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IoT-Based Lighting Panel Distribution Control Design for Smart Building Systems in Low-Rise Buildings

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Abstract: This research discusses a small schematic of an IoT-based smart building control system for a building's lighting distribution panel. This is intended to provide a basis for larger developments in the overall distribution of the building. The focus of this research is on IoT-based equipment and the design of the lighting distribution panel. IoT equipment can act as a pilot/command to control a lighting distribution panel, and the lighting panel is designed to be controlled by IoT-based equipment.

Keywords: *Control System, Lighting Distribution Panel, IoT, and Smart Building.*

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I. INTRODUCTION

The current development of IoT technology has become an innovation for the development of smart building designs. This is particularly true for lighting panel distribution control systems in buildings, which still utilize several products that dominate the market for smart building systems or building automation. [1] [2] [3] [4] [5]

Furthermore, the high cost and consumer dependence on providers are also driving innovations in smart buildings. This innovation aims to produce smart building products with relatively low prices and user-friendly operating systems. This research will outline the communication and control systems for electrical panel equipment in buildings. [6] [7]

II. CONCEPT

➢ *Concept of Equipment Network Communication.*

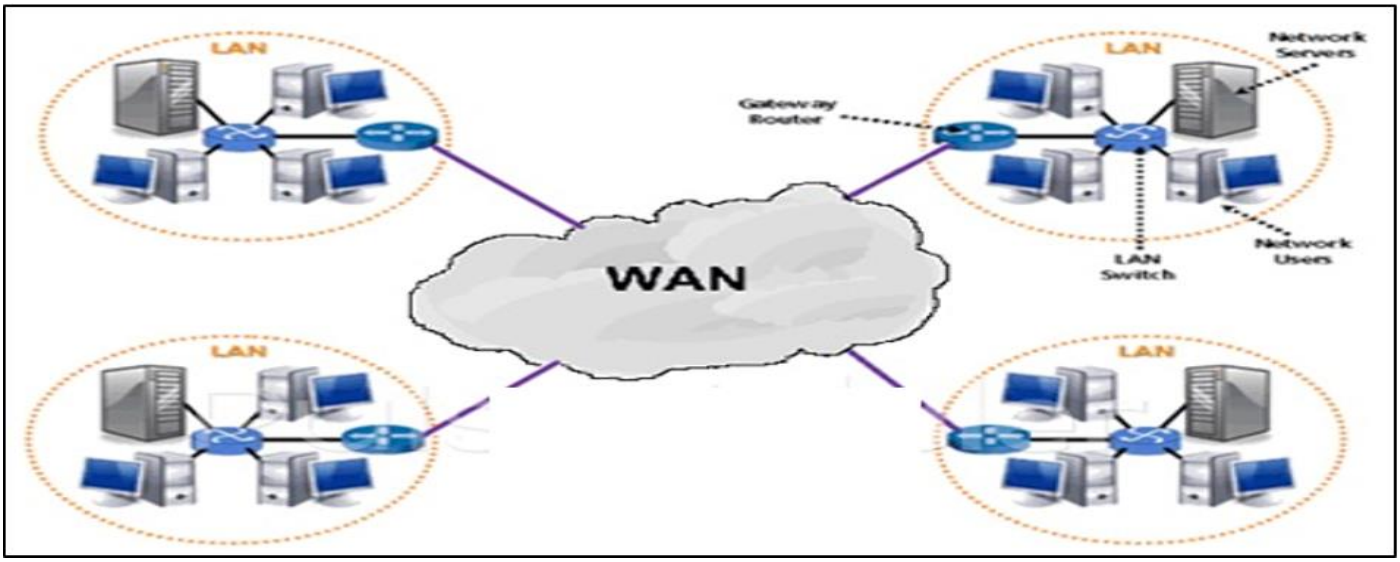

Fig 1 Ilustration for Local Area Network & Wide Area Network.

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Communication on IoT devices naturally uses the internet. The network communication process can connect each device, allowing it to communicate locally (Local Area Network) or over a wide area (Wide Area Network).[8] [9]

The Internet of Things (IoT) is a network of physical devices connected via the internet, capable of communicating with each other and exchanging data. These devices can encompass a wide range of objects, from electronic devices to sensors, vehicles, and household appliances.[10] [11] [12]

Fig 2 Ilustration Internet of Things.

In this study, the communication concept used is base on the working systems of internet and IoT networks. An illustration of the network and IoT itself can be seen in Figures 2 and 3. The communication concept can be designed step by step as follows:

