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Power Control System Outage Device

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Abstract. Power control system outage device are crafted to enhance electrical system reliability by integrating sensors, communication modules, and data analytics, enabling real-time monitoring of power parameters and automated responses to interruptions, ensuring uninterrupted power supply and improved system resilience. The study aimed to develop a power control system outage device integrating Internet of Things (IoT). This device combines sensors, communication modules, and data analytics to enable real-time monitoring of power parameters and automated responses to interruptions. Its main objectives included designing and implementing the IoT-based device, evaluating its efficiency and yield, consulting with IT specialists for assessing its embedded system, and conducting an end-user acceptance assessment. The IoT control functions include switching main power, backup power, temperature monitoring, and perimeter lights. The significance of the research lies in providing a safety device that prevents damage during natural disasters and ensures uninterrupted power supply. The evaluation involved 30 evaluators, including experts, instructors, technicians, and end-users. The findings indicated that the device was sensitive, with accurate responses to power outage in real-time.

Keyword: Power outage, over and under voltage protection, protective device, Automated, IoT, ATS

I. INTRODUCTION

Nowadays, the infrastructure supporting electrical energy needs to be reliable and secure. Now more than ever, given how deeply integrated electric-powered technology has become into every aspect of human endeavors. Thus, one of the main areas of research was safeguarding the electrical power supply system from disruptions brought on by different flaws. One of the parts used to protect the electricity system was the circuit breaker. When an issue or anomaly occurs, it was in charge of shutting down the system to protect the electrical machinery.

Some products and environments are becoming "smart" things as a result of the technological trend of integrating "smart" technologies in today's society, which was being driven by the growth of Cloud Computing and the Internet of Things (IoT). In this context, conventional electrical protection devices often go above and beyond to become "smart," providing enhanced fault detection and protection, remote monitoring, and event notification.

Some household device in a smart home was connected to the Internet and one another via ubiquitous computer technology. Computers, sensors, cameras, and other delicate technology were also integrated into the urban environment in a smart city. In the rising smart world, where more and more sensitive gadgets are linked, protecting the power supply grid from breakdowns becomes increasingly more important.

Additionally, the aim of this study was to tackle these concerns and explore the possibilities of IoT-integrated power interruption protection devices. Through a knowledge of present power outage challenges, the development of a smart protection system, increased efficiency and reliability, and an evaluation of user satisfaction, this research seeks to improve the field of Internet of Things-based power outage prevention technology. The study's conclusions can help decision-makers decide whether to use these kinds of devices, opening the door to a more dependable and robust power supply system.

The main purpose of this study was to develop a power control system outage device. Specifically, this study sought, to determine the sensitivity of remote control and real-time monitoring of the device in terms of internet connectivity.

II. METHODOLOGY

In order to establish an empirical foundation for the creation of both instructional and non-instructional products and tools, as well as new or improved models that guide their development, this study used design and development research (DDR), which is defined as the systematic study of design, development, and evaluation processes (Hung et al., 2010). (Richey and Klein, 2008).

According to Richey and Klein (2014), a number of studies in design and development research (DDR) can be classified as multi-method studies since they employ multiple methods, as opposed to only one.

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Based on insights gained from the literature review and stakeholder requirements, the research conceptualizes, and designs IoT-enabled protective devices tailored to address specific challenges related to power interruptions. This phase involves defining device specifications, selecting appropriate components and sensors, and designing the system architecture.

Developing, testing, and deploying protective devices with enhanced Internet of Things (IoT) capabilities is done through a multimodal method in this study. Research techniques include several phases, such as ideation, design, prototype, testing, and assessment. To establish a thorough understanding of current technologies, approaches, and applications linked to protective devices, power systems, and IoT integration, the research starts with a detailed review of the literature.

Overall, the methods of research for Internet-connected power outage prevention device encompass a systematic and iterative approach to design, develop, test, and evaluate innovative solutions for mitigating risks associated with power interruptions and enhancing the resilience of electrical infrastructure. Through collaboration with stakeholders, rigorous testing, and continuous improvement, these methods aimed to deliver reliable and effective IoT-enabled protective devices tailored to the needs of end-users and the requirements of modern power systems.

