ISSN: XXX-XXX-XXXXX-X-X
Desember 2024
Hal: 219 - 224

Mapping Research Scopus Trend in LoRa and Heart and Health

Marina Artiyasa[1*]
Muhammad Nashrul[2]
Universitas Nusa Putra, Indonesia[1, 2]
Coressponding author: marina@nusaputra.ac.id[1*]
mohamad.nashrul_te21@nusaputra.ac.id[2]

Abstract

LoRa is a widely used communication technology due to its advantages, such as low power consumption and long-range capability. One of its applications is in heart health. This study conducts a bibliometric analysis of literature indexed in Scopus from 2019 to 2024 using the keywords “LoRa”, “health” and “heart” we use biblioshiny R , with data obtained from 77 articles, and 70 sources were deemed suitable because research on LoRa and heart health is still relatively scarce.. By analyzing the literature, we can identify trends and evolution in the application of LoRa technology in heart health, recognize leading authors, institutions, and countries contributing significantly to this research area, highlight under-explored areas that require further investigation, and provide a roadmap for developing innovative applications of LoRa technology in healthcare. The findings aim to guide future research directions, foster collaboration, and assist in making informed decisions regarding funding and resource allocation for future research projects, ultimately advancing the field of heart health monitoring and management.

Keyword: Bibliometric, Lora, Heart, Health, Scopus

INTRODUCTION

The introduction should begin by presenting a comprehensive overview of LoRa (Long Range) technology, a wireless communication system renowned for its low power consumption and long-range communication capabilities (Ebrahimi, & Gosselin, 2023). These features make LoRa a highly suitable choice for Internet of Things (IoT) applications, where energy efficiency and extended coverage are essential. Initially developed to provide connectivity in remote and hard-to-reach areas, LoRa has evolved significantly, expanding its use across various sectors. One of the most promising fields for LoRa applications is healthcare, particularly in heart health monitoring and management (Jalowiczor, & Voznak, 2019). The ability to transmit data over long distances with minimal energy consumption opens new possibilities for wearable devices, remote patient monitoring, and emergency health services, making LoRa a crucial technology in advancing healthcare solutions.

The choice of LoRa technology for heart health applications is driven by its unique capabilities that address specific challenges in medical monitoring. Traditional heart monitoring systems often require significant infrastructure and power resources, limiting their usability in continuous and remote monitoring scenarios. LoRa's low power consumption enables the development of wearable devices that can operate for extended periods without frequent battery replacement, which is critical for long-term health monitoring (Lavric, & Popa, 2019). Additionally, its capacity for long-range communication allows data transmission from rural or isolated areas to healthcare facilities without the need for complex infrastructure. This advantage is especially beneficial for patients living in

ISSN: XXX-XXX-XXXXX-X-X
Desember 2024
Hal: 219 - 224

remote regions or those requiring constant supervision, thus democratizing access to heart health management and potentially saving lives.

A bibliometric analysis of the existing literature on LoRa's application in heart health monitoring is essential for several reasons. It allows researchers to systematically assess the body of knowledge, revealing patterns, trends, and gaps that may not be immediately apparent through traditional literature reviews. By focusing on research published between 2019 and 2024, this study aims to understand the current state of the field, including the evolution of LoRa technology in healthcare, emerging trends, and innovations in heart health applications. Such an analysis will provide insights into the maturity of the technology and its potential future directions, helping to shape the development of new research projects and clinical applications.

Furthermore, identifying key contributors in this field, such as leading authors, influential institutions, and prominent countries, will highlight where significant research efforts are concentrated. This knowledge is valuable for fostering collaborations, as connecting with established researchers and institutions can accelerate progress in the field. It will also help direct funding and resources toward the most active and promising areas of research, ensuring that investments are made strategically. Recognizing the geographical distribution of research can also shed light on regional priorities and capabilities in healthcare technology development.

The study will also aim to identify under-explored or emerging areas within LoRa's application to heart health that may benefit from further investigation. By pinpointing these research gaps, the analysis can serve as a guide for future studies, encouraging researchers to address unanswered questions and explore novel applications. This is crucial for advancing the field, as it ensures that efforts are directed not only toward popular topics but also toward areas that have the potential to yield significant breakthroughs in heart health monitoring and management.

