

Review

Systemic Integration of Artificial Intelligence in Financial Project Management: A Systematic Literature Review and BERTopic-Based Analysis

Styve L. Ndjonkin Simen ¹, Simon P. Philbin ^{1,*} and Gordon Hunter ²¹ School of Engineering, Kingston University London, London SW15 3DW, UK; s.simen@kingston.ac.uk² School of Computer Science and Mathematics, Kingston University London, London KT1 2EE, UK; g.hunter@kingston.ac.uk

* Correspondence: s.philbin@kingston.ac.uk

Abstract

Artificial Intelligence (AI) is increasingly embedded in project management within the financial sector, yet existing research remains fragmented and largely focused on isolated technical applications. A systemic understanding of how AI reshapes financial project management as an integrated socio-technical capability is still lacking. This study addresses this gap through a systematic literature review of 62 peer-reviewed articles (2022–2025), combined with BERTopic-based thematic analysis supported by large language model-assisted topic representation. The findings reveal the emergence of Agentic AI as a dominant theme, marking a shift from analytical support tools toward autonomous and collaborative agents embedded in project processes. While predictive analytics and automation are relatively mature, governance-oriented and human-centric dimensions remain underdeveloped and weakly integrated. This study contributes by: (1) presenting a computationally enhanced systematic mapping study that integrates a systematic literature review with BERTopic-based topic modelling to map the evolving research landscape; (2) identifying Agentic AI as a pivotal interface between technical execution and strategic governance; and (3) proposing a socio-technical target architecture that offers a structured roadmap for AI-enabled transformation in financial project management systems.

Keywords: artificial intelligence; project management; financial sector; BERTopic; system innovation



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1. Introduction

Artificial Intelligence has become a transformative force across the financial sector, reshaping organizational processes, decision-making mechanisms, and strategic capabilities [1–3]. Indeed, financial institutions increasingly rely on AI-driven systems to manage growing complexity, improve operational efficiency, and support data-intensive activities, such as risk assessment, forecasting, fraud detection, compliance monitoring, and performance evaluation. These capabilities enable faster responses to market fluctuations, more efficient resource allocation, and enable competitive advantage in an environment characterized by volatility and uncertainty [4,5]. In parallel, project management provides a key mechanism for translating strategic objectives into operational outcomes by ensuring that complex initiatives are delivered on time, within scope, according to budget, and aligned with organizational goals [6]. Within large-scale financial transformation programs, effective project management is essential for coordinating cross-functional teams, managing

interdependencies, and embedding innovation into day-to-day practice [7]. The intersection of AI and project management is therefore of growing interest to both scholars and practitioners seeking to achieve strategic transformation in financial institutions. By embedding AI capabilities into project management systems, organizations can move beyond isolated technical applications toward more systemic, integrated configurations that connect operational execution with strategic intent [8]. In this study, Financial Project Management (FPM) is conceptualized not merely as a set of administrative tasks, but as a complex engineered system characterized by high-frequency data inputs and multi-stakeholder feedback loops. Within this architecture, the systemic integration of AI systems and processes is understood as a control layer that optimizes resource allocation and risk governance, thereby enabling real-time monitoring of project performance; early identification of bottlenecks; and dynamic adjustment of decision-making across the project architecture [9].

Against this backdrop, this article introduces the notion of Agentic AI as an emergent capability in financial project environments. Agentic AI refers to that can autonomously perceive project contexts, initiate or adapt actions, and collaborate with human stakeholders through goal-directed behavior. Drawing on research in multi-agent systems and human–AI teaming, the study conceptualizes Agentic AI not as a passive analytical tool but as an active participant embedded within financial project governance structures. In practice, such systems can trigger workflows, optimize resource allocation, identify emerging risks, and adapt plans in response to real-time data while remaining under human oversight. Their emergence signals a shift from AI as decision support toward AI as an interface between technical execution and strategic governance.

Despite this potential, research on AI integration into project management within the financial sector remains fragmented and largely siloed [10]. Many studies focus on discrete applications, such as predictive analytics, process automation, intelligent decision support, or performance monitoring tools, without sufficiently examining how these technologies collectively reshape project management as a systemic organizational capability. While such operational perspectives provide valuable insights into technical implementation and efficiency gains, they often underplay organizational, strategic, and socio-technical dimensions of AI adoption. In much of the literature, AI is treated either as a technical artifact or as an operational enhancer rather than as an embedded component of project management systems that influences governance structures, strategic alignment, and organizational learning. This narrow focus limits understanding of how AI can transform decision-making hierarchies, reconfigure roles and responsibilities, and enable new forms of cross-functional collaboration within financial institutions. It also underplays the importance of integrating human, organizational, and regulatory considerations into AI-enabled project management practices, thereby constraining the development of a cumulative body of knowledge on AI-integrated project management in financial contexts.

Related strands of research have examined AI in project management, AI in finance, and AI governance, but typically address these domains separately than in an integrated way. Reviews of AI in project management tend to focus on general industrial or infrastructure settings, while work on AI in finance frequently concentrates on technical applications such as trading, risk analytics or credit scoring without explicitly connecting these capabilities to project management processes. Similarly, the AI governance literature emphasizes ethics, transparency, and compliance, but rarely links governance mechanisms to project-level execution or portfolio-level steering. This fragmentation makes it difficult to understand how AI capabilities, managerial practices, and strategic oversight interact as elements of a socio-technical system within financial project environments.

This study addresses that gap by focusing specifically on the systemic integration of AI in financial project management, applying a BERTopic-based machine learning

synthesis to enhance analytical rigor and reproducibility, and proposing a socio-technical architecture that positions Agentic AI as an interface between technical execution and strategic governance. This integrative approach provides a structured roadmap for AI-enabled transformation in financial project environments.

There is a critical need for studies that synthesize existing knowledge, capture the interrelationships among technical, human, and organizational dimensions, and conceptualize AI as a systemic driver of strategic transformation. Addressing this gap not only advances theoretical understanding but also provides actionable guidance for financial institutions seeking to apply AI in managing complex projects and achieving sustainable organizational transformation. Systematic Literature Reviews have long been employed as a rigorous method for synthesizing research across a field, identifying conceptual patterns, and mapping the evolution of knowledge over time [11]. By systematically screening, categorizing, and analysing existing studies, SLRs provide a structured foundation for theory development and evidence-based practice. However, conventional SLR approaches rely heavily on manual coding, qualitative synthesis, and subjective judgment, which can introduce bias, limit reproducibility, and constrain scalability [12–14].

Methodologically, the study responds to calls for more rigorous and reproducible review practices in technology-intensive fields by augmenting traditional SLR procedures with transformer-based topic modelling. Recent advances in natural language processing (NLP) and topic modelling offer promising opportunities to enhance traditional SLR methodologies with data-driven analytical rigor [15,16]. These techniques enable automated extraction of latent patterns, thematic clustering, and semantic analysis, thereby reducing subjectivity and improving scalability in evidence synthesis [16]. Among these approaches, BERTopic has attracted attention for its use of transformer-based embeddings, dimensionality reduction, and density-based clustering to generate semantically coherent topics in medium-sized academic corpora [17,18]. Specifically, BERTopic applies contextual embeddings to capture nuanced semantic relationships between documents, applies algorithms such as UMAP for reducing high-dimensional data to meaningful lower-dimensional representations, and uses HDBSCAN to identify dense clusters of related content [19–24].

This integration allows researchers to detect coherent thematic structures within complex corpora, providing a more objective, reproducible, and interpretable synthesis of the literature while preserving the interpretive flexibility required for theory development and system-oriented analyses [25]. BERTopic is particularly well-suited for medium-sized academic corpora, as it utilises transformer-based contextual embeddings to capture semantic relationships that extend beyond simple term frequencies [26]. Unlike traditional frequency-based topic models, BERTopic supports the identification of nuanced connections between documents, facilitating the detection of latent themes that may not be evident through surface-level textual analysis alone [27]. In this study, this capability is further augmented by a generative representation layer, which utilizes Large Language Models (LLMs) via the OpenAI API to synthesize statistical clusters into formal academic narratives. When embedded within a Systematic Literature Review framework, this hybrid approach combines the rigor of established review protocols with the objectivity and scalability of machine learning-driven analysis [16,19,28]. This integration enhances transparency, reproducibility, and thematic coherence, while maintaining the level of interpretability required for conceptual and theoretical development. Moreover, it supports a holistic understanding of socio-technical systems by enabling the systematic mapping of research landscapes, the identification of emerging trends, and the articulation of research gaps [29]. As such, the BERTopic-augmented SLR provides a systemic capability, revealing how technological,

governance, and organizational dimensions interact to drive strategic transformation in the financial sector.

Accordingly, this study aims to systematically synthesize existing research on the integration of AI into project management in the financial sector and conceptualize AI as a systemic driver of strategic transformation in financial project environments. This approach allows for the identification of latent research themes, their interrelationships, and patterns that may not emerge through traditional qualitative synthesis alone [16]. Specifically, the study addresses the following research questions (RQs): RQ1: What are the dominant research themes related to AI integration in project management within the financial sector? RQ2: How does existing literature conceptualize AI as a systemic driver of strategic transformation in financial project management? RQ3: What gaps and future research directions emerge from the thematic structure of the literature? By answering these questions, the study contributes to both theory and practice in three key ways. First, it provides a structured and comprehensive synthesis of fragmented research across the domains of AI, project management, and finance, offering a clearer understanding of the current knowledge landscape. Second, it demonstrates the applicability and added value of BERTopic as a methodological extension to traditional SLRs, enhancing transparency, reproducibility, and thematic coherence in system innovation research. Third, it generates actionable insights for practitioners and decision-makers, guiding the design, management, and governance of AI-enabled project management systems that can support sustainable strategic transformation in financial organizations. Overall, this study advances system innovation in financial project management by: (1) constructing a socio-technical architecture that positions Agentic AI as an interface between technical execution and strategic governance; (2) integrating a BERTopic-based systemic diagnostic of the AI–PM–finance literature; and (3) deriving a roadmap for adaptive, data-intensive project management systems in financial institutions.

The remainder of the article is organized as follows. Section 2 presents the methodological design, including the SLR protocol and the BERTopic-based analytical pipeline, including the LLM-assisted topic interpretation layer. Section 3 reports the results of the the topic modelling and socio-technical analysis, including the consolidated clusters and their evolution. Section 4 discusses these findings through a socio-technical lens to propose a “Target Architecture” for AI-enabled project management, specifically addressing the “systemic interface” gap through the emergence of agentic and autonomous-collaborative frameworks. Finally, Section 5 concludes by summarizing the main insights, outlining limitations, and suggesting directions for future research on autonomous and agentic AI in financial project management.

2. Methodology

The methodological design aligns with the principles of a systematic mapping study (SMS), which aims to structure and classify research domains rather than test causal hypotheses. Accordingly, this study adopts a computationally enhanced mapping approach that integrates systematic literature review procedures with BERTopic-based topic modeling to identify, categorize, and visualize thematic structures in artificial intelligence research related to financial project management. By combining traditional SLR protocols with machine learning-driven topic extraction, the methodology enhances analytical rigor, transparency, and reproducibility while capturing nuanced patterns that may be overlooked in conventional qualitative reviews [30]. This integrated approach supports a holistic understanding of AI-enabled project management, bridging operational, managerial, and strategic dimensions, and emphasizing socio-technical interactions between technology, governance, and organizational processes.

The research workflow comprises three interrelated stages: literature identification and screening of peer-reviewed articles published between 2022 and 2025 based on pre-defined inclusion and exclusion criteria; corpus preparation involving the preprocessing of titles and abstracts, semantic embedding using transformer-based language models (Sentence-BERT [31]; Hugging Face Inc., New York, NY, USA), and refinement for analytical consistency; and the application of BERTopic (Maarten Grootendorst, Amsterdam, The Netherlands, version 0.16.0 [32]) as an analytical subsystem to identify latent structural patterns in the literature through dimensionality reduction (UMAP [33]; umap-learn, Python Software Foundation, Wilmington, DE, USA) and density-based clustering (HDBSCAN [34]; hdbscan, Python Software Foundation, Wilmington, DE, USA), further enhanced by a hybrid representation layer in which statistical clusters are synthesised using a large language model (GPT-4o-mini; OpenAI Inc., San Francisco, CA, USA) to generate formal academic thematic summaries via the OpenAI API (OpenAI Inc., San Francisco, CA, USA) to generate formal academic thematic summaries. This integrated process drives the analysis of conceptual coherence, interrelationships, and system-level implications for AI integration in financial project management. By combining traditional SLR rigor with machine learning-enhanced analysis, the methodology functions as a diagnostic lens, revealing latent trends and emerging research trajectories in AI-integrated project management.

2.1. Literature Search and Selection

A structured literature search was conducted across Scopus (Elsevier, Amsterdam, The Netherlands), Web of Science (Clarivate, London, UK), IEEE Xplore (IEEE, Piscataway, NJ, USA), and Google Scholar (Google LLC, Mountain View, CA, USA) to identify peer-reviewed journal articles and conference papers addressing the integration of artificial intelligence and project management within the financial sector or financial services context. The search strategy employed Boolean operators to ensure both precision and coverage, combining core terms such as “artificial intelligence” or “machine learning” or “generative AI” and “project management” or “program management” or “portfolio management”, further refined by contextual filters including “finance” or “banking” or “financial services”.

