Review

Supply Chain Management for the Engineering Procurement and Construction (EPC) Model: A Review and Bibliometric Analysis

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Supply Chain Management for the Engineering Procurement and Construction (EPC) Model: A Review and Bibliometric Analysis

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Abstract: China's "Going Out" strategy and the "Belt and Road" initiative have significantly propelled the expansion of overseas contractual engagements, with a pronounced impact in the Engineering, Procurement, and Construction (EPC) sector. EPC contracting is increasingly recognized for its superior resource allocation and integration efficiency. Within the EPC framework, procurement is pivotal, exerting a direct influence on project cost, schedule, and quality parameters. This paper argues that the incorporation of supply chain management into the procurement processes of international EPC projects can optimize efficiency and mitigate costs. Through forging collaborative partnerships with suppliers and stakeholders, EPC contractors may realize enhanced project outcomes. While the integration of supply chains has been efficaciously realized in the manufacturing domain, its transposition to the construction industry is nascent and predominantly resides within the ambit of scholarly inquiry. The present discourse endeavors to elucidate the imperatives and methodologies for supply chain integration within the procurement management of international EPC ventures, thereby furnishing both theoretical and pragmatic guidance for principal contractors. An extensive literature review and bibliometric analysis conducted herein delineate extant research lacunae and articulate prospective trajectories for scholarly exploration in the procurement management sphere of international EPC projects. The advocated integrative modality seeks to deliver a systemic and holistic solution framework conducive to the triumphant execution of EPC projects, engendering viable avenues and opportunities for the advancement and symbiosis within the pertinent industrial sectors. The integration of supply chain management in EPC projects is a burgeoning field that holds significant potential for advancing sustainability in construction. As the industry moves toward greener practices, the role of EPC contractors in driving sustainable procurement and project management becomes increasingly vital.

Keywords: procurement management; international project; supply chain; EPC project; stakeholder management

1. Introduction

The burgeoning growth of China's overseas contract engineering business is rooted in the strategic drive of "Globalization" and the "Belt and Road" initiative, which have been key in propelling Chinese firms into the global market. In this international context, the Engineering-Procurement-Construction (EPC) model has risen as the preferred framework for project execution. The EPC model, which consolidates design, procurement, and construction into a single contract, is increasingly favored for its ability to streamline project delivery by effectively allocating and integrating resources throughout the project lifecycle. Luo L et al.[1] explored how work breakdown structure (WBS) and modular breakdown structure (MBS) help in dividing complex project tasks into manageable units, enhancing the control over supply chain processes in EPC projects[1]. Procurement, a critical component of the EPC model, significantly impacts the financial and operational metrics of projects, including cost, schedule, and quality standards. Wang Q et al.[2]

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identified 25 key procurement risk factors in international EPC projects, emphasizing the importance of analyzing the natural, economic, legal, and political environments of the project's host country.

This paper posits that the integration of Supply Chain Management (SCM) into procurement processes is essential for enhancing the efficiency and reducing the costs of international EPC projects. Strategic partnerships with suppliers and stakeholders can lead to improved supply chain coordination and procurement management, ultimately elevating project performance. Luo H et al.[3] proposed an innovative cooperation model that incorporates carbon emission rights into EPC energy projects[3]. This model introduces new financing avenues, particularly in the context of reducing carbon emissions and conserving energy, addressing the traditional financing challenges in EPC projects.

Procurement within the context of international EPC projects is a complex challenge. Traditional procurement management often views the relationships between contractors, suppliers, owners, and consultants as temporary and contractual, potentially fostering competitive and adversarial interactions. This perspective can lead to procurement-related issues such as inefficient interface management, lack of collaboration, and information asymmetry, all of which can negatively impact procedural efficiency, transaction costs, and overall project quality. To mitigate these issues, this paper advocates for the adoption of supply chain integration strategies that emphasize long-term, cooperative relationships and streamlined processes to facilitate seamless flows of information and resources, thus enhancing supply chain efficiency.

Despite the success of supply chain integration in manufacturing, its penetration into the academic research and practical application within the construction sector, particularly in the context of EPC projects, remains limited. This paper aims to bridge this gap by underscoring the need for implementing SCM within EPC procurement management. It encourages contractors to view procurement through the lens of supply chain value creation, integrating management practices to maximize stakeholder contributions .

The construction industry's supply chain, characterized by its project-centric and temporary nature, presents unique challenges for the application of traditional SCM tools. These tools, designed for the more stable supply chains of large manufacturers and retailers, may not seamlessly apply to the construction sector, necessitating a more adaptable approach to SCM to effectively handle the fluidity of project-based supply chains[5,6].

