MEDICINE, LAW & SOCIETY
Vol. 18, No. 2, pp. 333–358, October 2025

EXPLORING RESEARCH TRENDS IN HEALTHCARE ASSET MANAGEMENT SYSTEMS: KEY AREAS, STRATEGIC PRIORITIES, AND ACTIONABLE RECOMMENDATIONS

Accepted
20. 6. 2025

Revised
1. 8. 2025

Published
10. 10. 2025

DALIBOR STANIMIROVIĆ, LAN UMEK, DEJAN RAVŠELJ
University of Ljubljana, Faculty of Public Administration, Ljubljana, Slovenia
dalibor.stanimirovic@fu.uni-lj.si, lan.umek@fu.uni-lj.si, dejan.ravselj@fu.uni-lj.si

CORRESPONDING AUTHOR
dalibor.stanimirovic@fu.uni-lj.si

Abstract Asset Management Systems (AMS) are increasingly recognized for their potential to enhance operational efficiency, cost-effectiveness, and sustainability across asset-intensive sectors. In healthcare, however, the implementation of AMS remains fragmented, despite mounting pressures to improve medical equipment usage, infrastructure reliability, and service delivery. This study presents a literature review supported by a bibliometric analysis of 248 documents on AMS research in healthcare, published up to 2024 and indexed in the Scopus database, examining the evolution of AMS research with a specific focus on healthcare applications. Using Python and VOSviewer, the bibliometric analysis focuses on scientific production, geographical coverage, and major research clusters. The findings highlight a growing global interest in AMS and indicate a broader shift toward digitalization and strategic integration within healthcare systems. We synthesize these insights into a set of key areas and priorities, offering evidence-based recommendations to support more effective AMS adoption in healthcare.

Keywords
asset management system,
healthcare,
medical equipment,
research trends,
bibliometric analysis

https://doi.org/10.18690/mls.18.2.333-358.2025

University of Maribor Press

1 Introduction

The term *asset* is interpreted in various ways across disciplines; however, it is generally understood as any item, entity, or resource that holds value for an individual, company, or organization. Assets are typically classified into five principal categories: financial, human, informational, intangible, and physical (Van der Lei et al., 2012). Over the past three decades, the absence of well-established methods and practices for effective asset management has compelled organizations to explore more systematic approaches to improve asset performance. In the early stages, many organizations adopted trial-and-error strategies to enhance asset utilization, which led to the development of guidelines grounded in experiential knowledge (Al Marzooqi et al., 2019). Over time, these guidelines have been formalized, standardized, and globally disseminated, positioning asset management as a critical component of organizational performance and a driver of long-term growth (da Silva & de Souza, 2022). At the core of asset management lies the objective of maximizing the value derived from assets through a comprehensive and integrated management approach. Widely recognized definitions emphasize that asset management involves the coordinated activities of an organization aimed at realizing value from its assets. More specifically, it encompasses systematic and structured processes for managing assets, asset systems, performance, risks, and associated costs in a sustainable and optimized manner across their life cycles, all in alignment with the organization's strategic objectives (International Organization for Standardization, 2014).

Since its origins in the 1970s, the concept of asset management has undergone substantial evolution. Initially, it was predominantly concerned with the optimized maintenance of physical assets, emphasizing a balance between financial and operational objectives to ensure cost-effectiveness over the asset lifecycle – a practice commonly referred to as economic asset management (Ugarelli & Saegrov, 2022). With the progression of information and communication technologies (ICTs), asset management practices have become increasingly structured and data-driven, facilitating broader adoption across sectors (Gavrikova et al., 2020). The integration of advanced software systems and emerging technologies, such as Radio Frequency Identification (RFID), the Internet of Things (IoT), and Artificial Intelligence (AI), has further promoted the field by enhancing asset tracking, enabling predictive maintenance, and improving overall operational efficiency

(Chang et al., 2023; Chen & Chen, 2022). Asset Management Systems (AMSs) play a critical role in ensuring the effective operation, control, maintenance, cost savings, risk mitigation, better decision-making, and sustainability of both tangible and intangible assets within organizations (Diop et al., 2021; Lima et al., 2021). However, despite their potential, AMSs remain underutilized in many sectors, often resulting in fragmented activities, inefficiencies, and missed opportunities for optimization. The healthcare sector, in particular, has been identified as one of the most affected domains, characterized by poor coordination, unclear business processes, and limited control over asset-related activities.

Healthcare systems worldwide are under increasing pressure to deliver high-quality, efficient, and resilient services in the face of rising costs, staff shortages, and rapidly evolving technologies. Medical institutions are increasingly leveraging advanced technologies to improve diagnostics, treatment, and rehabilitation outcomes, relying on complex, high-value equipment, complicated infrastructure, and digital platforms that require coordinated and proactive management (Haleem et al., 2022). However, persistent challenges, such as inadequate tracking of medical equipment utilization, downtime, suboptimal maintenance planning, deficient resource allocation, and regulatory non-compliance, continue to hinder operational effectiveness. These shortcomings can lead to extended patient waiting times, financial inefficiencies, and diminished credibility. Medical equipment, often highly sophisticated and capital-intensive, demands specialized management and maintenance strategies. Consequently, effective asset management is imperative, as equipment underutilization or failure not only strains institutional budgets but also compromises the quality of patient care (Salem & Elwakil, 2023). AMSs, which provide a structured, lifecycle-oriented framework for asset management, could therefore offer significant benefits and development opportunities in the healthcare sector as well. These include improved medical equipment usage, better planning and procurement, predictive maintenance, transparent budgetary operations, and efficient business processes (Abd Rahman et al., 2023). Yet, in healthcare, where asset performance directly impacts patient care, treatment coordination, and overall financial effectiveness, the adoption of AMS has been inconsistent and often narrowly applied (Call, 2024). While emerging technologies like the IoT and AI are beginning to transform asset management capabilities (Tjebane & Musonda, 2024), their uptake in healthcare settings remains limited, often constrained by institutional inertia, organizational and process hurdles, and insufficient strategic considerations.

The main objective of this study is to map the key areas and thematic priorities that have been the focal point of AMS research in healthcare in recent years and to derive practical recommendations for implementing AMS in healthcare institutions. The study employs a literature review supported by a bibliometric analysis of 248 documents on AMS research in healthcare, published up to November 2024 and indexed in the Scopus database. The literature review is therefore enhanced by both established and innovative bibliometric methods, utilizing Python and VOSviewer software. Through a comprehensive bibliometric analysis, we chart the evolution of AMS research, uncover dominant topics, and examine the extent to which healthcare-specific issues are addressed. Special attention is given to technological enablers, stakeholder engagement, and the operationalization of AMS in real-world healthcare environments. The study is conducted in two phases. The first phase provides a comprehensive overview of AMS research in healthcare, focusing particularly on identifying both declining and emerging research trends. This phase highlights key areas and emerging priorities addressed in recent AMS research. The second phase centers on identifying the prerequisites for effectively adopting AMS in the healthcare sector and outlines actionable recommendations for implementing it. This phase highlights the importance of a well-structured AMS framework to ensure seamless integration and sustained use within healthcare settings.