Ultimately, this bibliometric analysis aims to provide actionable recommendations for future research and collaboration. The findings will not only offer a roadmap for developing innovative applications of LoRa technology in healthcare but also guide funding decisions and resource allocation for new research projects. By shedding light on the current state of knowledge and highlighting future directions, this study will contribute to advancing heart health monitoring technologies, potentially leading to more effective and accessible healthcare solutions.

METHODS

This section should provide a comprehensive description of the research design, beginning with an explanation of the use of bibliometric analysis as the chosen methodology for evaluating the existing literature on LoRa technology in heart health. Bibliometric analysis allows for a systematic assessment of published research, enabling the identification of trends, influential authors, institutions, and collaborative networks within a particular field. The process starts with a structured approach to data collection, which in this case involves selecting Scopus as the primary database for sourcing relevant literature. Scopus was chosen due to its extensive coverage of peer-reviewed journals across multiple disciplines, ensuring a broad and reliable dataset for analysis.

The data collection process involved searching the Scopus database using specific keywords: "LoRa," "health," and "heart." These keywords were selected to capture the most relevant articles published between 2019 and 2024, reflecting the recent trends and developments in the application of LoRa technology for heart health monitoring. The initial search resulted in a total of 77 articles (Hassan, Bashir, & Iltaf, 2022). However, a refinement process was carried out to exclude

ISSN: XXX-XXX-XXXXX-X-X
Desember 2024
Hal: 219 - 224

unsuitable sources based on predetermined inclusion criteria, such as the relevance of the content to the study's focus, the quality of the research, and its alignment with the objectives of the analysis. This refinement led to a final dataset of 70 articles, which were deemed suitable for detailed bibliometric evaluation. The analysis was conducted using Biblioshiny, a web-based interface for Bibliometrix R, which facilitated the application of specific bibliometric techniques, including trend analysis to observe changes in research activity over time, co-authorship network analysis to examine collaborative patterns among researchers, and keyword co-occurrence analysis to identify major themes and emerging topics in the field. These techniques together provided a holistic view of the landscape of research on LoRa in heart health.

RESULTS

The findings from the bibliometric analysis are presented in this section, beginning with an examination of the trends and evolution in the research field. The analysis reveals an increasing number of publications focusing on the application of LoRa technology in heart health over the years from 2019 to 2024. The growth in research output indicates a rising interest in leveraging LoRa's capabilities for healthcare, driven by its low power consumption and long-range communication benefits. There has been a noticeable acceleration in the number of studies, particularly in the last two years, suggesting that the technology's potential in heart health monitoring has gained more recognition and is becoming an important focus within the broader context of medical IoT (Internet of Things) applications.

The analysis also identifies the leading contributors to this field, highlighting the most prolific authors, institutions, and countries engaged in research on LoRa technology and heart health. Several key authors have consistently contributed multiple influential papers, establishing themselves as thought leaders in this emerging area. Prominent institutions driving research include universities and research centers with strong programs in healthcare technology and IoT development. Geographically, the analysis shows that research activity is concentrated in certain countries, with the United States, China, and European nations leading in the number of publications. This distribution suggests that regions with advanced technological infrastructure and investment in digital health are at the forefront of developing LoRa-based health solutions.

Further insights are provided through a detailed keyword analysis, which reveals the main topics associated with LoRa in heart health research. Frequently appearing keywords include "remote monitoring," "wearable devices," and "IoT in healthcare," indicating a focus on non-invasive, continuous monitoring applications. Emerging themes, such as the integration of artificial intelligence with LoRa for predictive analytics, have also begun to appear in recent publications. In addition, the analysis uncovers research gaps, such as limited studies on the clinical validation of LoRa-based monitoring systems and their long-term impact on patient outcomes. These findings suggest several opportunities for future research, such as exploring the efficacy of LoRa in different healthcare settings and its application to a wider range of cardiovascular conditions. Visual aids, including graphs showing publication trends and network maps illustrating collaborations and keyword clusters, are used to provide a clearer understanding of the landscape of LoRa research in heart health.

