Journal of Software Engineering, Information and Communication Technology (SEICT)

Journal homepage: https://ejournal.upi.edu/index.php/SEICT

Survey: IoT in Residential Areas for Energy Saving

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ABSTRACT

Internet of Things for House is an aspect that is desired by all industries or organizations. Making smart buildings is an important part of implementing smart concepts in various ways, now the need for energy savings is very high because the decline in the pandemic has made energy needs increase. Where all employers are applied Back to work in the office, making energy demands increase, especially in large industrial areas that require a lot of energy. One of the houses can take advantage of the Internet of Things (IoT). This technology can save energy by means of automation. In addition, there are several methodologies that can be used for energy efficiency, by utilizing sensors. This study uses a survey literature review to obtain research in the form of 20 papers to support research on smart housing.

ARTICLE INFO

Article History:
Submitted/Received 15 Sep 2022
First Revised 05 Oct 2022
Accepted 15 Oct 2022
First Available Online 15 Nov 2022
Publication Date 01 Dec 2022

Keywords:
Housing,
IoT,
Literature review,
Survey.

1. INTRODUCTION

Some knowledge to minimize electricity usage includes utilizing energy harvesting (Grossi, 2021). By harvesting energy from nature, it can be reused for energy needs in offices or industries. There are various techniques for energy harvesting, such as harnessing wind power (Leelavinodhan et al., 2021), where natural energy is utilized by harnessing wind to rotate turbines. Additionally, solar power can also be utilized (Peruzzi and Pozzebon, 2020), which taps into the abundant energy source of the sun to fulfil energy requirements.

Furthermore, minimizing energy needs through long-distance communication can be beneficial. Efficient communication can help reduce electricity demands. On the other hand, low-energy communication utilizing proper routing (Haseeb, 2020) can also be employed. However, there are challenges when it comes to large-scale routing in the context of large companies. Another solution is optimizing networks for energy savings (Qureshi et al., 2020). By employing network optimization, the energy utilized can be sufficient for the requirements of each building. Another energy-saving approach is utilizing building routing using fuzzy logic (Varun et al., 2020). Alternatively, IoT and WSN can be used to maximize WSN outcomes (Xu et al, 2019).

Moreover, batteries can be utilized with various methods to ensure their maximum usage (Cui, 2021). However, this requires significant effort due to the complexity of the circuitry involved. In smart buildings, non-renewable electricity needs can contribute to greenhouse effects. The concept of smart buildings typically entails significant electricity requirements for heating/cooling, lighting, and electrical appliances. Additionally, new regulations in countries like Southeast Asia stipulate that future electricity consumption must minimize CO2 emissions.

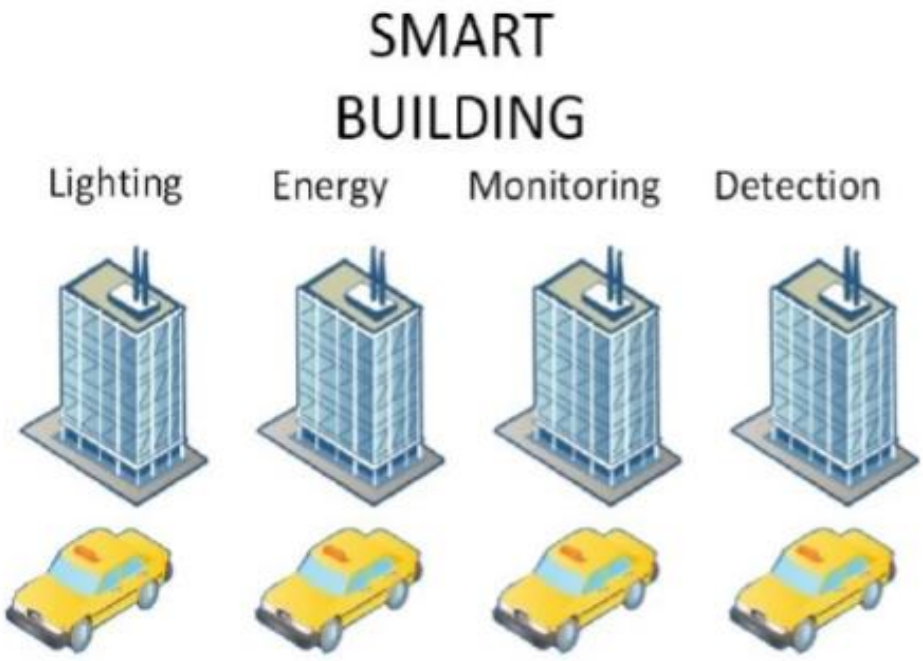

Figure 1. Internet of Things (IoT) concept for house area.

