Proceedings The 6th UMYGrace 2025
(Universitas Muhammadiyah Yogyakarta Graduate Conference)
Doi: 10.18196/grace.v5i2.677

Mapping IoT Applications in the Textile Industry: A Bibliometric Study using Biblioshiny and VOSviewer

Deni Kurnia[1,2, a)] Agus Sutanto[1, b)*,] Hanif Fakhrurroja[3, c)], and Lovely Son[1, d)]
[1]Department of Mechanical Engineering, Andalas University, Padang, Indonesia.
[2]Department of Mechatronics Engineering, Indorama Polytechnic, Purwakarta, Jawa Barat, Indonesia.
[3]Research Center for Smart Mechatronics, National Research and Innovation Agency, Bandung, Indonesia.
Emails: deni.kurnia@pei.ac.id [a)], agussutanto@eng.unand.ac.id [b)], hani010@brin.go.id [c)], and lovelyson@eng.unand.ac.id[d)]

ABSTRACT
The rapid advancement of technology, particularly the Internet of Things (IoT), has had a transformative impact on various industries, including the textile sector. IoT facilitates real-time data collection, monitoring, analysis, and decision-making, thereby enhancing efficiency, productivity, and resource sustainability. However, a comprehensive bibliometric study of IoT applications in the textile industry has yet to be undertaken. To address this research gap, this study employs bibliometric methods using the Biblioshiny R package and VOSviewer to examine research trends, key contributors, and emerging themes. By analyzing 177 relevant publications from 2015 to 2025, the study identifies major research directions, influential authors, leading institutions, and evolving areas of interest. The findings highlight a growing research focus on IoT-driven textile innovations, particularly the development of electronic textiles (e-textiles), which integrate electronic components into wearable devices for human use. This positioning of e-textiles at the forefront of smart wearable technology underscores their significance as a critical area of exploration within contemporary textile engineering. Furthermore, China, the United States, and India emerge as the predominant contributors to this research domain. The insights derived from this study offer valuable guidance for researchers, industry professionals, and policymakers, supporting future advancements and innovations in IoT applications within the textile industry.
Keyword: Internet of Things (IoT); textile industry; bibliometric analysis; e-textiles; smart wearable technology.

INTRODUCTION
Textile technology has undergone significant advancements over the years, evolving from traditional fabric manufacturing to the development of smart and functional textiles (1). The Internet of Things (IoT) is one of the most cutting-edge developments of recent years, potentially transforming traditional manufacturing processes (2). IoT, which is defined by interconnected devices and systems, enables real-time data collecting, analysis, and decision-making, resulting in enhanced efficiency, productivity, and sustainability. In the textile industry, IoT applications extend from smart machinery and automated quality control to electronic textiles (e-textiles) fabrics that integrate electronic components such as sensors, conductive fibers, microcontrollers, and wireless communication modules (3). This transition represents a paradigm shift in textile research, where the focus has expanded beyond conventional material properties to include intelligent, responsive functionalities.

Previous bibliometric studies on IoT in the textile sector had primarily focused on spinning machines (4); on the other hand, bibliometric analysis of AI applications in the textile sector has been conducted by displaying the largest number of articles (5), so there are still no comprehensive study has been undertaken to map the research environment and identify major trends, contributors, and emerging priority areas. As a result, a thorough investigation is required to fill this gap. Bibliometric analysis is a systematic approach to examining academic literature, providing insights into the development and progression of research within a specific field. This method enables researchers to assess trends, identify key contributions, and evaluate the impact of scholarly work over time (6). Researchers may visualize and analyze enormous collections of scientific articles by employing tools such as Biblioshiny in R package (7,8) and VOSviewer (9), uncovering patterns and insights that might otherwise go undiscovered.