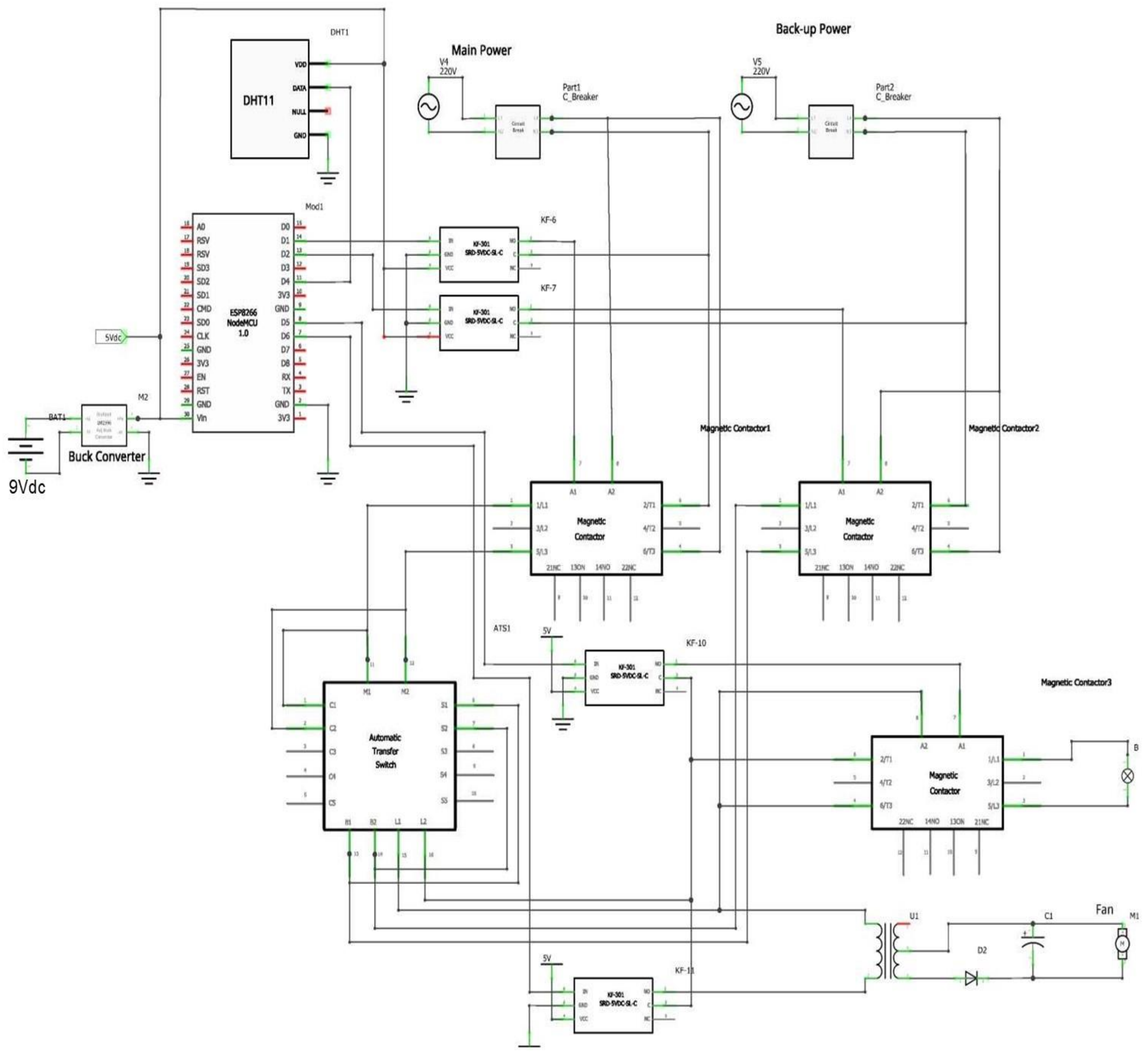

Figure 1. The schematic diagram of the power control system outage device.