The initial search returned 1356 records (Scopus: 412; Web of Science: 356; IEEE Xplore: 212; Google Scholar: 376). After removing 381 duplicates, 975 records remained for screening. Title and abstract screening excluded 793 records that did not address project management, focused solely on technical AI development without managerial relevance, or fell outside the financial domain. The remaining 182 full-text articles were assessed for eligibility using predefined inclusion criteria. Of these, 120 studies were excluded due to insufficient alignment with project management objectives or incompatibility with the BERTopic-based analytical framework, leaving a final corpus of 62 studies.

This systematic selection process resulted in a final corpus of 62 peer-reviewed studies, which constituted the empirical foundation for the BERTopic-driven topic modelling and thematic synthesis. The complete identification, screening, eligibility, and inclusion workflow is documented in the PRISMA 2020 flow diagram (Figure 1). Supplementary Materials now cited in Section 2.1: ‘Full PRISMA flow diagram, PRISMA-ScR checklist, and SLR dataset available as Supplementary Materials. The diagram also reports the reasons for exclusion at the full-text, including studies not focused on project management (n = 46), purely technical AI research without managerial context (n = 38), studies outside the financial sector (n = 21), and conceptual papers lacking analytical contribution (n = 15). The screening and eligibility assessment were conducted by the authors following the predefined inclusion and exclusion criteria. To enhance methodological transparency, the screening process was documented step-by-step in a structured screening log, and all

inclusion decisions were cross-checked against the eligibility criteria before the final corpus was constructed.

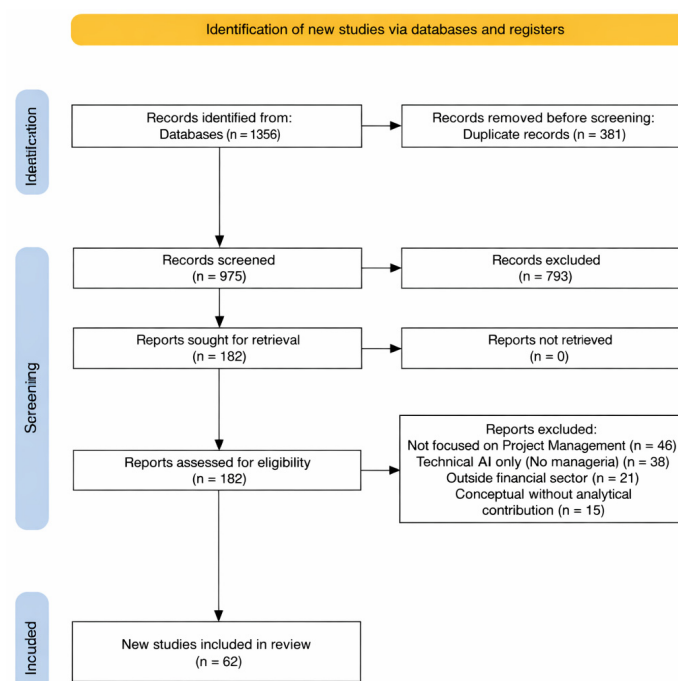


Figure 1. The PRISMA flow diagram.

The resulting 62 studies represent a diverse set of AI applications in financial project management. A comprehensive overview of these primary studies, including AI core technologies, financial applications, and project management process areas, is provided in Table 1 and serves as the dataset for the BERTopic-driven thematic synthesis presented in Section 3.

Table 1. The Summary of Selected Studies for Systematic Literature Review (n = 62).

ID	Author/Year	AI Core Technology	Financial Application	PM Process Area
1	Szymczak et al. (2025) [35]	Reinforcement Learning & GNN	Cyber Risk Cost Management	Risk Management
2	Drydakakis et al. (2025) [36]	Machine Learning (Classification)	Entrepreneurial ROI Analysis	Resource Management
3	Gashi et al. (2025) [37]	Distributed Ledger Technology (DLT)	Sustainable/Green Finance	Quality Management
4	Rakshith & Roopa (2025) [38]	Natural Language Processing (NLP)	Educational Resource Allocation	Integration Management
5	Junaedi et al. (2025) [39]	Explainable AI (XAI)	ML Software Lifecycle Costing	Development Lifecycle
6	Suganya et al. (2024) [40]	Deep Learning (LSTM/RNN)	Cryptocurrency Price Prediction	Risk & Uncertainty
7	Tariq et al. (2025) [41]	Expert Systems/ Sentiment Analysis	Employee Well-being & Productivity	Resource Management
8	Gordini et al. (2025) [42]	Automated Planning & Scheduling	Operational Cost Optimization	Schedule Management

Table 1. Cont.

ID	Author/Year	AI Core Technology	Financial Application	PM Process Area
9	Denni-Fiberesima et al. (2025) [43]	Predictive Analytics	Portfolio Optimization (PPEM)	Portfolio Management
10	Alam et al. (2025) [44]	Big Data Analytics	ESG Performance Tracking	Integration Management
11	Narasimhan et al. (2025) [45]	Recommender Systems	Digital Banking/ E-Finance UX	Stakeholder Management
12	Parchmann et al. (2025) [46]	Decision Support Systems (DSSs)	Medical Resource/ Finance Ethics	Risk Management
13	Miller et al. (2025) [47]	Multi-Objective Optimization	Regulatory Compliance Finance	Procurement Management
14	Padgaonkar et al. (2025) [48]	Linear Regression/ Random Forest	Cost Estimation (Construction)	Cost Management
15	Prakash et al. (2025) [49]	Time Series Analysis (ARIMA/ FBProphet)	Budgeting & Forecasting Accuracy	Cost Management
16	Marcos et al. (2025) [50]	Neural Networks (ANNs)	Financial Risk (Construction)	Risk Management
17	Kharatmol et al. (2025) [51]	Heuristic Algorithms	Personalized Wealth Management	Scope Management
18	Lukianchuk et al. (2025) [52]	BIM-Integrated AI (Digital Twin)	Asset Valuation & Budgeting	Cost Management
19	Alka et al. (2025) [53]	Topic Modeling (LDA)	Startup Valuation & Trends	Integration Management
20	Sahoo et al. (2025) [54]	Computer Vision & IoT	Agribusiness Supply Chain Finance	Quality Management
21	Hughes et al. (2025) [55]	Intelligent Agents (Agentic AI)	Global IT Asset Management	Integration Management
22	Arshad et al. (2025) [56]	Microservices-based ML	Scalable Fintech Operations	Integration Management
23	Rahi et al. (2024) [57]	Generative AI (LLMs/GANs)	Project Lifecycle Cost Optimization	Integration Management
24	Hoda et al. (2024) [58]	Augmented Agile/ Human-in-the-loop	Human Capital Financial Planning	Resource Management
25	Katamaneni et al. (2024) [59]	Expert Systems	Credit Risk Assessment	Risk Management
26	Likhitkar et al. (2024) [60]	Machine Learning (Hybrid Models)	Investment Decision Support	Risk Management
27	Al-Shaghdari et al. (2024) [61]	Case-Based Reasoning (CBR)	Real Estate ROI Analysis	Scope Management
28	Ahuja et al. (2024) [62]	Predictive Modeling	Green Bond Risk Factors	Risk Management
29	Thirumagal et al. (2024) [63]	Distributed Ledger (Blockchain)	Smart Contract Costing	Procurement Management
30	Al-Hadi et al. (2024) [64]	IoT Analytics & Sensors	Fraud Detection in Banking	Quality Management

Table 1. Cont.

ID	Author/Year	AI Core Technology	Financial Application	PM Process Area
31	Channi et al. (2024) [65]	Big Data/Data Mining	Metaverse Asset Valuation	Cost Management
32	Agal et al. (2024) [66]	Blockchain-AI Synergy	Decentralized Finance (DeFi) Trust	Stakeholder Management
33	Stiefenhofer et al. (2024) [67]	Statistical Machine Learning	Sustainable Market-Neutral Investing	Risk Management
34	Wu et al. (2024) [68]	Strategic AI Modeling	Green Finance Analysis	Integration Management
35	Rodgers et al. (2023) [69]	Algorithmic Behavioral Pathways	Behavioral Credit Scoring	Risk Management
36	Ma (2023) [70]	Reliability Engineering AI	System Stability/Financial Auditing	Quality Management
37	Grzeszczyk et al. (2023) [71]	Knowledge Management Systems	R&D Strategic Budgeting	Integration Management
38	Plotnikova et al. (2023) [72]	Data Mining (CRISP-DM)	Financial Services Process Design	Development Lifecycle
39	Liu et al. (2023) [73]	Robotic Process Automation (RPA)	Intelligent Financial Workflows	Resource Management
40	Soni et al. (2025) [74]	Predictive Analytics	Success Probability/NPV Analysis	Integration Management
41	Alshibi et al. (2025) [75]	Systematic AI Review	Multi-Sector Opportunity Costing	Risk Management
42	Kuster et al. (2024) [76]	NLP	Digital Transformation ROI	Integration Management
43	Ahmed et al. (2025) [77]	Machine Learning (General)	Resource Allocation/Capital Budgeting	Resource Management
44	Smith et al. (2025) [78]	Deep Learning	Project Feasibility Finance	Scope Management
45	Tan et al. (2025) [79]	Cost-Ranking Scheduling	Financial Risk Prevention	Schedule Management
46	Brem et al. (2024) [80]	Open Innovation AI	External Funding Integration	Stakeholder Management
47	Gupta et al. (2025) [81]	Predictive Implementation	Global Risk Forecasting	Risk Management
48	Karakuş et al. (2024) [82]	Hybrid Fuzzy Decision-Making	Carbon Capture Investment ROI	Risk Management
49	Chen et al. (2025) [83]	Agentic AI	Smart Future Resource Planning	Resource Management
50	Martinez et al. (2025) [84]	Mathematical Optimization	Letter of Credit (LC) Efficiency	Procurement Management

Table 1. Cont.

ID	Author/Year	AI Core Technology	Financial Application	PM Process Area
51	Thompson et al. (2025) [85]	FinTech Algorithms	Payment Systems Efficiency	Quality Management
52	Brown et al. (2025) [86]	AI-Assisted Auditing	Financial Transparency/ Assurance	Quality Management
53	Reddy et al. (2025) [87]	Cloud Infrastructure	SAP Real-time Financial Analytics	Resource Management
54	Okoro et al. (2025) [88]	Pattern Recognition	Anti-Money Laundering (AML)	Risk Management
55	Medina et al. (2022) [89]	Behavioral AI	Overdraft Fee Mitigation	Resource Management
56	Liang et al. (2025) [90]	Machine Learning Integration	Business Process Financialization	Integration Management
57	Varga et al. (2025) [91]	FinTech Integration	Payment Infrastructure Costing	Quality Management
58	Parida et al. (2024) [92]	Generative AI	Innovation Management Budgeting	Scope Management
59	Al-Adwan et al. (2024) [93]	Banking Risk AI	Credit Risk Assessment	Risk Management
60	Zhou et al. (2024) [94]	Generative Models	Innovation Strategy ROI	Integration Management
61	Bag et al. (2024) [95]	Supply Chain AI	Logistics Cost Management	Quality Management
62	Nguyen et al. (2025) [96]	Explainable AI (XAI)	Transparent Risk Decisioning	Risk Management

2.2. Corpus Preparation

For each selected article, titles and abstracts were extracted and combined to form a textual corpus for analysis. This approach balances semantic richness with methodological consistency, as titles and abstracts succinctly capture core research contributions while minimizing noise from full-text content. The corpus was pre-processed and cleaned through duplicate removal, filtering of short or insufficiently informative documents, lowercasing, punctuation removal, tokenization, and normalization. In addition, domain-specific ‘stop words’ were applied to suppress generic academic terms (e.g., “study,” “research,” “data”) that do not meaningfully contribute to topic differentiation.

These preprocessing steps ensured a high-quality, semantically rich corpus, maximizing the analytical subsystem’s capacity to detect subtle patterns and latent research themes within Financial Project Management (FPM) literature. By focusing on titles and abstracts and applying domain-specific refinements, the methodology emphasizes the key conceptual contributions of each study, enabling the subsystem to identify coherent themes while preserving interpretability and supporting a system-oriented analysis of AI-integrated project management [97].

Such structured corpus preparation and domain-specific text refinement practices are consistent with prior studies highlighting the importance of carefully curated textual inputs for extracting meaningful patterns and improving interpretability in AI-driven financial project management research [98,99].

2.3. BERTopic as an Analytical Subsystem and Topic Representation

This study frames BERTopic not merely as a software tool but as an analytical subsystem designed to decode latent structural patterns within the Financial Project Management (FPM) knowledge base. Functioning as a high-fidelity diagnostic module, the subsystem integrates multiple complementary components to capture the complexity of interdisciplinary data.