This paper aims to fill the gap by conducting a bibliometric analysis of IoT applications in textile production using dimension database (10), Biblioshiny, and VOSviewer to analyze data. The study will explore the growth of research in this area, identify influential authors and institutions, and highlight key themes and trends. In light of these issues, the study aims to address the following research questions (RQs): (RQ 1) What are the publication trends in IoT applications in textile production? (RQ 2) Who are the leading authors, institutions, and countries in this domain? (RQ 3) What are the emerging themes and future research directions?

By undertaking this research, the study aims to thoroughly examine the present landscape of IoT applications in textile industries, providing meaningful insights for academics, industry experts, and policymakers. Ultimately, this exploration will enhance the understanding of IoT's transformative impact on the future of textiles and help steer future research efforts in this rapidly evolving domain.

Doi: 10.18196/grace.v5i2.677

LITERATURE REVIEW

The integration of the Internet of Things (IoT) in textile production has introduced various innovative applications in the form of control and monitoring systems (11). This application utilizes interconnected devices such as sensors, controllers, and actuators. Then, the results of this integration provided convenience in analyzing data. One of the goals to be achieved is to increase efficiency, reduce costs, and improve the quality of the textile product itself (12). As IoT continues to evolve, its application in textile production is expected to drive further progress, strengthening its role as an important driver of Industry 4.0 in the textile sector (13).

Furthermore, there are several approaches for mapping and assessing earlier research results, including bibliometrics. A bibliometric study has the nobility of being within reach of students and researchers because of its methodology, practicality, relevance, resource-saving, the potential to extend to most of the scientific areas, multiple applications, and favoring the fact of not committing ethical misconduct related to research (14). The selection of journal databases in this article was obtained from Dimensions, considering that the Dimensions database has the most exhaustive journal coverage, with 82.22% more journals than Web of Science and 48.17% more journals than Scopus (15). As for analysis purposes, this article uses a feature in the R package called Biblioshiny and also combines with VOSviewer. A combination of Biblioshiny and VOSviewer is intended to provide powerful and complementary metadata visualization and mapping (16,17).

MATERIALS AND METHODS

The data sources (materials) for this bibliometric study were obtained from the Dimension database using the search query "Internet of Things" OR "IoT" AND "textile industry" with a publication period ranging from 2015 to 2025, with the selected data criteria being articles and proceedings. The search results are then saved in CSV, RIS, and XLS format. Additionally, before importing the data into R Studio and VOSviewer, a manual screening of titles was conducted using Microsoft Excel to remove those unrelated to the query and research questions. After completing this stage, the XLS data is imported and analyzed using Biblioshiny in R Studio version 4.4.2, while the CSV and RIS data are processed and visualized using VOSviewer.

The subsequent step in the data processing phase involves analyzing the data processed by Biblioshiny and VOSviewer to identify publication trends, as well as key authors, institutions, and countries. These tools work in tandem to analyze and visualize data, including trend analysis and thematic mapping. Finally, the Mendeley reference manager organizes and manages citations from selected journals and references pertinent to the topic and discussion.

RESULTS AND DISCUSSION

Publication Trend

To address and analyze RQ 1, which focuses on identifying publication trends in IoT applications in textile production, three types of analyses were conducted: annual scientific production, keyword trend analysis, and most cited documents. These analyses provide insights into the growth, thematic focus, and impact of research in this field over time. Based on the search results from the Dimensions database, 500 publications were retrieved using the keywords "Internet of Things" OR "IoT" AND "textile industry." In the initial stage, manual screening of titles and abstracts was conducted in Microsoft Excel, during which data were excluded based on criteria such as titles and topics captured by Dimensions that did not align with the search keywords. This process resulted in 287 documents deemed suitable for processing in R Studio. Subsequently, a second phase of automatic re-screening was performed, focusing only on paper and conference-type publications with a publication range between 2015 and 2025. This step yielded 177 documents that were ready for further processing and analysis. The findings of the analysis can initially be understood through the visualization presented in **Table1**, which includes the following data details:

Table 1. Overview of the Primary Information about the Documents Analysed (table source: Biblioshiny).