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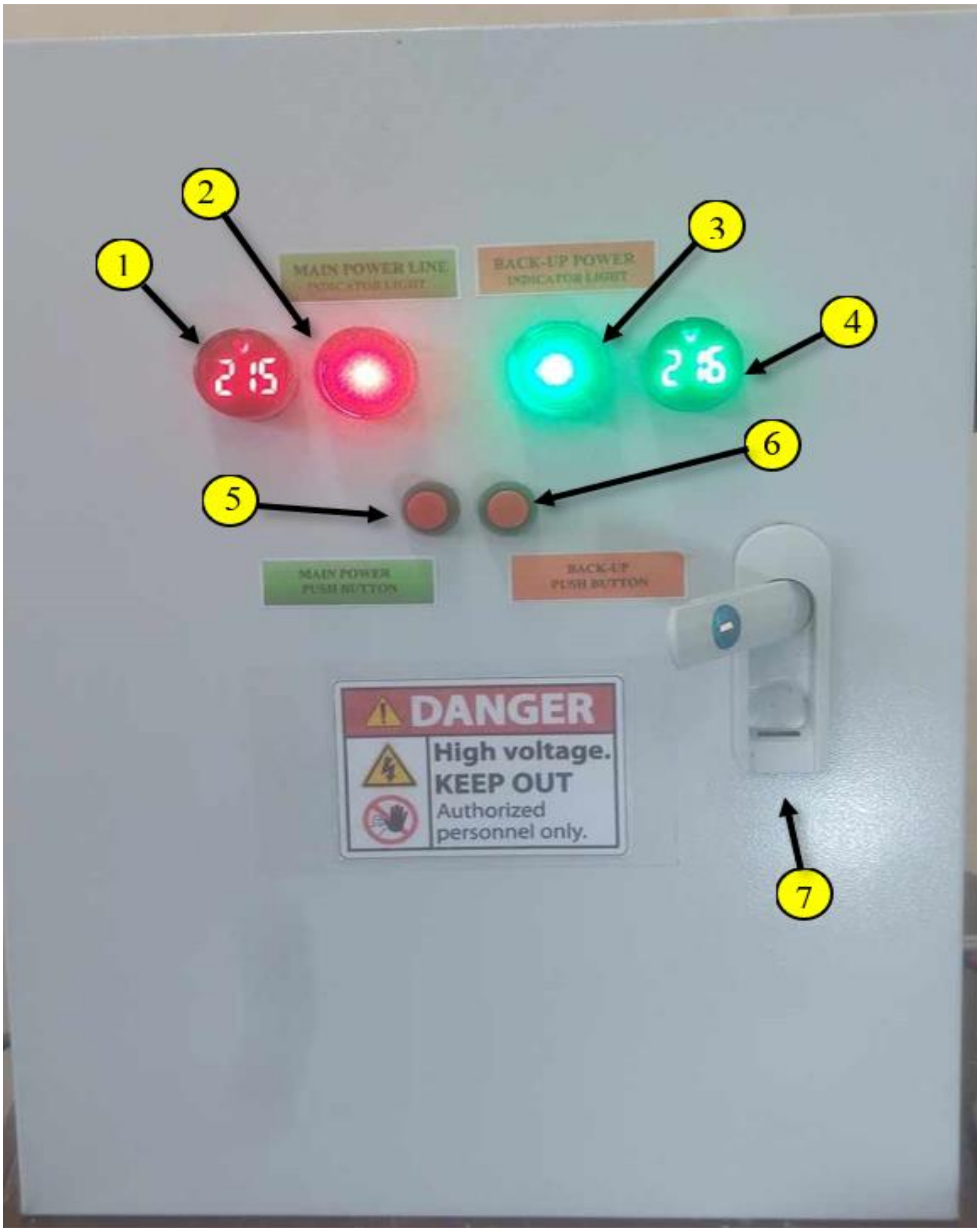

Legend:

1. Main Power Voltmeter (Grid)
2. Main Power Status Indicator
3. Backup Power Status Indicator
4. Backup Power Voltmeter
5. Main Power Manual Push Button Selector
6. Backup Power Manual Push Button Selector
7. Safety Door with Lock

Figure 2. The front panel of the power control system outage device.

