Journal of Scientific Insight

Vol. 1 (1), 2024
Page: 09-17

Research Techniques for IoT Use, Wearable Technology, and Smart Sensors in Mental Well-Being: A Literature Review from Several Studies

Sahriani [1], Mita Surahmawanti [2], Samsidar [1], Siti Fatmah [1], Syaiful Bachri Mustamin [1,*], Muhammad Atnang [1], Nurhikmah Fajar [2], Nur Azaliah Mar [1]

[1] Departement of Information Technology, Faculty of Science Technology and Health, Institut Sains Teknologi dan Kesehatan 'Aisyiyah Kendari, Indonesia
[2] Departement of Computer Engineering, Faculty of Engineering, Institut Teknologi dan Sains Muhammadiyah Kolata Utara, Indonesia

*Email (corresponding author): sbm@istekaisyiyah.ac.id

Abstract
This study reviews the literature on the application of technology to wearables, smart sensors, and the Internet of Things (IoT) in the monitoring and treatment of mental health. Several studies analyzed employ systematic review, experimental, and literature survey approaches to explore various aspects of technology implementation in the context of mental health. The studies adopt a systematic review design without involving specific samples or measurement tools but highlight the application of IoT in mental health monitoring. Meanwhile, other studies conduct systematic reviews encompassing 41 studies utilizing smart devices and wearable technology in mental health monitoring, yet without specifying the software used. Another research proposes an experimental design to test a wearable sensor-based machine learning stress monitoring system. On the other hand, there are literature survey reports on the use of wearable sensors in mental health monitoring without providing details of the reviewed study methodologies. Other studies explore the literature using a scoping review method to gather information on mental health technology, identifying 37 relevant scientific articles. This review emphasizes the need for rigorous methodological approaches to effectively understand and apply technology in mental health monitoring and intervention. Overall, this literature review highlights the importance of developing technology that can enhance mental health monitoring and intervention. The application of IoT, wearable devices, and smart sensors can be a potential solution but requires a multidisciplinary approach and meticulous methodology to optimize their use in clinical practice.

Keywords: Mental health technology, IOT, wearable devices, systematic review, machine learning, literature survey

1. Introduction

Research on the application of the Internet of Things (IoT) in mental health is crucial given the increasing use of this technology in various health aspects. The main issue focused on in this research is how IoT can be applied to monitor and analyze mental health, as identified by Chuvita et al. (2022). IoT technology's use in mental health is becoming more and more significant for research as it develops since it can provide innovative approaches to early identification and management of psychological disorders(Chuvita et al., 2022). Hickey et al. (2021) add that there is an increase in the production of smart devices and wearables used to detect and monitor anxiety, depression, and stress. This research critically identifies and

evaluates these devices, highlighting the importance of technical solutions for improved efficacy and precision of mental illness surveillance (Hickey et al., 2021). For example, Al-Atawi et al. (2023) developed a machine learning-based system that can track a person's stress levels through wearable sensors, demonstrating how IoT and machine learning can collaborate to create effective monitoring tools (Al-Atawi et al., 2023).

Furthermore, Gomes et al. (2023) examined the use of wearable sensors for mental health monitoring, emphasizing that these devices are increasingly important in healthcare settings, particularly amid the COVID-19 outbreak. They show how this technology can be used for more efficient and real-time monitoring (Gomes et al., 2023). Ahmed et al. (2023) also reviewed wearable technology that is functional to monitor anxiety and depression, demonstrating the great potential of this technology in everyday mental health care (Ahmed et al., 2023). These studies indicate a gap in the literature regarding mental health monitoring using the latest technology, and each study contributes to filling this gap. Chuvita et al. (2022) provide a conceptual basis for the application of IoT in mental health, while Hickey et al. (2021) offer a systematic review of smart devices and wearable technology. Al-Atawi et al. (2023) focus on developing a machine learning-based system, and Gomes et al. (2023) and Ahmed et al. (2023) highlight the use of wearable sensors in the context of mental health monitoring.

The main contribution of this research is to provide a foundational understanding of the technology that can be used for mental health monitoring, identify the latest devices and technologies, and encourage further research in this field. The expected outcome is the development of more accurate and effective monitoring systems that can help individuals manage their mental health and enable better interventions by health professionals (Chuvita et al., 2022; Hickey et al., 2021; Al-Atawi et al., 2023; Gomes et al., 2023; Ahmed et al., 2023).