Titles and abstracts are first encoded into high-dimensional semantic embeddings using the *all-MiniLM-L6-v2* Sentence-BERT model, capturing nuanced contextual relationships beyond surface-level word similarity [100,101]. These embeddings are then projected into a five-dimensional space using Uniform Manifold Approximation and Projection (UMAP), preserving local semantic structure while facilitating efficient clustering [102–109]. Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN) subsequently identifies dense clusters of semantically related documents and preserves outliers. This allows the subsystem to detect both prominent and emerging research streams, including early-stage topics such as the shift from rule-based AI to Agentic AI in supply chain projects (Topic 0). A minimum topic size of three documents was set to ensure the detection of granular research signals while maintaining statistical stability.

To translate these latent structures into interpretable knowledge units, a multi-aspect topic representation layer is applied. While Class-based Term Frequency–Inverse Document Frequency (c-TF-IDF) and KeyBERT-inspired extraction prioritize conceptually representative keywords, this study further integrates a Large Language Model (LLM) refinement stage using the *gpt-4o-mini* model via the OpenAI API [110].

By utilizing a customized academic prompt, the subsystem synthesizes cluster keywords and representative document snippets into formal academic paragraphs. This generative refinement ensures that extracted themes, particularly emerging frontiers like Agentic AI (Topic 0), are interpreted within the specific socio-technical context of Financial Project Management, bridging the gap between raw statistical clusters and high-level research discourse. Semantic refinement is further achieved through KeyBERT-inspired extraction and Maximal Marginal Relevance (MMR), which reduces redundancy and ensures diversity within each topic [111–113]. Representative documents with the highest topic probabilities are examined to validate conceptual coherence, providing triangulation between the statistical and semantic representations [114,115].

By integrating these components, the subsystem produces concise, semantically coherent, and diverse topic representations, enabling the detection of latent research streams, structural interrelationships, and emerging trends in AI-enabled project management [116,117]. This dual-layer framework, which combines structural detection through embeddings and clustering with semantic interpretation via c-TF-IDF and GPT-4o-mini synthesis, supports a system-oriented, socio-technical perspective. It highlights how technological, managerial, and governance dimensions interact within FPM systems [118].

Figure 2 illustrates the end-to-end workflow of the BERTopic-based analytical subsystem, showing the sequential stages from semantic embedding generation with SBERT, through dimensionality reduction with UMAP, clustering with HDBSCAN, and the final Hybrid Representation Layer combining c-TF-IDF, KeyBERT, and GPT-4o-mini generative synthesis. This visual representation clarifies how the subsystem operationalizes the detection of latent structures within the Financial Project Management knowledge base.

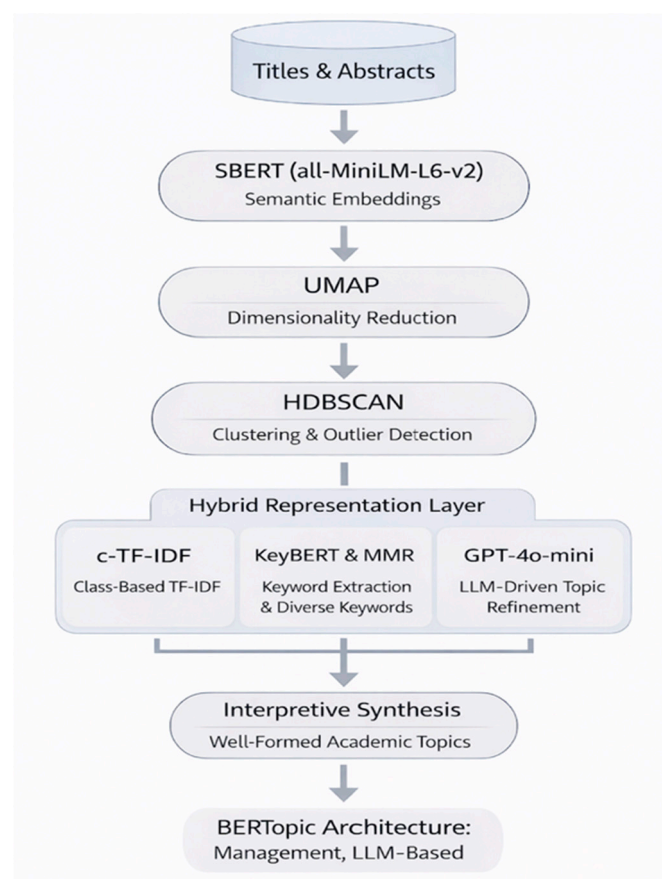


Figure 2. The BERTopic workflow for topic modelling.

Table 2 summarises the complete BERTopic pipeline configuration, including the embedding, dimensionality reduction, clustering, vectorisation, and dual representation layers (KeyBERT keywords and GPT-4o-mini model). These settings were selected to balance topic coherence, interpretability, and robustness for a relatively small corpus of 62 academic articles, with the LLM layer providing concise labels anchored in representative documents while preserving the topic boundaries determined by the embedding–UMAP–HDBSCAN pipeline.

Table 2. The configuration of the BERTopic Analytical Pipeline.

Component	Library/Model	Configuration and Rationale
Semantic Embedding Model	SentenceTransformer (all-MiniLM-L6-v2)	Generates 384-dimensional contextual sentence embeddings optimized for short academic texts (titles and abstracts). The compact architecture ensures computational efficiency while preserving semantic coherence, making it well-suited for subsequent UMAP projection and BERTopic clustering.
Dimensionality Reduction	UMAP (umap-learn)	Parameters: n_neighbors = 8, n_components = 5, min_dist = 0.0, metric = “cosine”, random_state = 42. This configuration prioritizes preservation of local semantic structures while projecting high-dimensional embeddings into a 5-dimensional latent space optimized for density-based clustering.

Table 2. Cont.

Component	Library/Model	Configuration and Rationale
Clustering Algorithm	HDBSCAN	Parameters: <code>min_cluster_size = 2</code> , <code>min_samples = 1</code> , <code>metric = "euclidean"</code> (applied in UMAP space), <code>cluster_selection_method = "leaf"</code> , <code>prediction_data = True</code> . The configuration is calibrated for a medium-sized corpus ($n = 62$) to retain fine-grained thematic structures while minimizing spurious micro-clusters.
Text Vectorization	CountVectorizer (scikit-learn)	Parameters: <code>ngram_range = (1, 2)</code> , <code>min_df = 1</code> , <code>max_df = 0.9</code> , with a custom stopwords list combining standard English stopwords and domain-specific academic terms. This setup captures meaningful unigrams and bigrams (e.g., "project management") while reducing high-frequency non-informative terms.
Topic Weighting Mechanism	ClassTfidfTransformer (c-TF-IDF)	Parameters: <code>reduce_frequent_words = True</code> , <code>bm25_weighting = True</code> . Enhances discriminative power of topic-specific terms and improves interpretability in short academic documents.
Keyword-Based Topic Representation	KeyBERTInspired	<code>top_n_words = 10</code> . Extracts representative and semantically diverse keywords per topic, ensuring traceability to the original document corpus.
LLM-Based Topic Labeling	BERTopic OpenAI Representation (GPT-4o-mini)	Applies the prompt: "I have the following documents: [DOCUMENTS]\nThese documents are about the following topic:" to generate concise, human-readable labels ("Main_Label") grounded in representative documents. The LLM enhances semantic clarity without modifying cluster boundaries.

Because the corpus consisted of a relatively small but highly curated set of studies ($n = 62$), the objective of the BERTopic analysis was exploratory thematic mapping rather than probabilistic topic inference. In contrast to large-scale corpus studies, the goal was to detect latent conceptual structures within a focused research domain. Parameter settings such as `min_cluster_size = 2` and `min_samples = 1` were intentionally selected to preserve emerging research signals that would otherwise be discarded as noise in a small corpus. Similar configurations have been reported in prior studies applying BERTopic to medium-sized or domain-specific academic datasets.

To evaluate the sensitivity of the clustering configuration, the BERTopic pipeline was re-executed using more conservative HDBSCAN parameters (`min_cluster_size = 4`, `min_samples = 2`) [See Appendix A]. The resulting model produced eight coherent topic clusters and nine outlier documents ($\approx 14\%$ of the corpus). Importantly, the thematic structure remained conceptually consistent with the clusters identified in the primary configuration, including dominant themes related to project management methodologies, sustainable finance, agentic AI systems, blockchain-enabled financial infrastructures, and financial decision-support models. This robustness check indicates that the identified thematic structure is not an artifact of permissive clustering parameters but reflects stable semantic patterns within the literature corpus.

To further evaluate the robustness and interpretability of the extracted topics, three complementary validation metrics were computed: topic coherence (`c_v`), normalized pointwise mutual information (NPMI), and silhouette score. Topic coherence measures the semantic consistency of the top keywords within each topic by assessing the degree to which

words co-occur in the corpus. NPMI evaluates the strength of word associations based on normalized co-occurrence probabilities, providing an additional measure of semantic relatedness. The silhouette score assesses clustering quality by comparing intra-cluster similarity with inter-cluster separation. These metrics collectively provide quantitative evidence regarding the semantic coherence and clustering stability of the BERTopic model (Table 3).

Table 3. Validation Metrics for BERTopic Topic Clustering.

Metric	Score	Interpretation
Topic Coherence (c_v)	0.38	Moderate semantic consistency
NPMI	−0.13	Weak co-occurrence structure
Silhouette Score	0.013	Weak cluster separation

The analysis produced a coherence score of 0.38, an NPMI of −0.13, and a silhouette score of 0.013. While these values indicate moderate semantic cohesion and limited cluster separability, such outcomes are expected in interdisciplinary corpora with overlapping semantic domains. Consequently, the BERTopic analysis is interpreted primarily as an exploratory thematic mapping approach, intended to reveal latent research patterns rather than produce statistically definitive topic partitions.

The sensitivity analysis also identified nine documents that were classified as outliers by the HDBSCAN algorithm when more conservative clustering parameters were applied. This corresponds to approximately 14% of the corpus, which is within the expected range for density-based clustering applied to small and interdisciplinary datasets. Outlier documents typically represent unique or emerging research topics that do not yet form dense thematic clusters within the literature.

While BERTopic is frequently applied to large corpora, recent studies demonstrate that transformer-based topic modeling approaches using contextual embeddings can effectively identify semantic structures in medium-sized academic datasets, particularly when the objective is exploratory thematic mapping rather than probabilistic topic inference [17,29]. Because contextual embeddings capture semantic similarity between documents rather than relying solely on word-frequency distributions, meaningful topic structures can emerge even in relatively compact research corpora.

2.4. Advanced Thematic Discovery and Keyword Diversity

The use of BERTopic within the SLR framework provides methodological contributions that extend traditional literature review approaches [119–122]. By applying transformer-based embeddings, UMAP dimensionality reduction, and HDBSCAN clustering, the approach identifies latent thematic structures that may not be immediately apparent through manual coding alone [17]. The integration of KeyBERT-inspired and Maximal Marginal Relevance (MMR) representations further enhances keyword diversity and topic interpretability, as illustrated in the technical refinement pipeline in Figure 3. This ensures that extracted themes are both coherent and semantically meaningful while avoiding the redundancy often found in standard frequency-based models [123]. By applying MMR, the system balances the relevance of keywords to their respective clusters with the diversity of the terms provided, effectively “de-noising” the thematic output. This combination of qualitative rigor and machine learning techniques reduces subjectivity, improves reproducibility, and supports transparent thematic synthesis across interdisciplinary domains such as AI, project management and finance [124–127].