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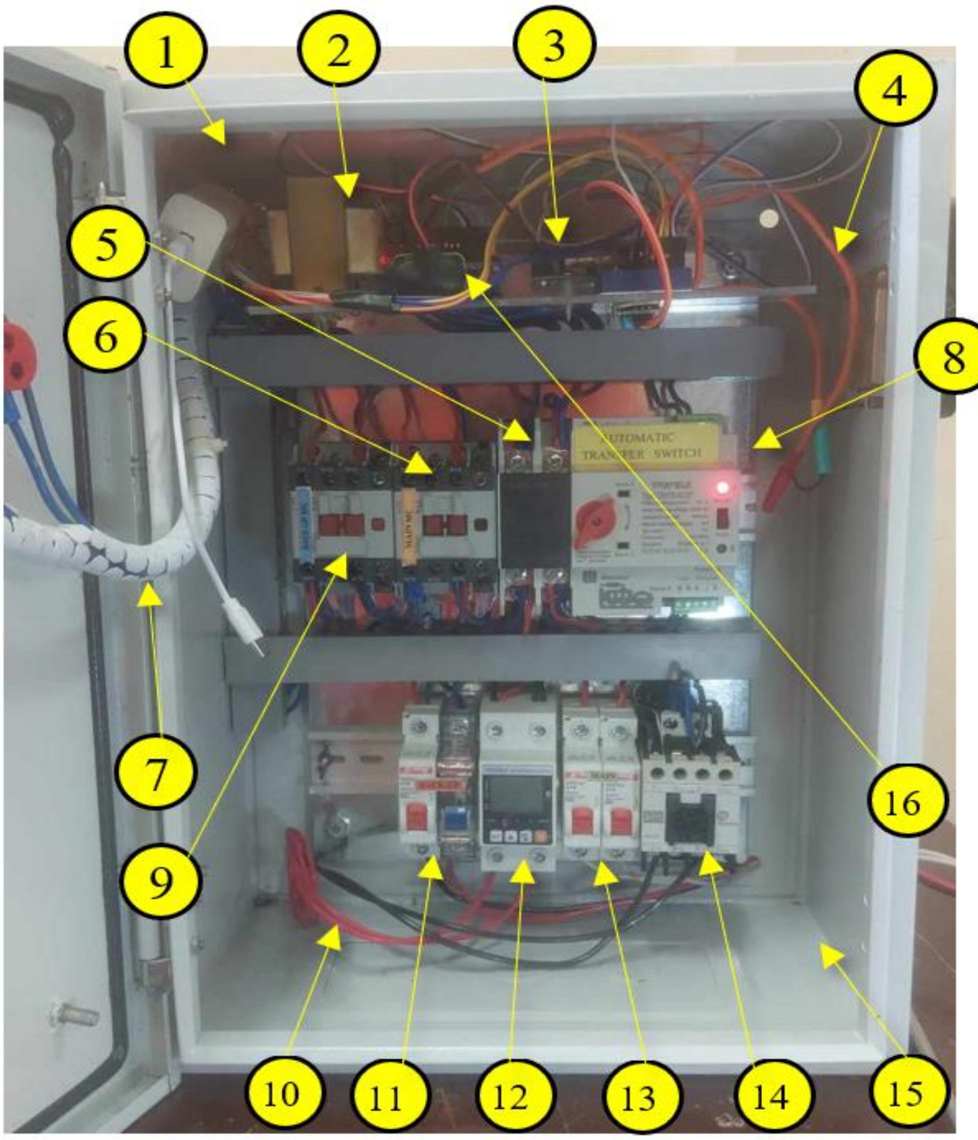

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Legend:

1. Magnetic Contactor
2. Wiring to
3. CB for Main Power
4. Sinotimer
5. CB for Back up Power
6. Magnetic Contactor
7. Panel Board/Chassis
8. 4 Channel Relay
9. Power Transformer for Exhaust fan
10. 9V Rechargeable Battery
11. Node MCU
12. Wiring
13. Magnetic Contactor
14. Magnetic Contactor
15. Wiring connection for manual control
16. Automatic Transfer Switch

Figure 3. The internal components of the power control system outage device.