2. Materials and Methods

The study of the literature on using the Internet of Things (IoT) for mental health applications by Chuvita et al. (2022) discusses the main topic of utilizing IoT technology to support mental health. Relevant previous research includes the analysis of IoT utilization for monitoring psychological conditions using IoT devices. The methods used in previous studies include literature reviews, data analysis from IoT sensors, and the development of IoT application prototypes for mental health. The main findings from previous research indicate the potential of IoT in supporting mental health services, although the results have not always met expectations. Identified gaps include the lack of analysis related to IoT implementation in mental health in Indonesia. By offering a fundamental grasp of mental health concepts and stimulating additional research in Indonesia, this study helps close this gap (Chuvita et al., 2022).

Furthermore, the literature review by Hickey et al. (2021) explains how to use wearable technology and smart devices to detect and keep an eye on mental health issues like stress, anxiety, and depression. Relevant previous research includes studies on the use of smartwatches, mobile applications, and other wearable sensors. Methods used include experimental studies, observational studies, and systematic reviews. The main findings show that smart devices and wearable technology have significant potential in detecting and monitoring early signs of mental health conditions, although there are challenges in terms of accuracy, reliability, and integration with healthcare systems. Identified gaps include the lack of critical evaluation of the devices and technologies and the lack of research linking device measurements to actual clinical outcomes. This study makes a significant contribution by

offering an extensive, methodical analysis of the ways in which wearable technologies and smart devices are used to identify and track mental health issues. (Hickey et al., 2021).

Al-Atawi et al. (2023) review of the literature focuses on creating wearable sensor and Internet of Things based stress monitoring solutions, and machine learning. The main topic discussed is the development of a machine learning-based stress monitoring system. Relevant previous research is mentioned only in general terms, and the methods and main findings of previous research are not detailed. Gaps in previous research are also not identified. This research contributes by developing an accurate machine learning-based stress monitoring system, although the document provides limited information on the theories or frameworks used and the debates in the literature related to this topic (Al-Atawi et al., 2023).

In their literature review, Gomes et al. (2023) discuss the use of wearable sensors for mental health monitoring. Relevant previous research includes various studies focusing on the use of wearable sensors to monitor symptoms, behaviors, and mental health signs. Methods used in previous research include experimental studies, case studies, and observational research. The main findings show that wearable sensors have the potential to monitor mental health, but some gaps are not explicitly identified. This study makes a contribution by offering an extensive, methodical analysis of the application of wearable sensors to the monitoring of mental health(Gomes et al., 2023).

The literature review by Ahmed et al. (2023) discusses the use of wearable devices to monitor anxiety and depression. Relevant previous research includes studies on the use of physiological sensors to monitor mental health. Methods used include collecting sensor data from wearable devices and analyzing it to identify patterns related to anxiety and depression. The main findings show the great potential of wearable devices in monitoring signs of anxiety and depression, although further development is still needed. The identified gaps include the lack of comprehensive studies on the features of wearable devices that can be used to monitor anxiety and depression. This research contributes by conducting a scoping review that explores the features of wearable devices for monitoring anxiety and depression (Ahmed et al., 2023).

In the context of machine learning, Al-Atawi et al. (2023) developed a stress monitoring system based on machine learning algorithms integrated with IoT and wearable sensors. This approach aims to enhance the accuracy and predictive capabilities of stress detection systems. The study focuses on leveraging machine learning techniques to analyze physiological data collected from wearable sensors, thereby advancing the understanding of stress patterns and responses. By adopting machine learning, the research contributes to the development of more effective stress monitoring tools, potentially improving mental health management strategies (Mustamin et al., 2024).