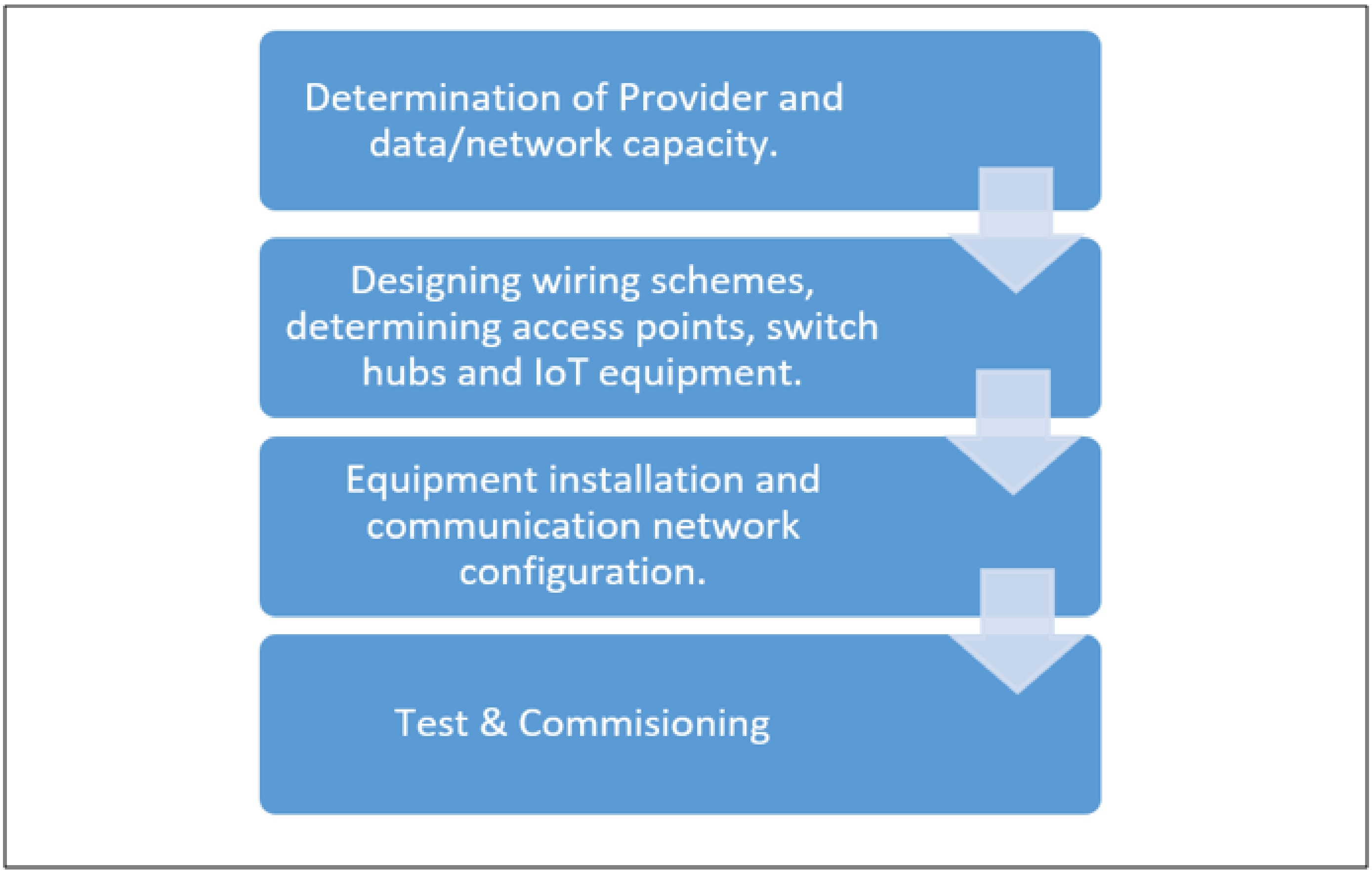

Fig 3 Step for Communication Design.

Based on the steps in each network communication design, the communication scheme for each device can be depicted, as shown in Figure 4. The actual application of the communication system can be seen in Figure 5, where the IoT device, a mini smart switch, is connected to an access point, router, smartphone/monitor, and the provider's network.

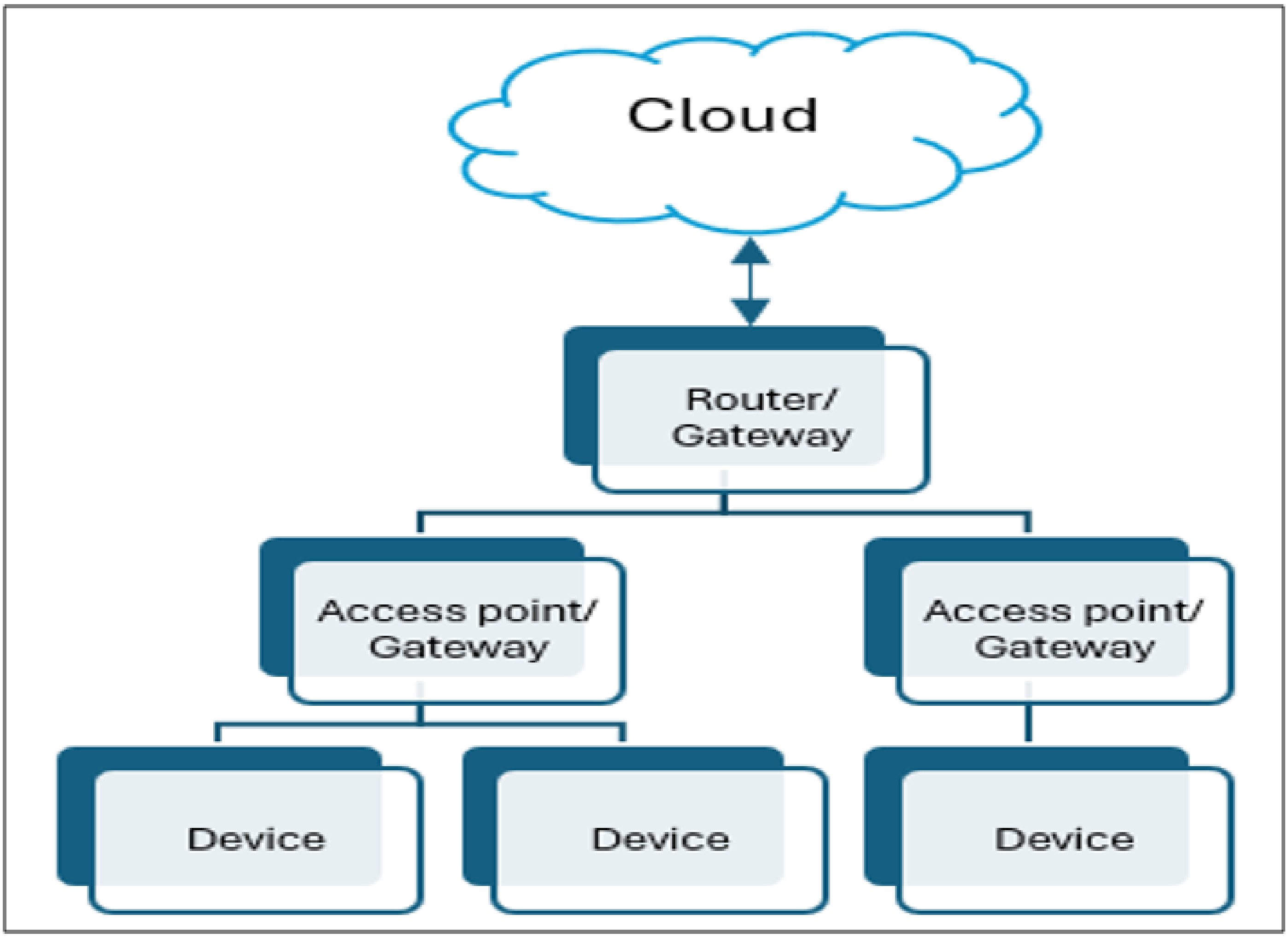

Fig 4 Communication network concept.