Beyond simply documenting research output, this study seeks to inform implementation strategies by highlighting underexplored areas and offering targeted recommendations. These include improving alignment between clinical operations and asset planning, investing in smart infrastructure, fostering interdisciplinary collaboration, and developing policy frameworks that support AMS integration at the organizational and system levels.

Following the introduction, the second section offers a targeted review of existing literature, highlighting current applications of asset management within the healthcare sector. The third section presents the methodological framework, outlining the structure of the literature review and detailing the bibliometric analysis approach, including the functionalities of the Python VOSviewer software employed. The fourth section presents research findings, mapping the specific landscape and key characteristics of AMS research in healthcare. The fifth section provides a critical discussion, examining the potential benefits and challenges associated with AMS integration, and offers actionable recommendations for effectively implementing it in healthcare systems. Finally, the sixth section concludes with a synthesis of the main findings and reflections on the strategic opportunities that asset management presents for the future development of healthcare services.

2 Literature Review

The concept of asset management has evolved considerably since its early beginnings, when it was primarily seen as a technical or maintenance concern. Over time, it has matured into a multidisciplinary framework for optimizing the performance, lifecycle, and value of assets across industries (British Standards Institution, 2008). AMSs provide organizations with the tools and methodologies to systematically manage assets while balancing performance, costs, and risks. While much of this evolution has been shaped by advances in engineering, information systems, and operational research, the healthcare sector has only recently begun to engage with the broader potential of AMS.

Bibliometric studies have shown a steady increase in AMS-related publications, particularly since the 2000s. The growth of AMS research over the past 20 years was further accelerated by the global diffusion and application of the ISO 55000 standard. Studies by Tajudin et al. (2021) and da Silva and de Souza (2021) confirm a concentration of research around the following research areas: engineering, business, management and finance, infrastructure, maintenance, risk, and computer science, with limited attention to healthcare. The findings reveal that most contributions to asset management research have been disseminated through journal articles and conference proceedings. The linguistic distribution of these studies is markedly imbalanced, with English comprising the predominant language of publication. Furthermore, these studies also highlight geographic disparities, with North America, Europe, and Asia dominating the field, while healthcare-specific AMS research remains fragmented and underrepresented. Although the studies focus on different subject areas, they predominantly emphasize the role of specialized digital applications in establishing asset management, along with the associated benefits and challenges (Garramone et al., 2020; Rampini & Cecconi, 2022). ICTs play an interesting dual role in this context: they are both assets that AMSs must monitor and manage, and tools that enable the functioning and application of AMSs.

In healthcare, although AMS studies span diverse thematic domains, they tend to concentrate on more specific aspects of asset management, such as predictive maintenance for medical equipment or digital systems for hospital facilities and infrastructure, rather than on comprehensive, strategic integration across healthcare operations. For instance, Leiblein et al. (2016) explored facility management, water system risks in hospitals, and associated infections. Several studies corroborate the growing adoption of asset management practices in the healthcare sector, highlighting its substantial potential for integrating digital technologies with asset management principles (Rousek et al., 2014). A recurring focus within this body of research is the strategic management of medical equipment, healthcare facilities, and digital assets aimed at improving operational efficiency (Aboelmaged & Hashem, 2018). Moreover, digital transformation, particularly through implementing AMSs incorporating technologies such as the IoT and AI, has recently emerged as a prominent trend in healthcare asset management research (Sen et al., 2018). Despite these advancements, notable gaps persist within the current literature. Although prior studies emphasize aspects such as medical facility maintenance, lifecycle optimization, and the integration of digital technologies, there remains a lack of comprehensive investigations examining the broader impact of enhanced asset management on patient care, healthcare service delivery, and treatment outcomes.

On the other hand, it is important to note that analyses of AMS-related research (including bibliometric studies) often employ methodologies such as co-word analysis, thematic clustering, and topic modeling to identify key themes. These methodological approaches predominantly rely on keywords, terminology, and constructs derived from the corporate domain, which are frequently absent in the healthcare context. As a result, numerous studies that substantively address asset management and its implications in healthcare tend to be overlooked, and their impact and visibility within both professional and academic communities remain relatively limited.

In comparison to studies within the broader asset management domain, research on healthcare asset management remains underdeveloped, particularly with respect to systematic frameworks and patient-centered perspectives (Yuen et al., 2022). An essential critique of the existing literature in this field is its predominant focus on narrow, technology-driven aspects of asset management, often at the expense of human and material resources, development, organizational, and other dimensions.

These include stakeholder engagement, employee participation, regulatory and decision-making frameworks, and broader business processes. Moreover, interdisciplinary perspectives are noticeably underrepresented, despite the clear relevance of fields such as public health, operations management, finance, and organization in the healthcare asset management concept (Chen et al., 2021). One of the underlying reasons for the relatively limited volume of research in this area may be attributed to the structural and operational characteristics of healthcare systems themselves. These systems are typically rigid, heavily regulated, and resistant to rapid transformation, posing significant challenges for integrating novel management concepts and emerging technologies. In this context, effectively adopting AMS necessitates a paradigm shift, entailing comprehensive reforms across managerial practices, organizational structures, operational processes, regulatory frameworks, and information systems.

3 Materials and Methods

Comprehensive bibliometric data on AMS research in the healthcare domain were systematically retrieved in May 2025 from Scopus, one of the most comprehensive and widely recognized bibliographic databases for peer-reviewed literature. Scopus was selected as the primary source for this bibliometric study due to several well-established advantages that position it as a more suitable choice over alternative databases such as Web of Science.

Firstly, Scopus offers broader disciplinary coverage, encompassing a wider spectrum of scientific publications compared to Web of Science (Gerasimov et al., 2024). This inclusivity is particularly critical in an interdisciplinary field such as AMS in healthcare, which spans medical technology, engineering, hospital operations, and public health policy. Secondly, Scopus provides more extensive indexing of Social Sciences and Humanities research, an area underrepresented in Web of Science (Singh et al., 2021). Since implementing AMS often involves organizational, managerial, and behavioral dimensions within healthcare institutions, access to this broader coverage enriches the analytical scope. Thirdly, Scopus includes a greater volume of non-English publications while still providing English-translated titles, abstracts, and keywords – ensuring that global perspectives are captured without sacrificing consistency in language processing for bibliometric analysis (Vera-Baceta et al., 2019).

Furthermore, from a methodological standpoint, the decision to use Scopus is underpinned by a fundamental statistical principle: larger sample sizes and more diverse datasets typically lead to more robust, precise, and generalizable analytical results (Rogers et al., 2020). In light of this, Scopus appears to be the more relevant bibliographic database, as it aligns with the specifics of AMS research. Its extensive coverage increases the likelihood of capturing all relevant publications related to AMS in healthcare, thereby enhancing the comprehensiveness and validity of the findings.