Table 1. Research items that have been investigated and documented

The Studied Object	Method Used Research	Results	References
IoT in Mental Health	Literature study, analysis of IoT sensor data	Potential use of IoT, limited analysis in Indonesia	Chuvita et al., 2022
Smart Devices and Wearable Technology	Experimental studies, observational studies, systematic reviews	Great potential but challenges in accuracy and integration	Hickey et al., 2021

The Studied Object	Method Used Research	Results	References
IoT and ML-Based Stress Monitoring System	Development of monitoring system, machine learning evaluation	Development of an accurate ML-based system, lacking in-depth information	Al-Atawi et al., 2023
Wearable Sensors for Mental Health	Experimental studies, case studies, observational research	Great potential for symptom monitoring, gaps not explicitly identified	Gomes et al., 2023
Wearable Devices for Anxiety & Depression	Collection and analysis of wearable sensor data	Great potential but requires further development	Ahmed et al., 2023

Table 1 outlines the results of current studies on the use of technology in emotional wellness. It includes studies on IoT in mental health literature, experiments and reviews of smart devices and wearable technology, and the development of IoT and machine learning-based stress monitoring systems. The study also emphasizes the use of wearable sensors to track mental health symptoms and gather information from wearable technology to control sadness and anxiety. While showing great potential, major challenges include accuracy, integration, and further technological development for more effective applications in clinical practice.

3. Results and Discussion

3.1. Systematic Review of IoT and Wearable Technologies in Mental Health

Considering Chuvita's et al. (2022) evaluation of the literature on the application of the Internet of Things (IoT) in mental health, the research design used was a literature study or systematic review. Data collection methods involved searching literature from various relevant bibliographic sources. No specific research samples were mentioned, as this study was a literature review that did not require specific samples. The study also did not use specific measuring instruments or tools, hence the validity and reliability of measurement tools were not discussed. Data collection procedures were conducted through a literature search, and data were qualitatively analyzed through synthesis and interpretation of the reviewed literature. The journal did not mention the use of specific software or analytical tools, and there were no specific steps taken to address biases or errors in this research (Chuvita et al., 2022).

In contrast, the study by Hickey et al. (2021) examined the use of wearable technology and smart devices in identifying and tracking stress and mental health issues using a systematic review design. Data were collected through comprehensive searches of electronic databases such as MEDLINE, Embase, PsycINFO, and the Cochrane Library. Based on predetermined inclusion and exclusion criteria, research samples were chosen, and 41 studies in total were reviewed. Various smart devices and wearable technologies were used to measure signs of anxiety, depression, and stress. Although the validity and reliability of measurement tools were not explicitly discussed, this study conducted rigorous data collection procedures and analyzed data using a narrative synthesis approach and quality assessment of studies. The journal also did not mention the use of specific analytical software, but steps to address biases included comprehensive search and systematic study selection (Hickey et al., 2021).

The inquiry was conducted by Al-Atawi et al. (2023) tested a machine learning-based stress monitoring system using an experimental design. Data were collected using wearable sensors measuring physiological variables related to stress from volunteer participants. Although not detailed, the study used wearable sensors to measure variables such as heart rate and skin temperature. The validity and reliability of measurement tools were not extensively discussed, and data were analyzed using machine learning algorithms to develop stress prediction models. Specific software or analytical tools were not mentioned, and steps to address bias or errors in this research were also not elaborated in detail (Al-Atawi et al., 2023).

Gomes et al. (2023) in they employed a literature review methodology in their survey of wearable sensors for monitoring mental health. However, this survey did not provide detailed information on research design, data collection methods, sample selection, sample size, or measuring instruments used in the reviewed studies. The validity and reliability of measurement tools and data collection procedures were not explained, and data analysis was conducted qualitatively focusing on synthesizing existing literature. Specific software or analytical tools were not mentioned, and steps to address bias or errors were also not detailed (Gomes et al., 2023).

Finally, the study by Ahmed et al. (2023) used a scoping review design to evaluate wearable devices for monitoring anxiety and depression. Data collection methods involved systematically searching scientific databases such as PubMed, Embase, and IEEE Xplore. The research sample consisted of 37 scientific articles that met inclusion criteria. This study did not use direct measuring instruments, as its focus was on literature analysis. The validity and reliability of measurement tools were not discussed, and data were analyzed using a qualitative synthesis approach. Specific software or analytical tools were not specified, but the authors followed the PRISMA-ScR guidelines to address biases and errors in this research (Ahmed et al., 2023).