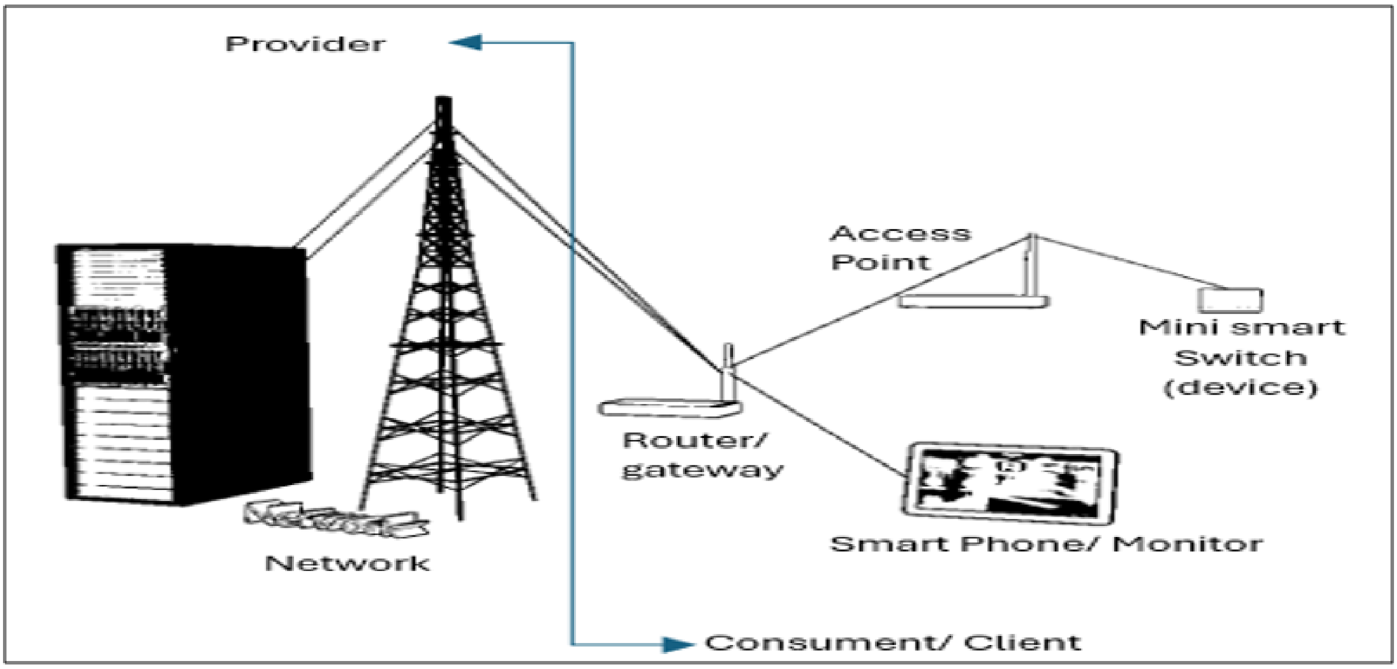

Fig 5 Actual Concept for Communication Aplication.

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➢ *The Concept of Iot Equipment as a Control System Controller.*

Fig 6 Figure 6 IoT Device, Mini Smart Switch 4 CHPRO

The IoT device used in this study is a 4CHPRO smart switch. This device includes several features, including:

- 4CHPRO consists of four digital outputs, configured in software or an app (developed by Tuya) within the network system.
- 4 direct/manual buttons for each output channel.
- 4 indicator lamps for each output channel, and one wireless indicator.

From the data above, this device can control four outputs remotely using an internet connection via the available application. It can also control four outputs over short distances using the direct/manual buttons on the 4CHPRO device.

Each component of the device can be seen in Figure 7. This device can also be configured using smart applications such as Smart Lamp, Smart Life, and Tuya Smart, available on the Play Store or similar smartphone apps.

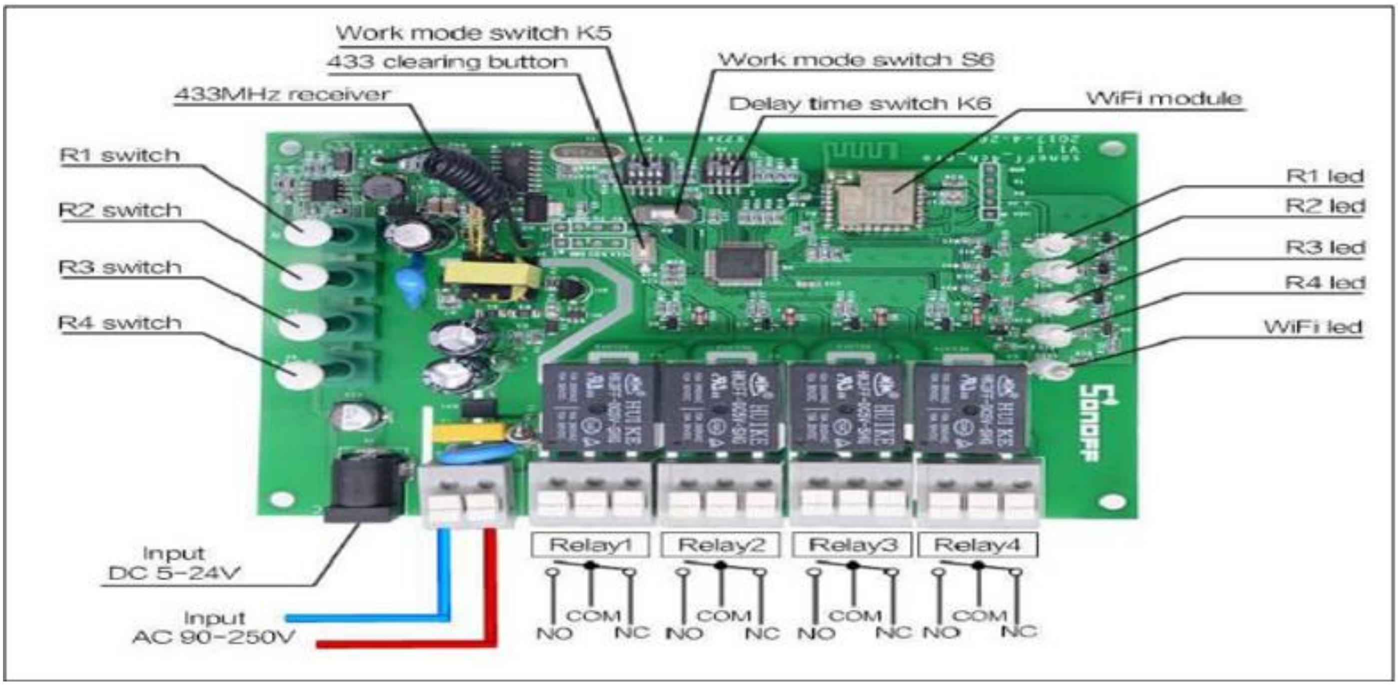

Fig 7 Function for Fixture.