Topic	Count	Name	Representation	KeyBERT	MMR	Representative_Docs	
0	-1	13	-1_metaverse_software_projects_supply	[metaverse, software, projects, supply, big, d...]	[ai supply, strategic projects, finance, innov...	[metaverse, big data, mining, supply chain, ag...	[Risk factors in Islamic green finance and a c...
1	0	5	0_agentic_agentic ai_genai_ethical	[agentic, agentic ai, genai, ethical, older, c...]	[ai agents, agentic ai, genai, clinical, genai inn...	[agentic, agentic ai, genai, ethical, cdss, ag...	[Generative AI and the future of innovation ma...
2	1	4	1_examination_audit_lc_auditing	[examination, audit, lc, auditing, model, redu...	[intelligence financial, financial auditing, a...	[audit, auditing, lc examination, bankers, ml ...]	[Modelling credit and investment decisions bas...
3	2	4	2_blockchain_agriculture_trust_technology	[blockchain, agriculture, trust, technology, c...]	[ai blockchain, blockchain ai, ai financial, b...	[blockchain, trust, blockchain technology, tec...	[Innovative Financial Services Driven by AI an...
4	3	3	3_sustainable_sustainable finance_pairs_pairs ...	[sustainable, sustainable finance, pairs, pair...	[finance ai, sustainable finance, sustainable ...]	[sustainable finance, pairs trading, sustainab...	[The Role of Technology, AI, ML and DLT in Sus...
5	4	3	4_rpa_intelligent_platform_cryptocurrency	[rpa, intelligent, platform, cryptocurrency, u...	[intelligent financial, personalized investmen...	[rpa, automation, intelligent financial, advis...	[Enhancing Cryptocurrency Market Predictabilit...
6	5	3	5_project management_approaches_management pro...	[project management, approaches, management pr...	[project management, role ai, project portfoli...	[project management, approaches, management pr...	[Critical Success Factors for Project Manageme...
7	6	3	6_education_training_edtech_startups	[education, training, edtech, startups, ai bus...	[ai business, edtech startups, entrepreneurs, ...]	[ai business, edtech startups, entrepreneurs, ...]	[Emerging Trends and Innovation in AI for Busi...
8	7	3	7_construction_construction projects_construct...	[construction, construction projects, construc...	[construction projects, construction industry,...]	[construction projects, construction industry,...]	[AI Based Financial Modeling for Cost Efficien...
9	8	3	8_efm_compared_traditional_precise	[efm, compared, traditional, precise, lstm, ar...	[financial forecasting, financial prediction, ...]	[efm, lstm, recall, financial forecasting, acc...	[Enhanced Financial Forecasting and Budgeting ...]
10	9	2	9_intelligence risk_risk management_role artif...	[intelligence risk, risk management, role arti...	[ai risk, risk management, manage risks, stres...	[intelligence risk, risk management, role arti...	[The Role of Artificial Intelligence in Risk M...
11	10	2	10_banking_banking operations_iot_devices	[banking, banking operations, iot, devices, pa...	[fintech artificial, banking operations, banki...	[banking operations, iot data, banking sector,...]	[Banking Transformation Through FinTech and th...
12	11	2	11_prm_module_lime_explanations	[prm, module, lime, explanations, interpretabl...	[project risk, ai models, optimize ai, risk as...	[project risk, phases, interpretable model, in...	[Leveraging Artificial Intelligence in Project...
13	12	2	12_financial products_fuzzy_green finance_prod...	[financial products, fuzzy, green finance, pro...	[ai fuzzy, investment carbon, finance environm...	[financial products, green finance, features, ...]	[Innovative financial solutions for sustainabl...
14	13	2	13_financial benefits_accountability_ai projec...	[financial benefits, accountability, ai projec...	[ai projects, project management, responsibili...	[ai projects, compliance financial, benefits s...	[Simultaneous pursuit of accountability for re...
15	14	2	14_property_learning business_business_busines...	[property, learning business, business, busine...	[entrepreneurial operations, investing ai, lea...	[learning business, business management, gen a...	[Integrating machine learning into business an...
16	15	2	15_users_attention_message_limited attention	[users, attention, message, limited attention,...]	[mitigate financial, personal financial, behav...	[limited attention, behavioral finance, risk m...	[AI-Based Risk Management in Financial Service...
17	16	2	16_project life_life_sustainable project_genai	[project life, life, sustainable project, gena...	[ai work, generative ai, ai genai, genai proje...	[project life, genai, ai work, healthcare, wor...	[AI and work-life balance: Transforming employ...
18	17	2	17_scenario_scenario planning_outputs_mlsa	[scenario, scenario planning, outputs, mlsa, c...	[interpretability ai, liquidity management, ma...	[scenario planning, cash flow, mlsa developmen...	[An Integrated Software Process Framework to I...
19	18	2	18_fraud_detection_financial risk_prevention	[fraud, detection, financial risk, prevention,...]	[ai financial, fraud detection, predictive ana...	[fraud, money laundering, learning algorithms,...]	[Harnessing Artificial Intelligence for combat...

Figure 3. The technical architecture of the BERTopic-augmented analytical subsystem.

2.5. Stability Test

To evaluate the sensitivity of the BERTopic clustering to random initialization, the full analytical pipeline was re-executed using an alternative UMAP random seed (random_state = 10 instead of 42). The second run produced 18 topics compared to 19 in the initial run, while the number of outlier documents remained identical (n = 13). Although minor variations occurred in the composition of fine-grained clusters, the core thematic structure remained consistent, with recurring themes related to sustainable finance, project management methodologies, blockchain infrastructure, financial risk analytics, and emerging agentic AI applications. These results (Figure 4) indicate that the BERTopic-derived themes are robust at the conceptual level, supporting their interpretation as exploratory thematic structures rather than strictly deterministic clusters.

The figure displays the topics identified during the second BERTopic run used for the seed sensitivity test. Despite minor variations in fine-grained cluster composition, the overall thematic structure remains consistent with the initial run, supporting the robustness of the derived research themes. Additional exploratory runs confirmed similar topic structures.

Topic	Count	Name	Representation	KeyBERT	MMR	Representative_Docs	
0	-1	13	-1_life_sdlic_software_cycle	[life, sdlic, software, cycle, life cycle, regu...	[incorporating ai, ai driven, ai projects, ai ...	[life cycle, data mining, project life, ai sdl...	[Risk factors in Islamic green finance and a c...
1	0	5	0_sustainable_environmental_sustainable financ...	[sustainable, environmental, sustainable finan...	[finance ai, sustainable finance, finance envi...	[sustainable finance, pairs trading, financial...	[The Future of Sustainable Finance: AI-Driven ...
2	1	5	1_project management_agile_project_approaches	[project management, agile, project, approche...	[project management, ai project, software proj...	[project management, agile, project portfolio,...	[Critical Success Factors for Project Manageme...
3	2	4	2_construction_national projects_national_proj...	[construction, national projects, national, pr...	[construction projects, predict project, finan...	[national projects, projects, construction pro...	[Exploring the Efficiency of AI-Assisted Finan...
4	3	4	3_blockchain_agriculture_trust_technology	[blockchain, agriculture, trust, technology, c...	[ai blockchain, blockchain ai, ai financial, b...	[blockchain, agriculture, blockchain technolog...	[Innovative Financial Services Driven by AI an...
5	4	3	4_examination_lc_model_lc examination	[examination, lc, model, lc examination, banke...	[stress ai, bankers risk, ai coaching, intelli...	[lc examination, bankers risk, european indust...	[Computational Analysis of Cyber Risk Manageme...
6	5	3	5_education_training_edtech_startups	[education, training, edtech, startups, ai bus...	[ai business, edtech startups, entrepreneurs, ...	[ai business, edtech startups, entrepreneurs, ...	[Emerging Trends and Innovation in AI for Busi...
7	6	3	6_project management_systematic_open innovatio...	[project management, systematic, open innovati...	[project management, innovation projects, adop...	[project management, open innovation, systemat...	[How artificial intelligence will transform pr...
8	7	3	7_efm_compared_traditional_precise	[efm, compared, traditional, precise, lstm, fi...	[financial forecasting, financial prediction, ...	[efm, lstm, financial forecasting, accuracy, f...	[Enhanced Financial Forecasting and Budgeting ...
9	8	3	8_supply_agentic ai_agentic_genai	[supply, agentic ai, agentic, genai, constrain...	[ai supply, genai innovation, innovation manag...	[agentic ai, agentic, genai, constraints, supp...	[Generative AI and the future of innovation ma...
10	9	2	9_cryptocurrency_financial risk_historical_dri...	[cryptocurrency, financial risk, historical, d...	[ai financial, predictive analytics, market pr...	[cryptocurrency, financial risk, bitcoin, ethe...	[Enhancing Cryptocurrency Market Predictabilit...
11	10	2	10_scenario_outputs_scenario planning_mlsa	[scenario, outputs, scenario planning, mlsa, c...	[interpretability ai, liquidity management, ma...	[scenario planning, cash flow, financial resil...	[An Integrated Software Process Framework to I...
12	11	2	11_rpa_intelligent_user_automation	[rpa, intelligent, user, automation, intellige...	[intelligent financial, financial advisor, off...	[rpa, intelligent financial, rpa technology, i...	[Research on "AI+RPA" Interactive Technology o...
13	12	2	12_property_learning business_business_busines...	[property, learning business, business, busine...	[entrepreneurial operations, investing ai, lea...	[learning business, business management, gen a...	[Integrating machine learning into business an...
14	13	2	13_banking_banking operations_ilot_devices	[banking, banking operations, ilot, devices, io...	[fintech artificial, banking operations, banki...	[banking operations, ilot data, payment systems...	[Banking Transformation Through FinTech and th...
15	14	2	14_knowledge management_strategic_banks_strate...	[knowledge management, strategic, banks, strat...	[practices banking, banking sector, banking, o...	[knowledge management, strategic importance, s...	[The Role of Artificial Intelligence in Risk M...
16	15	2	15_metaverse_big data_big_data metaverse	[metaverse, big data, big, data metaverse, fin...	[finance, business finance, trends finance, me...	[metaverse, big data, data metaverse, trends f...	[Big Data Tools for Business and Finance Secto...
17	16	2	16_prm_module_lime_explanations	[prm, module, lime, explanations, interpretabl...	[project risk, ai models, optimize ai, like pr...	[phases, project risk, ai methodologies, durat...	[Leveraging Artificial Intelligence in Project...
18	17	2	17_older_cdss_medical_gai	[older, cdss, medical, gai, treatment, patient...	[ai clinical, identification ethical, decision...	[cdss, medical, gai, focus groups, older patie...	[The impact of generative AI on management inn...

Figure 4. Topic Distribution from the BERTopic Stability Test Using an Alternative UMAP Random Seed (random_state = 10).

2.6. Generative Synthesis via the Hybrid Representation Layer

Unlike traditional topic modeling, which relies solely on frequency-based keywords, a core innovation of this study is the use of an LLM-based representation layer to move beyond frequency-based keyword analysis. By passing representative document clusters to the GPT-4o-mini model, the subsystem synthesized fragmented data into formal academic summaries. Table 4 contrasts the raw statistical keywords generated via KeyBERT with the AI-refined academic summaries. The comparison illustrates the generative layer's function as a semantic bridge, elevating lexical indicators into higher-level thematic constructs that better reflect the strategic, methodological, and governance-oriented dimensions of AI integration in financial project environments.

The study integrates an LLM-based representation layer to enhance thematic interpretability. By passing the top representative documents and keywords of each consolidated cluster to the OpenAI API (GPT-4o-mini), the model generates a context-aware “Academic Summary” for each topic. To ensure consistency and academic rigor, the generative process was guided by a structured prompt: *Academic_Summary = ““I have a topic described by the following keywords: [KEYWORDS]. Based on these keywords, summarize this topic in one academic paragraph for a research article focused on AI integration into Project Management within the Finance sector.”“*

The LLM-generated summaries were produced directly from the topic keywords and representative documents associated with each cluster. Because the summaries are grounded in statistically derived topic representations rather than free-form prompts, the generated descriptions remain anchored to the empirical structure of the corpus. This design ensures that the thematic descriptions reflect the semantic composition of each topic cluster rather than independent generative interpretation.

Table 4. Contrast between Statistical Keywords and AI-Refined Academic Summaries.

Topic	Raw Keywords (KeyBERT)	OpenAI Refined Academic Summary (Thematic Synthesis)
Topic 0	Agentic, autonomous, genAI, innovation	Autonomous-Collaborative Frameworks: Synthesizes the shift toward Agentic AI systems that coordinate complex supply chain ecosystems through autonomous decision-making and ethical agent management.
Topic 1	Analytics, predictive, models, methodology, examination	Advanced Predictive Analytics: Focuses on the development, evaluation, and validation of analytics-driven and predictive AI models used to support operational decision-making and execution in financial project environments, emphasizing methodological rigor and reliability.
Topic 3	Sustainable, finance, risk, ESG	Strategic ESG Governance: Integrates AI-enabled risk assessment with long-term sustainability goals, positioning AI as a tool for balancing financial performance with ethical oversight.

As illustrated in Figure 5, this process provides a bridge between raw statistical topic clusters and the strategic discourse required for financial project management analysis. By conditioning the generative prompt on the keywords and representative documents of each cluster, the Hybrid Representation Layer translates machine-derived topic structures into academically interpretable summaries while preserving the semantic boundaries defined during the BERTopic clustering stage.

```
System components initializing...
Testing API connectivity (gpt-4o-mini)...
Success! API is responsive.
Fitting BERTopic model to documents...
```

=====

TOPIC MODELING COMPLETE

=====

	Topic	Count	Academic_Summary	Keywords
0	-1	1	[This research article explores the pivotal role of AI integration in project management within the finance sector as a catalyst for enhancing a country's economic and social competitiveness. By focusing on infrastructure projects that address key problems facing businesses, the study examines how AI can improve project management practices, thereby facilitating the achievement of national economic goals. The integration of AI technologies allows for a more efficient allocation of resources, streamlining processes that ultimately elevate the quality of projects executed within the finance sector. This approach not only fosters growth in the economy but also empowers businesses to navigate complexities more effectively, ensuring that infrastructure development aligns with strategic objectives. Through this lens, the article reveals how AI-driven project management can serve as a critical lever for increasing national competitiveness while addressing the multifaceted challenges of modern economies.]	[projects, infrastructure, russia, economic, government, economy, funding, risk, modernization, national]
1	0	34	[This research article explores the integration of artificial intelligence (AI) into financial project management, highlighting its potential to enhance decision-making processes and risk management strategies. By leveraging AI technologies and data analysis, financial institutions can improve operational efficiency and sustainability in their projects. The study examines how AI can transform traditional finance practices, enabling organizations to make more informed decisions based on real-time data insights. Furthermore, the research underscores the importance of understanding the implications of AI in financial contexts, focusing on how these advancements contribute to better management and optimization of resources in the finance sector.]	[finance, ai, financial investment, investors, fintech, banking, sustainable, risk, analytics]
2	1	23	[This research article explores the integration of artificial intelligence (AI), particularly generative AI (GenAI), into project management within the finance sector, highlighting both the challenges and opportunities associated with its implementation. As organizations increasingly turn to AI-driven solutions to enhance decision-making processes and mitigate risks, it becomes critical to examine the implications of such technologies on project management methodologies. This study reviews existing literature and presents findings from empirical research that underscore the importance of effective integration strategies. By analyzing how AI can be leveraged to optimize project workflows and improve outcomes, this article contributes to the growing body of knowledge on the intersection of technology and management practices in finance, offering insights for practitioners and researchers alike.]	[ai, projects, management, development, project, agile, software, innovation, intelligence, knowledge]
3	2	6	[The integration of artificial intelligence (AI) into project management within the finance sector presents a transformative opportunity for entrepreneurs and startups, particularly in the realm of educational technology (edtech). This study explores the challenges and solutions associated with leveraging machine learning applications for enhancing business operations and management strategies. By examining the training and development of AI systems tailored for financial firms, the research aims to identify real-world applications that can streamline processes and improve decision-making. It further investigates the implications of AI in the learning and adaptation of project management practices, highlighting how firms can navigate the complexities of adopting such technologies to optimize their performance and maintain competitive advantage in an evolving landscape.]	[entrepreneurial entrepreneurs, ai, business, development, learning, firms, software services, startups]

Figure 5. LLM-assisted summarization of BERTopic-derived clusters using the Hybrid Representation Layer.