4. Conclusions

Based on the literature reviews analyzed from several journals, it is evident that various methods are employed in research on the application of technology in mental health, particularly the Internet of Things (IoT), wearable devices, and smart sensors. The study by Chuvita et al. (2022) utilized a literature study or systematic review design. The primary method for data collection involved searching literature from various sources such as scientific journals, books, and other libraries talking on how IoT is being used in mental health. No samples or measuring instruments were used as this was a literature study. Data collection procedures were conducted through a literature search, and data were qualitatively analyzed through synthesis and interpretation of the reviewed literature. No specific steps were taken to address biases or errors since it was a literature study.

Hickey et al. (2021) also employed a systematic review design. Data collection methods included comprehensive searches of electronic databases such as MEDLINE, Embase, PsycINFO, and the Cochrane Library. Research samples were selected through systematic selection based on predetermined inclusion and exclusion criteria. This review included 41 studies, with various smart devices and wearable technologies used in the studies. Data were analyzed using systematic review approaches, including narrative synthesis and quality assessment of studies. There was no specific information about the software used, but standard tools for systematic reviews were utilized.

In the study by Al-Atawi et al. (2023), an experimental design was used to test a machine learning-based stress monitoring system. Data were collected using wearable sensors measuring physiological variables related to stress. However, detailed information on how research samples were selected or the sample size was not provided. Data collected were analyzed using machine learning algorithms to develop stress prediction models, but no specific software for this analysis was mentioned. The study conducted by Gomes et al. (2023) did not offer comprehensive research design details, data collection methods, or data analysis used in the discussed studies. As a literature survey, this research reviewed various studies related to wearable sensors for monitoring mental health but did not provide methodological details of these studies.

Finally, the study by Ahmed et al. (2023) utilized a scoping review design. The primary method of data collection involved systematically searching scientific databases such as PubMed, Embase, and IEEE Xplore. The research sample consisted of 37 scientific articles meeting the inclusion criteria. Data collection procedures included literature search, article screening based on inclusion criteria, and data extraction from selected articles. Data were analyzed using a qualitative synthesis approach. Specific steps to address biases or errors were not detailed, but the authors followed the PRISMA-ScR guidelines for scoping reviews.

.

Funding

This research is self-funded and does not involve any external funding sources.

Acknowledgments

We extend our utmost appreciation and gratitude to the Institute of Science Technology and Health 'Aisyiyah Kendari and the Institute of Technology and Sciences Muhammadiyah North Kolaka for their invaluable support. This support has been immensely meaningful to us and has played a crucial role in achieving our shared goals. The collaboration forged not only strengthens institutional relationships but also drives mutual progress in the fields of science and technology. We deeply appreciate every contribution that has been made.

Conflicts of Interest

This research is conducted on a personal basis, and there are no personal, financial, or other interests that could potentially influence the interpretation or representation of the research results. The study is independent of any external influences or funding that could impact the design, data collection, analysis, interpretation, or publication decisions. Funders were not involved in the design of the study, data collection, analysis, or interpretation, article preparation, or the choice to publish the findings.

References

Abrahão, S., Figueira, A., Martins, B., & Queirós, C. (2021). A systematic review on the use of mobile health applications for the detection of depression and anxiety in patients with coronary heart disease. International Journal of Environmental Research and Public Health, 18(4), 1610. https://doi.org/10.3390/ijerph18041610

Ahmed, A., Aziz, S., Alzubaidi, M., Schneider, J., Irshaidat, S., Abu Serhan, H., Abd-alrazaq, A. A., Solaiman, B., & Househ, M. (2023). Wearable devices for anxiety & depression: A scoping review. *Computer Methods and Programs in Biomedicine Update*, 3, 100095. https://doi.org/10.1016/j.cmpbup.2023.100095

Akena, D., Kiguba, R., Obuku, E. A., & Okello, E. S. (2019). A narrative review of telepsychiatry and its relevance to Uganda. *African Journal of Primary Health Care & Family Medicine*, 11(1), 1-8. https://doi.org/10.4102/phcfm.v11i1.1806

Al-Atawi, A. A., Alyahyan, S., Alatawi, M. N., Sadad, T., Manzoor, T., Farooq-i-Azam, M., & Khan, Z. H. (2023). Stress Monitoring Using Machine Learning, IoT and Wearable Sensors. *Sensors*, 23(21), 8875. https://doi.org/10.3390/s23218875