The display on the smartphone application installed on the smartphone for the 4CHPRO smart control application. The display shows four control buttons on the screen and four addresses for each named output.[13]

Fig 8 Application display on smartphone in 4CHPRO control application.

➢ *Lighting distribution panel concept.*

Since the output of an IoT control system is digital, the lighting distribution panel concept must be magnetically operable. Therefore, several key mechanical devices in electrical connection devices can be divided into two operating characteristics:

- Manually operated mechanical connectors, such as MCCBs, MCBs, and other non-magnetic or motor-operated connectors.
- Magnetically operated mechanical connectors or motor-operated connectors. These include ACBs (motorized), MCCBs (motorized), magnetic contactors, relays, and other electrical connectors.

Given the operating characteristics of electrical connection devices, each manual mechanical connector must be the primary input from the power source before being fed to the magnetically operated connectors. Each work command from each magnetically operated connector is executed through relays controlled by the IoT control device.[14] [15] [16] [17]

A schematic diagram of a lighting distribution panel can be seen in Figure 9. The panel consists of:

- 3-Phase MCCB.
- 3-Phase Magnetic Contactor.
- Single-phase MCB.
- Single-phase magnetic contactor.
- Control relay.
- Digital input terminal (for connecting IoT equipment outputs to the lighting distribution panel).

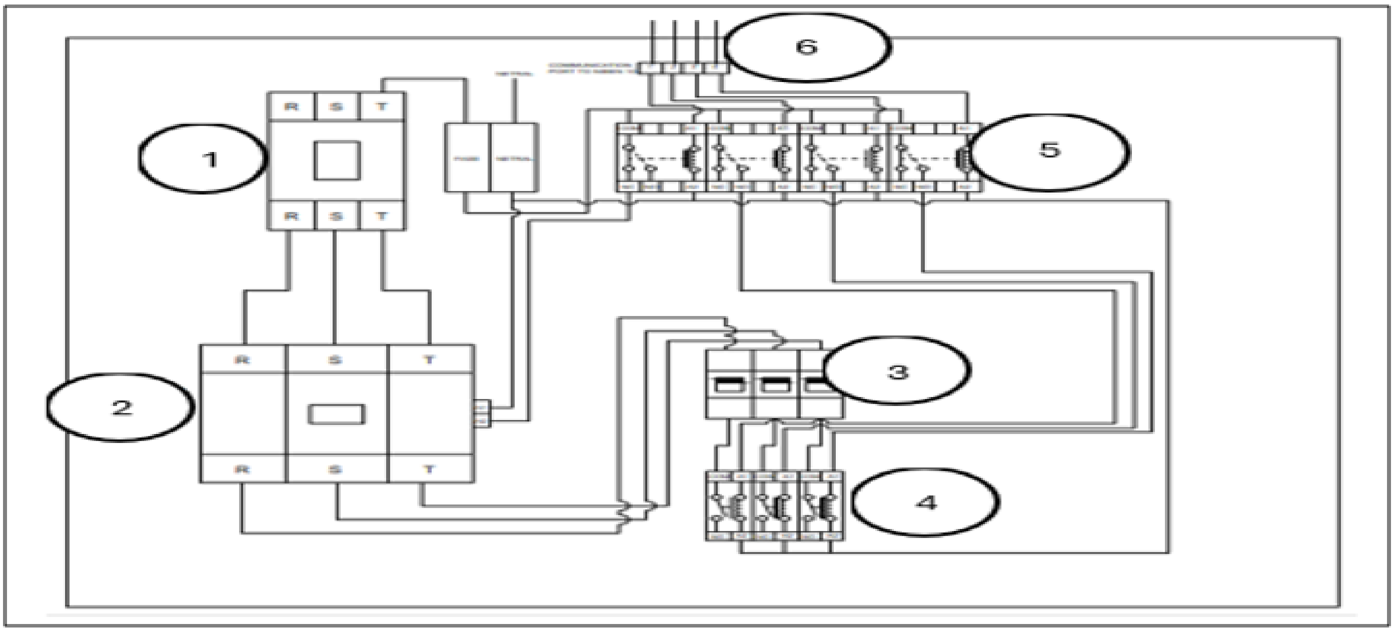

Fig 9 Schematic drawing of lighting distribution panel plan.

III. EQUIPMENT DESIGN SCHEME.

The equipment design scheme can be derived from several predetermined concepts, including the communication concept, the IoT equipment concept, and the lighting distribution panel concept.

Based on the IoT equipment concept used, several equipment design schemes can be determined. These include:

- IoT equipment communication.
- IoT equipment control system in the lighting distribution panel.

- *Iot Equipment Communication.*

IoT equipment communication in the design of an IoT-based lighting distribution panel control system requires several network devices and network requirements from the provider. Because the network is not built using a standalone big data or an in-building server, the network communication requirements include:

- Internet network from a provider (Telkom, Biznet, Republik, and others as network providers).
- Access points for wireless network communication are placed in each control room and lighting distribution panel.
- Network cable installation.

The communication scheme can be seen in Figure 10.