Importantly, the LLM does not influence topic formation, clustering boundaries, or document assignments; these are determined exclusively by the BERTopic pipeline (SBERT

embeddings, UMAP dimensionality reduction, and HDBSCAN clustering). The generated summaries are therefore treated strictly as descriptive representations of statistically derived clusters rather than as independent analytical interpretations. Their purpose is to improve the readability and interpretability of the extracted topics while preserving the semantic structure defined by the BERTopic pipeline.

3. Results

3.1. Overview of Extracted Topics and Socio-Technical Layering

The BERTopic analysis identified a set of semantically coherent topics representing dominant research streams in AI integration within financial project management (FPM). By applying transformer-based semantic embeddings combined with density-based clustering, the model revealed a multi-layered topic structure reflecting both mature and emerging areas.

The hierarchical structure of the research landscape shows distinct, weakly connected thematic clusters within the field. As shown in the Hierarchical Clustering Dendrogram (Figure 6), specific technical innovations such as banking operations and software development lifecycles remain conceptually isolated from high-level governance and sustainability objectives. This visual mapping provides a roadmap for the necessary integration of these research streams into a unified systemic architecture.

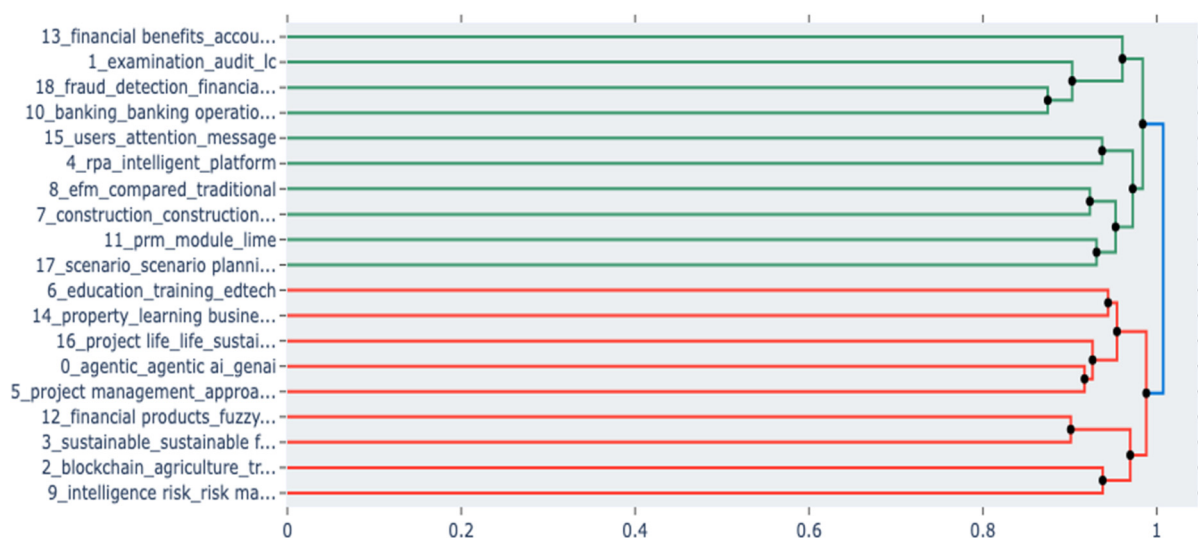


Figure 6. The hierarchical clustering dendrogram.

This unsupervised modeling phase initially yielded 19 discrete topics, offering a granular and fine-grained representation of the literature landscape. However, while this level of detail enhances interpretive richness, it can fragment the broader structural patterns underlying the corpus. To transition from localized thematic signals to a higher-level systemic diagnostic, a hierarchical topic reduction procedure was applied. This consolidation process aggregated semantically proximate topics into eight statistically robust and conceptually coherent clusters (Figure 7). The resulting thematic groupings capture the dominant research trajectories within the field, encompassing methodological rigor and model validation, blockchain-integrated data infrastructures, sustainable finance and governance, intelligent market platforms, project management methodologies, sector-specific innovation contexts, and industry-oriented cost and execution studies.

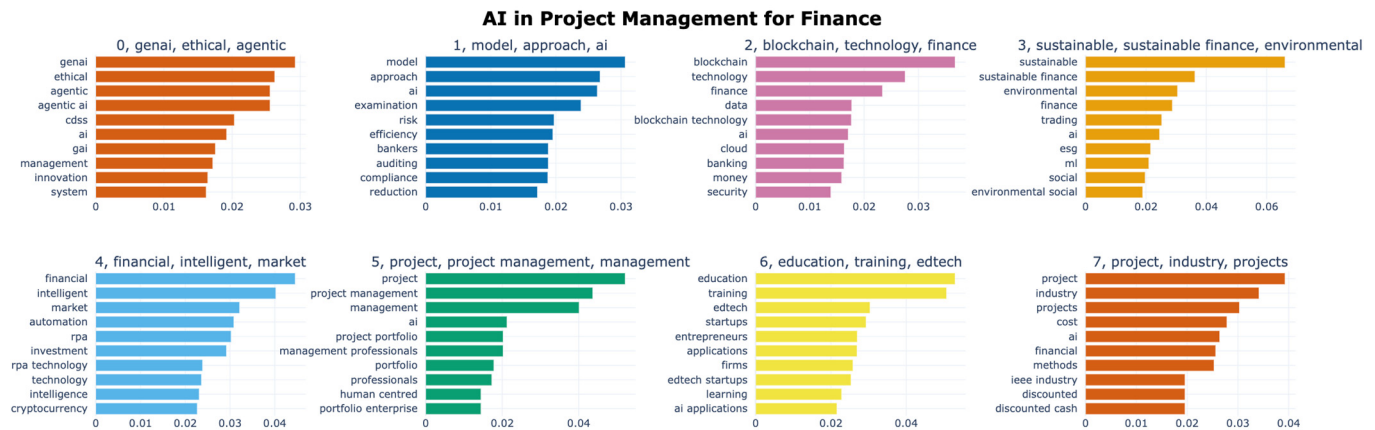


Figure 7. The eight consolidated topic clusters derived from hierarchical topic reduction.

The initial BERTopic extraction generated 19 fine-grained topics, reflecting localized research streams within the literature corpus. While this level of granularity captures subtle thematic variations, it can fragment broader conceptual structures that are necessary for system-level interpretation. To facilitate a higher-level analytical perspective, a hierarchical topic reduction procedure was applied using BERTopic's `reduce_topics` function with `nr_topics = 8`. This procedure employs agglomerative clustering on the c-TF-IDF topic-term matrix, merging semantically similar topics based on the cosine similarity of their term representations. The reduction therefore groups conceptually proximate micro-topics into broader thematic clusters rather than artificially forcing new structures. The resulting eight consolidated topics represent higher-order research themes, enabling clearer interpretation of the socio-technical relationships within the field while preserving the semantic foundations of the original 19 clusters. Consequently, the reduced topic structure serves as an analytical abstraction layer, allowing systemic patterns across technical execution, governance mechanisms, and emerging AI innovations to be more clearly identified. The 19-topic structure remains available as the underlying fine-grained representation of the corpus, while the 8-topic structure provides a higher-level interpretive framework for the subsequent socio-technical analysis. A parameter sensitivity test using more conservative clustering thresholds (`min_cluster_size = 4`, `min_samples = 2`) produced a comparable structure of eight coherent clusters, confirming the robustness of the thematic configuration.

The resulting 8 consolidated clusters provide a robust structure for mapping interactions between technical execution capabilities (e.g., predictive analytics, RPA) and governance themes (e.g., ESG, agentic coordination), as shown in Figure 7. This consolidated structure ensures that the final 8 themes represent statistically significant and interpretable research streams within the 2022–2025 corpus. When applying the hierarchical topic reduction step (`nr_topics = 8`) to the stability test runs using alternative UMAP random seeds, both runs converged to the same eight higher-order thematic clusters, further supporting the robustness of the conceptual structure.

3.2. Socio-Technical Functional Subsystems of AI in Financial Project Management

Table 5 categorizes the extracted topics into socio-technical layers, highlighting their system roles and representative keywords. This classification provides a structured view of how technical execution, governance frameworks, and next-generation innovation interact within the financial project management knowledge base.

Figure 8 visually synthesizes these relationships, illustrating a layered socio-technical architecture in which technical execution forms the foundational layer, governance provides structural alignment, and innovation represents the strategic frontier. Together, these

subsystems demonstrate how AI integration in financial project management evolves from operational enhancement to systemic transformation.

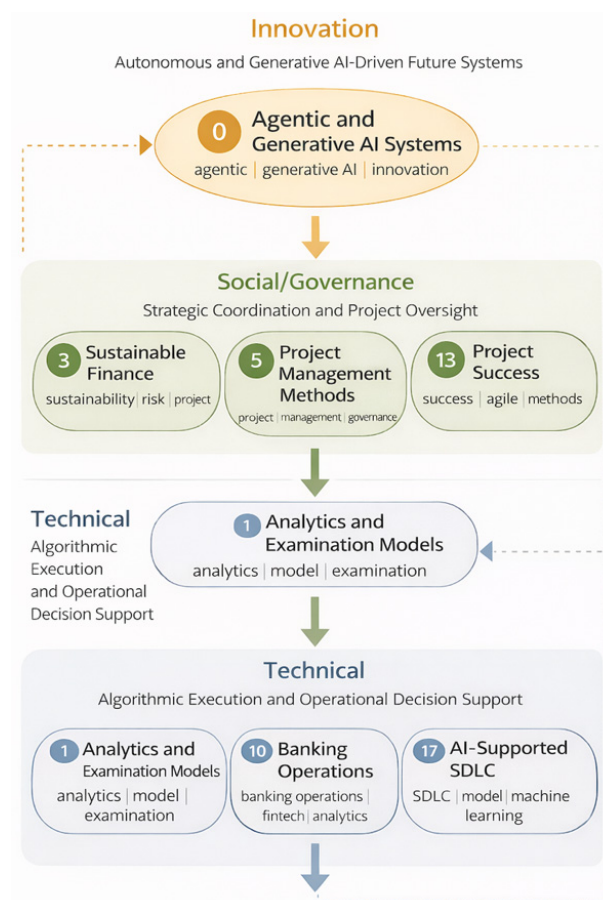


Figure 8. Socio-Technical Mapping of Topics in Financial Project Management.

Table 5. The Summary Table of “Functional Subsystems”.

Subsystem	Cluster ID	Descriptive Label	Representative Keywords (c-TF-IDF)	Strategic Synthesis (LLM-Enhanced)
Innovation	0	Agentic AI & Ethical Innovation	agentic, genai, ethical, supply	Focuses on autonomous-collaborative frameworks and generative agents as active project participants.
Technical	1	Model Methodological Rigor	model, ai, examination, predictive	Addresses the validation of algorithmic architectures and technical rigor in financial analytics.
Technical	2	Data Infrastructure & Blockchain	blockchain, technology, finance, big data	Explores decentralized architectures and big data systems as the backbone of financial PM.
Social/Gov	3	Sustainable Finance & Strategic Gov	sustainable, finance, environmental, ESG	Positions AI as a tool for balancing financial performance with long-term ESG and ethical oversight.

Table 5. Cont.

Subsystem	Cluster ID	Descriptive Label	Representative Keywords (c-TF-IDF)	Strategic Synthesis (LLM-Enhanced)
Technical	4	Intelligent Markets & RPA	financial, intelligent, market, rpa	Emphasizes the automation of routine execution and operational efficiency via intelligent platforms.
Social/Gov	5	Management Methodologies & Success	project, management, portfolio, agile	Focuses on evidence-based decision-making and the evolution of PM governance frameworks.
Innovation	6	EdTech & Startup Innovation	education, training, startup, innovation	Highlights AI’s role in scaling innovation and human capital development in entrepreneurial finance.
Technical	7	Industry Projects & Cost Optimization	industry, project, cost, estimation	Reflects practical applications in industrial financial projects and resource optimization.