Barnett, I., Torous, J., Staples, P., Sandoval, L., Keshavan, M., & Onnela, J. P. (2019). Relapse prediction in schizophrenia through digital phenotyping: a pilot study. *Neuropsychopharmacology*, 44(10), 1991-1999. https://doi.org/10.1038/s41386-019-0405-0

Bucci, S., Schwannauer, M., & Berry, N. (2019). The digital revolution and its impact on mental health care. *Psychological Bulletin*, 145(3), 302-322. https://doi.org/10.1037/bul0000172

Bucci, S., Schwannauer, M., & Berry, N. (2019). The digital revolution and its impact on mental health care. Psychological Bulletin, 145(3), 302-322. https://doi.org/10.1037/bul0000172

Bush, N. E., Ouellette, G., & Kinn, J. T. (2016). Wearable technology and long-term weight loss. Journal of the American Medical Association, 316(11), 1161-1162. https://doi.org/10.1001/jama.2016.8634

Chuvita, L., Sampetoding, E. A. M., Pongtambing, Y. S., Christiana, E., & Ambabunga, Y. A. M. (2022). Studi Litelatur Penerapan Internet of Things pada Kesehatan Mental. *Journal Dynamic sainT*, 7(1), 13-19. https://doi.org/10.47178/dynamicsaint.v7i1.68

De Angel, V., Lewis, S., White, K., & Oetzmann, C. (2020). Digital health interventions for the management of chronic pain in older people: a systematic review. *BMC Geriatrics*, 20(1), 181. https://doi.org/10.1186/s12877-020-01575-4

Depp, C. A., Perivoliotis, D., Holden, J., Dorr, J., & Granholm, E. (2021). Single-session mobile-augmented intervention for social functioning in serious mental illness: a randomized controlled trial. *Journal of Psychiatric Research*, 133, 75-83. https://doi.org/10.1016/j.jpsychires.2020.12.015

Donovan, E., Poole, M., Boyer, E. W., & McKeon, R. (2019). How smartphones are changing the face of mobile and participatory healthcare: an overview, with example from eCAALYX. Biomedical Engineering Online, 18(1), 31. https://doi.org/10.1186/s12938-019-0655-4

Figueroa, C. A., & Aguilera, A. (2020). The need for a mental health technology revolution in the COVID-19 pandemic. *Frontiers in Psychiatry*, 11, 523. https://doi.org/10.3389/fpsyt.2020.00523

Firth, J., Torous, J., Nicholas, J., Carney, R., Pratap, A., Rosenbaum, S., & Sarris, J. (2017). The efficacy of smartphone-based mental health interventions for depressive symptoms: a meta-analysis of randomized controlled trials. *World Psychiatry*, 16(3), 287-298. https://doi.org/10.1002/wps.20472

Gomes, N., Pato, M., Lourenço, A. R., & Datia, N. (2023). A Survey on Wearable Sensors for Mental Health Monitoring. *Sensors*, 23(3), 1330. https://doi.org/10.3390/s23031330

Henson, P., & Wisniewski, H. (2017). Digital R&D: the challenges and rewards of ensuring quality in mental health apps. Evidence-Based Mental Health, 20(3), 97-99. https://doi.org/10.1136/eb-2017-102707

Hickey, B. A., Chalmers, T., Newton, P., Lin, C.-T., Sibbritt, D., McLachlan, C. S., Clifton-Bligh, R., Morley, J., & Lal, S. (2021). Smart Devices and Wearable Technologies to Detect and Monitor Mental Health Conditions and Stress: A Systematic Review. *Sensors*, 21(10), 3461. https://doi.org/10.3390/s21103461

Holmes, E. A., Ghaderi, A., Harmer, C. J., Ramchandani, P. G., Cuijpers, P., Morrison, A. P., ... & Craske, M. G. (2018). The Lancet Psychiatry Commission on psychological treatments research in tomorrow's science. The Lancet Psychiatry, 5(3), 237-286. https://doi.org/10.1016/S2215-0366(17)30513-8

