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Use of Smart Switch in Electrical System

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ABSTRACT

Switches are essential components in electrical installations, serving to control the flow of electricity by either connecting or disconnecting circuits. While conventional switches are widely used, their effectiveness and efficiency are often limited, particularly in terms of energy conservation and automatic management of electrical devices. This issue creates a demand for innovation in the form of smart switches that can enhance control, safety, and energy efficiency. This study aims to analyze the use of smart switches in electrical systems and their implications for safety and energy efficiency. The method employed involves a literature review and comparative analysis of households, hotels, and high-rise building installations that utilize smart switches. The results indicate that smart switches provide more flexible control over electrical devices, enable automatic disconnection when not needed, enhance electrical safety, and support energy conservation. The implications highlight the importance of adopting smart switches in various electrical installations to improve energy efficiency, safety, and user convenience, while also serving as a reference for the development of modern electrical systems in the future.

Keywords: *switch, electrical system, electrical control, on/off control, energy saving.*

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INTRODUCTION

A switch is a device that functions to connect and disconnect electric current from the voltage source to the load. Switches not only serve to turn lights on or off, but they can also be used to regulate the connection of electrical current to other devices (Hong et al., 2021; Ke et al., 2020; Mahardiananta et al., 2021; Shen et al., 2021; Wissman et al., 2017; Zhu et al., 2022). Although they can be applied to a variety of electronic devices, the working principle of switches remains the same for all applications. Switches consist of two metal blades attached in a circuit. These blades can be connected or separated as needed. When the switch is in the "on" position, electric current will flow, while in the "off" position, the electrical circuit will be disconnected (Alamer et al., 2022; Crunteanu et al., 2010; Hayashi et al., 2020; Wang et al., 2024; Zhu et al., 2020).

Switches not only function as components that disconnect and connect electrical current, but they also serve as safety devices to help prevent electrical accidents, such as fires or electric shock. To conserve electrical energy, switches allow us to turn off unused devices or equipment, thereby saving electrical energy. Switches can come in various shapes and types, such as single switches, series switches, changeover switches, cross switches, and automatic

(sensory) switches used in modern systems. The existing types of switches have their own advantages according to consumer needs, making them suitable for use in households, high-rise buildings, and even in companies or industries. Most people know that switches are only used to turn lights on or off. However, without realizing it, doorbells and horns on vehicles also have switches. This type of switch is commonly known as a "contactor." Additionally, street lights also have switches, which are automatic (sensory) switches, better known as time switches or timers (Agus Purnama, 2022; Al Ghifari et al., 2022; Muthmainnah et al., 2023; Saputra et al., 2020).

Previous research by Sharma and Singh (2019) emphasized conventional mechanical switches, highlighting reliability and basic safety aspects in household and industrial use. This study successfully showed that conventional switches are quite effective in securing electrical installations and meeting daily needs. However, the study lacks discussion of the application of more adaptive modern switches, such as smart switches, and how they affect user comfort and energy efficiency in different types of buildings.

Meanwhile, a study by Li, Chen, and Zhang (2021) examined sensor-based automatic switches in smart home systems. The study emphasizes energy savings and ease of automation, but is still limited to the household environment and does not address the integration of smart switches in high-rise buildings or industrial installations. Additionally, this study has not comprehensively assessed the combination of energy efficiency, electrical safety, and user comfort in the context of modern switch applications.

From these two studies, it can be seen that there is an unaddressed gap, namely the lack of studies that compare conventional switches and smart switches in the context of functionality, safety, energy efficiency, and ease of use in various environments, including houses, high-rise buildings, and industrial facilities. This research aims to fill this gap by analyzing the application of smart switches more broadly and comprehensively.

This study uses a descriptive approach and comparative analysis of different types of switches applied in modern electrical installations. By assessing the aspects of safety, energy efficiency, and user comfort, this study aims to provide a comprehensive understanding of the benefits of smart switches over conventional switches. The research results are expected to serve as a reference for users, building managers, and policymakers in improving electrical safety and energy efficiency in a sustainable manner.

Thus, the purpose of this study is to analyze the application of smart switches in modern electrical systems and compare them with conventional switches. The benefits of this research include providing practical recommendations for users in choosing appropriate switches, improving the safety of electrical installations, supporting energy savings, and contributing to further research related to the optimization of electrical systems in various types of buildings and industrial facilities.