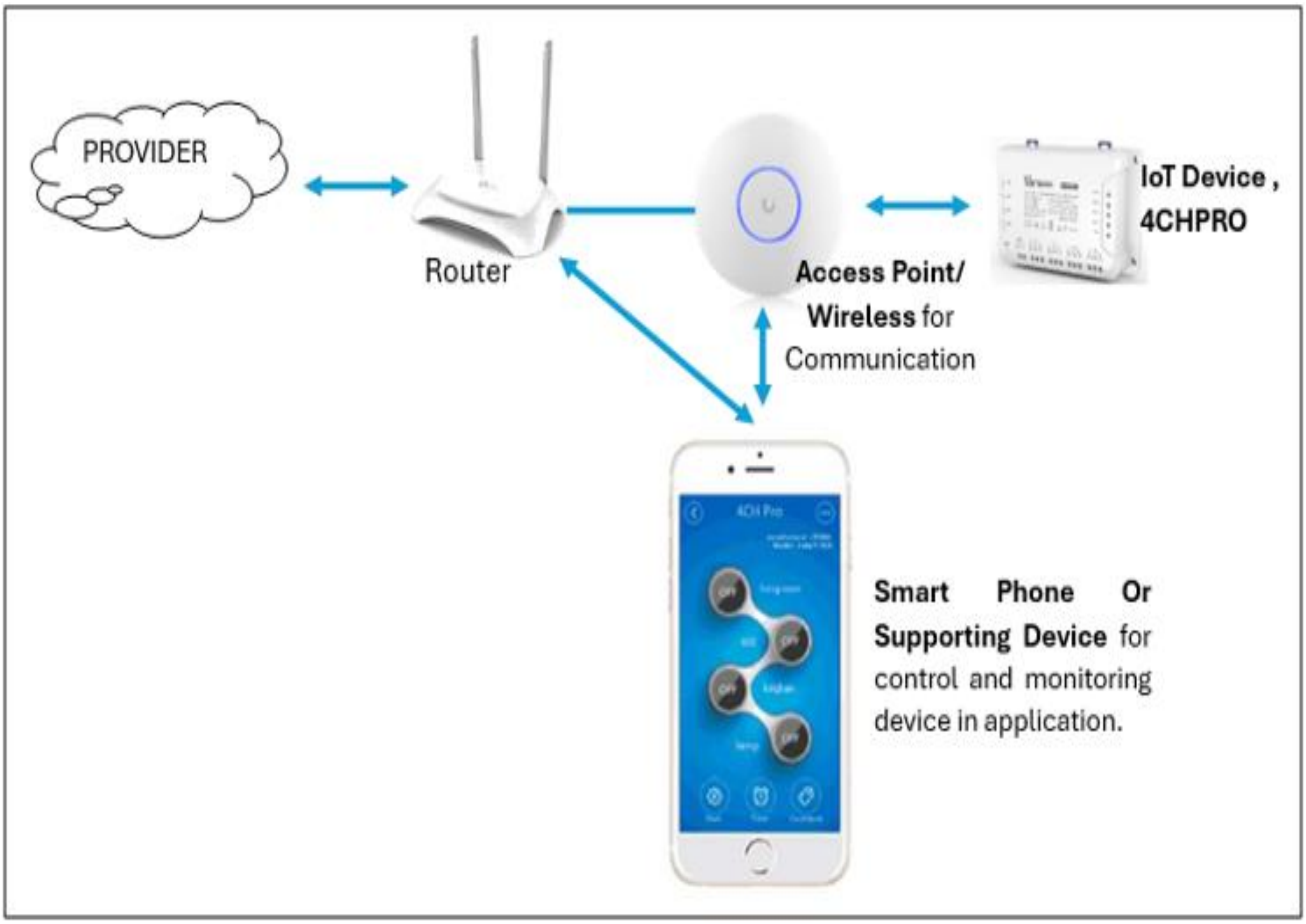

Fig 10 4CHPRO IoT Equipment Network Communication Schematic.

- *Wiring the Iot Control System on a Lighting Distribution Panel.*

Wiring can be determined based on the digital outputs required for the control system on the lighting distribution panel and tailored to the needs of the lighting distribution panel.[18] [19] [20]

In this IoT control system wiring, reference can be made to the outputs of the IoT equipment used. If the IoT equipment has four digital outputs, the lighting distribution panel can also be adjusted to only four outputs. For larger designs, this research can be further developed and designed according to actual requirements.

The wiring schematic can be seen in Figure 11.

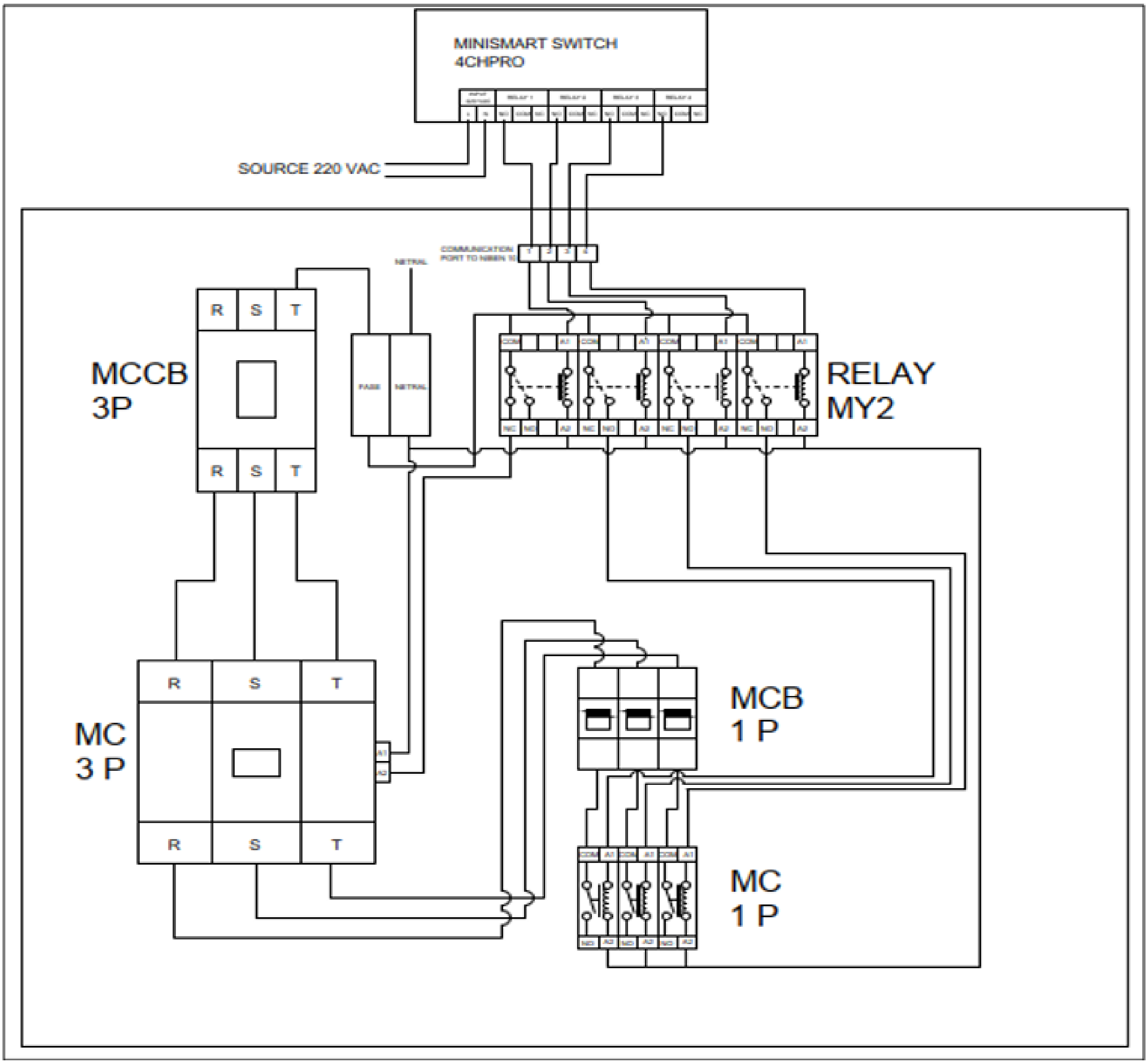

Fig 11 IoT Equipment wiring diagram on the lighting distribution panel.

