# PED-TECH: Progressive and Efficient Data-driven Pedestrian Traffic Signalling with IoT and Technology Integration

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# PED-TECH: Progressive and Efficient Data-driven Pedestrian Traffic Signalling with IoT and Technology Integration

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**Abstract.** PED-TECH system is a pedestrian and vehicle traffic control system designed to promote safety and improve traffic flow efficiency. The system was designed and developed by the researchers as a solution to the traffic congestion problems in the city of San Jose Del Monte (SJDM). In response to these challenges, PED-TECH was designed as a comprehensive pedestrian and vehicle traffic control solution. The PED-TECH system consists of various output components, including LED lights for both the vehicle and pedestrian, an audible buzzer, and a I2C LCD. Additionally, the pedestrian button provides input for pedestrian users. The system can operate in either manual or automatic mode, depending on the firmware that is flashed onto the Arduino. With option to be integrated on solid state relays for high power AC signalling lamps. To assess the performance of the PED-TECH system, a quality of service (QoS) survey was conducted. The results of this survey indicated that the PED-TECH system performed exceptionally well in terms of functionality, accessibility, performance, and reliability. The mean scores consistently reached high levels and were classified as "Very Good." In conclusion, the results of the QoS survey paint a positive picture of the PED-TECH system's potential to provide outstanding results. The system has been designed and developed with the utmost excellence, and its combination of cutting-edge technology and user-centric design provides a promising solution to the traffic challenges faced by the city.

**Keywords:** Arduino Uno, Liquid Crystal I2C, AT-09 module, QoS, IoT

## 1. Introduction

Pedestrian traffic management has been a crucial issue in cities worldwide, as the increasing number of road users poses a threat to the safety of those who cross the roads on foot. In the Metro Manila Philippines alone there are more than 2,122 pedestrian accidents happening including over 100 fatal injuries to the victim.[1] Not only that, vehicular accidents are on the rise too. With the ever-growing car-centric culture in the country, it is expected that both cases of pedestrian and vehicular accidents would continue to rise. As we navigate the busy streets, we are all too familiar with the dangers posed to pedestrians, especially those on their daily commute to school. Personal anecdotes, such as those shared by almost everyone, serve as a reminder of the urgent need for safer pedestrian traffic management in cities worldwide. Locally, most congestion mostly happens at the intersection of national highways, particularly on those that lead to major centers such as malls, city capital, school, etc. This is evident during rush hour, the mix of workers, students and leisure travelers all clash together on the road.

## 2. Methodology

This hybrid research design combines both quantitative and qualitative research into one. Since the researchers are evaluating the PED-TECH system in the context of user Quality of Service (QoS) it is necessary to gather both quantitative (performance metric) and qualitative (user feedback) data. The researchers will use the following methods to gather the data needed for the study. This design also

offers the flexibility needed to conduct a physical test of the PED-TECH system. Which is primarily focused on the reliability of the controller and the circuitry itself. The user feedback would be collected by the researchers through the aid of survey questionnaires and interviews. By combining both types of data, the researchers will be able to gain a more complete understanding of the PED-TECH system and its impact on user QoS. Researchers deemed hybrid design as appropriate because of the following advantages:

- Hybrid approaches can address the limitations of using a single research method. For example, qualitative methods can provide in-depth information about participants' experiences, while quantitative methods can provide data on the prevalence of certain phenomena in a larger population.
- Flexibility Hybrid approaches offer more flexibility in terms of the types of data that can be collected and the methods used to collect it, allowing researchers to adapt to the specific needs of the study.
- Cost-effectiveness Hybrid approaches can be more cost-effective than using a single research method, as they can be used to collect data that would otherwise require multiple methods.

*2.1 Objectives*

The goal of the paper is to present a solution to the growing issue of pedestrian traffic management in the City of San Jose del Monte Bulacan, and potentially in other cities facing similar challenges. With the rising car-centric culture, the number of pedestrian and vehicular accidents is expected to continue to rise, making it crucial to find a solution to this issue as soon as possible. PED-TECH system is designed to be both affordable and reliable, making it accessible to the City of San Jose del Monte Bulacan and other prospective users. The researchers prioritize the use of off-the-shelf components and a simple design philosophy in the creation of the system, to minimize costs and maximize reliability.

*2.2 System Design*

PED-TECH main objective is to create a system that is both affordable and reliable as stated in the introduction. The researchers aims to achieve this by using off the shelf components and a simple design philosophy on developing the Minimum Viable Product (MVP) of the system. The system is composed of two main components. The first component is the traffic light controller. This is composed of the Arduino Microcontroller and its USB Power Supply (5V@1A). The second component is the output device. This includes the Buzzer, pedestrian, vehicular and traffic light. Which is responsible on providing intuitive cues.

The researchers integrates audible buzzer to provide a more intuitive and audible cue to the pedestrian users and additional accessibility to visually impaired individuals. Additionally, the electrical connection of vehicular and pedestrian traffic light are connected in series of each other. This design ensures that both light would turn on and off at the same time with single PWM signal provided by the Arduino microcontroller.