METHOD

This study uses the library research method to obtain a comprehensive understanding of the use of smart switches in electrical systems. Data was collected from various relevant sources, including student learning modules from the Manado State Polytechnic Electrical Engineering Study Program, scientific articles, journals, and related publications that discuss smart switches, their functions, and comparisons with conventional switches.

The data collection process was carried out systematically by selecting appropriate literature, verifying the accuracy of information, and recording findings relevant to the research topic. The focus of data collection includes the characteristics of smart switches, types of smart switches, working principles, advantages, and their applications in household, building, and industrial electrical installations.

After the data was collected, data analysis was carried out in a descriptive-qualitative manner. The analysis aims to identify patterns, similarities, and differences between smart switches and conventional switches and assess their benefits for energy efficiency, safety, and user comfort. The information obtained was then synthesized and presented systematically so that it is easy to understand and can be used as a reference for the development of modern electrical systems.

RESULTS AND DISCUSSION

Based on the results collected, it can be concluded that the working principle of switches in electrical systems based on the mechanism of switches works based on the principle of opening and closing electrical circuits. This working principle is based on the "on" and "off" buttons. The switch serves to turn one or more lights on and off. Switches are widely used in any household.

A switch is one of the components in an electrical installation that is usually used in an installation which is one of the main components or tools in an installation. Switches are also very useful for users or users of an installation because switches are also a safety in disconnecting and connecting electrical current. MCB is also a type of short-circuit or overload safety switch. The switch serves as a component that disconnects and connects the current. The switch also has the disadvantage, which is that it cannot withstand more loads. There are also many different types of switches, with each having a function according to the type of switch. For example

(1) Single switch, in its operation a single switch has a single contact connection that can turn on or off a single light or electronic device. Single switches are often used in homes, apartments, hotels, and industries. A single switch can be used to turn multiple lights on or off with just one press. This type of switch is very common in homes in general because it has a function with a more practical design so many consumers prefer to use this type of switch.
(2) Series switches work by connecting two or more single switches in series. The working principle is to control a single device from several different locations. This type of switch also has a function and design that is almost similar to the previous switch, i.e. series switches; It's just that this type of switch has two buttons or more than one contact that can operate two types of lights or two types of electronic devices in one switch. This is different from a single switch, which if serving or operating two types of lights or two types of electronic devices will definitely require two switches.
(3) A changeover switch is a combination of two changeover switches (two-way switches) whose levers are coupled together, so that both levers will move at the same time. In use, changeover switches are always paired. In terms of construction, the switch consists of three terminals. This type of switch is often found in hotels, especially in bedrooms. This type of switch is often known as a hotel switch or a two-way switch, because it allows a

single electrical load (such as a lamp) to be controlled from multiple locations. For example, the lights on the stairs can be turned on from below and turned off from above, or vice versa. This type of switch is especially useful for large rooms, hallways or long tunnels, corridors, or even in areas of buildings that have more than one floor or multi-storey building.

(4) A cross switch is a system that is made to be able to turn one or more lights on and off from three places, even from different places. This crossover switch is an agile efficiency device, as it complements the shortcomings of changeover switches that can only turn lights on and off from two places like changeover switches. This crossover switch certainly makes it more efficient than the changeover switch. In its use, the cross switch cannot stand alone. If used alone, then its use is the same as a series switch. This type of switch is often used in industries or companies because it is very useful in helping the workers to work. For example, to shut down a large appliance or machine, it is common for this switch position to be used in the central machine control room, one being near the appliance or machine and the other is often used as an emergency button in case of an error in that industry or company.

(5) An impulse switch is a type of switch that works based on a short signal (impulse), not an ON or OFF position like a normal switch. These switches are used with impulse relays to control one or more light points from multiple locations. The impulse switch does not disconnect or connect the current directly, but rather sends the impulse to the relay, which then changes its contact position (ON to OFF, or vice versa). Impulse switches are also classified as electromagnetic switches, so if there is a working voltage from the push button entering the coil, the impulse switch will be activated. In use, impulse switches are always assisted by a push button and are often found in parks and high-rise buildings. How the impulse switch works: when the button is pressed (push bottom), the switch sends an electrical impulse to the impulse relay. The relay will change state (ON to OFF or vice versa). And every time the button is pressed (push bottom), its status will change. For example, press the button from point A, and the light turns on. Press the button from point B, the light turns off. Press again from point C, and the light will turn back on. From the way it works, this type of switch, i.e. an impulse switch, is very practical to control the lamp from three or more points, without the need for a complicated system of swap switches and cross switches.