3.3. Word Cloud of Core Research Pillars

To provide a high-level synthesis of the research landscape, a generative thematic map was constructed through the extraction of the top 100 semantically significant terms across all clusters, as shown in Figure 9. This visual representation utilizes c-TF-IDF weighting to illustrate the dominance of core research pillars, specifically artificial intelligence, finance, and project management, which function as the primary structural nodes of the field. The dense surrounding keywords, such as ‘risk,’ ‘decision,’ and ‘automation’ reveal the operational intensity of the current literature. This visualization underscores the study’s finding that while the technical core is robustly defined, the strategic and human-centered dimensions occupy a smaller semantic space, reinforcing the necessity for the systemic interface proposed in the subsequent sections of this analysis.



Figure 9. Generative thematic synthesis of core research pillars and latent topics.

3.4. Topic Relationships and Thematic Structure

The BERTopic-driven analysis reveals a structurally bifurcated research landscape that delineates two core components of a socio-technical system within Financial Project Management (FPM). On one side, the Technical Subsystem is composed of Topic 1 (Analytics and Model Examination), Topic 10 (Banking Operations and Analytics), and Topic 17 (AI-Supported Software Development Lifecycles). These topics emphasize engineered artifacts, algorithmic architectures, and execution-oriented applications of AI, reflecting a dominant focus on operational efficiency, analytics-driven decision support, and technological optimization in financial projects. Collectively, they constitute the execution layer of AI-enabled FPM, where technical capability and performance considerations prevail over organizational and strategic integration.

Conversely, the Social and Governance Subsystem is represented by Topic 3 (Sustainable Finance and Risk Governance), Topic 5 (Project Management Methods), and Topic 13 (Project Success). These clusters foreground governance-oriented and human-centric considerations, including sustainability objectives, risk mediation, accountability structures, and managerial oversight. Rather than centering on algorithmic performance, this subsystem addresses the institutional, strategic, and normative dimensions through which AI-integrated projects are coordinated and evaluated within financial organizations.

Proximity and thematic overlap analysis indicate limited but meaningful convergence between these subsystems. Technically oriented topics related to analytics, model-based examination, and financial operations exhibit moderate proximity to Sustainable Finance and Risk Governance (Topic 3), suggesting that operational AI capabilities are increasingly mobilized to support risk management, compliance, and sustainability-related objectives. However, these connections remain partial and fragmented rather than structurally embedded within an integrated system architecture. Notably, the analysis identifies a *missing systemic interface* between technical execution and higher-level managerial governance or strategic intent. Agentic and Generative AI (Topic 0) emerges as a coherent but relatively isolated cluster, indicating its potential role as an integrative construct rather than a fully realized bridging mechanism. As illustrated conceptually in Figure 10, Topic 0 represents an emergent interface capable of enabling future system-level integration between operational AI execution and strategic governance within financial project management.

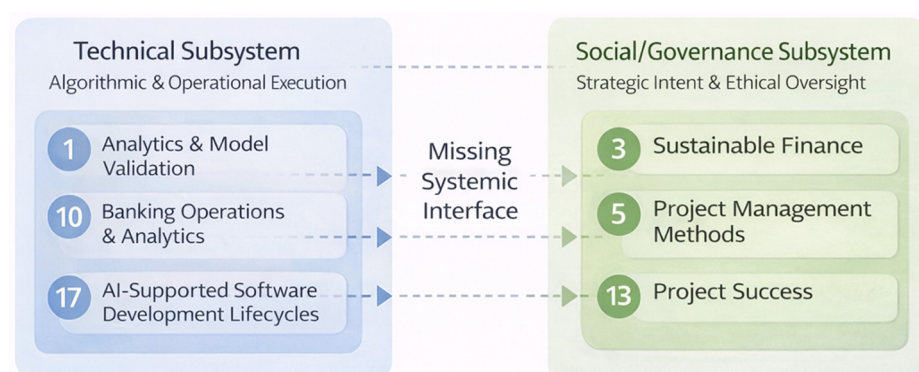


Figure 10. The Conceptual “Missing Systemic Interface” in Financial Project Management.

3.5. Spatial Analysis of Thematic Distribution

The spatial distribution in the Intertopic Distance Map (Figure 11) provides empirical ‘spatial proof’ of the thematic fragmentation identified in this study. While the established technical core comprising predictive analytics, banking operations, and model validation forms a dense, central cluster, the themes of Agentic AI (Topic 0) and Human-Centric Factors (Topic 16) are positioned as distal outliers. This significant physical distance on the map

is not merely a statistical artifact; it represents the ‘Missing Systemic Interface’ discussed in Section 3.4. The isolation of these clusters confirms that governance, ethical oversight, and autonomous innovation are currently treated as peripheral or ‘siloed’ concerns rather than being integrated into the operational heart of financial project management. Consequently, the distance between the technical core and the social/innovation clusters visually validates the governance gap, highlighting the urgent need for frameworks that bridge these semantically disconnected research streams.

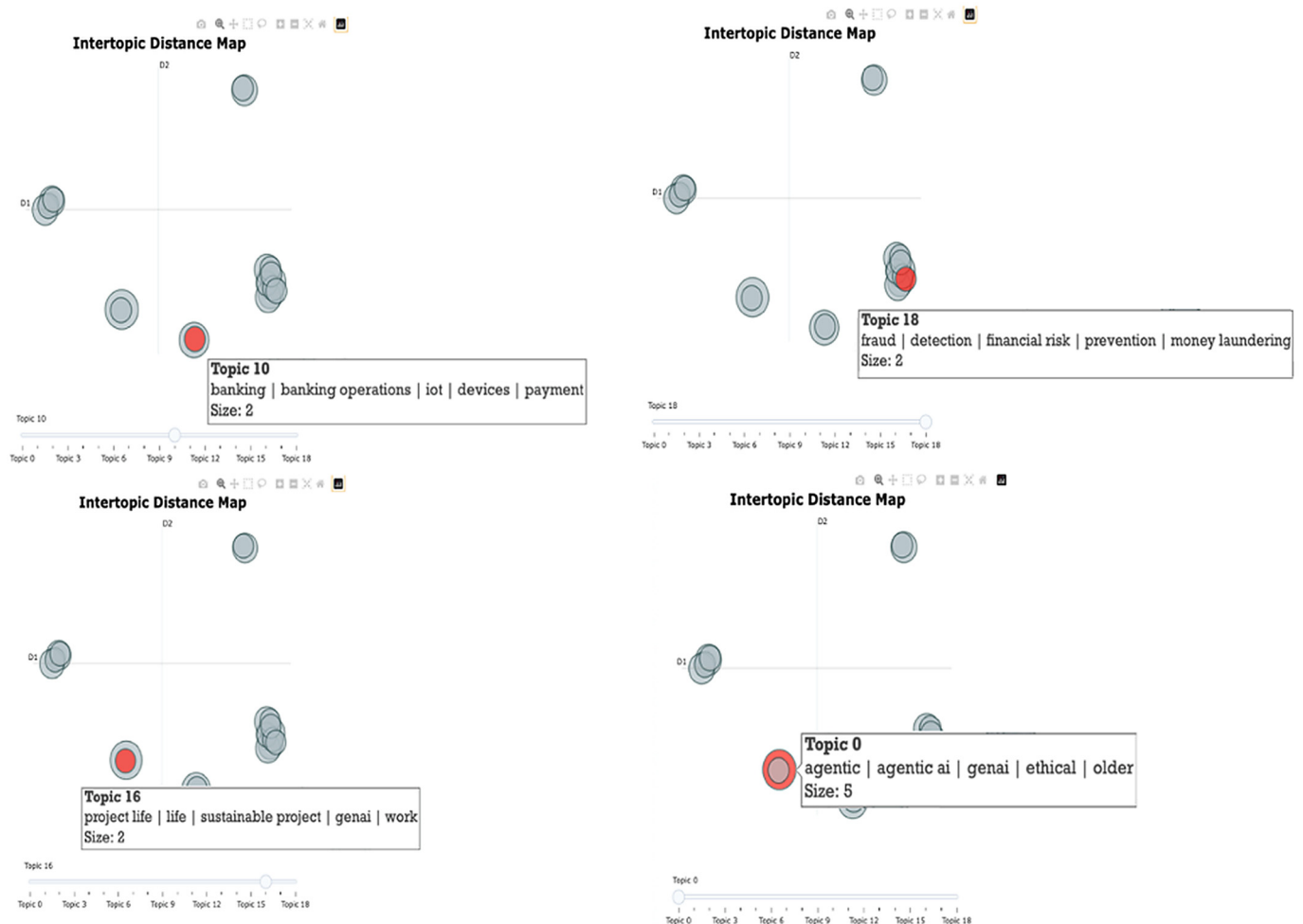


Figure 11. Intertopic Distance Map demonstrating the spatial isolation of Innovation and Social sub-systems from the technical core.

Topics centered on banking operations, IoT-enabled payment systems, and technical execution (Topic 10) form compact clusters that are positioned at a distance from themes concerned with fraud detection, financial risk, and compliance mechanisms (Topic 18). This separation suggests that operational and infrastructural discussions are largely developed independently from governance-oriented risk and control perspectives. Similarly, themes associated with project life cycles, sustainable project work, and generative AI in organizational contexts (Topic 16) occupy a distinct region of the semantic space, further reinforcing the fragmentation between execution-focused and sustainability-oriented discourses.

Notably, agentic and ethical AI considerations (Topic 0) appear as a larger and more isolated node, indicating both growing academic attention and limited semantic overlap with predominantly technical or operational themes. The spatial distance between this cluster and those related to banking operations and fraud prevention highlights a disconnect between ethical–agentic discussions and applied financial project practices.

Overall, the Intertopic Distance Map demonstrates a pronounced gap between technical implementation themes and strategic, ethical, and sustainability-oriented themes. This separation provides empirical support for the argument that current research insufficiently theorizes the interface between technical subsystems and broader governance and organizational objectives. Consequently, the spatial evidence validates the need for the conceptual framework proposed in this study, which aims to bridge isolated technical capabilities with integrated project governance, ethical oversight, and sustainable value creation.

3.6. Fragmentation of AI and Project Management Research

Beyond spatial distance, the hierarchical relationships between topics reveal how micro-level operational practices aggregate into broader functional subsystems. To visualize these high-dimensional semantic relationships, a two-dimensional projection was generated using UMAP (Figure 12). The thematic map reveals the systemic structure of the current research landscape, where the proximity of document clusters indicates semantic similarity. Notably, the map shows a dense central nexus of research focused on ‘Sustainable Finance’ and ‘Green Innovative Products,’ suggesting that environmental accountability is a core systemic driver in modern financial PM. Conversely, emerging specialized themes such as ‘Work–life Balance’ (Topic 16) and ‘Agentic AI’ (Topic 0) appear as distinct clusters, highlighting their role as novel, disruptive vectors within the broader AI-PM integration framework.