Inkster, B., Sarda, S., & Subramanian, V. (2018). An empirical study of social networking behavior using smartphone data. *PloS One*, 13(11), e0206542. https://doi.org/10.1371/journal.pone.0206542

Kretzschmar, K., & Tyroll, H. (2020). Learning to manage mental health symptoms through peer support: the experiences of young people using an online forum. *Journal of Mental Health*, 29(3), 312-319. https://doi.org/10.1080/09638237.2020.1713998

Lattie, E. G., Adkins, E. C., Winquist, N., Stiles-Shields, C., Wafford, Q. E., & Graham, A. K. (2019). Digital mental health interventions for depression, anxiety, and enhancement of psychological well-being among college students: a systematic review. *Journal of Medical Internet Research*, 21(7), e12869. https://doi.org/10.2196/12869

Levin, M. E., Hayes, S. C., & Pistorello, J. (2016). Web-based self-help for preventing mental health problems in universities: comparing acceptance and commitment training to mental health education. *Journal of Clinical Psychology*, 72(3), 207-225. https://doi.org/10.1002/jclp.22254

Menon, V., Rajan, T. M., & Sarkar, S. (2020). Psychotherapeutic applications of mobile phone-based technologies: a systematic review of current research and trends. *Indian Journal of Psychological Medicine*, 42(1), 9-18. https://doi.org/10.4103/IJPSYM.IJPSYM_253_19

Mohr, D. C., Weingardt, K. R., Reddy, M., & Schueller, S. M. (2017). Three problems with current digital mental health research... and three things we can do about them. *Psychiatric Services*, 68(5), 427-429. https://doi.org/10.1176/appi.ps.201600541

Mohr, D. C., Zhang, M., & Schueller, S. M. (2017). Personal sensing: understanding mental health using ubiquitous sensors and machine learning. *Annual Review of Clinical Psychology*, 13, 23-47. https://doi.org/10.1146/annurev-clinpsy-032816-044949

Mustamin, S. B., Muhammad Atnang, Sahriani, B. Sulham, Samsidar. (2024). Health Data Analysis for In-Depth Understanding of Patterns, Prediction, and Disease Management: A Case Study on Diabetes Mellitus. International Journal of Science and Technology, 1(1), Vol.2(1), 2024, 27-34.

Naslund, J. A., Aschbrenner, K. A., Marsch, L. A., & Bartels, S. J. (2016). The future of mental health care: peer-to-peer support and social media. *Epidemiology and Psychiatric Sciences*, 25(2), 113-122. https://doi.org/10.1017/S2045796015001067

Pratap, A., Wang, S., & Mooney, S. D. (2019). The accuracy of passive phone sensors in predicting daily mood. *Depression and Anxiety*, 36(1), 72-81. https://doi.org/10.1002/da.22822

Renton, T., Tang, H., Ennis, N., Cusimano, M., Bhalerao, S., Schweizer, T., & Topolovec-

Vranic, J. (2014). Web-based intervention programs for depression: a scoping review and evaluation. *Journal of Medical Internet Research*, 16(9), e209. https://doi.org/10.2196/jmir.3147

Rus-Calafell, M., Garety, P., Sason, E., Craig, T. J. K., & Valmaggia, L. R. (2018). Virtual reality in the assessment and treatment of psychosis: a systematic review of its utility, acceptability, and effectiveness. Psychological Medicine, 48(3), 362-391. https://doi.org/10.1017/S003329171700194X

Torous, J., Firth, J., Mueller, N., Onnela, J. P., & Baker, J. T. (2017). Methodology and reporting of mobile health and smartphone application studies for schizophrenia. Harvard Review of Psychiatry, 25(3), 146-154. https://doi.org/10.1097/HRP.0000000000000149

Torous, J., Jän Myrick, K., Rauseo-Ricupero, N., & Firth, J. (2020). Digital mental health and COVID-19: using technology today to accelerate the curve on access and quality tomorrow. *JMIR Mental Health*, 7(3), e18848. https://doi.org/10.2196/18848

Wisniewski, H., Liu, G., & Henson, P. (2019). Understanding the quality, effectiveness, and attributes of top-rated smartphone health apps. *Evidence-Based Mental Health*, 22(1), 4-9. https://doi.org/10.1136/ebmental-2018-300069.