IV. DESIGN & TESTING

➢ *Design*

From the communication and wiring diagram of the IoT devices in the lighting distribution panel control system, the overall communication and wiring diagram can be illustrated in Figure 12.

From Figure 12, the operating principle of the IoT control system can be outlined as follows:

- IoT devices must be scanned on available networks so that the communication systems on the IoT device can communicate with each other on the available network.
- Once a device has been configured in a single application, both the ID of each IoT device and the device ID of the available network can be controlled with a single application on the available network. Each network device has been configured with the ID of each IoT device used.
- Based on the above, when the application informs a circuit on a specific channel to turn on/off, the circuit will be turned on/off in real time, either remotely or within the control area and the controlled equipment room.
- This equipment can also be directly controlled, either on/off, using the available IoT equipment's manual button. This is to prevent network communication failures.

This design depicts a single diagram of the lighting distribution panel, as seen in Figure 13, and each test on the single control diagram using a relay simulation application.

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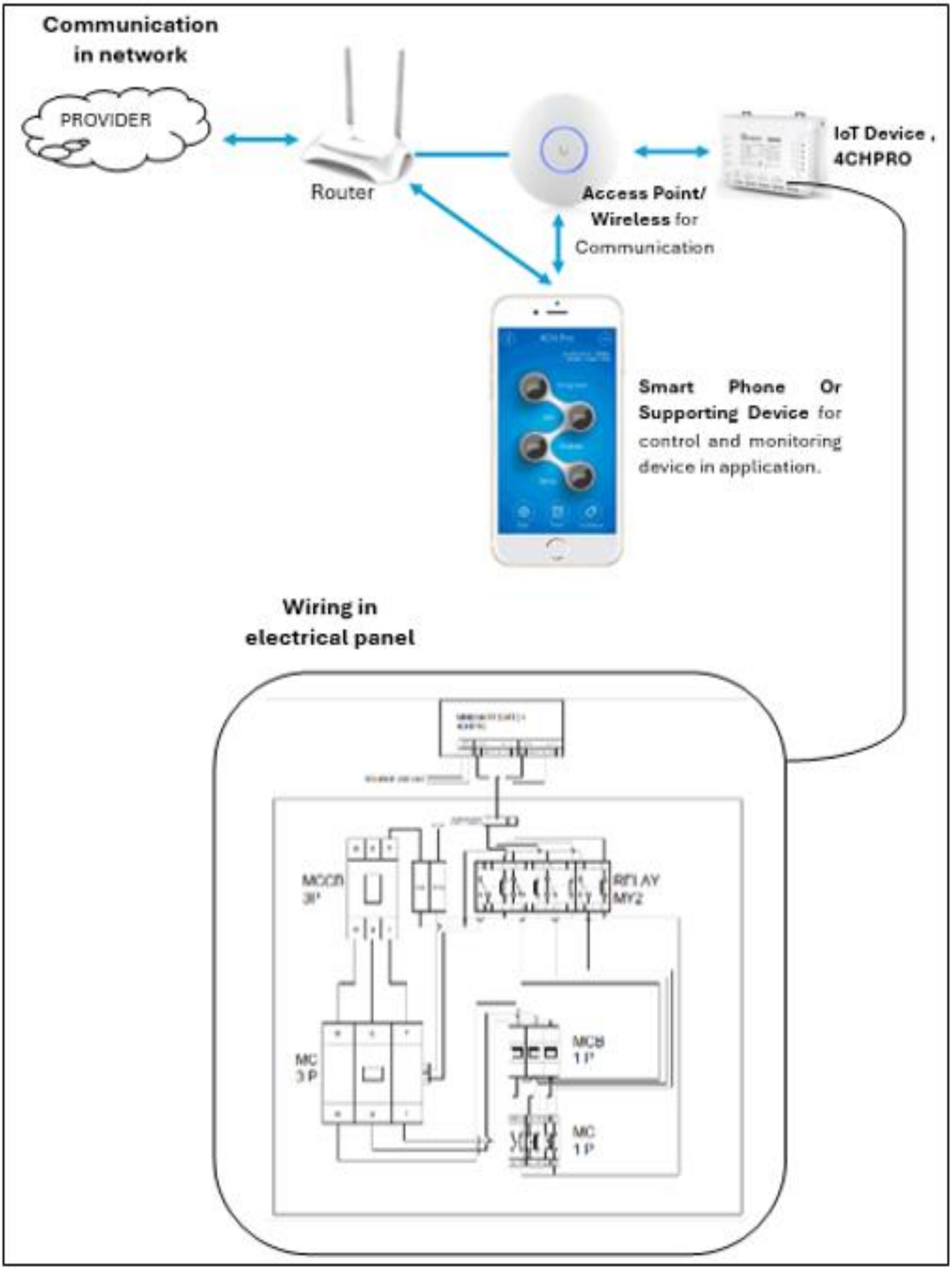

Fig 12 Overall schematic of IoT equipment in terms of communication and wiring.

