Towards an Intelligent Scientific Publication Management System: Motivation, Methodological Foundations, and Conceptual Design

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Abstract

Scientific publication management requires handling heterogeneous data, assigning reviewers effectively, and maintaining evaluation quality. This paper presents a conceptual design for an intelligent Scientific Publication Management System (SPMS) that integrates data-driven preprocessing, knowledge modeling, and AI-assisted review components. The system preprocesses submissions and publication data using NLP and metadata enrichment, transforms these into structured knowledge representations including publication taxonomies and author–reviewer networks, and leverages AI agents for reviewer recommendation, compliance checking, quality assessment, and feedback generation. By connecting data, information, and knowledge layers, the proposed SPMS improves reviewer assignment accuracy, streamlines workflows, and supports program committee decision-making. The paper presents the motivation, methodological foundations, and conceptual design of the approach.

Keywords

Scientific Publication, Conference Management, Reviewer Recommendation, Knowledge Graph, NLP, AI Agent

1. Introduction

The rapid growth of scientific publishing has significantly increased submission volumes across disciplines, particularly in fields such as artificial intelligence, machine learning, and data science [1, 2]. Major venues such as NeurIPS, ICML, and CVPR report continuously rising submission numbers [3, 4, 5], reflecting both the expansion of the research community and increasing pressure on peer-review systems [6]. Peer review remains central to ensuring scientific quality, originality, and relevance [7], yet increasing workloads place strain on reviewers, often resulting in fatigue, inconsistent evaluations, and delays [8]. At the same time, publishers and conference organizers must manage growing volumes efficiently while maintaining quality standards and ensuring timely dissemination [9, 10]. Existing Scientific Publication Management Systems (SPMS) support submission handling and review coordination but remain fragmented, focusing on isolated tasks rather than integrated, knowledge-driven workflows. This results in inefficiencies across submission preparation, reviewer assignment, evaluation consistency, and post-publication dissemination.

Building on prior research in knowledge management, semantic technologies, and intelligent systems such as VIKEF, KM-EP [11, 12] and taxonomy-based knowledge organization approaches [13, 14, 15], as well as applied systems in domains like SMARTMICE and KGen4MICE [16], this work extends these concepts to scientific publishing. It addresses the lack of integration between knowledge management, AI-driven analytics, and workflow orchestration in publication processes by proposing an intelligent, lifecycle-oriented SPMS. The study investigates how scientific publication workflows can be modeled as a lifecycle-oriented, knowledge-driven ecosystem that supports submission preparation, peer review, and dissemination through integrated AI-assisted processes. It explores how intelligent tools can assist authors in producing compliant and high-quality submissions, how AI-supported methods can enhance reviewer assignment, evaluation consistency, and structured feedback generation, and how post-acceptance workflows can be improved through metadata enrichment, interoperability, and automated

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dissemination. Furthermore, it aims to design and model a scalable, interoperable SPMS architecture that integrates knowledge management, AI-driven intelligence, and workflow orchestration across all publication phases. The research follows the Information Systems framework by Adams and Courtney [17], covering Observation, Theory Building, Systems Development, and Experimentation. Within this paper, the focus lies on the Observation and Theory Building phases, providing the conceptual foundation for the proposed system.

2. State of the Art in Science and Technology

Efficient scientific communication depends on systems that manage knowledge, support collaboration, and streamline research workflows. This section reviews key domains underpinning these capabilities, including Knowledge Management Systems (KMS), Intelligent Knowledge Mining Frameworks (IKMF), academic research platforms, and Conference Management Systems (CMS). Together, these systems support data acquisition, discovery, review automation, and decision-making, while enabling more integrated publication workflows.

Knowledge Management Systems (KMS)

KMS transform structured and unstructured publication data into actionable knowledge following the DIKW model [18, 19]. In scientific publishing, they support submission management, reviewer expertise tracking, semantic tagging, and metadata enrichment [20, 21], enabling improved discoverability and decision-making [22]. When combined with AI-based workflow support, they provide context-aware insights across publication stages. However, current systems process data, metadata, and analytical outputs in isolation, which limits integrated knowledge creation and leaves semantic fusion largely manual. This fragmentation highlights the need for a unified knowledge layer within SPMS that consolidates heterogeneous and multimodal sources into consistent, machine-actionable representations.