To extract relevant documents, we employed an advanced search strategy using Scopus' sophisticated query engine to conduct a comprehensive title, abstract, and keyword search. The search focused on retrieving specific documents that included the phrase "asset management" in conjunction with at least one of the following healthcare-related terms: "healthcare," "hospital," "medical equipment," or "medical devices." This targeted strategy ensured that we captured only publications directly relevant to the intersection of AMS and healthcare. Accordingly, the full search query was structured as follows: (TITLE-ABS-KEY ({asset management}) AND TITLE-ABS-KEY ({healthcare} OR {hospital} OR {medical equipment} OR {medical devices})).

No language restrictions were applied to the search, allowing us to include documents in any language. However, since Scopus indexes all titles, abstracts, and keywords in English, the language of the full text does not affect the consistency or interpretability of bibliometric results. To avoid skewed temporal distributions and ensure comparability across publication years, the dataset was restricted to documents published up to and including the year 2024. This cut-off ensures a stable reference time frame and eliminates distortion from disproportionate representation of data for 2025. Based on this search strategy and the presented search query, we identified a total of 248 documents on AMS research in healthcare as eligible for inclusion in the following bibliometric analysis.

To extract insights from the retrieved literature, we conducted a multi-step bibliometric analysis using a combination of data analysis and visualization tools. We executed the core bibliometric analysis using the Python data analysis libraries Pandas and Numpy (McKinney, 2012), and visualized using the Python visualization library Matplotlib (Hunter, 2007). We performed the network analysis, i.e., keyword co-occurrence with VOSviewer, a widely used software tool for constructing and visualizing bibliometric networks (Van Eck & Waltman, 2010). This enabled us to identify dominant themes, emerging topics, and interconnections among conceptual clusters within the literature.

In addition to the quantitative mapping, we were able to draw qualitative content clusters (research hotspots), including representative keywords, from the abstracts of selected publications to provide contextual insights into how AMS is conceptualized, implemented, and evaluated in healthcare settings. These content-based reflections complemented the bibliometric indicators and provided a more nuanced understanding of the field's current landscape, including research gaps, key areas, and strategic priorities.

4 Results

AMS research in healthcare comprises 248 documents published between 1979 and 2024. The majority of these are journal articles (50.4%) and conference papers (31.9%), followed by book chapters (8.1%), conference reviews (3.2%), and review articles (2.8%). The least represented document types are books (1.6%), short surveys (1.2%), and notes (0.8%). Figure 1 illustrates how the scientific production in AMS research evolved within the healthcare domain from 2000 to 2024. Prior to 2000 (not shown in Figure 1), AMS research in healthcare was already present but limited, with a total of 28 documents published between 1979 and 1999. From 2000 to the mid-2000s, publication activity remained relatively steady with low annual output. A noticeable increase began after the mid-2000s, with consistent growth in the number of publications and rising academic interest. From 2010 onward, both publication output and citation impact began to accelerate, reflecting a broader interest in AMS topics within healthcare research. This upward trend continued into the 2020s, culminating in a peak of scientific activity in the most recent years, highlighting the field's growing scholarly significance and maturity over time.

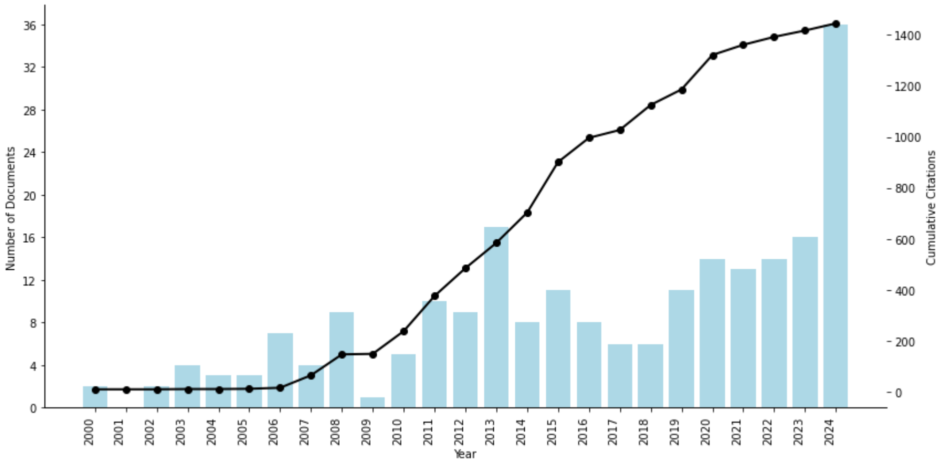

Figure 1: Scientific production in AMS research in healthcare
Source: Own elaboration based on the Scopus database.

Figure 2 presents a comparative overview of the most relevant countries contributing to AMS research in healthcare, based on the number of published documents and total citations received, both shown on logarithmic scales. The size of each bubble reflects the H-index, indicating the combined measure of productivity and citation impact. At the same time, the color gradient represents the average year of publication, with lighter tones indicating more recent research activity. The figure shows that the United States and the United Kingdom lead in both research output and impact, suggesting strong and sustained engagement in AMS research. Countries such as Canada, Australia, and South Korea exhibit notable influence with relatively high citation counts despite smaller publication volumes. Meanwhile, India, Malaysia, and China represent more recent contributors to the field, with growing scholarly output and emerging citation impact. Overall, the figure highlights both established and emerging contributors to AMS research in healthcare on a global scale.

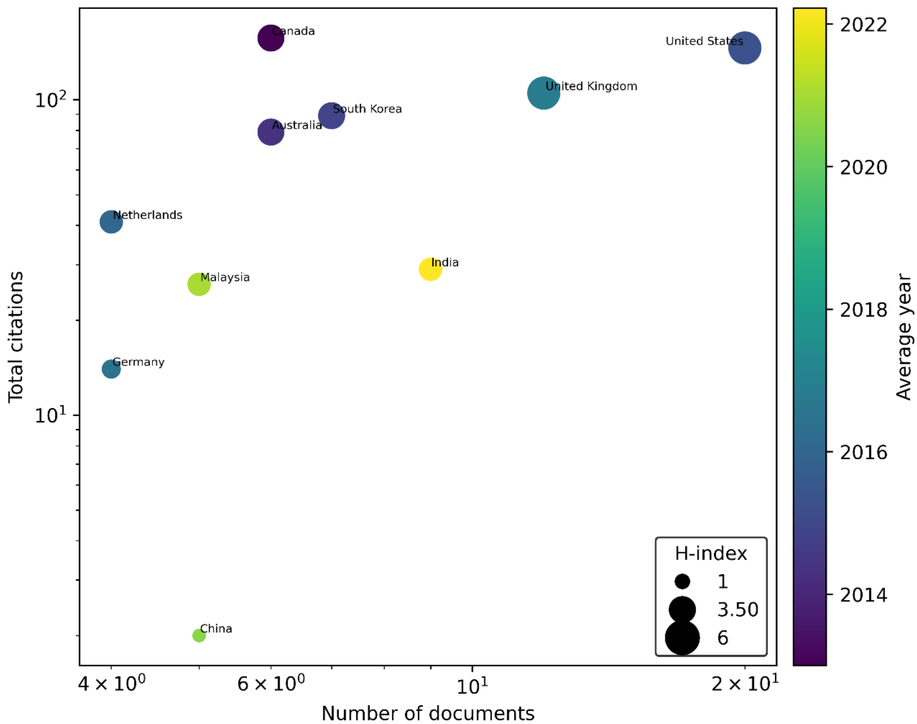

Figure 2: The most relevant countries in AMS research in healthcare
Source: Own elaboration based on the Scopus database.

