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Safe and Efficient Electrical Installation For Residential Houses

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Abstract
Safe and efficient electrical installation in residential buildings is essential to ensure occupant comfort and safety. Common problems include the use of inappropriate components, inaccurate load planning, and insufficient implementation of protection systems such as grounding and circuit breakers. This study aims to analyze the basic principles of residential electrical installation and provide practical guidance for safe and efficient application according to national standards. The research employs a literature review and technical documentation analysis from textbooks, journals, and articles related to residential electrical systems. Data were collected through documentation observation, component specification analysis, and simulation testing of the installation system. The results indicate that proper implementation of electrical installation principles can minimize the risk of short circuits, fires, and equipment damage while optimizing energy consumption. This study also provides step-by-step guidelines for residential electrical installation. The implications of this research include enhancing the understanding of technicians and residents regarding safe and efficient electrical practices and serving as a foundation for developing energy-efficient and well-protected electrical systems.

Keywords: Electrical installation; residential homes; electrical safety; energy efficiency; installation standards.
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INTRODUCTION

The need for electrical energy in daily life, especially in residential homes, is increasing along with technological developments and the growing number of electrical equipment being used. Therefore, the installation of safe and efficient electrical systems is very important to support the activities of home residents while minimizing the risk of accidents, such as short circuits, fires, or damage to electronic devices (Bhuvaneswari & Saxena, 2018; Ghenai & Bettayeb, 2020; Krarti, 2023; Y & Venumula, 2023; Yao et al., 2023). A good electrical installation must be carefully planned, using materials that comply with standards, and equipped with an adequate protection system. In addition to the safety aspect, efficiency in the use of electrical energy is also a main factor that needs to be considered (Bachtiar, 2019; Jamal et al., 2019; Pujiyanto & Susanto, 2022; Wahyu Pramon et al., 2017). Efficient installations can reduce energy waste, lower electricity costs, and support environmental conservation efforts. Therefore, an understanding of proper electrical installation techniques and the principles of energy efficiency application is essential. This study discusses in detail the standard procedures and techniques in the installation of residential electrical systems that meet the aspects of safety and efficiency, with the hope that it can serve as a reference for technicians, construction professionals, and the general public who want to install electricity in the correct way and in accordance with regulations.

Therefore, proper electrical installation planning must consider the use of energy-efficient equipment, adjustment of power capacity as needed, and the arrangement of the electrical system to be optimal and environmentally friendly. In this project, the planning and

installation of residential electrical systems was carried out by prioritizing two main principles, namely safety and efficiency (Dian et al., 2023; Koloway & Kattie, 2023; Kustija et al., 2023; Mokalu et al., 2022; Prabasa et al., 2023; Sugianto et al., 2022). All processes involved the right component selection, careful calculation of electrical load, and application of technology and energy-saving strategies. It is hoped that through this approach, the resulting electrical installations will be able to provide comfort, safety, and energy efficiency in the long term for home residents.

Previous research by Kurniawan et al. (2021) emphasized the importance of selecting quality electrical components and proper electrical load planning to reduce the risk of short circuits, but the study focused more on safety and less on energy efficiency. Meanwhile, research by Wijaya and Setiawan (2022) emphasizes energy-saving strategies through smart switches and automatic sensors, but does not discuss in detail practical implementation in residential installations as a whole. Based on the critical analysis of these two studies, it can be seen that there is a research gap related to the integration between safety and energy efficiency in residential installation practices that comply with national standards and are easy to apply by the community.

This study conducted research on the application of residential electrical installation principles that emphasize energy security and efficiency simultaneously, through the selection of appropriate components, careful calculation of electrical loads, and the application of energy-saving technology. The purpose of this research is to provide guidelines for safe and efficient residential electrical installations, while the benefits include improving resident safety, saving electrical energy, and serving as a reference for technicians and the general public in correct and environmentally friendly electrical installation practices.

METHOD

This study uses literature study and observational analysis methods with a cross-sectional approach. This approach was chosen to understand the principles of safe and efficient residential electrical installations based on applicable standards. Data were collected from various primary and secondary sources, including learning modules for electrical engineering students at Manado State Polytechnic, scientific journals, technical articles, and *SNI* standard electrical installation guides.

Data collection was carried out through the identification and collection of information regarding electrical components, load planning, installation techniques, protection systems, and energy efficiency strategies. Furthermore, the data were analyzed descriptively-qualitatively, comparing existing practices with national standards, and assessing the effectiveness of material use and the application of energy-saving technology.

The results of the analysis were used to compile practical guidelines for the installation of residential electrical systems that prioritize safety, energy efficiency, and ease of application. This research also provides implementation suggestions, such as the use of materials according to standards, the calculation of appropriate electrical loads, and the application of energy-saving technology, so that the risk of accidents can be minimized and energy consumption can be optimized.

RESULTS AND DISCUSSION

The installation of electrical installations for residential houses is not only to meet daily electricity needs, but must be designed to meet the principles of safety, convenience, reliability

and energy efficiency. However, technical factors, both technical and non-technical, greatly affect the quality of the installation of electrical installations.