Intelligent Knowledge Mining Framework (IKMF)

The IKMF extends knowledge management by integrating AI-driven semantic enrichment with ontology-based knowledge graph construction and long-term preservation mechanisms, ensuring provenance, integrity, and reproducibility of knowledge artifacts [15]. Its dual-stream architecture combines knowledge mining with preservation, enabling transformation of heterogeneous data into machine-actionable knowledge while maintaining auditability. Despite these strengths, IKMF does not explicitly address integration into iterative and adaptive workflow systems such as scientific publication pipelines. This gap suggests that SPMS should incorporate AI-driven knowledge extraction, enrichment, and preservation directly into continuous and evolving workflows, enabling seamless interaction between data processing and operational processes.

Academic Research Platforms

Academic platforms such as Google Scholar, IEEE Xplore, SpringerLink, and ScienceDirect provide large-scale access to scientific publications, metadata, and citation networks [23], supporting literature discovery, bibliometric analysis, and collaboration mapping. These platforms offer valuable input for workflow intelligence, including reviewer recommendation, expertise identification, and conflict-of-interest detection. However, they primarily function as external repositories and remain detached from submission and peer-review workflows, limiting their impact on operational decision-making. This separation indicates that tighter integration of external platforms into SPMS environments would enhance interoperability and allow external knowledge sources to directly inform submission handling, reviewer selection, and dissemination processes.

Conference Management Systems (CMS)

Conference Management Systems such as EasyChair, Ex Ordo, and Indico support submission handling, reviewer assignment, and decision-making processes in academic publishing [24, 25, 26, 27]. Recent advances incorporate AI and NLP techniques for reviewer matching, semantic analysis, submission

quality assessment, and compliance checking [28, 29], alongside methods such as argument mining, review summarization, and claim verification [30]. Nevertheless, these capabilities are often implemented as isolated modules rather than as components of a unified workflow, limiting their effectiveness in providing consistent decision support across all publication stages [31]. This situation underscores the importance of designing SPMS architectures that embed AI-driven analytics directly into end-to-end workflows, enabling coherent, lifecycle-oriented publication management.

Summary

The analysis demonstrates that existing approaches provide substantial capabilities in knowledge management, semantic enrichment, and workflow support, yet remain fragmented across systems and lifecycle stages. Key limitations include the insufficient integration of heterogeneous knowledge sources, the lack of alignment between AI-driven knowledge mining and adaptive workflows, limited interoperability with external academic platforms, and the absence of unified AI-supported decision-making within publication systems. These observations point toward the necessity of an integrated, lifecycle-oriented SPMS that connects data, information, and knowledge across all phases of scientific publishing. This forms the basis for the following chapter, which introduces a use case-driven and lifecycle-based conceptual design and modeling approach, integrating data preprocessing, knowledge modeling, and AI-assisted workflow components into a unified architecture for intelligent reviewer recommendation, automated compliance checking, structured feedback generation, and enhanced dissemination.

3. Conceptual Design and Modeling

The simple use case diagram of the proposed SPMS is illustrated in Figure 1. It outlines the sequence of activities across the manuscript lifecycle, highlighting the interactions between key stakeholders, namely the author, editor, and reviewer. It captures the progression from call for publication and manuscript submission to review, revision, and final publication. This workflow representation provides a high-level view of how tasks are coordinated and how responsibilities are distributed, serving as a foundation for the system's integrated knowledge management and AI-driven processes.

Figure 1: Simple Use case Diagram of the proposed SMPS

While the use case diagram provides a high-level representation of stakeholder interactions and workflow progression across the manuscript lifecycle, a deeper architectural perspective is needed to explain how these activities are supported and operationalized within the system. In this regard, the conceptual design of the proposed SPMS is grounded in the Information Extraction Lifecycle (IELC) [16], which structures the transformation of raw data into actionable knowledge. Data Collection covers submission handling and ingestion of historical data from publication databases and legacy systems.

Data Preparation includes document parsing, section detection, and metadata extraction and enrichment using NLP techniques. The Information Extraction phase applies topic modeling and classification to identify entities and relationships. Information and Knowledge Organization structures outputs into taxonomies and graph-based representations such as author–reviewer networks. Finally, Information Access and Retrieval is implemented via a knowledge base supporting reviewer recommendation, decision support, and reuse of historical data to improve efficiency.