Figure 3 presents a network analysis, i.e., keyword co-occurrence, performed on the 50 most frequent authors' keywords. Note that the nodes indicate keywords and the links the co-occurrence relations between them. The node size is proportional to the number of keyword occurrences, showing research intensity (node degree), while the link width is proportional to the co-occurrences between keywords (edge weight). Additionally, the node color indicates the cluster to which a particular keyword belongs (Wang et al., 2020). The analysis identifies five key hotspots in AMS research focused on deterring unethical practices, each addressing a critical area of AMS: 1) emerging technologies in maintenance and infrastructure (red cluster), 2) core infrastructure and reliability management (green cluster), 3) risk and resilience in infrastructure (blue cluster), 4) infrastructure condition assessment and rehabilitation (yellow cluster), and 5) smart grid and asset monitoring (purple cluster).

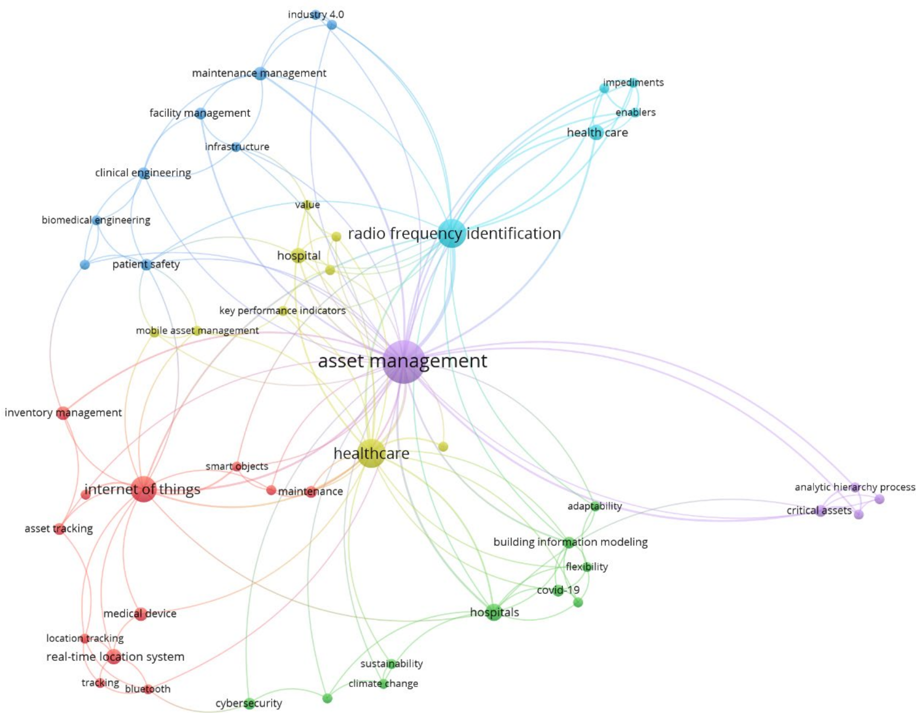

Figure 3: Keyword co-occurrence network of AMS research in healthcare

Source: Own elaboration based on the Scopus database.

Table 1 provides a detailed synopsis of the main research hotspots identified in AMS research in healthcare, derived from a keyword co-occurrence network analysis. The first cluster focuses on smart technologies and asset tracking, emphasizing the integration of advanced digital tools, automation, and interconnected systems that enable real-time monitoring, location tracking, and effective asset utilization. This research direction underscores the importance of leveraging technologies such as IoT and wireless communication to improve operational transparency, reduce asset loss, and support data-driven decision-making. The second cluster addresses risk and sustainability, reflecting a growing interest in the capacity of AMS to contribute to resilient and sustainable healthcare systems. It highlights how asset management can support preparedness for external shocks such as pandemics and climate change, and promote environmentally responsible practices within healthcare infrastructure. The third cluster centers on engineering and operational systems, focusing on the foundational role of clinical and biomedical engineering, as well as digital transformation strategies that support efficient facility management, system integration, and continuous operational improvement. This cluster also encompasses the evolution of AMS alongside developments in industry 4.0 and 5.0, indicating a shift toward intelligent, interconnected, and adaptive healthcare environments.

Table 1: Research hotspots based on keyword co-occurrence network of AMS research in healthcare

Research Hotspots	Representative keywords
Smart technologies and asset tracking (red cluster)	5g, asset tracking, Bluetooth, internet of things, inventory management, location tracking, logistics, maintenance, medical device, real-time location system, smart objects, tracking
Risk and sustainability (green cluster)	adaptability, building information modeling, climate change, COVID-19, cybersecurity, flexibility, hospitals, pandemic, risk management, sustainability
Engineering and operational systems (dark blue cluster)	biomedical engineering, clinical engineering, enterprise resource planning, facility management, industry 4.0, industry 5.0, infrastructure, maintenance management, patient safety
Performance value management in healthcare logistics (yellow cluster)	critical infrastructure, healthcare, hospital, key performance indicators, mobile asset management, performance, real-time location system, supply chain management, value
Strategic asset capital planning (purple cluster)	analytic hierarchy process, asset management, capital renewals, critical assets, healthcare facilities
Patient centric enablers and barriers (light blue cluster)	enablers, health care, impediments, patient management, radio frequency identification

Source: Own elaboration based on the Scopus database.

The fourth cluster is concerned with performance value management in healthcare logistics, emphasizing the need to measure and enhance the value generated by AMS through key performance indicators, real-time data, and supply chain optimization. Research in this area seeks to improve the efficiency, reliability, and responsiveness of logistics operations, ultimately supporting better patient outcomes and institutional performance. The fifth cluster addresses strategic asset capital planning, drawing attention to the importance of long-term investment strategies, lifecycle analysis, and prioritization frameworks in managing healthcare infrastructure. It highlights the role of AMS in supporting evidence-based decision-making around capital renewals, critical assets, and infrastructure upgrades, especially in the context of limited financial resources and growing demand. Finally, the sixth cluster focuses on patient-centric enablers and barriers, exploring the human, organizational, and technological factors that influence the adoption and success of AMS initiatives. This research area stresses the importance of aligning asset management practices with patient care objectives, addressing user needs, overcoming implementation challenges, and ensuring that technology serves to enhance, rather than hinder, patient experience. In this regard, patient well-being, including mental health support, should be considered as a critical enabling factor for AMS adoption. Coaching-based approaches aimed at enhancing children's mental health and well-being, for example, can provide valuable psychosocial support that increases user acceptance and reduces resistance to change (Cajnko, Cajnko, & Gomboc, 2025).