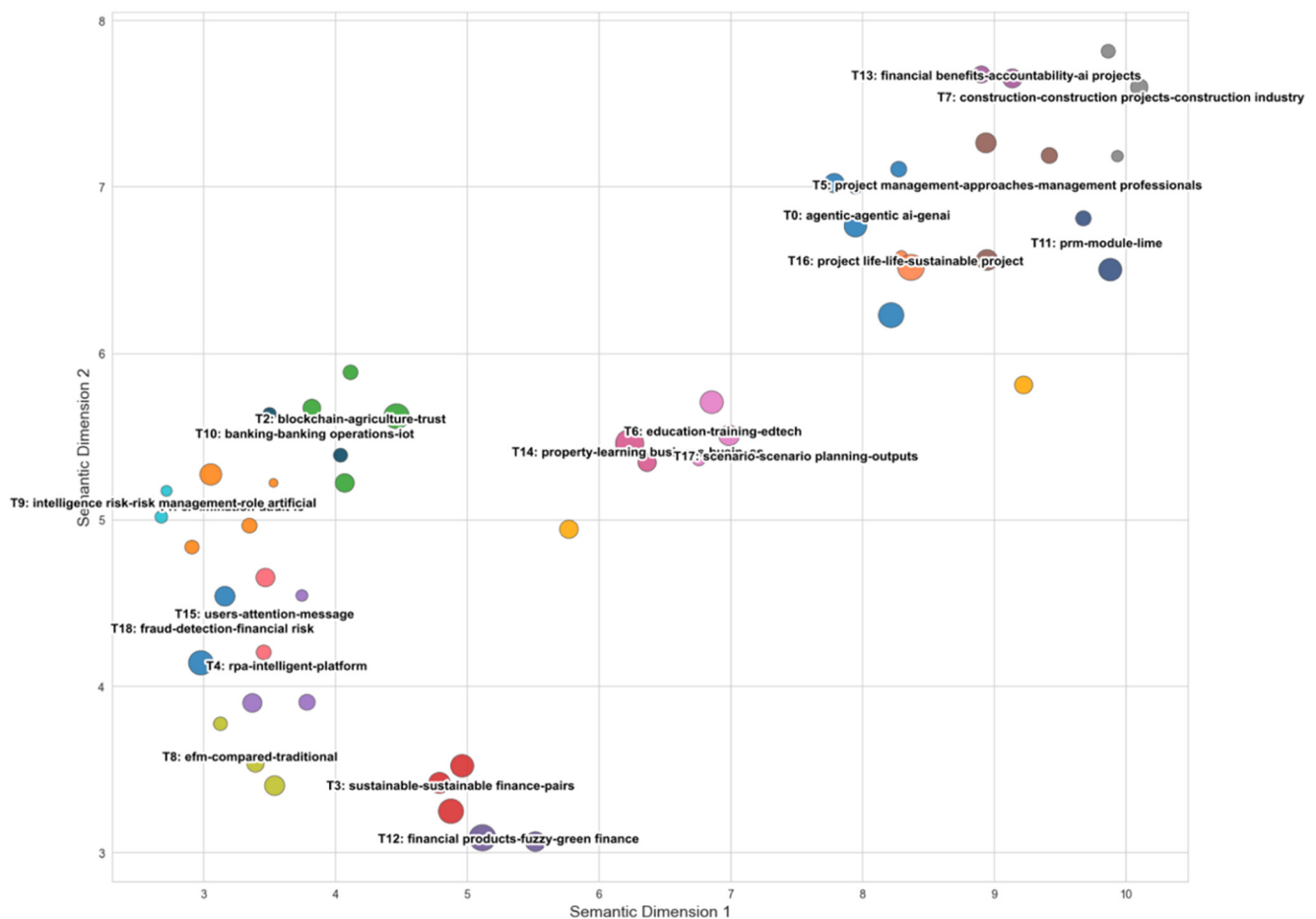


Figure 12. Thematic Map of AI in Financial Project Management.

This fragmentation reflects a tendency within the literature to treat AI as a functional tool for specific activities rather than a socio-technical force that reshapes organizational structures, roles, and governance arrangements. Dimensions such as stakeholder coordi-

nation, leadership, control mechanisms, and learning processes are often underexplored in relation to AI adoption. The limited integration of project management theory restricts the ability of current research to explain how AI capabilities are embedded, scaled, and sustained across complex financial projects [10].

These findings are consistent with longstanding critiques in the project management and information systems literature, which highlight the under-theorization of digital technologies as systemic elements of project governance and strategic alignment. By focusing narrowly on technical performance metrics, much of the existing research overlooks the organizational and institutional conditions required for successful AI-integrated project outcomes [128–130]. Consequently, the literature provides an incomplete understanding of how AI contributes to strategic transformation through project-based change in financial organizations, reinforcing the need for more integrative and theory-driven research approaches.

3.7. Emergence of System-Oriented Perspectives

Although the literature remains fragmented across application domains, recent topic modeling results indicate a gradual yet limited shift toward system-oriented perspectives in AI-integrated financial project management. Rather than viewing AI solely as a technical tool, an emerging stream of research conceptualizes it as embedded within organizational systems that interact with governance structures, human decision-making, and strategic objectives [131–135]. As shown in Figure 13, research between 2022 and 2025 evolves unevenly from foundational applications such as blockchain, auditing, and risk analytics, with different growth trajectories across themes. Auditing-related research shows a notable increase over time, while blockchain-related topics exhibit signs of stabilization, suggesting a maturing research focus. Meanwhile, sustainability and ESG themes remain consistently present, reflecting their structural integration, while automation-oriented topics such as RPA continue to develop steadily. Overall, operational efficiency continues to anchor the field, while indications of broader system-level integration remain limited within the observed period.

Evolution of AI Research Themes in Financial Project Management (2022 – 2025)

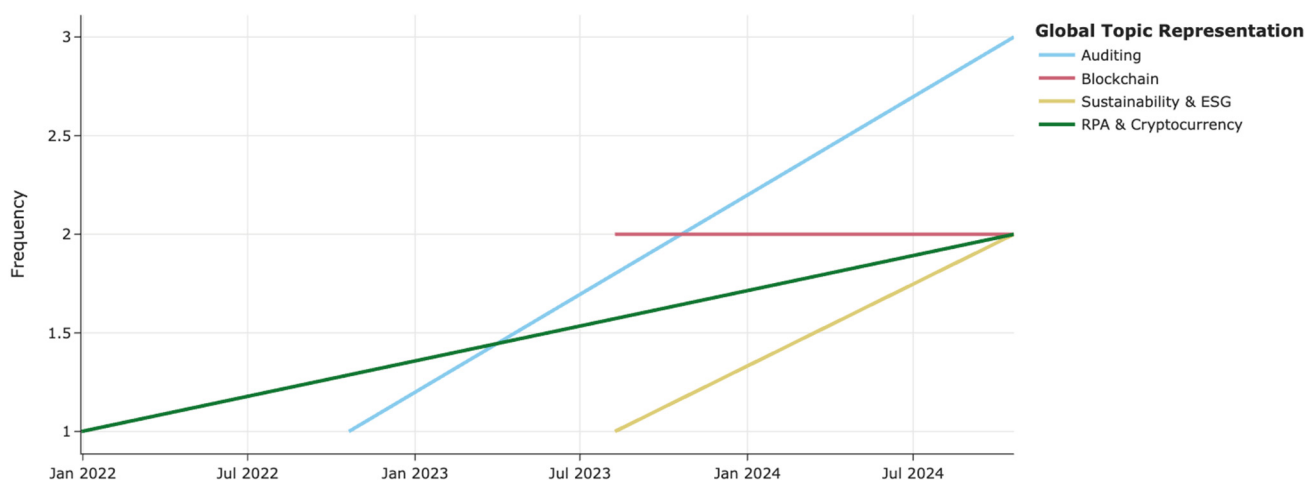


Figure 13. Evolution chart of AI research topics in Finance Project Management.

The temporal scope of this study focuses on publications from 2022 to 2025 in order to capture the most recent phase of AI development. Earlier research on decision support

systems, portfolio optimization, and AI-supported risk analytics provides important conceptual foundations for the recent developments examined in this study. Future studies may extend the analysis to earlier periods to provide a longer-term evolutionary perspective.

3.8. Research Gaps

The analysis of AI-integrated project management research reveals several critical gaps, highlighting opportunities for both scholars and practitioners to advance system-oriented approaches. First, there is limited empirical validation of AI-integrated project management frameworks in real-world financial settings. Most studies remain conceptual or focus on technical models, leaving unanswered questions about how AI-driven systems perform under practical constraints. Second, central dimensions such as governance, ethics, and human–AI interaction remain underexplored. Despite their strategic importance, few studies systematically examine how decision-making authority, accountability structures, workforce adaptation, and ethical oversight are embedded in AI-integrated project management processes. Third, the persistent disconnect between technical architectures and managerial practices underscores the need for integrative research designs. Current studies often treat AI implementation, process optimization, and governance as separate domains, limiting insights into how socio-technical systems can be designed to facilitate sustainable organizational and project-level outcomes.

Addressing the identified gaps requires a system-oriented research agenda that conceptualizes AI-integrated project management as a socio-technical system integrating operational, strategic, and human dimensions [136–140]. As a step toward this vision, Figure 14 outlines a target architecture for a holistic AI-integrated Financial Project Management System. In this model, technical modules such as AI-supported development lifecycles, banking analytics, and automation form the execution layer. Agentic and generative AI act as an integrative layer, linking operational processes with strategic governance through adaptive coordination and real-time decision support. These components are embedded within governance structures encompassing ethics, sustainability, oversight, and human factors to ensure regulatory alignment and long-term value creation. Bi-directional feedback across layers allows continuous learning and system-wide adaptation, supporting the transition from isolated AI tools to coordinated, system-level intelligence.

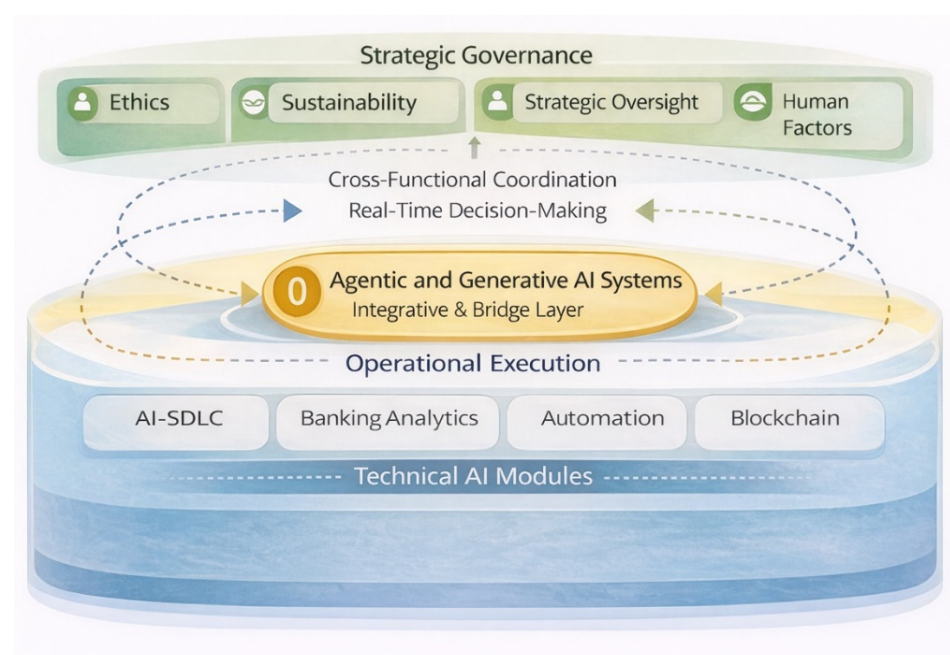


Figure 14. The target architecture for a holistic AI-enabled Financial Project Management System.

3.9. Practical Implications

The findings of this study provide several actionable insights for practitioners and decision makers in the financial sector. First, the predominance of operationally focused AI applications highlights the need to balance efficiency-driven adoption with broader strategic objectives. While predictive analytics, automation, and AI-supported project execution can improve performance, financial institutions should avoid deploying these capabilities as isolated solutions. Instead, AI initiatives should be explicitly aligned with organizational strategy and coordinated through governance mechanisms that ensure long-term value creation.

Second, the results underscore the importance of embedding governance, ethical oversight, and human-centered practices directly into the AI-enabled project lifecycle. Project managers and executives should move beyond treating AI systems as opaque tools and instead establish clear accountability structures, decision rights, and escalation mechanisms. This becomes increasingly critical as organizations adopt more autonomous AI capabilities, where responsibilities and human–AI interaction boundaries must be clearly defined.

Third, adopting a socio-technical perspective, as illustrated in Figure 14, can enhance project outcomes by integrating technical execution with managerial and governance processes. For example, aligning AI-supported SDLC practices with agile project management methods and sustainability-oriented performance metrics allows a more holistic view of project health and risk.

Finally, organizations can utilize the analytical subsystem developed in this study to support portfolio-level decision making. By using topic modeling and project analytics to assess the maturity and focus of their AI initiatives, leaders can better prioritize investments that bridge the gap between technical capability and strategic intent. Collectively, these practices support a transition from short-term efficiency gains toward coordinated, strategically aligned AI-enabled project management.

4. Discussion

4.1. The Agentic Frontier: A Systematic Paradigm Shift

The primary contribution of this study is the identification of Topic 0 (Agentic AI) as an emerging innovation trajectory that may evolve into a coordination layer linking technical execution and governance structures within financial project management systems. While most of the literature (the Technical Subsystem) remains focused on AI as a passive tool for predictive analytics and risk calculation, the emergence of agentic frameworks signals a paradigm shift toward autonomous-collaborative project environments.

As evidenced by the spatial isolation of Topic 0 in the Intertopic Distance Map (Figure 10), the physical isolation of Cluster 0 suggests the presence of a potential systemic interface gap. This distance suggests that while the technology for agentic PM is ready, it has not yet been semantically or operationally integrated into standard banking workflows.

4.2. Bridging the “Missing Systemic Interface”

The transition from human-centric oversight to hybrid, agent-enabled governance represents the “Missing Systemic Interface” identified in this analysis. Our findings suggest that for Agentic AI to move from an isolated innovation to a core operational standard, three systemic integrations must occur:

1. Distributed Decision Authority: Moving beyond simple Robotic Process Automation (RPA) toward systems that can autonomously adjust project portfolios based on shifting ESG priorities (Topic 3).

2. **Socio-Technical Alignment:** Integrating the human-centric dimensions of project management, such as trust and work–life balance (Topic 16), into the design of agentic logic to ensure ethical alignment.
3. **Governance Synchronization:** Developing new accountability structures that recognize the agent as an active participant in the project lifecycle, capable of supporting the “Governance Subsystem” rather than just executing “Technical” tasks.