Descriptions	Results
Timespan	2015:2025
Sources (articles, proceedings)	177
Documents	287
Annual Growth Rate %	2.92
Average citations per doc	24.72
Author's Keywords (DE)	157
Authors	1173
Authors of single-authored docs	29
Co-Authors per Doc	4.57
International co-authorships %	20.91

Additionally, the publication trends from 2015 to 2025, based on the top 10 rankings, are illustrated in Figure **1.**

Doi: 10.18196/grace.v5i2.677

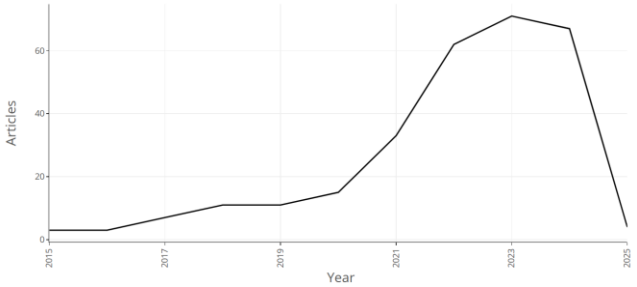

Figure 2. Publication trend from 2015-2025 (image source: Biblioshiny).

Figure 1 shows that of all the top ten publications, the largest peak of 71 articles occurred in 2023, while the lowest article occurred in 2015, with three articles. Following **Figure 1**, the publication trend demonstrates a steady rise from 2015 to 2023, with a minor decline observed in 2024, as the number of articles decreased from 71 to 67, reflecting a 5.63% drop. As for 2025, since the data was collected at the beginning of the year (February 2025), the number of articles for the full year cannot yet be determined. However, based on the overall trend, the number of publications has consistently increased year-on-year.

The next step in the analysis involves examining keyword trends through co-occurrence analysis, which helps identify the most frequently occurring and interconnected terms in the research literature. This analysis provides insights into the dominant themes and emerging topics within IoT applications in textile production. **Figure 2** depicts the popular associated keywords used by researchers investigating this topic from the database.

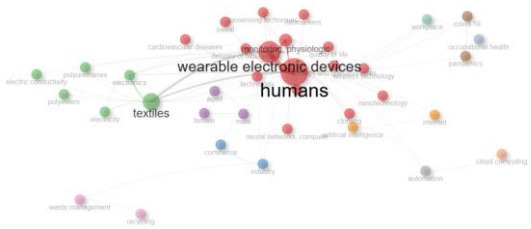

Figure 2. The visualization data of co-occurrence analysis (image source: Biblioshiny).

Based on **Figure 2**, the keywords humans, wearable electronic devices, and textiles continue to show a strong relationship and have been extensively discussed in publications over the past decade. The keyword Internet of Things directly linked to textiles appears less frequently. However, this article provides research results on how IoT and wearable devices have an increasing trend (18), indicating that the development of IoT applications in the textile industry remains an open and promising area with significant potential for future growth and innovation.

To complete the findings other than keywords, **Figure 3** provides a more detailed visualization of the trends in words and phrases most frequently mentioned by researchers, offering deeper insights into the recurring themes and focus areas within the field of IoT applications in textile production.

Figure 3. World Cloud, the most talked about word by researchers (image source : biblioshiny).

From **Figure 3**, it is evident that the prominence of keywords like "humans" and "wearable electronic devices" in the word cloud highlights the growing integration of smart textiles and wearable technology. This trend underscores the increasing focus on the relationship between humans and advanced wearable devices in this field. The integration of IoT within textiles is predominantly centered on human use, particularly in wearable electronic devices such as smart clothing, fitness trackers, and healthcare monitoring garments (19). Consequently, humans frequently appear as a key term in related research (20).

Based on previous studies, wearable technology represents one of the most significant applications of IoT in the textile industry, encompassing innovations such as smart fabrics, biosensors, and interactive clothing (21). This has resulted in wearable electronic devices emerging as a dominant keyword in bibliometric studies. Additionally, a substantial portion of IoT-driven textile research is dedicated to monitoring physiological parameters, including heart rate, body temperature, respiration, and muscle activity. These applications are particularly relevant in the healthcare sector, where they support remote patient monitoring and chronic disease management (22).