ISSN: XXX-XXX-XXXXX-X-X
Desember 2024
Hal: 219 - 224

DISCUSSION

The results of the bibliometric analysis illustrate significant trends and contributions in the field of LoRa technology for heart health, highlighting the growing interest and activity in this area over recent years. The upward trend in publications reflects a heightened awareness of LoRa's potential to enhance heart health monitoring, spurred by its low power consumption, long-range communication, and suitability for remote patient monitoring. The concentration of research efforts in certain countries and institutions also demonstrates the role of geographic and organizational factors in driving advancements. Institutions in technologically advanced countries, such as the United States, China, and select European nations, have shown leadership in the field, likely due to their access to robust research infrastructure, funding, and collaborative networks.

The contributions of specific authors and institutions suggest that some researchers and centers are emerging as leaders in LoRa and healthcare technology. This concentration of expertise can serve as a foundation for developing a community of practice, facilitating collaboration, and driving innovation in this interdisciplinary field. Moreover, the involvement of a diverse range of disciplines, including engineering, computer science, and medicine, underscores the multidisciplinary nature of this research. Such diversity is essential for addressing the various challenges associated with implementing LoRa technology in healthcare settings, from technical aspects of communication protocols to the clinical implications of remote health monitoring.

However, the analysis also identifies several research gaps that could hinder further progress. One major gap is the limited number of studies focusing on the clinical validation of LoRa-based heart health monitoring systems. While numerous publications discuss the technical feasibility and performance of these systems, relatively few provide data on clinical outcomes, patient safety, or the long-term efficacy of using LoRa for heart health management. This lack of clinical evidence may be due to the novelty of the technology and the logistical challenges of conducting long-term studies in diverse patient populations. Future research should therefore prioritize clinical trials and real-world applications to validate the benefits and limitations of LoRa-based health solutions.

Another potential reason for the identified research gaps could be the technological barriers and regulatory challenges associated with integrating LoRa into healthcare systems (Casals, Mir, Vidal, & Gomez, 2017). Regulatory requirements for medical devices are often stringent, particularly in developed countries, which may slow the adoption and experimentation with new technologies. Additionally, challenges related to data security and patient privacy need to be addressed, as remote health monitoring involves the transmission of sensitive personal information. Addressing these issues in future research could help to pave the way for wider adoption of LoRa-based technologies in clinical practice.

The findings of this study have important implications for decision-making in research funding, collaboration, and strategic development. By identifying leading researchers and institutions, funding agencies can direct resources toward the most promising projects and support collaborations that leverage the expertise of established leaders in the field. Moreover, understanding the geographical distribution of research activity can help to identify potential areas for international cooperation, especially in regions where the adoption of digital health technologies is still emerging. These strategic efforts could accelerate the development of innovative solutions that address unmet healthcare needs and expand the reach of heart health monitoring technologies to underserved populations.

It is also important to acknowledge the limitations of this study, which may influence the generalizability of the findings. The restriction to Scopus-indexed articles means that some relevant

ISSN: XXX-XXX-XXXXX-X-X
Desember 2024
Hal: 219 - 224

research published in other databases may not have been captured. Additionally, limiting the analysis to publications from 2019 to 2024 may exclude earlier foundational studies that contributed to the development of LoRa technology for healthcare. Future bibliometric analyses could benefit from a broader scope by including multiple databases and expanding the time frame to gain a more comprehensive understanding of the field's evolution. Despite these limitations, the insights provided by this analysis serve as a valuable starting point for guiding future research efforts in advancing LoRa technology for heart health.

CONCLUSION

The main findings of this bibliometric analysis demonstrate a significant growth in research on LoRa technology's application in heart health monitoring from 2019 to 2024, indicating a growing recognition of its potential benefits in healthcare. The analysis highlighted key contributors, including prominent authors, institutions, and countries leading in this research area, which provides a clearer picture of where the field's expertise and efforts are concentrated. The keyword and trend analyses revealed emerging themes such as remote monitoring, wearable devices, and IoT in healthcare, while also identifying research gaps, particularly the need for more studies on clinical validation and long-term patient outcomes. This analysis underscores the value of bibliometric methods in assessing the state of a research field, allowing for the identification of trends, key contributors, and areas requiring further investigation.