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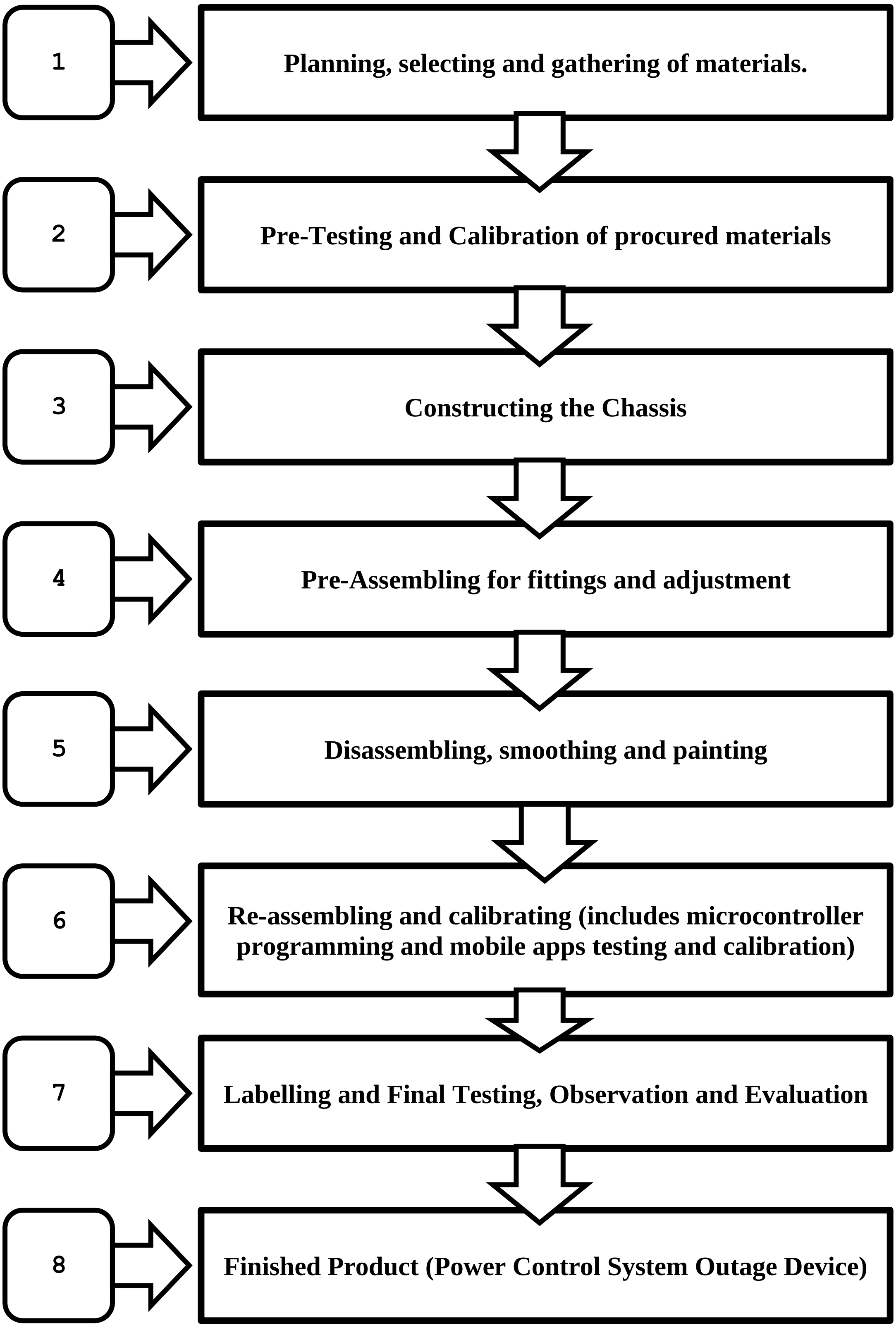

Figure 4. Flow chart in making the power control system outage device.