The increasing convergence of e-textiles with the Internet of Things (IoT) is a key factor driving this transformation. Researchers are developing wearable electronic systems capable of real-time data collection, wireless communication, and automated responses by embedding sensing, processing, and connectivity features into textiles. This integration positions e-textiles at the forefront of smart wearable technology, making them a critical area of exploration within modern textile engineering.

Leading Authors, Institutions, and Countries

Doi: 10.18196/grace.v5i2.677

In this section, the results and discussion focus on addressing RQ 2, which aims to identify the leading authors, institutions, and countries in the domain of IoT applications in textile production. This analysis highlights the key contributors and their affiliations, providing insights into the global distribution of research expertise and collaboration in this field. **Table 2** shows author distributions an overview of the top ten most leading authors from 2015 to 2025 reveals the key contributors who have significantly influenced research in IoT applications in textile production. These authors are identified based on their publication output, citation impact, and overall contribution to advancing knowledge in this field during the specified period.

Table 2. Overview of the top ten most leading author during 2015 and 2025 (table source : biblioshiny).

Authors	Articles	Articles Fractionalized
Wang J	6	1.06
Zhang Y	6	0.87
Lee C	5	1.20
Park J	5	0.94
Wang Y	5	0.77
Chen J	4	0.67
Chen X	4	0.73
Kumar A	4	0.76
Li X	4	1.26
Liu T	4	0.60
Wang X	4	0.71

Table 2 provides data on authors and their contributions to academic articles, measured through two metrics: the total number of articles authored and the fractionalized article count. The fractionalized count adjusts for co-authorship by distributing credit proportionally among collaborators. Key insights from the data include:

- Wang J and Zhang Y lead in total publications with 6 articles each, but their fractionalized contributions differ (1.06 and 0.87, respectively), reflecting varying degrees of co-authorship involvement.
- Lee C has authored 5 articles and holds the highest fractionalized contribution (1.20), indicating significant individual input.
- Li X also stands out with a fractionalized count of 1.26, despite having only 4 articles, suggesting a strong influence as an author.
- Other authors, such as Wang Y, Chen J, and Liu T, exhibit lower fractionalized counts, pointing to a higher reliance on co-authorship in their publications.

To identify the institutions with the highest number of publications, the data is presented in TABLE 3. This table provides a clear breakdown of the leading institutions contributing to research in IoT applications in textile production, ranked by their total publication output. This analysis helps highlight the most active and influential organizations in the field.

Table 3. Overview of the top ten most leading affiliation during 2015 and 2025 (table source : biblioshiny).

Affiliation	Articles
Department of Bioengineering, University of California, Los Angeles, California, USA	16
School of Automation and Software Engineering, Shanxi University, Taiyuan, China	10
Dalian Key Lab of Marine Micro/Nano Energy and Self-Powered System, Marine Engineering College, Dalian Maritime University, Dalian, China.	9
Icar-National Institute of Natural Fibre Engineering and Technology, Kolkata, India	9
Wuhan National Laboratory for Optoelectronics, and School of Computer Science and Technology, Huazhong University of Science and Technology, Wuhan, China	9
Department Of Dermatology, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China	8
Department Of Metallurgical And Materials Engineering, Metu, Ankara, Türkiye	8
Key Laboratory of Bionic Engineering, Ministry of Education, Jilin University, Changchun, China	8
Key Laboratory of Synthetic and Biological Colloids, Ministry of Education, School of Chemical and Material Engineering, Jiangnan University, Wuxi, China	8

Table 3 offers an overview of the top ten leading affiliations/institutions regarding research article contributions between 2015 and 2025, based on data extracted from Biblioshiny. Key Observations are the following:

- The Department of Bioengineering, University of California, Los Angeles (UCLA), USA, tops the list with 16 published articles.
- China dominates the list, with four institutions featured:
  - School of Automation and Software Engineering, Shanxi University (10 articles)
  - Dalian Maritime University (9 articles)
  - Huazhong University of Science and Technology (9 articles)
  - Jilin University (8 articles)

Doi: 10.18196/grace.v5i2.677

- India and Türkiye each have one institution in the top 10, reflecting their emerging contributions in their respective research areas.

