

Project Proposal (Matthew Williams)

by Matthew Williams

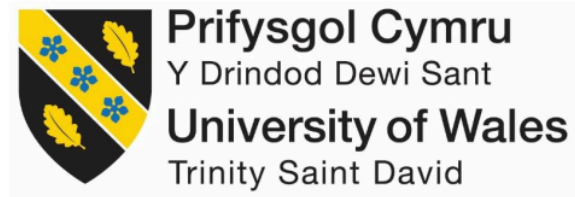
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**Monitoring of Street Lighting at Pembrokeshire
County Council to verify that the Part Night
switching policy is being implemented correctly**

by
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Potential Supervisor: STEPHEN MOSEY

Independent Project Proposal submitted as part of the
requirements for the award of
BEng (Hons) Electrical and Electronics Engineering

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Abstract

This project aims to develop a basic tool for monitoring street lighting switching times at Pembrokeshire County Council (PCC), therefore ensuring that the present Part-Night switching regime policy is correctly applied. Apart from being crucial for public safety, street lighting contributes significantly to any authority's energy consumption. PCC's Part-Night Switching Policy seeks to maximise street lighting operation while at the same time balancing public needs with energy savings. On the other hand, irregular application of this policy makes the public dissatisfied and causes many complaints.

Introduction

The project "Monitoring of Street Lighting at Pembrokeshire County Council to verify that the Part-Night switching policy is being implemented correctly," addresses a major issue, ensuring that the street lighting switching regime conforms with PCC Street Lighting policy criteria. PCC's street lighting system is one essential part of public infrastructure supporting security, safety, and accessibility all around the county. Though, the correct implementation of the switching regime, which regulates when streetlights turn on and off, has also generated many complaints. This project intends to design, build, and test a device to determine whether the council's street lighting switching policy is being properly implemented and to find any inconsistencies or inefficiencies in the system.

Aims & Objectives

The projects primary aim is confirming that the PCC's Part-Night Street Lighting Switching Policy is being correctly implemented. A PIC microcontroller will be used to build a light-monitoring system able to identify and record when a light is turned on or off. This system must be adaptable to monitor all types of streetlights. Additionally, the device will be adaptable to various kinds of lighting systems, for example tracking light use in PCC's public buildings and schools to help reduce energy costs. This will be achieved through the following SMART objectives:

- ✓ **Specific** - Design, build, test a light monitoring system using a PIC microcontroller.
- ✓ **Measurable** - Record and analyse data for a period of up to seven days to identify if the switching regime deviates from the current PCC policy. The project will be regarded as successful if the system can detect and record the on/off status of a light over a seven-day period.
- ✓ **Achievable** - Using a PIC Microcontroller, photoresistor (LDR) and data logging, the system will be developed and tested in a controlled environment.
- ✓ **Relevant** - To ensure that the street lighting system operates efficiently, reducing unnecessary energy consumption and costs, while maintaining public safety and most importantly of all, reducing complaints.
- ✓ **Time-bound** - Complete the project in seven months including reporting and data analysis.

Background

Street lighting plays a critical role in ensuring the safety, security, and well-being of the public, particularly in public spaces and residential areas. In many authorities, street lighting systems operate on set schedules to balance energy consumption and public safety needs. However, differences between expected and actual lighting schedules can lead to public dissatisfaction and complaints, as seen in PCC. Over recent years, the council has experienced increased public complaints about the accuracy of its street lighting schedule following the ending of night inspections. Historically, night inspectors monitored the street lighting, ensuring they followed the recommended on and off times outlined in the Part-Night policy. Since the ending of these night inspections, the council has not been able to verify that streetlighting schedules are accurate. Relying instead on public interaction which is fundamentally subjective and not always accurate. This project intends to develop a cost-effective system using modern technology for streetlighting monitoring to verify the switching schedule and addressing customer concerns.

Over the past ten years, technological advancements in street lighting have generated improvements and more efficient alternatives. One innovation is the Internet of Things (IoT) being introduced into street lighting systems. IoT-enabled street lighting systems provide remote monitoring, troubleshooting, and control of lighting systems, therefore enabling authorities to collect real-time data on the state of streetlights. Apart from improving energy efficiency by changing illumination settings depending on ambient conditions, Fouad Agramelal says this model enables tracking of when lights are turned on or off. This approach could provide authorities like PCC with a means of monitoring the switching schedules of their streetlights. Fouad Agramelal also acknowledges the high cost associated with this model. [1]