DOI: https://doi.org/10.17509/seict.v3i2.53798
p- ISSN 2774-1656 e- ISSN 2774-1699

In addition, the concept of a smart building should not act statically because something considered smart can be defined as "alive". Another important concept in smart buildings is ventilation, heating systems, and air conditioning, as their loads can be significant. Another crucial component is Building Energy Management Systems (BEMS) (Liu et al., 2020). BEMS combines efficiency with electricity and can perform key energy management tasks, such as monitoring electricity supply information, automated demand response, electricity detection, and anomaly detection.

Various literature reviews discuss electricity optimization in buildings, smart grids, energy harvesting, energy conservation, and energy transfer. However, this study focuses on a different aspect compared to other literature reviews. While other studies focus on energy management articles with hardware techniques, this study concentrates on the software aspect, which has received limited attention regarding electricity savings (Budgen et al., 2018). The aim of this survey study is to provide a systematic overview of various AI approaches for BEMS.

To achieve this, the study will reflect on a survey conducted in phase 1, which will introduce the planned research. Phase 2 will explain the Systematic Literature Review (SLR) methodology, focusing on AI-based smart buildings. Phase 3 will present the findings of the SLR. In phase 4, the authors will discuss the results obtained.

2. METHODS

Previous studies have not focused on research applicable to Indonesia. Therefore, this survey serves as a useful reference, **Figure 2** illustrates the research roadmap.

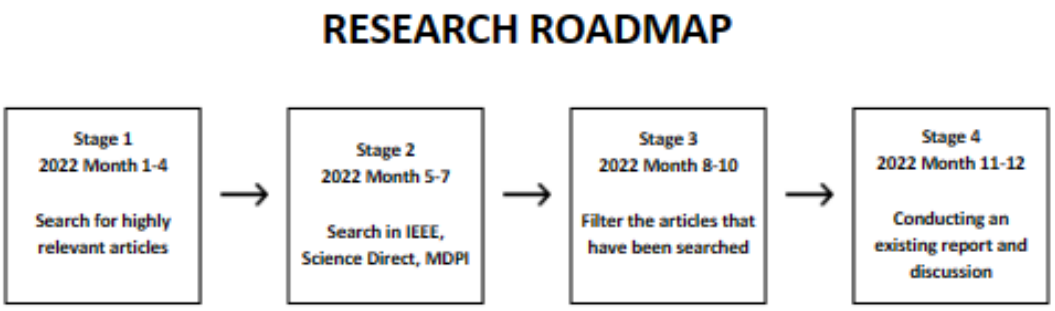

Figure 2. Research roadmap.

As shown in **Figure 2**, the first step is to search for relevant and accountable articles. In step 2, the search is focused on IEEE, Science Direct, and MDPI. Then, in step 3, the results are filtered. Finally, a report and discussion are conducted based on the obtained results, by utilizing several technologies such as the Internet of Things (IoT), smart components, and other intelligent elements (Engmann et al., 2018).

DOI: https://doi.org/10.17509/seict.v3i2.53798
p-ISSN:2744-1656 e-ISSN:2774-1699

2.1. Internet of Things (IoT)

It is a connectivity framework that enables devices to connect to the internet and interact with each other. Typically, it utilizes devices such as sensors and microcontrollers that are interconnected (Liu et al, 2017).

2.2. Wireless sensor network

It is a device that is part of the Internet of Things and is usually used for communication with other sensor devices without an internet connection. It is commonly used for regular automation devices (Widianto et al, 2021).

2.3. Information system

It is software used to coordinate electronic devices and other peripherals, serving as the central command center for various sensors and microcontrollers. This is a crucial stage in designing an information system (Albahri, 2022).