This data underscores the global nature of research collaboration and highlights the significant role of Chinese institutions in driving research productivity during this period. Next, the analysis based on the distribution of countries is illustrated in **Figure 4.**

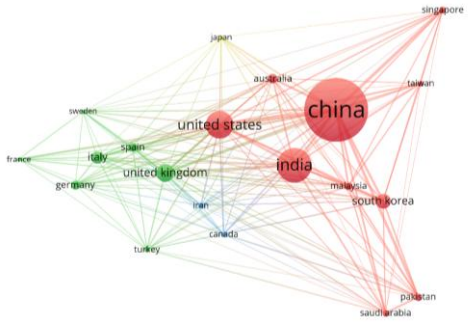

Figure 4. Distribution of articles by leading countries (image source: VOSviewer).

Figure 4 presents a collaboration network visualization of countries involved in academic research. Key observations include that China emerges as the most dominant participant, indicated by the largest node size, reflecting its extensive involvement and partnerships with other nations. The United States and India also hold significant roles, as highlighted by their prominent node sizes, demonstrating their notable contributions to global research efforts. Asian countries, such as Singapore, South Korea, Malaysia, and Taiwan, display active regional collaboration, as evidenced by dense connections with China and India. Meanwhile, European nations, including Germany, Italy, the United Kingdom, and France, form a tightly interconnected cluster, showcasing robust intra-regional cooperation.

Figure 4 further reveals intercontinental collaborations, with strong links connecting Asia, Europe, and North America, underscoring the global nature of the research network. Although represented by smaller nodes, Iran, Canada, and Australia remain active contributors to international partnerships. In summary, the visualization highlights a thriving global research ecosystem, with China serving as a central hub for fostering cross-border collaborations across diverse regions.

Citation Analysis, Thematic Cluster, and Future Directions

This section addresses RQ 3, which identifies emerging themes and future research directions. The analysis is organized into three primary categories: the most cited works by country, thematic clusters, and potential direction for future research.

The first category identifies countries with the highest research impact based on citation counts, highlighting their contributions to the global academic landscape. **Figure 5** provides a citation analysis highlighting the highly cited countries. This visualization showcases the countries with the most significant research impact, measured by the total number of citations, offering insights into their contributions to global academic advancements.

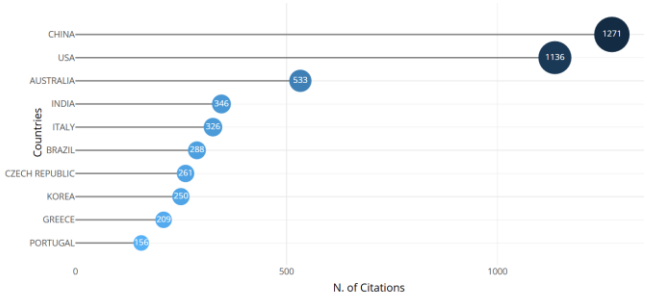

Figure 5. Citation Analysis based on highly cited countries. **(**image source: Biblioshiny)

Following **FIGURE 5**, China dominates with the highest number of citations (1.271), reflecting its significant contributions to globally impactful research. The United States follows closely with 1.136 citations, emphasizing its role as a major research powerhouse. Australia ranks third with 533 citations, demonstrating its strong presence in the global research community. India and Italy hold the fourth and fifth positions, with 346 and 326 citations, respectively, highlighting their growing influence. Countries like Brazil (288 citations), the Czech Republic (261 citations), and South Korea (250 citations) indicate substantial contributions, particularly in niche areas. Greece (209 citations) and Portugal (156 citations) round out the list, showcasing their engagement in impactful research despite smaller research outputs. Overall, the visualization highlights a global distribution of research impact, with China and the United States leading considerably, followed by other nations actively contributing to the academic landscape.