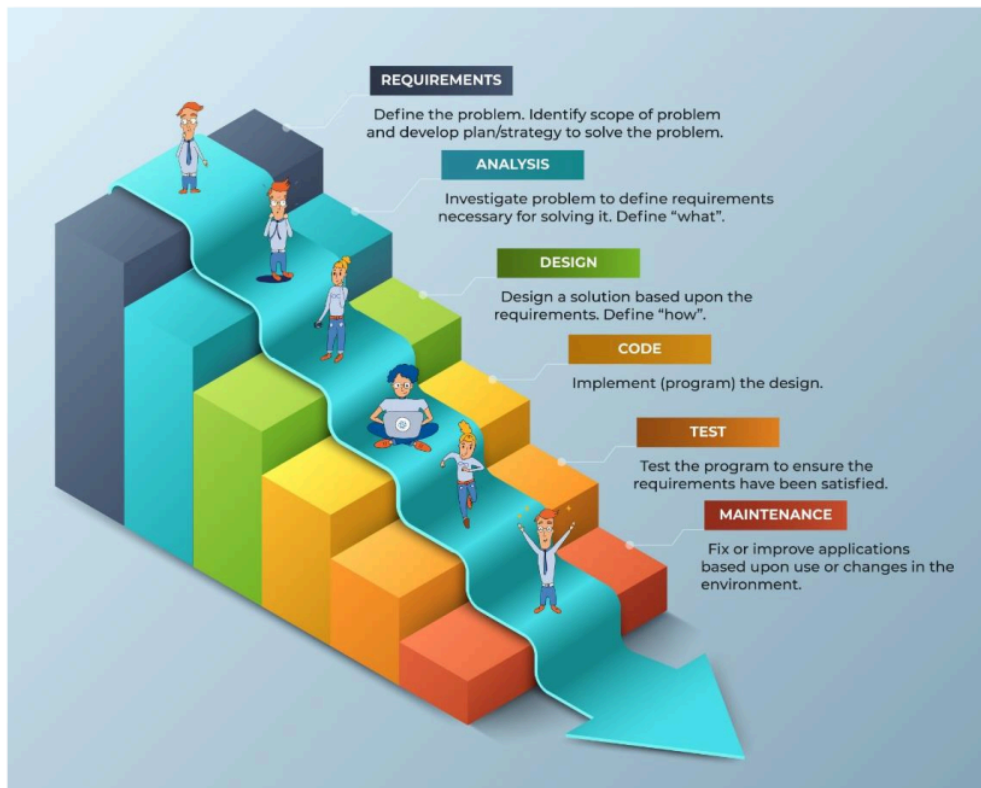
Another development is adaptive lighting, which changes light intensity depending on current conditions such as traffic and pedestrian movement as well as weather conditions. Christina Skandali highlights the benefits of adaptive lighting systems, particularly in urban settings where better light control and energy savings have been evident. However, rather than ensuring adherence to set operational policies, which is the major issue in Pembrokeshire these solutions focus on lowering energy costs. [2]

Although many studies have focused on the automation and energy efficiency of street lighting systems, there remains a notable research gap on public sector accountability in streetlighting. Most studies, such those by Fouad Agramelal and Christina Skandali above, concentrate on using smart controls and adaptive lighting to maximise energy usage. Still, relatively little attention has been paid to the need for verifying lighting schedules from a public service perspective. This project is relevant and topical since it looks at the link between public sector responsibility and technological innovation. Furthermore, this idea is not limited to Pembrokeshire and can act as a model for other authorities coping with similar issues. As public demands for transparency in public services grow, the need for monitoring systems becomes increasingly important.

Project Design

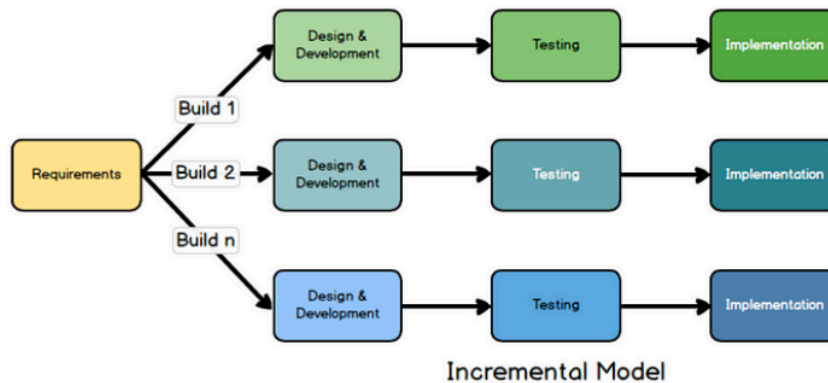
- Development Methodologies

This project will use a combination of Waterfall and Incremental development Methodologies. Mitchell claims that the industry follows the Waterfall technique as the standard. Still, every approach has advantages and disadvantages. [3]



[4]

The Waterfall technique is useful since it helps each project milestone to be completed in sequence. Considering time restrictions, this will ensure that the project advances in a specific order.