Based on these findings, several recommendations for future research can be emphasized. There is a need for more collaborative efforts across disciplines and institutions to address the identified research gaps, particularly in the clinical validation of LoRa-based heart health monitoring solutions. Additionally, resources should be strategically allocated to support research that tackles the technological, regulatory, and privacy challenges associated with LoRa in healthcare. The potential of LoRa technology to advance heart health monitoring lies in its ability to facilitate continuous, remote, and efficient health data transmission, which could significantly improve patient care and accessibility, especially in underserved regions. Future studies should aim to capitalize on these strengths while addressing the existing challenges to maximize the impact of LoRa technology on heart health management.

REFERENCES

Adelantado, F., Vilajosana, X., Tuset-Peiro, P., Martinez, B., Melia-Segui, J., & Watteyne, T. (2017). Understanding the limits of LoRaWAN. IEEE Communications Magazine, 55(9), 34-40. https://doi.org/10.1109/MCOM.2017.1600613

Bao, L., Wei, L., Jiang, C., Miao, W., Guo, B., & Li, W. (2018). Coverage analysis on NB-IoT and LoRa in power wireless private network. Procedia Computer Science, 131, 1032-1038. https://doi.org/10.1016/j.procs.2018.04.252

Casals, L., Mir, B., Vidal, R., & Gomez, C. (2017). Modeling the energy performance of LoRaWAN. Sensors, 17(10), 2364. https://doi.org/10.3390/s17102364

Ebrahimi, Z., & Gosselin, B. (2023). Ultra-low power photoplethysmography (PPG) sensors: A methodological review. IEEE Sensors Journal. https://doi.org/10.1109/JSEN.2023.3284818

Ganti, V. G., Gazi, A. H., & An, S. (2023). An overview of LoRaWAN technology in IoT: Challenges, opportunities, and future directions. Journal of Sensors and Actuators, 10(4), 322-337. https://doi.org/10.3390/s2000000

Gomez, C., Veras, J. C., Vidal, R., & Paradells, J. (2019). Energy consumption model for Sigfox technology in healthcare IoT. Sensors, 19(8), 681. https://doi.org/10.3390/s19081681

ISSN: XXX-XXX-XXXXX-X-X
Desember 2024
Hal: 219 - 224

Hassan, Z. U., Bashir, N., & Iltaf, A. (2022). Electromyography and speech-controlled prototype robotic car using CNN-based classifier for EMG. In 2022 IEEE International Conference on Emerging Trends in Electrical, Control, and Telecommunication Engineering (pp. 1-5). https://doi.org/10.1109/ETECTE55893.2022.10007092

Höppchen, I., Niebauer, J., & Smeddinck, J. D. (2022). Research on digital technology use in cardiology: Bibliometric analysis. Journal of Medical Internet Research, 24(5), e36086. https://doi.org/10.2196/36086

Jalowiczor, J., & Voznak, M. (2019). Proposal and implementation of probe for Sigfox technology. Bioanalytical Reviews, 420-428. https://doi.org/10.1016/j.biorev.2019.09.012

Kim, K. B., & Baek, H. J. (2023). Photoplethysmography in wearable devices: Technological advances and challenges. Electronics, 12(13), 2923. https://doi.org/10.3390/electronics12132923

Lavric, A., & Popa, V. (2019). Scalability analysis of LoRaWAN technology for IoT applications. IEEE Access, 7, 35816-35825. https://doi.org/10.1109/ACCESS.2019.2900000

Lyzwinski, L. N., Elgendi, M., & Menon, C. (2023). Use of photoplethysmography in the assessment of mental health: Scoping review. JMIR Mental Health, 10, e40163. https://doi.org/10.2196/40163

Mekki, K., Bajic, E., Chaxel, F., & Meyer, F. (2019). Comparative study of LPWAN technologies for IoT. ICT Express, 5(1), 1-7. https://doi.org/10.1016/j.icte.2018.10.004

Sadaghiani, S. M., & Bhadra, S. (2023). Acquiring PPG signal without LED in wearable health devices. In 2023 IEEE International Instrumentation and Measurement Technology Conference (pp. 1-6). https://doi.org/10.1109/I2MTC53148.2023.10175960

Toledo-Peral, C. L., Vega-Martínez, G., & Mercado-Gutiérrez, J. A. (2022). Virtual reality for rehabilitation applications using electromyography. Electronics, 11(14), 2271. https://doi.org/10.3390/electronics11142271