2.4. Energy efficiency

By utilizing energy-saving techniques, the Internet of Things for residential applications can optimize energy usage and promote environmental friendliness. Several schemes have been developed, considering various components that impact energy consumption in residential settings. The research objectives and benefits of this study are as follows:

1) Research Objectives:

   a. To conduct a literature survey focusing on the Internet of Things for residential applications.
   b. To conduct a literature survey influencing research on electricity savings.
   c. To serve as inspiration for future research on the Internet of Things for residential applications and electricity savings based on the survey findings.

2) Research Benefit:

This research provides the following benefits:

   a. Facilitates researchers in finding studies related to the Internet of Things for residential applications.

3. RESULTS AND DISCUSSION

With the following requirements, the study employed a Systematic Literature Review (SLR) methodology, adopting the approach and pattern established in previous studies conducted (Dadkhah et al., 2020; Khan et al., 2017) as shown in **Figure 3**. This approach enabled the researchers to systematically analyze a wide range of relevant literature sources, ensuring a comprehensive review of the topic at hand. By following the established framework, the study aimed to build upon the existing knowledge and insights presented in the prior research, while also incorporating any updates or advancements that may have emerged since the publication of those earlier studies. Through this rigorous and methodical approach, the researchers sought to gather valuable evidence and draw meaningful conclusions based on

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p- ISSN 2774-1656 e- ISSN 2774-1699

the collective findings of the reviewed literature, thereby contributing to the current understanding and advancement of the field.

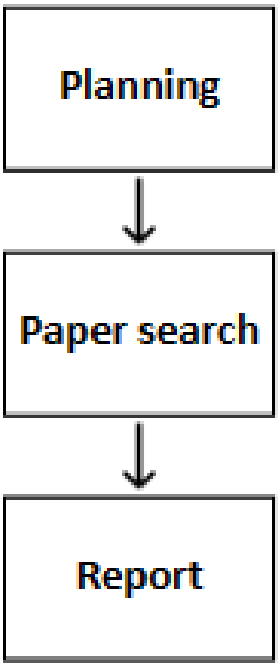

Figure 3. Survey using SLR.

a. Planning

Focuses on defining the research questions and problem statement.

b. Finding paper

Focuses on searching for relevant articles.

c. Report

Focuses on searching for relevant articles that align with the research.

The results of the SLR conducted are mapping based on the sources of articles and their discussions as shown in **Table 1**:

Table 1. Total and article sources.

No	Article Source	Total
1	IEEE	123
2	Science Direct	147
3	MDPI	34
	Total	304

DOI: https://doi.org/10.17509/seict.v3i2.53798
p-ISSN:2744-1656 e-ISSN:2774-1699

Out of the 304 results obtained for this research, a careful analysis identified 20 studies that were deemed relevant and therefore selected as the primary sources. These studies were chosen based on their direct relevance to the research topic, ensuring that they provided valuable insights and information necessary for the study. By utilizing these 20 selected studies as the primary sources, the research aims to build upon the existing knowledge and contribute to a comprehensive understanding of the subject matter.

The following are the results from the various phases conducted, following the phases outlined by Afzal as shown in **Table 2** (Afzal et al., 2009).

Table 2. Filtering sing 5 phase.

	Phase 1	**Phase 2**	**Phase 3**	**Phase 4**	**Phase 5**
Data	304	177	80	47	20

3.1. Internet of Things technic

The utilization of IoT technology requires minimal power consumption while offering the potential for energy savings in residential IoT applications. Several studies have focused on significant power-consuming components such as heaters, air conditioning systems, and ventilation (Jindal et al, 2018).

3.2. Energy efficient technic

The research findings encompass various techniques such as energy harvesting (Grossi, 2019), transfer (Enssle and Parspour, 2020) and conservation (Abbas and Yoon, 2015). These techniques can assist in optimizing energy efficiency and contribute to electricity savings in residential IoT applications.

4. CONCLUSION

In conclusion, this research aimed to conduct a literature review survey by utilizing the identified studies. The search was performed on IEEE, Science Direct, and MDPI platforms, resulting in a total of 304 articles, of which 20 were deemed relevant. The 20 selected studies provided valuable insights and discussions on energy savings applicable to Wireless Sensor Networks (WSNs), Internet of Things (IoT), Information Systems, and various electrical efficiency techniques.

5. AUTHOR'S NOTE

The authors declare that there are no conflicts of interest associated with the publication of this article. The authors also ensure that this paper is free from plagiarism.

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p- ISSN 2774-1656 e- ISSN 2774-1699