Lastly, the second category focuses on emerging themes and future research. By analyzing publication trends, keywords, and citation data, it is clear that the rapid convergence of textiles and electronics is driving the seamless and extensive integration of sensors into fabrics, as well as accelerating the development of conductive yarn (23). The potential of smart fabrics will expand the uses and functions of medical devices (24,25). Future research on smart textile

Doi: 10.18196/grace.v5i2.677

devices (including wearable electronic devices) requires a multidisciplinary approach, such as smart materials, microelectronics, and chemistry integrated into a single textile product (26). In line with the theme, IoT applications play a crucial role in driving and accelerating the advancement of this technology (27).

The synergy between e-textiles and IoT is one of the most transformative aspects of modern textile research. E-textiles act as wearable IoT devices, capable of sensing and transmitting biometric, environmental, and movement-related data in real-time. This connectivity allows for continuous health monitoring, remote diagnostics, and adaptive user interactions, making e-textiles an essential component of IoT-enabled healthcare, sports, and defense applications.

CONCLUSION

This bibliometric study examines the growing impact of the Internet of Things (IoT) in transforming textiles into smart and functional materials. Through the integration of IoT and embedded electronics, textiles have evolved beyond conventional fabrics to become intelligent systems capable of sensing, responding to, and adapting to environmental changes, as well as monitoring human physiological data. These advancements create new opportunities for applications across various sectors, including healthcare, sports, fashion, and industry. The findings indicate a steady increase in research publications from 2015 to 2025, with a significant concentration of studies focusing on wearable electronics and smart fabrics. China, the United States, and India have emerged as the leading contributors to IoT research in textiles. Key institutions and influential authors play a pivotal role in driving innovation in this domain. Analyzing publication trends and keyword occurrences suggests that future research should prioritize the integration of IoT with artificial intelligence (AI), smart materials, and sustainable textile production. As IoT adoption continues to expand, interdisciplinary collaboration among researchers, engineers, and industry stakeholders will be crucial in unlocking the full potential of smart textile solutions. This study provides a foundation for further exploration and strategic advancements in IoT applications within the textile industry.