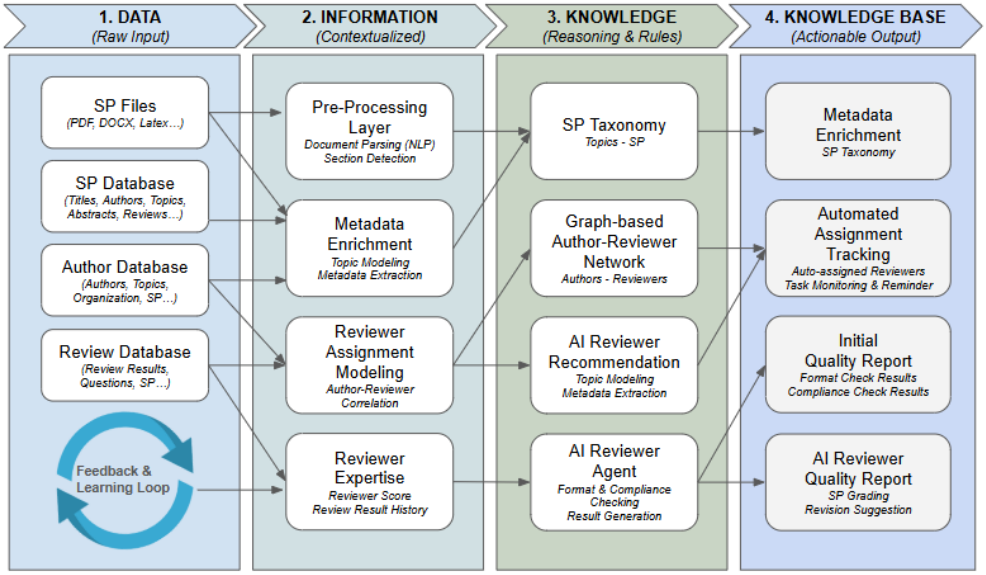

Figure 2: Conceptual design and modeling of the proposed SPMS

As shown in Figure 2, the workflow begins at the data layer, where raw submissions, publication databases, and historical reviewer information are integrated from PDF and relational sources. These are processed in a preprocessing layer that performs document parsing, section detection, and metadata enrichment. Topic modeling and classification are used to enhance semantic representation and derive relationships between authors, reviewers, and publications. The enriched information is then transformed into structured knowledge, including publication taxonomies and graph-based author–reviewer networks. Based on this, an AI-based reviewer recommendation model is trained to support automated matching, while an AI review agent provides preliminary assessment, including compliance checking, scoring, and structured feedback generation. The knowledge base consolidates these outputs to support key SPMS functions such as topic-aware categorization, reviewer assignment, and automated quality assessment. Feedback loops enable continuous improvement using historical review data and publication outcomes, while temporal dynamics support adaptation to evolving research topics and reviewer behavior.

In summary, the proposed design presents an end-to-end framework that transforms heterogeneous publication data into structured, actionable knowledge. Through the integration of preprocessing, knowledge modelling, and AI-driven agents, the system enhances efficiency, consistency, and decision support in scientific workflows. The next section discusses key insights, limitations, and future directions.

4. Discussion and Outlook

The proposed SPMS conceptual design shows how integrating knowledge management, AI-driven analytics, and workflow orchestration can address key limitations in scientific publishing. Aligned with the DIKW framework, it transforms submission data into actionable insights, supporting stakeholders across the publication lifecycle while improving efficiency, transparency, and compliance with

reproducibility and auditability standards. Unlike isolated CMS platforms, SPMS enables a unified environment where knowledge is continuously refined and applied. A key implication is the emergence of intelligent, adaptive workflows. By embedding AI and NLP into core processes, SPMS supports reviewer assignment, semantic checks, and context-aware recommendations, reducing manual effort while improving consistency and fairness. Integration with external research platforms further expands knowledge use while maintaining traceability.

Despite these benefits, challenges remain. Multimodal integration across text, metadata, and citations requires robust harmonization and ontology management [32]. AI components must balance automation with human oversight to ensure trust and compliance [33]. Additionally, scaling across disciplines and institutional contexts demands modular, configurable architectures [34]. Looking ahead, SPMS enables continuous learning by leveraging historical workflow data to improve reviewer selection and optimize processes [35]. Its preservation-aware design ensures artifacts remain verifiable and reusable. Future work may incorporate advanced AI techniques such as argument mining and predictive analytics [36].

In conclusion, SPMS represents a step toward knowledge-driven, lifecycle-aware publication management. By addressing RC1–RC4, it provides a foundation for next-generation systems, offering a path toward more efficient, transparent, and impactful scientific publishing.

Declaration on Generative AI

During the preparation of this work, the author used GPT-4o in order to: Grammar and spelling check. After using this service, the author reviewed and edited the content as needed and takes full responsibility for the publication's content.

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