[5]

Incremental development will help each "Waterfall" level to be broken down. Every module will follow the same procedures—requirement, design, implementation, and testing. Early in the process, the first module should produce a functional software version. More features will be included in every module. This approach will allow for improvements based on early testing and validation at every level of the design process.

- Mechanical Design

The mechanical design will concentrate on building a durable housing unit to protect the electronics from environmental conditions including dust, wind and rain. The housing unit will be built to be easily mounted on a streetlight column without interfering with its normal operation. The installation process will need to be non-invasive, ensuring that the streetlighting column remains intact. Additionally, it will ensure easy access for data collection and battery access purposes.

- Hardware Design

The project's hardware design seeks to track light intensity by interfacing a photoresistor (LDR) to an Analog-to-Digital (ADC) converter on a PIC Microcontroller. The LDR resistance will adjust in reaction to the ambient light, the system can then ascertain whether the light source is on or off. Additionally, the device will incorporate an SD card, and a GPS module interfaced with the Microcontroller. The SD card will log the data, which may then be retrieved for analysis. The system will be tested extensively to confirm its reliability over a range of lighting situations and its capacity to precisely monitor illumination levels.

- Software Design

Embedded C will be used to build the software system of the PIC microcontroller, that will track and record light data at specified intervals. The software will also gather GPS information, ensuring that the data collected satisfies any auditing procedures recognise where the readings were taken. The microcontroller's programming will save the timestamp, light intensity levels and GPS information to non-volatile memory.

- Data Collection

The data that will be collected will include:

- Timestamps
- Illumination level
- GPS location information.

- Data Analysis

The collected data will be analysed by comparing switching timestamps with PCC's Part Night switching regime schedules. Critical analysis of the on/off timings of the monitored light will identify differences between the expected and real time data. From the recorded data, a time series graph showing the operational activity of the streetlights during the monitoring period will be generated. The results will help PCC ensure compliance with the policy rules and feedback to customer complaints.

Resources

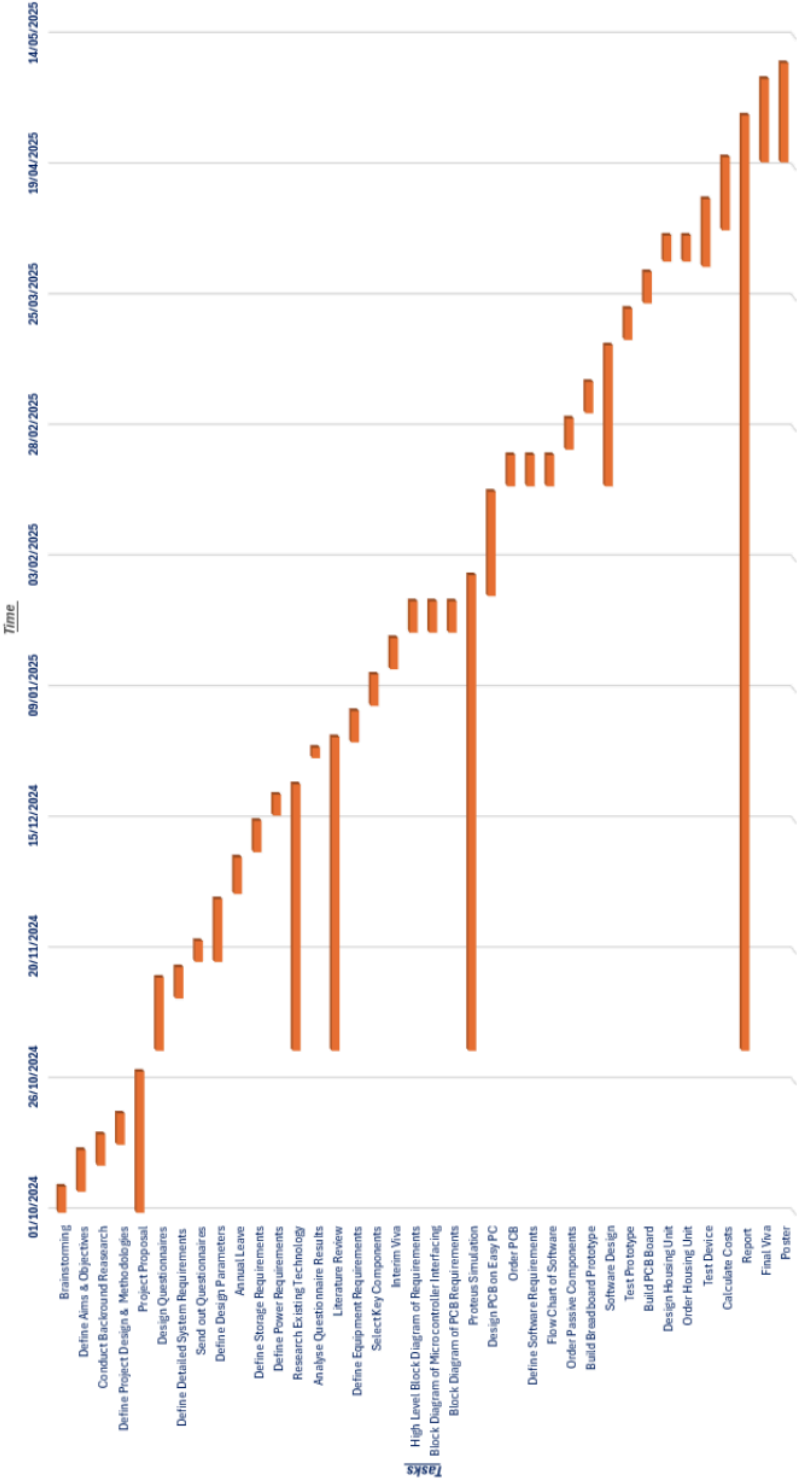
The resources required for this project include hardware components and software tools:

Category	Components & Tools	Deliverables
Hardware	PIC Microcontroller	This is the core processing unit that will handle inputs from the sensors, process the data, and log the lighting levels.
	Light Dependent Resistor (LDR)	To detect the light intensity or determine when the light turns on or off.
	GPS Chip	To accurately log and time stamp the reading, as well as prove location.
	SD Card Module	For data storage and logging.
	Power Supply	A suitable power supply will be needed for the system (e.g. Li-ion Battery).
	Resistors, Capacitors and other passive components	For building the sensor, SD Card and GPS interface circuits.
	PCB or Breadboard	For prototyping the circuit.
	3D Printer	To design and create the files needed to order the housing module.
	Pickit3 Debugger	To debug and program the PIC Microcontroller
Software	Proteus	Simulation software for developing and testing the circuit before physical implementation.
	Easy PC	To design any PCBs and create the files needed to order.
	CCS Compiler	For compiling C code written for the PIC microcontroller.
	3D Printing Software	For designing the durable housing module
	MS Excel	Will be used to generate time series graphs

Plan

The project will span seven months, with key stages outlined in the below Gantt Chart:

Project Gantt Chart



References

- [1] F. Agramelal, M. Sadik, Y. Moubarak, and S. Abouzahir, "Smart Street Light Control: A Review on Methods, Innovations, and Extended Applications," Nov. 01, 2023, *Multidisciplinary Digital Publishing Institute (MDPI)*. doi: 10.3390/en16217415.
- [2] C. Skandali, N. Papatzelakis, and L. T. Doulos, "The Role of Adaptive Lighting in Street Lighting Applications."
- [3] . IEEE Staff, *2009 3rd International Symposium on Empirical Software Engineering and Measurement*. IEEE, 2009.
- [4] Krusche & Company, "What is the Waterfall software development methodology and is it still relevant?" Accessed: Oct. 17, 2024. [Online]. Available: <https://kruschecompany.com/waterfall-software-development-methodology/>
- [5] J. More, "Software Development Model — Incremental Development," Bootcamp. Accessed: Oct. 17, 2024. [Online]. Available: <https://medium.com/design-bootcamp/dlc-software-development-model-incremental-development-7598ae6500e6>

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GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

74/100

Intro / A&O (400 words)		
Project title; Identification of a specific problem to be investigated; Well-defined aims and SMART objectives; Explaining why this project is worth doing; Discussion of what the project needs to do in order to be a success; Description any deliverables that will be produced at the end of the project	20	16
Excellent description of the problem to be addressed, along with SMART objectives and project deliverables		
Background to the Project / Literature Review (400 words)		

Description of how the work to be done by in the project relates to the work identified in the literature review; Discussion of any ethical issues raised by the project Identifying what has already been done within the field; Topic familiarity; Brief literature review using appropriate sources – 6-8 journal papers and book chapters rather than just websites; Selection of relevant models & concepts Excellent background material presented. Very good range of relevant, credible references listed although some were missing some information.	20	14
Project Design (500 words)		
Clear statement of which development methods are to be used and why they are appropriate; Clear statement of which tools are to be used and why they are appropriate; Clear description of how data collected will be analysed Very good clear description of the methodology and tools to be used within this project, along with data collection and analysis methods.	30	21
Resources / Planning (200 words)		

List of any deliverables; Clear diagram showing both timing and resource use; Completed ethics form; Limited and relevant appendices Very good levels of planning evident, although some tasks appear to be sequenced incorrectly. Ethics form completed.	15	9.75
Document Presentation		
Correct spelling, grammar and punctuation; Flow of narrative/fluency; Coherence; Word processed ; Correct use of referencing with bibliography; Strict word limit Document is written and presented to an excellent standard.	15	13.5
TOTAL	100	74.25

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