REFERENCE

1. Rathore DB. Textile Industry 4.0 Transformation for Sustainable Development: Prediction in Manufacturing & Proposed Hybrid Sustainable Practices. Eduzone Int peer Rev Acad Multidiscip J. 2022;11(01):223–41.
2. Elkateb S, Métwalli A, Shendy A, Abu-Elanien AEB. Machine learning and IoT – Based predictive maintenance approach for industrial applications. Alexandria Eng J. 2024;88(January):298–309.
3. Shi J, Liu S, Zhang L, Yang B, Shu L, Yang Y, et al. Smart Textile-Integrated Microelectronic Systems for Wearable Applications. Adv Mater. 2020;32(5):1–37.
4. Manglani H, Hodge G, Oxenham W. Application of the Internet of Things in the textile industry. Text Prog. 2019 Jul 3;51:225–97.
5. Halepoto H, Gong T, Noor S, Memon H. Bibliometric Analysis of Artificial Intelligence in Textiles. Materials (Basel). 2022;15(8).
6. Berger JM, Baker CM. Bibliometrics: An Overview. Rajiv Gandhi Univ Heal Sci J Pharm Sci. 2014;4(3):81–92.
7. Dervis H. Bibliometric analysis using bibliometrix an R package. J Scientometr Res. 2019;8(3):156–60.
8. Farooq R. Mapping the field of knowledge management: a bibliometric analysis using R. VINE J Inf Knowl Manag Syst [Internet]. 2023 Jan 1;53(6):1178–206.
9. Van Eck NJ, Waltman L. Manual for VOSviewer version 1.5.2. Leiden Univeristy [Internet]. 2012;(September):1–28.
10. Hook DW, Porter SJ, Herzog C. Dimensions: Building Context for Search and Evaluation. Front Res Metrics Anal. 2018;3(August):1–11.
11. Islam MM, Mintoo AA, Saimon ASM. Enhancing Textile Quality Control With Iot Sensors: a Case Study of Automated Defect Detection. Int J Manag Inf Syst Data Sci. 2024;1(1):19–30.
12. Uchechukwu Christopher Anozie, Kenneth Pieterson, Obinna Barnabas Onyenahazi, Umeh Okenna Chukwuebuka, Prince Chukwuemeka Ekeocha. Integration of IoT technology in lean manufacturing for real-time supply chain optimization. Int J Sci Res Arch. 2024;12(2):1948–57.
13. Khan IH, Javaid M. Role of Internet of Things (IoT) in Adoption of Industry 4.0. J Ind Integr Manag [Internet]. 2021 Jan 27;07(04):515–33. Available from: https://doi.org/10.1142/S2424862221500068
14. Salinas-Ríos K, García López AJ. Bibliometrics, a useful tool within the field of research. J Basic Appl Psychol Res. 2022;3(6):9–16.
15. Singh VK, Singh P, Karmakar M, Leta J, Mayr P. The journal coverage of Web of Science, Scopus and Dimensions: A comparative analysis. Scientometrics [Internet]. 2021;126(6):5113–42.
16. Wong D. VOSviewer. Tech Serv Q. 2018;35(2):219–20.
17. Fakruhayat M, Rashid A. How to Conduct a Bibliometric Analysis using R Packages: A Comprehensive Guidelines. J Tour Hosp Culin Arts. 2023;15(1):24–39.

Doi: 10.18196/grace.v5i2.677

18. Poongodi T, Krishnamurthi R, Indrakumari R, Suresh P, Balusamy B. Wearable devices and IoT [Internet]. Vol. 165, Intelligent Systems Reference Library. Springer International Publishing; 2020. 245–273 p.
19. Prihatin J, Corebima AD, Ariffin, Gofur A. The Effect of Exposure of Mulberry to Acid Rain on the Defects Cocoon of Bombyxmori L. Procedia Environ Sci [Internet]. 2015;23:186–91.
20. Motti VG, Caine K. Human factors considerations in the design of wearable devices. Proc Hum Factors Ergon Soc. 2014;2014-Janua:1820–4.
21. Godfrey A, Hetherington V, Shum H, Bonato P, Lovell NH, Stuart S. From A to Z: Wearable technology explained. Maturitas [Internet]. 2018;113(April):40–7.
22. Ehizogie Paul Adeghe, Chioma Anthonia Okolo, Olumuyiwa Tolulope Ojeyinka. A review of wearable technology in healthcare: Monitoring patient health and enhancing outcomes. Open Access Res J Multidiscip Stud. 2024;7(1):142–8.
23. Raji RK, Miao X, Boakye A. Electrical conductivity in textile fibers and yarns—review. AATCC J Res. 2017;4(3):8–21.
24. Singh A V., Rahman A, Sudhir Kumar NVG, Aditi AS, Galluzzi M, Bovio S, et al. Bio-inspired approaches to design smart fabrics. Mater Des [Internet]. 2012;36:829–39.
25. Júnior HLO, Neves RM, Monticeli FM, Dall Agnol L. Smart Fabric Textiles: Recent Advances and Challenges. Textiles. 2022;2(4):582–605.
26. Choudhry NA, Arnold L, Rasheed A, Khan IA, Wang L. Textronics—A Review of Textile-Based Wearable Electronics. Adv Eng Mater. 2021;23(12).
27. Fernández-Caramés TM, Fraga-Lamas P. Towards the internet-of-smart-clothing: A review on IoT wearables and garments for creating intelligent connected E-textiles. Electron. 2018;7(12).