5 Discussion

The results of conducted literature review and bibliometric analysis underscore a rapidly expanding body of research on AMSs, with a clear shift toward digitalization, predictive analytics, and smart infrastructure (Truong et al., 2023). However, this growth is not uniformly distributed across sectors. While AMS is now firmly embedded in fields like engineering, management and finance, construction, infrastructure, manufacturing, energy, and transport (Frankó et al., 2020; Pericault et al., 2023), its integration in healthcare remains both limited and uneven. AMS research in healthcare has grown steadily since the mid-2000s, with a sharp rise in publications and citations after 2010, reflecting increasing academic interest and the field's maturation. This growth is driven by global contributions, with the United States and United Kingdom leading in both output and impact, while countries like Canada, Australia, and South Korea show strong influence despite smaller publication volumes, and newer contributors such as India and China are gaining momentum. The thematic landscape of the field, revealed through keyword co-occurrence analysis, is organized into six dominant clusters that span topics from smart technologies and asset tracking to patient-centered planning and system-level strategy. Together, these trends highlight the expanding role of AMS as both a technical and strategic enabler of healthcare innovation, operational efficiency, and digital transformation.

Nevertheless, several gaps remain. First, the existing research predominantly emphasizes managerial and technological potentials rather than healthcare-specific AMS implementations, applications, and improvement opportunities (Abd Wahab, et al., 2024). Studies focus on how AMSs can reduce equipment downtime, optimize infrastructure reliability or energy use (Pascale & Achour, 2024), but give far less attention to how it can improve clinical workflows, reduce patient wait times, or support care coordination. The potential of AMS to inform broader strategic decisions, such as public health policymaking, developing and implementing healthcare programs, or budgetary planning, is hardly addressed. Second, while technological enablers like IoT and AI are increasingly discussed (Saritha et al., 2024; Godager et al., 2024), there is little research on the human, organizational, and process factors that condition the successfully implementing AMS in healthcare. For example, adopting digital asset tracking tools may require significant changes to hospital governance, data-sharing protocols, and interdepartmental collaboration – areas rarely explored in AMS literature. Third, despite healthcare being one of the most asset-intensive and risk-sensitive sectors, very few studies investigate the return on investment of AMS from a healthcare system's perspective. There is a lack of rigorous evaluation frameworks that measure how AMS contributes to health outcomes, cost-efficiency, or operational performance over time.

Beyond the primary findings, this study has uncovered several critical insights that require careful consideration in guiding future research and practice. A crucial area of focus should be the strategic alignment of AMSs with both clinical and organizational objectives. For AMS to deliver meaningful value, it must be more effectively integrated into healthcare planning, service delivery approaches, and budgeting processes. This requires a clearer understanding of how AMS can support institutional objectives such as enhancing patient safety, improving care quality, and optimizing the use of resources. Another critical area is digital readiness and interoperability. Successfully implementing AMS depends on robust digital infrastructure that enables real-time asset tracking, predictive maintenance, and data-driven decision-making. Future studies should investigate the technological and organizational challenges of achieving interoperability, with a focus on developing standardized frameworks that connect AMS platforms with existing health information systems. Stakeholder engagement and organizational change management also emerged as key considerations. Adopting AMS is not solely a technical process but involves significant behavioral and cultural shifts (Morecroft, 2017). Research should therefore explore how leadership commitment, effective staff training, and targeted communication strategies influence the uptake, use, and long-term sustainability of AMS in healthcare institutions. Strong leadership and a culture of knowledge sharing are equally important for fostering innovation and building organizational capacity. Knowledge leadership that actively promotes the exchange of expertise among stakeholders can significantly improve the success rate and sustainability of AMS implementation (Rahman et al., 2025). Equally important are policy and governance frameworks that can support systematically integrating AMS into healthcare environments. There is a pressing need for comprehensive guidelines addressing utilization rates, data governance, regulatory compliance, risk mitigation, and long-term asset lifecycle planning (Yong & Kundakchian, 2020). These frameworks should be adaptable to different healthcare contexts while ensuring accountability and transparency. The importance of evaluation and evidence-based implementation should not be overlooked. There is a notable gap in empirical studies that assess the real-world impact of AMSs on clinical outcomes, operational efficiency, financial performance, and patient satisfaction. Future research should include cost-benefit analyses, longitudinal case studies, and robust evaluation models to provide actionable insights for decision-makers. Ultimately, while AMSs hold considerable promises for transforming healthcare operations, realizing their full potential requires a purposeful reorientation of both research and practice. Interdisciplinary collaboration, stakeholder engagement, robust digital infrastructure, patient-centered design, and well-considered implementation strategies will be essential in advancing the effective use of AMSs within healthcare systems.

Based on the research findings, particularly the identified key areas and strategic priorities, we propose the following general recommendations to guide effectively implementing AMS in healthcare settings:

1. Establish policy and strategic foundations
   - Develop policy and regulatory frameworks:
     - Collaborate with national and regional policymakers to create AMS-specific healthcare guidelines.
     - Ensure regulations address data governance, privacy, procurement rules, and healthcare-specific compliance.
   - Integrate AMS into institutional strategy:
     - Embed asset management into strategic plans, operational frameworks, and budgeting cycles.
     - Establish governance structures and leadership endorsement to support AMS sustainability and accountability.

- Set clear objectives and operative/outcome performance metrics and indicators:
    - Define clear strategic objectives for AMS (e.g., optimize asset utilization, reduce equipment downtime, extend asset lifespan, etc.).
    - Identify key performance indicators (KPIs) such as service quality, patient safety, utilization rate, asset lifecycle cost, maintenance response time, and asset availability.
    - Align goals and KPIs with patient care quality benchmarks and healthcare regulatory standards.

2. Conduct initial assessments and planning

- Comprehensive asset inventory and assessment:
    - Perform an exhaustive inventory of all physical assets (medical equipment, IT infrastructure, and facilities).
    - Classify assets by type, function, usage, criticality, risk, condition, and maintenance costs.
    - Establish standard data collection procedures, capturing relevant information like serial numbers, location, purchase dates, service history and records, and warranty details.
- Establish asset lifecycle management framework:
    - Define each stage of the asset lifecycle, from acquisition and installation to utilization, maintenance, upgrades, and decommissioning.
    - Use lifecycle data to plan budgets for replacing assets approaching the end of their effective life, reducing emergency expenditures.
    - Develop clear policies and protocols for decommissioning and disposal of assets, ensuring they meet environmental and safety regulations.