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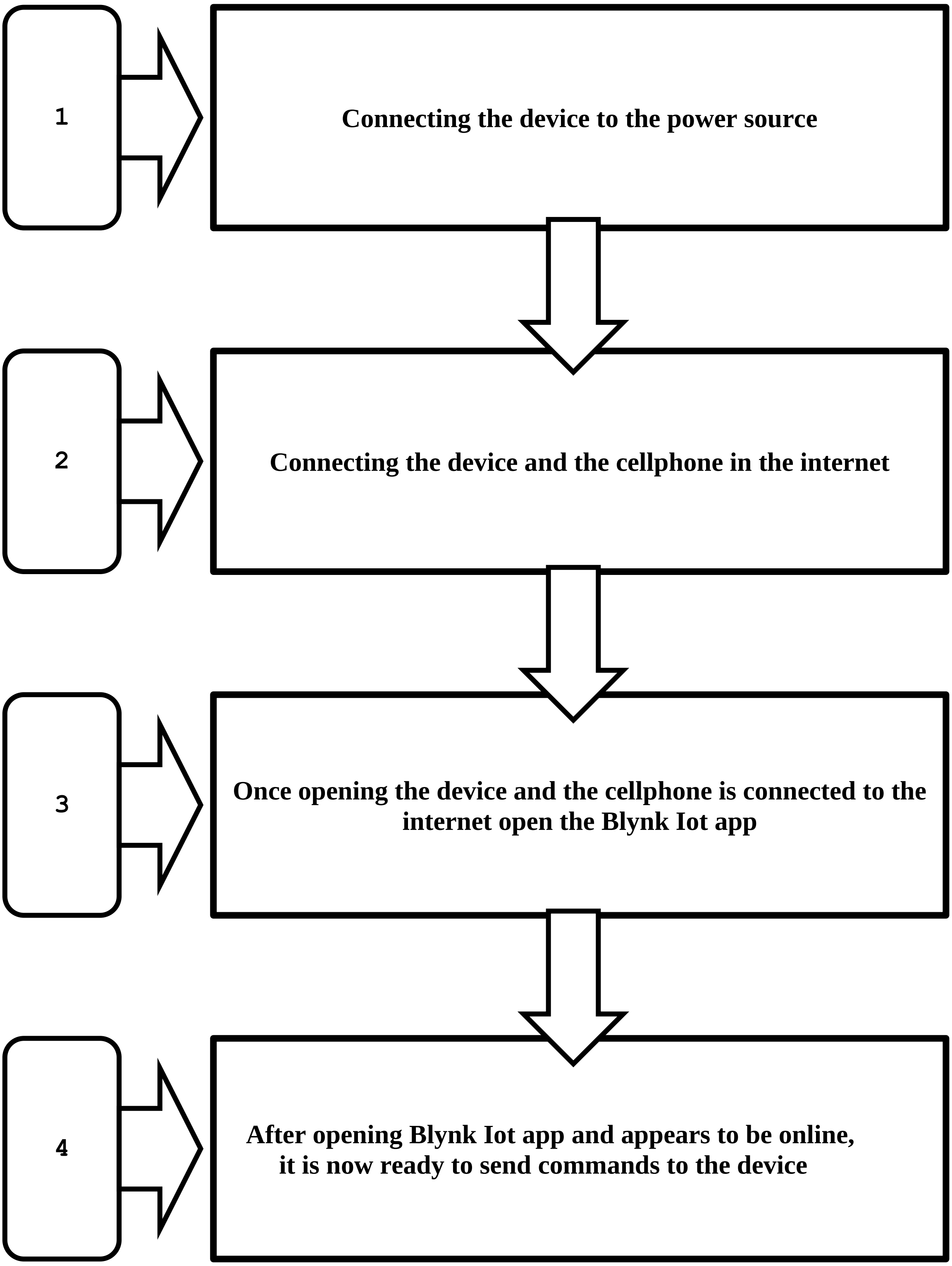

Figure 5. Flow chart on how to use the device.