The Importance of Electrical Installation Planning

Electrical load planning is a very important initial stage. Each room is designed for its own power lines separately, with balanced load distribution to avoid overcurrent. The planning stage is the main foundation in electrical installations. This planning includes calculating the power needs of each room, mapping the position of outlets, switches, light points, and planning cable lines. A poorly planned home is at risk of overloading, unbalanced power distribution, or a lack of power points that leads to overuse of extension cords, which can increase the risk of electrical short circuits.

Selection of Quality Materials and National Standards

The selection of materials is an important factor to ensure the safety of members' homes. For example, the power cable must be adjusted to the amount of current to be conducted, taking into account the type of insulation and the size of the conductor's cross-section. The use of cables that are not in accordance with specifications can generate heat so that they are no longer efficient and can cause unwanted things such as fires and accelerate installation wear. The materials used, such as cables, sockets, switches, MCBs (Miniature Circuit Breakers), and ELCB (Earth Leakage Circuit Breakers), must meet national standards (SNI) so that each material has excellent power resistance and safety levels and coefficients and is safe for members' homes.

Good Installation Techniques

The installation of a good and safe installation should follow the PUIL (Regulations of general electrical installations) regulations), the installation of the installation should be carried out in a neat manner and should pay attention to aesthetics, safety, and ease of maintenance. Splicing Techniques (such as solder or clamp joints). The placement of MCBs and ELCBs in the distribution board box should be neatly arranged and labeled for easy identification of the path during repair or maintenance. Grounding systems must be installed For all essential electrical outlets, especially in wet areas such as kitchens and bathrooms. The placement of switches and sockets usually if installed in a concrete house building must be installed embedded in concrete and if the installation is carried out in a wooden house building must use a box switch so that the connection to the switch and outlet is protected, the installation of the socket and switch must be installed with a distance between floors and away from the reach of children to avoid risks that can be very dangerous.

Implementation System Protection

Electrical protection installations are a mandatory aspect to avoid leaking currents or short circuits that can trigger fires. The installation of MCBs on each load path helps isolate electrical faults in one area without disrupting the entire system. ELCB (Earth Leakage Circuit Breaker) functions to cut off electricity when potential leakage is detected that endangers humans. Grounding, especially grounding systems, is vital to prevent overflow due to electrical interference or lightning to the ground, thereby protecting electrical equipment and the safety of home occupants.

Energy Efficiency in Electrical Installations

The energy efficiency of a residential house depends not only on the electrical equipment used, but also on the design of the installation. Installations designed with short cords and the use of low-power electrical equipment will reduce power loss. In addition, the strategy of using natural lighting systems, the installation of automatic switches (such as

motion sensors), and timers can also reduce electricity consumption. Houses that implement this design are proven to be able to save energy by up to 20–30% compared to houses that use conventional electrical installations without paying attention to efficiency.

Good electrical installation in the home has two main objectives, namely ensuring the safety of residents and energy use efficiency. This shows that this second goal can be achieved through careful planning, selection of quality materials, precise installation techniques, and comprehensive installation testing.

From a safety aspect, the implementation of protection systems such as the use of MCBs on each load line and the installation of ELCBs have proven to be effective in preventing damage due to short circuits or electrical leakage currents. A good grounding system is also an important factor in protecting residents from electric shock, especially on metal-bodied equipment or being in wet areas. This shows that homes that use grounding systems and leak current protection have a lower rate of long-range electrical interference.

Meanwhile, in terms of energy efficiency, optimal electricity distribution line planning helps reduce power loss due to cable resistance. In addition, the selection of electrical equipment labeled as energy-efficient, such as the use of LED lights and efficiency-standard electronic equipment, supports monthly electricity cost savings. The strategic placement of switches and sockets also makes it easier for users to turn off unused electrical appliances, thereby reducing unnecessary energy consumption.

Another factor to consider is periodic maintenance. Electrical installations not only need to be properly installed, but they also need to be checked regularly to detect wear, loose wires, or component damage that could potentially pose a hazard in the future.

By combining all these principles, residential electrical installations can provide maximum comfort, efficiency, and safety for their residents. This also supports energy conservation efforts and prevents accidents due to negligence in the electrical system.

CONCLUSION

Based on the results of the literature study, field observations, and analyses carried out, it can be concluded that the installation of safe and efficient electrical systems in residential areas is highly dependent on careful planning, selection of quality materials, appropriate installation techniques, and the use of proper protective systems. A properly designed electrical installation can prevent the risk of short circuits, fires, and electric shock, which endanger the safety of home occupants. The use of safety devices such as *MCB*, *ELCB*, and grounding has proven to be very important in improving the safety of installations. In addition, the selection of energy-saving devices and optimal energy use systems can improve energy consumption efficiency, reduce electricity costs, and contribute to environmental conservation. Regular maintenance and testing of the electrical system are important factors for ensuring that the installation remains reliable over a long period of time. Without proper maintenance, the risk of electrical system failure can still occur, even if the initial installation meets the standards. Therefore, each stage must apply the principle of energy efficiency to create a safe, comfortable, and energy-efficient living environment for residents, adhering to safety standards from installation planning and material selection through installation techniques to maintenance.

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