3. Invest in AMS and infrastructure

- Select and procure a suitable AMS platform:

  - Choose software capable of real-time asset tracking, condition monitoring, maintenance management, compliance reporting, and predictive analytics.
  - Prioritize systems with integration capabilities for electronic health records, hospital information systems and other devices, and IoT for real-time monitoring.
  - Ensure scalability and customization of the software to fit the organization's size, number of assets, and specific healthcare needs.
- Develop a centralized asset database:
  - Implement a secure and centralized database to store all asset-related information, accessible to authorized personnel across departments.
  - Ensure data is accurate, regularly updated, and protected to prevent unauthorized access and comply with data privacy regulations.
  - Allow access to the database for relevant departments such as management, finance, maintenance, and procurement to facilitate cross-functional cooperation and coordinated asset management.
- Enhance digital infrastructure and interoperability:
  - Invest in digital platforms and connectivity solutions linking AMS with enterprise resource planning, clinical, and admin systems.
  - Adopt standard protocols and application programing interfaces to support data flow between AMS, external tools, and health IT systems.
  - Enable smart asset tracking using IoT sensors and condition-monitoring technologies (computerized maintenance management system).

4. Build organizational capacity and engagement
- Training and organizational readiness:
  - Develop workforce training programs to build technical, analytical, and operational AMS competencies.
  - Conduct comprehensive training sessions for various staff levels covering AMS use, reporting, control, and maintenance.

    - Include AMS education in onboarding and ongoing professional development programs.
    - Involve end-users and frontline personnel in system design and feedback loops to foster adoption and reduce resistance to change.
- Promote a culture of asset responsibility:
    - Encourage departments to take ownership of equipment care and accurate asset data reporting.
    - Establish clear roles, responsibilities, and promote accountability for asset management across the organization, where each staff member understands the importance of maintaining and properly using equipment.
    - Provide ongoing communication and establish regular feedback channels to support users, improve the system and address barriers to adoption.

5. Operationalize AMS and enhance maintenance strategy
- Implement preventive and predictive maintenance measures:
    - Schedule regular preventive maintenance based on asset importance, age, usage, and manufacturer guidelines.
    - Leverage predictive analytical tools and performance data to foresee failures and schedule repairs proactively, reducing unexpected asset outages.
    - Establish emergency response protocols to address sudden equipment malfunctions swiftly and minimize the impact on patient care.
- Ensure regulatory compliance:
    - Familiarize with local and international healthcare asset management standards and regulations, such as those from the International Organization for Standardization (ISO 55000) and medical device safety codes.
    - Keep comprehensive documentation, reports, and records of maintenance activities, inspections, and incidents to meet compliance requirements and facilitate auditing.

    - Regularly review compliance status and conduct periodic audits to ensure adherence to all legal and safety standards, reducing risks of equipment-related incidents and penalties.

6. Monitor, improve, and ensure the AMS's resilience and adaptability
    - Monitor and review system performance:
        - Conduct periodic audits and AMS performance reviews against the defined KPIs and compliance benchmarks.
        - Use findings to refine maintenance schedules, asset replacement timelines, and update policies for continual improvement.
        - Introduce beneficial system/process updates based on emerging technologies, innovative concepts, and organizational feedback.
    - Promote interdisciplinary research and innovation:
        - Encourage collaborative research among healthcare, IT, engineering, management, and operations experts.
        - Launch pilot projects and living labs to experiment with AMS innovations in real-world settings.
        - Use insights from these initiatives to drive continuous improvement and evidence-based scaling.
    - Plan for strategic development and long-term sustainability:
        - Plan for the future by ensuring AMS scalability to accommodate growing asset base, new business processes, and technology advancements.
        - Use data-driven insights from the AMS (asset performance, usage trends, and maintenance costs) for decision-making, long-term planning, procurement strategies, and risk management.
        - Keep informed about industry advancements in asset management and healthcare technology to continually improve and update the system.

Implementing AMS in healthcare is a dynamic, multi-phase process requiring alignment between policy, infrastructure, people, and technology. This integrated framework of recommendations guides institutions through a logical and actionable roadmap, from foundation-setting to ongoing performance optimization. When regularly reviewed and adapted, asset management could empower healthcare organizations to optimize asset utilization, enhance the quality of patient care, and improve financial efficiency and productivity.

The implications of our findings are manifold. First, they highlight the need for sustained investment in AMS research to address asset management challenges in healthcare, where asset reliability and operational efficiency are critical. The identification of emerging technologies, such as AI and IoT within AMS research underscores the growing demand for intelligent, automated asset management solutions. However, the much-needed shift toward rigorous studies that examine the tangible effects of AMSs on inherently clinical aspects, such as care quality, patient outcomes, public health status, and healthcare expenditure, remains regrettably limited. Policymakers, healthcare managers, industry leaders, and researchers can leverage these insights to drive innovation and promote a more proactive approach to integrating AMSs into healthcare institutions. Accordingly, future research projects and analyses should focus on how AMSs support public health priorities, such as care quality, patient safety, and resource optimization. In this context, it would be beneficial to reorient the overall research approach to AMS in healthcare more explicitly toward patient-centered value and impact. Our findings emphasize the need to move beyond theoretical exploration and isolated managerial and technological case studies, toward more practical, interdisciplinary, and outcome-oriented research. To unlock the full potential of AMS in healthcare, future efforts must align technological innovation with policy development, institutional strategies, and public health goals.

Despite its comprehensive scope, this study has certain limitations. The analysis is based on bibliometric data from the Scopus database, which, while extensive, may not capture all relevant research published in other databases such as Web of Science or IEEE Xplore. Additionally, the reliance on keyword co-occurrence analysis means that emerging but less frequently used terms might not be fully represented in the research. While our study provides a global overview of AMS research in healthcare, it does not consider the specific methodologies employed in individual studies, thereby limiting our ability to assess the methodological rigor within the field. Moreover, the general recommendations proposed for the effective implementation of AMS in healthcare settings are largely theoretical, grounded in prior research and conceptual frameworks, and have not yet undergone empirical validation in real-world healthcare environments. As a result, both the chosen methodological approach and the derived inferences may be open to debate, and the proposed recommendations should be interpreted with caution. Nonetheless, this study provides valuable insight into AMS research in healthcare, highlights the potential for utilizing AMS within healthcare institutions, and outlines the associated dynamics and complex challenges involved in integrating AMSs into healthcare systems.

6 Conclusion

This study provides a comprehensive overview of global research trends regarding the role and application of AMSs in the healthcare sector. Through a bibliometric analysis of 248 Scopus-indexed documents, we identified key thematic clusters, technological enablers, and gaps in the literature regarding adopting AMS in healthcare environments. The results reveal a clear evolution of AMS from traditional maintenance-focused practices toward more intelligent, data-driven systems powered by IoT and AI. While sectors like engineering, management and finance, manufacturing, energy, and transport have largely embraced these advancements, healthcare continues to lag behind, with most studies concentrating on isolated technological applications rather than systemic implementation. Despite this underutilization, the healthcare sector stands to benefit significantly from AMSs. Medical equipment, digital health assets, and physical infrastructure represent high-value and mission-critical components of healthcare delivery. Better management of these assets could improve efficiency, reduce costs, and enhance patient care. Yet, while existing research acknowledges the role of AMSs in healthcare, it pays only limited attention to how asset management can influence broader healthcare outcomes, such as quality of health services, productivity of health care providers, and patient wait times. To fully unlock this potential, it is essential to ensure the strategic alignment of AMSs with both clinical and institutional objectives. This requires a deeper integration of AMSs into healthcare planning, budgeting, and service delivery strategies. By embedding asset management into the core of healthcare activities and decision-making processes, organizations can not only optimize resource utilization but also drive meaningful improvements in patient care and operational efficiency. Future research should further explore these integrative strategies to provide actionable insights for healthcare leaders and policymakers.