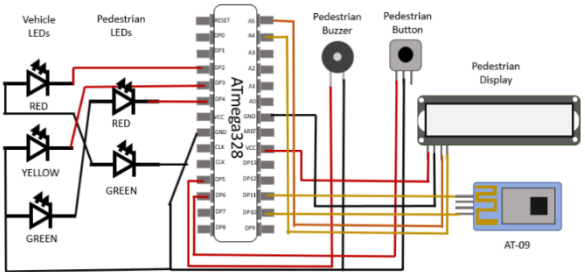


*Figure 1: Simplified PED-TECH Circuit Diagram*

On the circuit diagram above, it should be noted that some passive components, such as

resistors, have been omitted for simplicity. The Vehicle's red light is in series with the pedestrian's green light, while the vehicle's green light is in series with the pedestrian's red light. This design ensures that both the "Stop" and "Go" signals will result in both the vehicle and pedestrian lights being illuminated simultaneously. The buzzer, yellow LED, and HID button are each connected to separate I/O pins.

OUTPUT COMPONENTS

This section provides a detailed explanation of the main output components of the PED-TECH system. This includes both vehicle and pedestrian lights and the audible passive pedestrian buzzer.

- Red Vehicle LED and Green Pedestrian LED - This LED is responsible for indicating that the vehicle should stop. This LED is connected to the Arduino's digital pin 2.
- Yellow Vehicle LED - This LED is responsible for indicating that the vehicle should slow down. This LED is connected to the Arduino's digital pin 3.
- Green Vehicle LED and Red Pedestrian LED - This LED is responsible for indicating that the vehicle should go. This LED is connected to the Arduino's digital pin 4. [2]
- Buzzer - This buzzer is responsible for providing an audible cue to the pedestrian users. This buzzer is connected to the Arduino's digital pin 6.

In compliance with the 1968 Vienna Convention on Road Signals which is ratified by the Philippines, all PED-TECH signal LED is illuminated solidly when the signal is active.[3]

Liquid Crystal I2C display - This display is responsible for providing a visual cue to the pedestrian users, it displays the remaining pedestrian time crossing and pedestrian waiting time. This display is connected to the Arduino's analog pin 4 and 5.

INPUT COMPONENTS

- Pedestrian Button - Provides input Human Interface Device (HID) for the pedestrian users to interact with the system. This button is connected to the Arduino's digital pin 6. Depending on the firmware flashed on Arduino, the button can be used to activate the pedestrian signal on Manual mode where the pedestrian can manually activate the pedestrian signal. On Automatic mode, the button is deactivated as PED-TECH cycles through both vehicle and pedestrian timing every 30 seconds or customize delay whichever applies.
- Bluetooth AT-9 Module – Provides wireless Bluetooth serial debugging capability to PED-TECH system for field testing and maintenance.

## 3. Results

Presenting the Summary of Results, and Conclusions from the Data Analysis.

**Table 1.** PED-TECH Quality of Service (QoS) Survey

| | Mean | Interpretation |
|---|---|---|
| **A. Functionality** | | |
| *Functional Completeness* | 4.83 | Very Good |
| *Functional Correctness* | 4.83 | Very Good |
| *Functional Appropriateness* | 4.83 | Very Good |
| **B. Accessibility** | | |
| *System Intuitiveness* | 4.83 | Very Good |

| | | |
|---|---|---|
| *System Comprehension* | 4.83 | Very Good |
| **C. Performance** | | |
| *Signal Synchronization* | 4.83 | Very Good |
| *Resource Utilization* | 4.83 | Very Good |
| *System Capacity* | 4.67 | Very Good |
| **D. Reliability** | | |
| *Signal Synchronization* | 4.83 | Very Good |
| *Resource Utilization* | 4.83 | Very Good |
| *System Capacity* | 4.83 | Very Good |

Analysis of the PED-TECH System: An assessment of the system has uncovered remarkable results in terms of its functionality. The aspects of functional completeness, functional correctness, and functional appropriateness all achieved a mean score of 4.83, deemed as Very Good

Accessibility also presents a strong aspect of the PED-TECH system, with both system intuitiveness and system comprehension receiving a mean score of 4.83, classified as Very Good. Performance wise, the PED-TECH system proved to be quite remarkable, with an average score of 4.77, still considered to be Very Good. The evaluation of signal synchronization, resource utilization, and system capacity all yielded mean scores within close proximity, further fortifying the system's strong performance. Reliability also stands out in the PED-TECH system, with the evaluation of signal synchronization, resource utilization, and system capacity all obtaining a mean score of 4.83, classified as Very Good.

To sum up, the evaluation results indicate that the PED-TECH system performs excellently across all evaluated categories, consistently exhibiting high mean scores and receiving the classification of Very Good.

## 4. Conclusion

In conclusion, the results of the PED-TECH system evaluation highlight its impressive performance in terms of functionality, accessibility, performance, and reliability. With mean scores consistently reaching high levels and being classified as Very Good, it is evident that the PED-TECH system has been designed and developed with excellence. These findings emphasize the potential of the PED-TECH system to meet the needs and expectations of its users, making it a strong contender in its field. Overall, the evaluation results paint a positive picture of the PED-TECH system, and its potential to deliver outstanding results.

## 5. References

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