running out.

Cloud Data Storage like AWS, Firebase

- **Rationale:** They are used for storing parking data, historical usage, or providing remote access to the system for analysis.
- **Availability**: Free levels exist (AWS, Firebase, etc.); charges apply depending on usage.
- **Notes**: Perhaps able to sign up to educational credits or trial services for students' projects