Acknowledgements

The authors acknowledge the financial support from the Slovenian Research and Innovation Agency (research programme No. P5-0093, project No. V5-24052 and project No. J5-50183. In the preparation of this manuscript, the authors utilized ChatGPT, version 4o, developed by OpenAI, for limited and supplementary purposes. Specifically, ChatGPT was employed to assist with checking the grammar, enhancing clarity, and polishing the language in certain sections of the manuscript. It must be stressed that the role of the ChatGPT was minor and purely supportive in nature. The core content of the manuscript, including all scientific interpretations, conclusions, and critical revisions, is the exclusive output of the human authors. ChatGPT did not contribute to the manuscript's intellectual content or scientific insights.

References

Abd Rahman, N.H., Ibrahim, A.K., Hasikin, K. & Abd Razak, N.A. (2023). Critical Device Reliability Assessment in Healthcare Services. *Journal of Healthcare Engineering*, *2023*, 3136511. https://doi.org/10.1155/2023/3136511

Abd Wahab, N.H., Hasikin, K., Wee Lai, K., Xia, K., Bei, L., Huang, K. & Wu, X. (2024). Systematic review of predictive maintenance and digital twin technologies challenges, opportunities, and best practices. *PeerJ. Computer science*, *10*, e1943. https://doi.org/10.7717/peerj-cs.1943

Aboelmaged, M. & Hashem, G. (2018). RFID application in patient and medical asset operations management: A technology, organizational and environmental (TOE) perspective into key enablers and impediments. *International journal of medical informatics*, *118*, 58-64. https://doi.org/10.1016/j.ijmedinf.2018.07.009

Al Marzooqi, F.A., Hussain, M. & Ahmad, S.Z. (2019). Performance of physical asset management using the analytic hierarchy process. *Property Management*, *37*(3), 327-345. https://doi.org/10.1108/PM-07-2018-0039

British Standards Institution. (2008). *PAS 55-1:2008. Asset management: Specification for the optimized management of physical assets*. British Standards Institution. London, United Kingdom.

Cajnko, P., Cajnko, K. & Gomboc, T. (2025). Harnessing coaching skills for children's mental health and well-being. *Interacción y perspectiva: revista de trabajo social, 15*(1), 304–317. https://produccioncientificaluz.org/index.php/interaccion/article/view/42924

Call, S. (2024). Deferred maintenance of physical infrastructure and its association to hospital profitability in Washington State. *Facilities*, *42*(11/12), 876-884. https://doi.org/10.1108/F-02-2024-0021

Chang, H., Choi, J. Y., Shim, J., Kim, M. & Choi, M. (2023). Benefits of Information Technology in Healthcare: Artificial Intelligence, Internet of Things, and Personal Health Records. *Healthcare informatics research*, *29*(4), 323-333. https://doi.org/10.4258/hir.2023.29.4.323

Chen, J., Lim, C.P., Tan, K.H., Govindan, K., & Kumar, A. (2021). Artificial intelligence-based human-centric decision support framework: An application to predictive maintenance in asset management under pandemic environments. *Annals of Operations Research*, 1-24. https://doi.org/10.1007/s10479-021-04373-w

Chen, Y. & Chen, G. (2022). Optimization of the intelligent asset management system based on WSN and RFID technology. *Journal of Sensors*, *2022*(1), 3436530. https://doi.org/10.1155/2022/3436530

da Silva, R.F. & de Souza, G.F.M. (2021). Mapping the literature on asset management: A bibliometric analysis. *Journal of Scientometric Research*, *10*(1), 27-36. https://doi.org/10.5530/jscires.10.1.4

da Silva, R.F. & de Souza, G.F.M. (2022). Modeling a maintenance management framework for asset management based on ISO 55000 series guidelines. *Journal of Quality in Maintenance Engineering*, *28*(4), 915-937. https://doi.org/10.1108/JQME-08-2020-0082

Diop, I., Abdul-Nour, G. & Komljenovic, D. (2021). Overview of strategic approach to asset management and decision-making. *International Journal of Engineering Research & Technology*, *10*, 64-89. https://doi.org/10.17577/IJERTV10IS120059

Frankó, A., Vida, G. & Varga, P. (2020). Reliable Identification Schemes for Asset and Production Tracking in Industry 4.0. *Sensors* (Basel, Switzerland), *20*(13), 3709. https://doi.org/10.3390/s20133709

Garramone, M., Moretti, N., Scaioni, M., Ellul, C., Re Cecconi, F. & Dejaco, M.C. (2020). BIM and GIS integration for infrastructure asset management: a bibliometric analysis. *ISPRS annals of the photogrammetry, remote sensing and spatial information sciences*, *6*, 77-84. https://doi.org/10.5194/isprs-annals-VI-4-W1-2020-77-2020

Gavrikova, E., Volkova, I. & Burda, Y. (2020). Strategic aspects of asset management: An overview of current research. *Sustainability*, *12*(15), 5955. https://doi.org/10.3390/su1215595

Gerasimov, I., Kc, B., Mehrabian, A., Acker, J. & McGuire, M.P. (2024). Comparison of datasets citation coverage in Google Scholar, Web of Science, Scopus, Crossref, and DataCite. *Scientometrics*, 129(7), 3681-3704. https://doi.org/10.1007/s11192-024-05073-5

Godager, B., Merschbrock, C. & Huang, L. (2024). Exploring the Enterprise BIM concept in practice: The case of Asset Management in a Norwegian hospital. *Journal of Information Technology in Construction (ITcon)*, *29*(25), 549-572. https://doi.org/10.36680/j.itcon.2024.025

Haleem, A., Javaid, M., Singh, R.P. & Suman, R. (2022). Medical 4.0 technologies for healthcare: Features, capabilities, and applications. *Internet of Things and Cyber-Physical Systems*, *2*, 12-30. https://doi.org/10.1016/j.iotcps.2022.04.001

Hunter, J.D. (2007). Matplotlib: A 2D graphics environment. *Computing in science & engineering*, *9*(3), 90-95. https://doi.org/10.1109/MCSE.2007.55

International Organization for Standardization. (2014). *ISO 55000:2014. Asset management – Overview, principles, and terminology*. Geneva: International Organization for Standardization.

Leiblein, T.W., Tucker, M., Ashall, M., Lee, S. B., Gollnisch, C. & Hofer, S. (2016). Legionella and risk management in hospitals - A bibliographic research methodology for people responsible for built environment and facility management. *International journal of hygiene and environmental health*, *219*(8), 890-897. https://doi.org/10.1016/j.ijheh.2016.07.003

Lima, E.S., McMahon, P. & Costa, A.P.C.S. (2021). Establishing the relationship between asset management and business performance. *International Journal of Production Economics*, *232*, 107937. https://doi.org/10.1016/j.ijpe.2020.107937

McKinney, W. (2012). *Python for data analysis: Data wrangling with Pandas, NumPy, and IPython*. O'Reilly Media, Inc.