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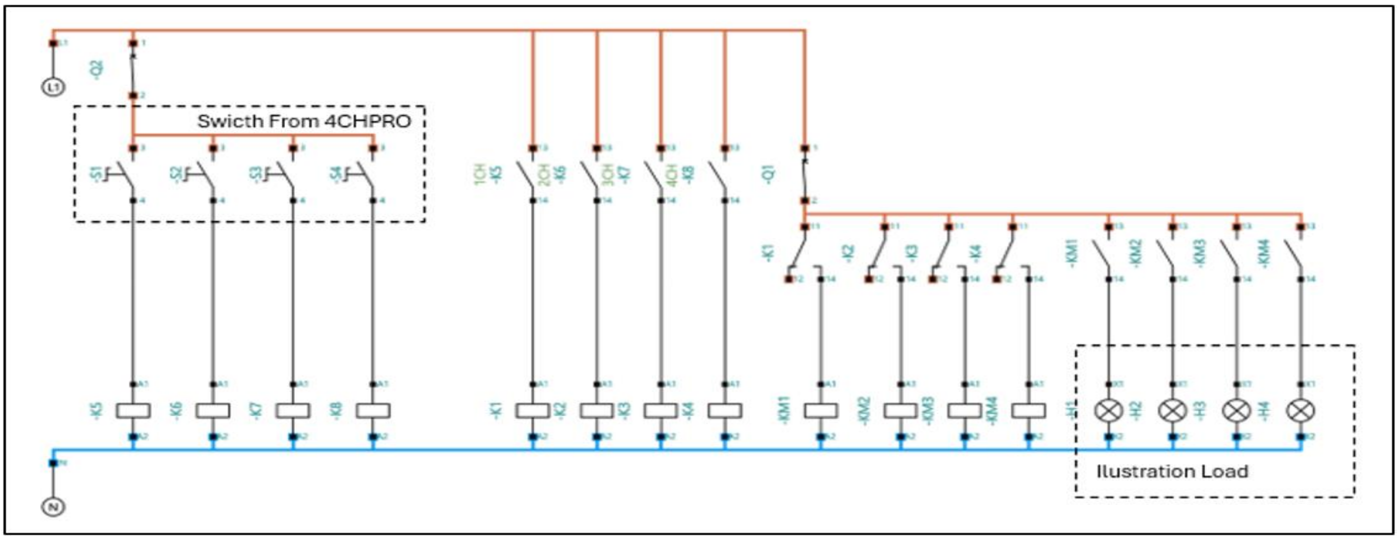

Fig 13 Single Diagram Lighting Distribution Board.

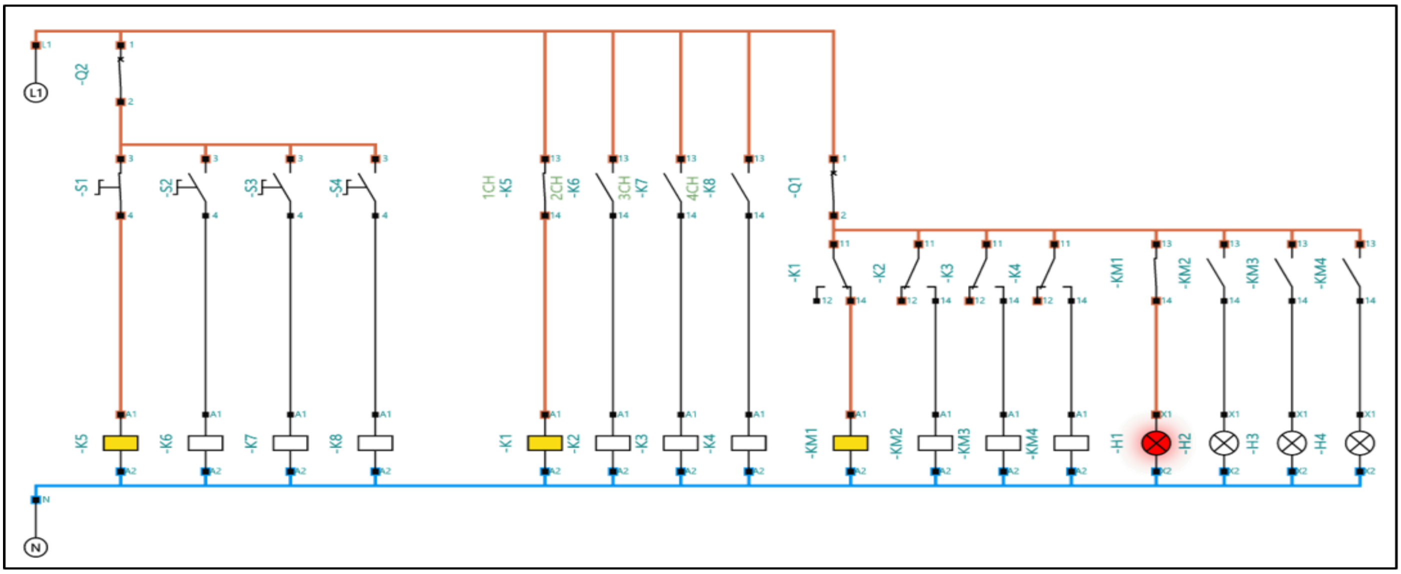

Fig 14 The condition of the circuit working under 2 load conditions.

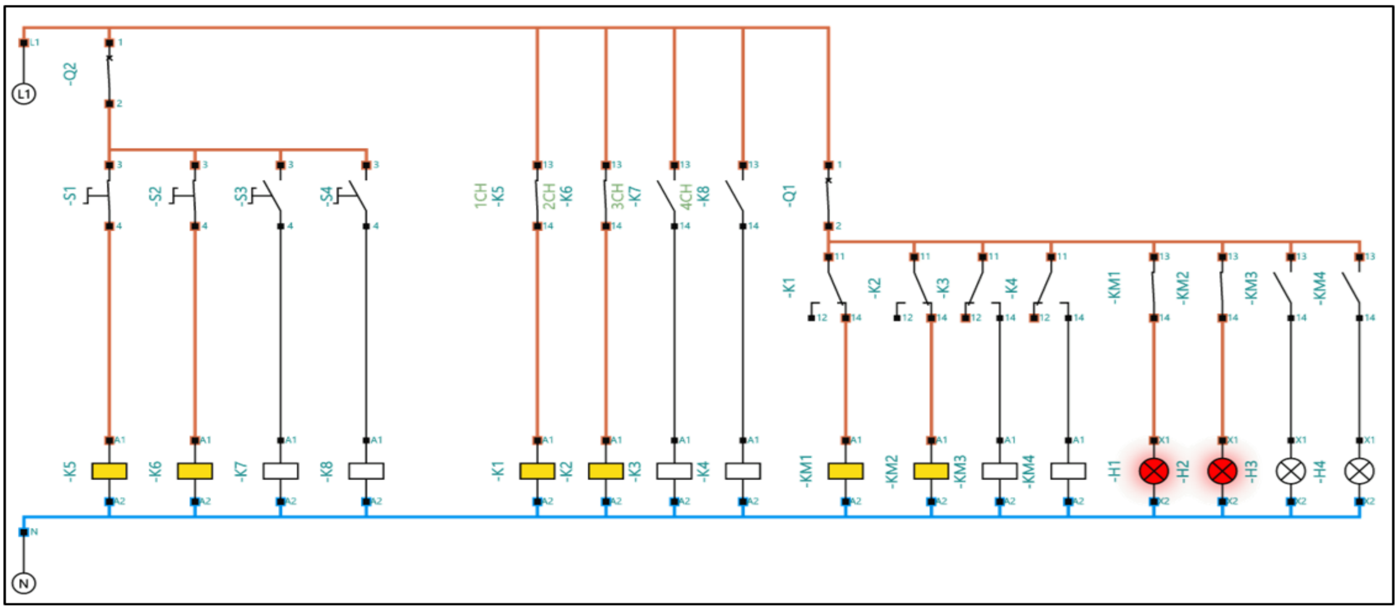

Fig 15 The condition of the circuit working under 3 load conditions.