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III. RESULTS & DISCUSSION

Sensitivity of Power Control System Outage Device Remote Control and Real-Time Monitoring in terms of Internet Connectivity

The sensitivity of the power control system outage device remote control and real-time monitoring in terms of internet connectivity was found to be "Very Sensitive". Prototyping was conducted to translate the conceptual design into a physical prototype of the IoT-enabled protective device. This involves assembling the necessary components, integrating IoT modules, and developing the firmware or software necessary to enable communication, data acquisition, and control functionalities. The prototype undergoes rigorous testing and validation to assess its performance, reliability, and effectiveness in detecting, monitoring, and responding to power interruptions.

This result was also another sensitive issue regarding power system fault-protection related to the complexity of integrating the IoT based controls to the power sources in the existing power grid and auxiliary power sources available, which underlines even more the necessity of viable solutions against faults like short-circuits and brownout. Consequently, this highlights the importance of disconnecting power when detecting current zero-crossing. Nevertheless, the assimilation of distributed sources into existing power distribution networks raises important technical challenges, including issues related to the need of enhanced protection systems against power failures. Moreover, the remote control and real time monitoring of power interruption protective device with IoT, the researcher employed ten (10) trials to get the grand score of 10 interpreted as "Very Accurate". The analysis of the current state-of-the-art feature of IoT based monitoring shows the advantage of smart system—type solution, and the traditional protection systems do not offer real-time monitoring and communication features. There is an emerging Electrical Substation Communications Standard (IEC-61850) that is Smart Grid compatible and enables communication over the power grid for monitoring and control, however such systems are generally dedicated for power utility providers and specialists, not being designed to provide monitoring or notifications to end-users or third-parties (e.g local public administration entities or emergency services). The remotely controllable and monitoring in IoT based integration include smart breakers and automatic transfer switch used for local power generator capacity and automatically transfer to the power grid if the power returns to normal operation and it represents a remotely controllable device protecting against short-circuits and overloads. The device demonstrated sensitivity in terms of internet connectivity, allowing for effective remote control and real-time monitoring of power interruptions. As mentioned above, the device has been designed with the goal been integrated in smart environments like smart homes or smart cities for protecting the electrical equipment from faults and anomalies. The device allows remote monitoring and control of the coupling/decoupling feature using IoT, but also supports real-time notifications and provides enhanced protection against a wide range of electrical failures.

This means that the sensitivity of remote control and real-time monitoring of power interruption protective devices with IoT underscores the critical importance of reliable internet connectivity. Addressing connectivity challenges and implementing redundancy measures are essential to maximize the effectiveness and reliability of IoT-based systems for power interruption detection and response.

The result of this study conforms with the study of Noura et al (2019) that the importance of interoperability in IoT as it allows integration of devices, services from different heterogeneous platforms to provide the efficient and reliable service. Overall, the sensitivity of remote control and real-time monitoring of power interruption protective devices with IoT in terms of internet connectivity is crucial for ensuring prompt detection, response, and mitigation of power-related issues, thereby enhancing the reliability and resilience of electrical infrastructure.

Table 1. Sensitivity of remote control and real-time monitoring of power control system outage device in terms of internet connectivity.

Quality Attributes	Trials										Score
	1	2	3	4	5	6	7	8	9	10	
Remote Control	1	1	1	1	1	1	1	1	1	1	10
Real-time	1	1	1	1	1	1	1	1	1	1	10

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IV. CONCLUSION

Based on the above end-user evaluation result mentioned in the findings of the study, the following conclusions were drawn:

The IoT-integrated power control system outage device has precise and responsive manual and remote control features. Through mobile phones, users can receive timely alerts and updates about power outages and overheating. Furthermore, in the event of an interruption, the automatic system seamlessly transitions to a backup power supply and guarantees real-time monitoring. Due to its adaptability, it may be installed on panels at any location with internet connectivity.

The findings of the study disclosed that the power interruption protective device with IoT was “Very Sensitive”. It was very sensitive in its remote control and real-time monitoring.

The device automatically responded when power interruption occurred. This was due to the design of the device which functions properly.

Regarding the power control system outage device's accuracy using the Internet of Things for real-time power interruption response and detection. The researcher used ten (10) trials to determine the grand score of 10 which was interpreted as "Very Accurate," in order to detect power interruptions in the device.

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