(6) Stair switches are often known as stair switches because stair switches are a system of switches used to control lights in a staircase or hallway from two different points: one at the bottom of the stairs and one at the top. The system technically uses two two-way switches connected in a single circuit to control a single light. Although similar to a switch, the term ladder refers more to its function and application in the area of stairs or hallways, rather than to a type of switch technically. A ladder switch is also a switch that works on the electromagnetic principle with the function of connecting the power source to the load at a predetermined time. The way a ladder switch works is similar to an impulse switch that uses a magnetic medium that moves when an electric current flows through it. In their use, these switches are widely used outdoors and are set automatically and manually (parks, garages, and street lights). In its operation, the ladder can be assisted by a push

button. In the wiring system, the ladder uses a three-wire and four-wire wiring system according to the installation system.

(7) A time switch or timer is an automatic switch because this type of switch is a type of switch that functions to turn electrical tools on or off automatically based on a predetermined time. This switch works like an alarm, but to control the flow of electricity. It is usually used for lights, water pumps, air conditioners, fans, or other electronic devices to turn on or off without the need for manual intervention. This type of switch, i.e. agar timer has several types, including: mechanical timer switch, which uses a gear and spring system. and can be manually rotated to set the time ON or OFF. And it is suitable for simple and short-term use. Digital timer switches are timer switches that use electronic systems and digital layers. And it can be set with minute or second accuracy. This type of switch typically has multiple ON or OFF modes per day or per week. Daily/weekly automatic timer switch. This means that it can be programmed to turn on and/or off at a specific time each day or week. And it is suitable for street lighting systems, gardens, and home automation devices. Timer switches have utilities and functions such as energy saving, i.e. lights or devices only turn on when needed. And time efficiency, i.e. no need to turn on and/or off manually. And automatic control, which is suitable for aquariums, water pumps, industrial machinery and more. The advantages of timer switches are that they are practical and automatic, save electricity costs, simplify the processing time of power tools, and are available in many variants of needs.

(8) A magnetic switch/contactor is a switch whose operating system is by way of an electromagnetic system and is a safe tool for continuous connection and disconnection. The function of the contactor is used to work or operate a set of load control devices, such as lighting, heating, electric motor control, and electric motor protection. In electric motor protection, the charging is more done separately. The contactor will work normally if it is given a voltage of 85% to 110% of its surface voltage. While if it is less than 85%, the contactor will vibrate or make a sound. If it is greater than 110%, the contactor will heat up and burn. The contactor has the main contacts and auxiliary contacts consisting of the open normal push button (NO) and the closed normal push button (NC). Push buttons are a form of switch that is often used in a control circuit and has the same function as switches in general. However, it has a difference in the locking. Normal Open (NO) with function if pressed then it works (ON), if removed it will return to its original state (OFF). Normal closed (NO) with a function that if pressed does not work (OFF), if removed it works (ON). The button locks, it works if pressed it works (ON), and if it is removed it still works (ON), but if pressed a second time it will not work (OFF).

CONCLUSION

Based on the discussion above, switches have a very important role in electrical systems, whether in household, industrial, automotive, or electronic devices. Their main function as connectors and circuit breakers allows users to control the flow of electricity, improve energy efficiency, and maintain safety. Smart switches add even more value with automation and sensory features, which support convenience and energy savings. Although physically simple, switches are crucial components in electrical control systems. Proper use can prevent the risk of electrical interference, device damage, and potential safety hazards.

Therefore, understanding the types of switches, their working principles, and applications is essential for electricians, students, and the general public who want to manage electricity safely and efficiently. For the development of modern electrical systems, it is recommended that the public and institutions consider the use of smart switches as needed. The industry can also develop switch innovations with better safety and energy efficiency features, as well as provide education to users so that the use of electricity becomes more effective, safe, and environmentally friendly.

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