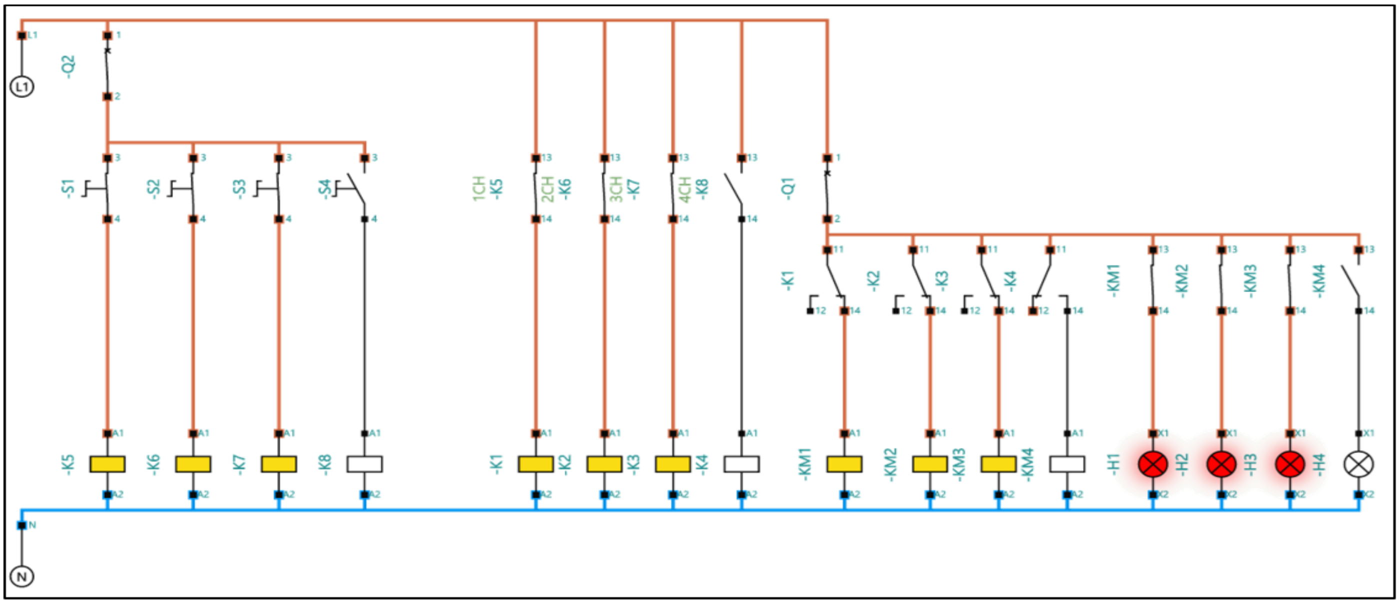

Fig 16 The condition of the circuit working under 3 load conditions.

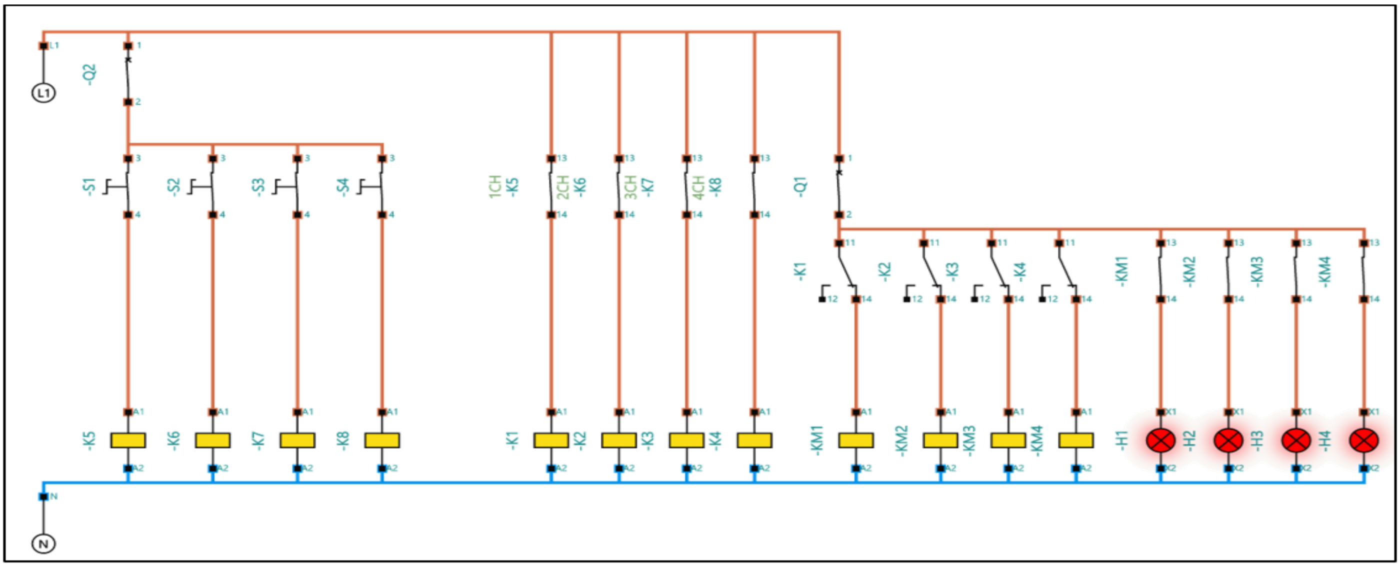

Fig 17 The condition of the circuit working under 4 load conditions.

V. CONCLUSION

Based on the data compiled in the research on the design of an IoT-based lighting distribution panel control system and circuit testing using simulations in control software, it can be concluded that:

- The control system can be applied in real life.
- This control system allows for remote control and can be operated by multiple operators from different locations, as communication uses internal and external networks.
- In real-world development, real-world requirements can be calculated.
- IoT equipment can be further developed on a large scale, for both commercial and industrial needs.

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