Morecroft, N.E. (2017). *The origins of asset management from 1700 to 1960: Towering investors*. Springer International Publishing. https://doi.org/10.1007/978-3-319-51850-3

Pascale, F. & Achour, N. (2024). Envisioning the sustainable and climate resilient hospital of the future. *Public health*, *237*,435-442. https://doi.org/10.1016/j.puhe.2024.10.028

Pericault, Y., Viklander, M. & Hedström, A. (2023). Modelling the long-term sustainability impacts of coordination policies for urban infrastructure rehabilitation. *Water research*, *236*, 119912. https://doi.org/10.1016/j.watres.2023.119912

Rahman, M.M., Röntynen, R., Ardabili, F.S., Newaz, H.T.M.Q., Voitenko, E. & Cajnko, P. (2025). Knowledge leadership and innovation: The mediating role of knowledge sharing. *Journal of ecohumanism, 4*(2), 249–260. https://doi.org/10.62754/joe.v4i2.5933

Rampini, L. & Cecconi, F.R. (2022). Artificial intelligence in construction asset management: a review of present status, challenges and future opportunities. *Journal of Information Technology in Construction*, *27*, 884-913. https://doi.org/10.36680/j.itcon.2022.043

Rogers, G., Szomszor, M. & Adams, J. (2020). Sample size in bibliometric analysis. *Scientometrics*, 125(1), 777-794. https://doi.org/10.1007/s11192-020-03647-7

Rousek, J.B., Pasupathy, K., Gannon, D. & Hallbeck, S. (2014). Asset management in healthcare: Evaluation of RFID. *IIE Transactions on Healthcare Systems Engineering*, *4*(3), 144-155. https://doi.org/10.1080/19488300.2014.938207

Salem, D. & Elwakil, E. (2023). Asset condition assessment model for healthcare facilities. International *Journal of Construction Management*, *23*(1), 182-203. https://doi.org/10.1080/15623599.2020.1857002

Saritha, K., Abhiram, C., Reddy, P.A., Sathwik, S.S., Shaik, N.R., Alzubaidi, L.H. ... & Yadav, D.K. (2024). IoT enabled hospital asset tracking using advanced interdisciplinary approaches. *In E3S Web of Conferences, 507*(01007). International Conference on Futuristic Trends in Engineering, Science & Technology (ICFTEST-2024). https://doi.org/10.1051/e3sconf/202450701007

Sen, D., Fashokun, A., Angelotti, R., Brooks, M., Bhaumik, H., Card, C., Lodhi, A., Godrej, A. & Chung, C. (2018). An Artificial Intelligence Platform for Asset Management Contributes to Better Decision-making Tools for Operations, Maintenance, and Utility Management. *Water environment research*, *90*(4), 355-375. https://doi.org/10.2175/106143017X15131012152762

Singh, V.K., Singh, P., Karmakar, M., Leta, J. & Mayr, P. (2021). The journal coverage of Web of Science, Scopus and Dimensions: A comparative analysis. *Scientometrics*, 126, 5113-5142. https://doi.org/10.1007/s11192-021-03948-5

Tajudin, A., Khan, N. & Ismail, A. (2021). Bibliometric Overview and Retrospective Analysis of Asset Management Research between 1965 and 2020. *International Journal of Academic Research in Accounting Finance and Management Sciences*, *11*(3), 772-800. https://10.6007/IJARAFMS/v11-i3/11371

Tjebane, M.M. & Musonda, I. (2024). Artificial intelligence in healthcare facilities asset information management: mixed review. *Infrastructure Asset Management*, 1-16. https://doi.org/10.1680/jinam.23.00033

Truong, V.T., Le, L. & Niyato, D. (2023). Blockchain meets metaverse and digital asset management: A comprehensive survey. *IEEE Access*, *11*, 26258-26288. https://doi.org/10.1109/ACCESS.2023.3257029

Ugarelli, R. & Saegrov, S. (2022). Infrastructure asset management: Historic and future perspective for tools, risk assessment, and digitalization for competence building. *Water*, *14*(8), 1236. https://doi.org/10.3390/w14081236

Van der Lei, T., Herder, P. & Wijnia, Y. (2012). *Asset management*. New York, US: Springer. https://doi.org/10.1007/978-94-007-2724-3

Van Eck, N.J. & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, 84(2), 523-538. https://doi.org/10.1007/s11192-009-0146-3

Vera-Baceta, M.A., Thelwall, M. & Kousha, K. (2019). Web of Science and Scopus language coverage. *Scientometrics*, 121(3), 1803-1813. https://doi.org/10.1007/s11192-019-03264-z

Wang, C., Lim, M.K., Zhao, L., Tseng, M.L., Chien, C.F. & Lev, B. (2020). The evolution of Omega-The International Journal of Management Science over the past 40 years: A bibliometric overview. *Omega*, 93, 102098. https://doi.org/10.1016/j.omega.2019.08.005

Yong, W. & Kundakchian, A. (2020). Critical Care Equipment Management Reimagined in an Emergency. *Blockchain in healthcare today*, *3*, 1-12. https://doi.org/10.30953/bhty.v3.146

Yuen, P.L., Lai, J.H.K. & Edwards, D.J. (2022). An analytic network process model for hospital facilities management performance evaluation. *Facilities*, *40*(5/6), 333-352, https://doi.org/10.1108/f-09-2021-0082

Povzetek v slovenskem jeziku

Sistemi za upravljanje sredstev (AMS) so vse bolj prepoznani kot orodje z velikim potencialom za povečanje operativne učinkovitosti, stroškovne učinkovitosti in trajnosti v sektorjih, ki temeljijo na intenzivni uporabi sredstev. V zdravstvu pa je izvajanje AMS še vedno razdrobljeno, kljub naraščajočim pritiskom za izboljšanje uporabe medicinske opreme, zanesljivosti infrastrukture in kakovosti storitev. Ta študija predstavlja pregled literature, podprt z bibliometrično analizo 248 dokumentov o raziskavah AMS v zdravstvu, objavljenih do leta 2024 in indeksiranih v podatkovni bazi Scopus, pri čemer analizira razvoj raziskav na področju AMS s posebnim poudarkom na zdravstvenih aplikacijah. Z uporabo orodij Python in VOSviewer bibliometrična analiza zajema znanstveno produkcijo, geografsko pokritost in glavne raziskovalne grozde. Ugotovitve poudarjajo naraščajoče globalno zanimanje za AMS ter kažejo na širši premik k digitalizaciji in strateški integraciji znotraj zdravstvenih sistemov. Na podlagi teh spoznanj so oblikovana ključna področja in prioritetne usmeritve ter ponujena na dokazih temelječa priporočila za učinkovitejše uvajanje AMS v zdravstvu.