4.3. Strategic Transformation vs. Operational Efficiency

The dominance of the Technical Subsystem (Topics 1, 10, and 17) suggests that financial organizations are currently prioritizing short-term efficiency gains over long-term strategic transformation. However, the rise of Generative and Agentic AI clusters since late 2023 indicates that this focus is shifting. If progressively integrated into project governance structures, Agentic AI may enable organizations to move from reactive data processing toward more adaptive and proactive project steering.

This study interprets the “Innovation Subsystem” (Topic 0) as more than a peripheral addition to existing project management tools. Instead, the findings suggest that it may represent an emerging architectural layer through which future AI-enabled capabilities could be integrated into financial project management systems. In particular, the prominence of Agentic AI-related themes indicates a developing research trajectory that may influence how autonomous and collaborative agents are incorporated into socio-technical project environments. Future research may therefore explore ways to reduce the separation observed in the intertopic map, examining how these emerging capabilities can be progressively integrated into the broader project management framework.

4.4. The Target Architecture

Based on the synthesis of the eight clusters, the study outlines a conceptual target architecture for AI-enabled financial project management. This architecture bridges the Technical Subsystem (execution) and the Social/Governance Subsystem (oversight) through the Innovation Subsystem (Agentic AI). By delegating routine or low-context analytical tasks to AI-supported systems, project managers may focus more on strategic activities such as stakeholder coordination, governance oversight, and ESG alignment (Cluster 3). In practical project environments, these governance mechanisms are operationalized through established project management artefacts such as stage-gate reviews, portfolio steering committees, risk registers, and change-control boards, which provide the institutional structures through which human oversight of AI-supported decisions can be exercised.

Because the proposed architecture is derived from literature-based thematic synthesis rather than field observation, it should be interpreted as a conceptual framework rather than an empirically validated implementation model. Future research should therefore examine the architecture in real financial project environments. Possible empirical designs include longitudinal case studies of AI-enabled project portfolios, pilot implementations of agentic coordination tools within project management offices, and quasi-experimental comparisons of AI-supported versus traditional governance mechanisms. Such studies would allow the systemic interface proposed in this research to be evaluated against real organizational processes, including project steering committees, risk governance structures, and portfolio decision-making workflows.

4.5. Ethical and Governance Implications of Agentic AI in Financial Project Management

The integration of Agentic AI into financial project management raises critical ethical, regulatory, and accountability questions. Autonomous decision-making in credit allocation, project prioritization, and risk assessment can amplify biases present in training data and obscure lines of responsibility when outcomes diverge from expectations. Financial regula-

tors increasingly require transparency, auditability, and demonstrable human oversight in AI-enabled systems.

The target architecture proposed in this study positions Agentic AI within human-in-the-loop governance structures, where human decision-makers retain ultimate responsibility and can interrogate AI recommendations, override autonomous actions when necessary, and maintain accountability for strategic outcomes. This design principle aligns with emerging regulatory frameworks (e.g., EU AI Act, financial supervision standards) and ensures that autonomy is balanced with control.

Future implementations must explicitly address: (1) bias detection and mitigation in AI-driven project allocation; (2) audit trails for autonomous decisions; (3) clear role definitions for human oversight; and (4) mechanisms for stakeholder transparency and recourse when AI systems fail or produce unintended consequences.

4.6. Theoretical Positioning of the Proposed Architecture

The architecture proposed in this study builds upon established socio-technical systems theory, which emphasizes the interaction between technological infrastructures and organizational structures in complex work systems. Early work by *Trist and Bamforth* [141] conceptualized organizations as interdependent social and technical subsystems, highlighting the importance of aligning technological capabilities with human and governance structures.

The framework proposed here extends this perspective by identifying an emerging Agentic AI coordination layer within financial project management systems. While traditional socio-technical models distinguish between operational technologies and governance structures, the findings of this study suggest the emergence of semi-autonomous agent systems capable of mediating interactions between execution processes and strategic oversight. In this sense, Agentic AI is conceptualized not merely as an operational tool but as a dynamic coordination mechanism linking technical execution with governance objectives.

Unlike digital twin governance models that focus primarily on system mirroring and monitoring, the proposed architecture introduces agentic coordination mechanisms capable of proactive intervention within project workflows. Similarly, while human-in-the-loop frameworks emphasize oversight, the architecture conceptualizes AI agents as active coordination participants within project governance systems.

This perspective differs from conventional service-oriented architectures or digital governance frameworks by emphasizing the role of adaptive AI agents in facilitating real-time coordination across project execution and strategic management layers. The architecture therefore represents a conceptual extension of existing socio-technical models to AI-enabled financial project environments.

5. Conclusions, Limitations and Future Directions

This study addressed three research questions on the systemic integration of artificial intelligence in financial project management through a BERTopic-augmented systematic literature review of 62 peer-reviewed articles published between 2022 and 2025. In relation to RQ1, the analysis identified several dominant research themes within the literature, including predictive analytics and methodological validation, blockchain-based financial infrastructures, sustainable finance and governance, intelligent automation platforms, project management methodologies, and emerging innovation trajectories associated with Agentic AI. The results reveal a research landscape in which technical AI applications dominate, while governance and human-centric dimensions remain comparatively underrepresented and weakly integrated. Regarding RQ2, the analysis indicates that AI is increasingly conceptualized in the literature not only as an operational support tool

but also as a potential coordination mechanism linking technical execution with strategic governance within financial project ecosystems. However, this transformation remains constrained by limited alignment between technical capabilities and organizational governance structures. Concerning RQ3, the study identifies a persistent systemic interface gap between rapidly advancing AI capabilities and underdeveloped governance and managerial frameworks. Addressing this gap requires the development of resilient socio-technical architectures in which AI-enabled systems operate within clearly defined governance structures, enabling accountable and strategically aligned project decision-making throughout the project lifecycle.

Rather than offering only a literature synthesis, this study proposes a system-level innovation architecture and socio-technical roadmap integrating AI capabilities, human governance, and organizational processes.

The relatively small corpus limits the statistical generalizability of the clustering results; therefore, the BERTopic analysis should be interpreted as a thematic mapping exercise rather than a definitive topic taxonomy. The modest silhouette score reflects the semantic overlap characteristic of interdisciplinary research fields and the relatively small corpus size ($n = 62$), where thematic boundaries are expected to be less sharply separated.

Future research should advance from thematic mapping toward empirical validation by prototyping AI-enabled project platforms in real financial institutions, designing governance and human-in-the-loop control frameworks, conducting longitudinal socio-technical studies, and extending the systemic mapping approach to other regulated industries. Such efforts will enable the operationalization and validation of AI-enabled project management architectures as fully integrated system innovations.

Supplementary Materials: The following supporting information can be downloaded at: https://osf.io/br9dq/overview?view_only=872598ce86d84e41953d510f8508ad65 (accessed on 18 March 2026).

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Topic	Count		Name	Representation	KeyBERT	MMR	Representative_Docs
0	-1	9	-1_sdlc_intelligent_software_data mining	[sdlc, intelligent, software, data mining, min...	[ai financial, intelligent financial, financia...	[software, data mining, ai sdlc, risk managem...	[Knowledge Management Practices in Research an...
1	0	15	0_project management_construction_pm_agile	[project management, construction, pm, agile, ...	[ai projects, project management, project risk...	[project management, agile, systematic literat...	[Enhancing Project Management Success through ...
2	1	8	1_sustainable_green_sustainable finance_enviro...	[sustainable, green, sustainable finance, envi...	[sustainable finance, green finance, sustainab...	[sustainable finance, big data, green finance,...	[The Role of Technology, AI, ML and DLT in Sus...
3	2	8	2_genai_supply_agentic_agentic ai	[genai, supply, agentic, agentic ai, ethical, ...	[ai supply, ai work, ai agents, genai innovati...	[genai, agentic ai, ethical, supply chain, age...	[Artificial intelligence in supply chain manag...
4	3	7	3_blockchain_banking_agriculture_fintech	[blockchain, banking, agriculture, fintech, te...	[ai blockchain, blockchain ai, blockchain tech...	[blockchain, banking, agriculture, iot, blockc...	[Innovative Financial Services Driven by AI an...
5	4	6	4_business_education_entrepreneurs_training	[business, education, entrepreneurs, training,...	[ai business, learning business, entrepreneuri...	[entrepreneurs, ai business, business applicat...	[From Education 3.0 to 4.0: A Systematic Liter...
6	5	6	5_efm_making_financial decision_market	[efm, making, financial decision, market, trad...	[financial forecasting, financial advisor, fin...	[efm, financial decision, market, cryptocurren...	[Reliability Analysis of Financial Management ...
7	6	5	6_examination_model_lc_audit	[examination, model, lc, audit, auditing, erro...	[ai risk, intelligence financial, bankers risk...	[auditing, role artificial, risk management, b...	[Modelling credit and investment decisions bas...

Figure A1. BERTopic topic extraction results for the sensitivity analysis using HDBSCAN parameters (min_cluster_size = 4, min_samples = 2). Note: The thematic structure produced under the conservative parameter configuration remains conceptually consistent with the clusters reported in the main analysis.

Appendix B. PRISMA Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE
TITLE			
Title	1	Systemic Integration of Artificial Intelligence in Financial Project Management: A Systematic Literature Review and BERTopic-Based Analysis	1
ABSTRACT			
Structured summary	2	This study systematically reviews 62 peer-reviewed articles (2022–2025) on AI integration in financial project management, combining SLR and BERTopic topic modeling for thematic synthesis. Key results, including the emergence of Agentic AI and socio-technical gaps, are presented (Abstract, p. 1).	1
INTRODUCTION			
Rationale	3	AI is increasingly embedded in project management within the financial sector. This review addresses the systemic interface gap by synthesizing technical, governance, and organizational aspects of AI adoption.	1–2
Objectives	4	To systematically identify dominant research themes, conceptualize AI as a systemic driver, and highlight gaps for future research in financial project management (pp. 3–4).	3–4

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE
METHODS			
Protocol and registration	5	No formal review protocol was registered; however, the review followed PRISMA 2020 reporting guidelines and a predefined systematic screening procedure.	5
Eligibility criteria	6	Included peer-reviewed journal articles and conference papers published 2022–2025 in English, focusing on AI applications in financial project management.	6
Information sources	7	Databases searched: Scopus, Web of Science, IEEE Xplore, Google Scholar. Search executed January 2026.	6
Search	8	Boolean search strategy: ('Artificial Intelligence' OR 'Machine Learning' OR 'Generative AI') AND ('Project Management' OR 'Program Management' OR 'Portfolio Management') AND ('Finance' OR 'Banking' OR 'Financial Services'). Filters: English, 2022–2025. Full search string detailed in Methods	6
Selection of sources of evidence	9	Title and abstract screening excluded irrelevant studies. Full texts of 182 articles assessed for eligibility; 62 included in final SLR. Screening was conducted by the authors using predefined criteria.	6–7
Data charting process	10	Data extracted into a pre-tested Excel sheet, including authors, AI methods, project management processes, and key findings. Data verified by a second reviewer for consistency	7–9
Data items	11	The following variables were extracted from each study: authors, publication year, AI core technologies, financial applications, project management process areas, methodological approach, and thematic findings.	7–9
Critical appraisal of individual sources of evidence	12	No formal critical appraisal of individual studies was performed. The objective of this review is to map the research landscape and identify thematic trends rather than evaluate intervention quality.	17
Synthesis of results	13	The data were synthesized using descriptive analysis combined with BERTopic-based topic modeling. BERTopic integrates transformer-based embeddings, UMAP dimensionality reduction, HDBSCAN clustering, and a GPT-4o-mini representation layer to generate interpretable thematic summaries (Section 2.3, Figure 2).	15–16

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE
RESULTS			
Selection of sources of evidence	14	A total of 1356 records were identified through database searches. After removing 381 duplicates, 975 records were screened. 793 records were excluded during title and abstract screening. 182 full-text articles were assessed for eligibility, of which 120 studies were excluded, resulting in a final corpus of 62 included studies.	16–20
Characteristics of sources of evidence	15	Table 1 summarizes the characteristics of the included studies, including authors, publication year, AI technologies, financial applications, and project management process areas.	16–20
Critical appraisal within sources of evidence	16	Not applicable.	
Results of individual sources of evidence	17	Key characteristics and contributions of the included studies are summarized in Table 1.	20–25
Synthesis of results	18	The BERTopic analysis identified eight consolidated thematic clusters representing major research streams in AI-enabled financial project management. Intertopic distance analysis reveals structural gaps between technical execution themes and governance- or agentic-AI-oriented topics. The thematic structure and conceptual relationships are illustrated in Figures 2, 7, 11 and 14.	25
DISCUSSION			
Summary of evidence	19	The review indicates that systemic integration of AI in financial project management is emerging. Current research is dominated by technical AI applications, while governance mechanisms, human–AI interaction, and strategic coordination remain underexplored.	26
Limitations	20	The study has several limitations, including restriction to English-language publications, the absence of formal critical appraisal of individual studies, potential publication bias, and reliance on BERTopic-driven thematic synthesis within a relatively small corpus.	29
Conclusions	21	The findings provide a conceptual roadmap for integrating Agentic AI as a coordination interface between technical execution and strategic governance within financial project management systems.	29
FUNDING			
Funding	22	No funding was received for this study.	32

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