Although many scholars have explored international engineering management with the goal of enhancing procurement within global engineering efforts, the implementation of SCM integration within construction project management is still in its infancy. This paper conducts an exhaustive literature review and bibliometric analysis on SCM in international EPC projects, probing key questions in the field such as the current state of the art, critical factors in procurement management, and the role and significance of procurement in international EPC projects[7–9].

This study demonstrates the need for contractors to integrate procurement management processes from a supply chain value creation perspective, to enhance the contributions of each participant in the procurement activities of international EPC projects. It is crucial for firms to achieve commendable procurement performance and to gain a competitive edge in the market. Therefore, a comprehensive review of academic research in this field is necessary to better understand this critical aspect.

The remainder of this study is organized as follows: Section 2 describes the research methodology and data used. Section 3 analyzes the selected research papers, presents survey findings, and offers interpretations related to procurement management, supply chain integration, and stakeholder management in international EPC projects. Section 4 concludes the study with a summary of findings and implications for future research.

In order to provide a comprehensive and in-depth understanding of the current state of research, this introduction has reviewed existing studies on procurement management, supply chain integration, and stakeholder management within the context of international EPC projects.

In conclusion, the future of EPC projects is inextricably linked to the adoption of sustainable practices. As this study's literature review and analysis have shown, there is a clear trend towards

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integrating SCM into EPC procurement processes to enhance efficiency, reduce costs, and improve project performance while also considering the environmental and social impacts. The path forward for EPC contractors involves not only technical and managerial innovations but also a deep commitment to sustainable development, ensuring that their projects leave a positive legacy for the environment and communities they serve. This commitment is essential for firms to achieve commendable procurement performance and to gain a competitive edge in the market, aligning with the broader objectives of sustainability in the construction industry

2. Materials and Methods

2.1. Development of a Corpus of International Engineering EPC Projects

To facilitate our analysis, we employed a systematic literature review methodology to assemble a database of relevant articles. Our aim was to capture the most recent and pertinent research developments; hence, we established a search timeframe spanning from 2005 to 2024. The initial phase of our literature search involved querying two prominent databases: the Web of Science Core Collection (WOS) and Scopus. Our search strategy targeted the "title," "abstract," and "keywords" fields of documents, utilizing a carefully selected array of keywords associated with "EPC project," "supply chain in construction," "stakeholder management," and "procurement management in construction."

From the array of publications retrieved from WOS and Scopus, we applied stringent criteria to refine our selection, excluding books and conference papers to focus exclusively on scholarly journal articles. This meticulous selection process was designed to ensure the inclusion of high-quality, peer-reviewed academic research in our analysis. The intricate search syntax that guided this process is detailed in Table 1 of our study.

Continuing with our exposition, Table 2 provides a comprehensive summary of the literature search outcomes, encapsulating key metrics and insights from the body of work reviewed. To visually articulate the structured approach underpinning our literature review, Figure 1 presents a schematic outline of the entire review process. This diagrammatic representation serves as a navigational tool, illustrating the sequential steps and decision-making junctures that shaped the curation of our article database, which underpins the subsequent analysis and discussion presented in our research.

Table 1. Syntax to compile research on EPC project.

Data source	**Syntax**
Web of Science Core Collection www.webofscience.com	First layer: TS = ((“International project*”) NOT TS = (equipment OR "Electronic product code") Second layer: 1) TS = (“EPC project” OR general contract project); 2) TS = (Supply chain OR Supply chain management in the construction); 3) TS = (Stakeholder management); 4) TS = (Procurement management in the construction)
Scopus www.scopus.com	First layer: TITLE-ABS-KEY (International project) Second layer: 1) TITLE-ABS-KEY (“EPC project” OR general contract project); 2) TITLE-ABS-KEY (Supply chain OR Supply chain management in the construction); 3) TITLE-ABS-KEY (Stakeholder management); 4) TITLE-ABS-KEY (Procurement management in the construction)

Table 2. Overview of literature search results.

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Period		Type	Number of Research Articles
2005–2024	International Project	EPC project	WOS + Scopus: 34+4→37 (Duplicate: 1)
2005–2024		Supply chain in the construction	WOS + Scopus: 39+ 2→41 (Duplicate: 1)
2005–2024		Stakeholder management	WOS + Scopus: 921 + 4→924 (Duplicate:1)
2005–2024		Procurement management in the construction	WOS + Scopus: 226+6→232 (Duplicate: 2)
			TOTAL:1220 (Duplicate: 5)

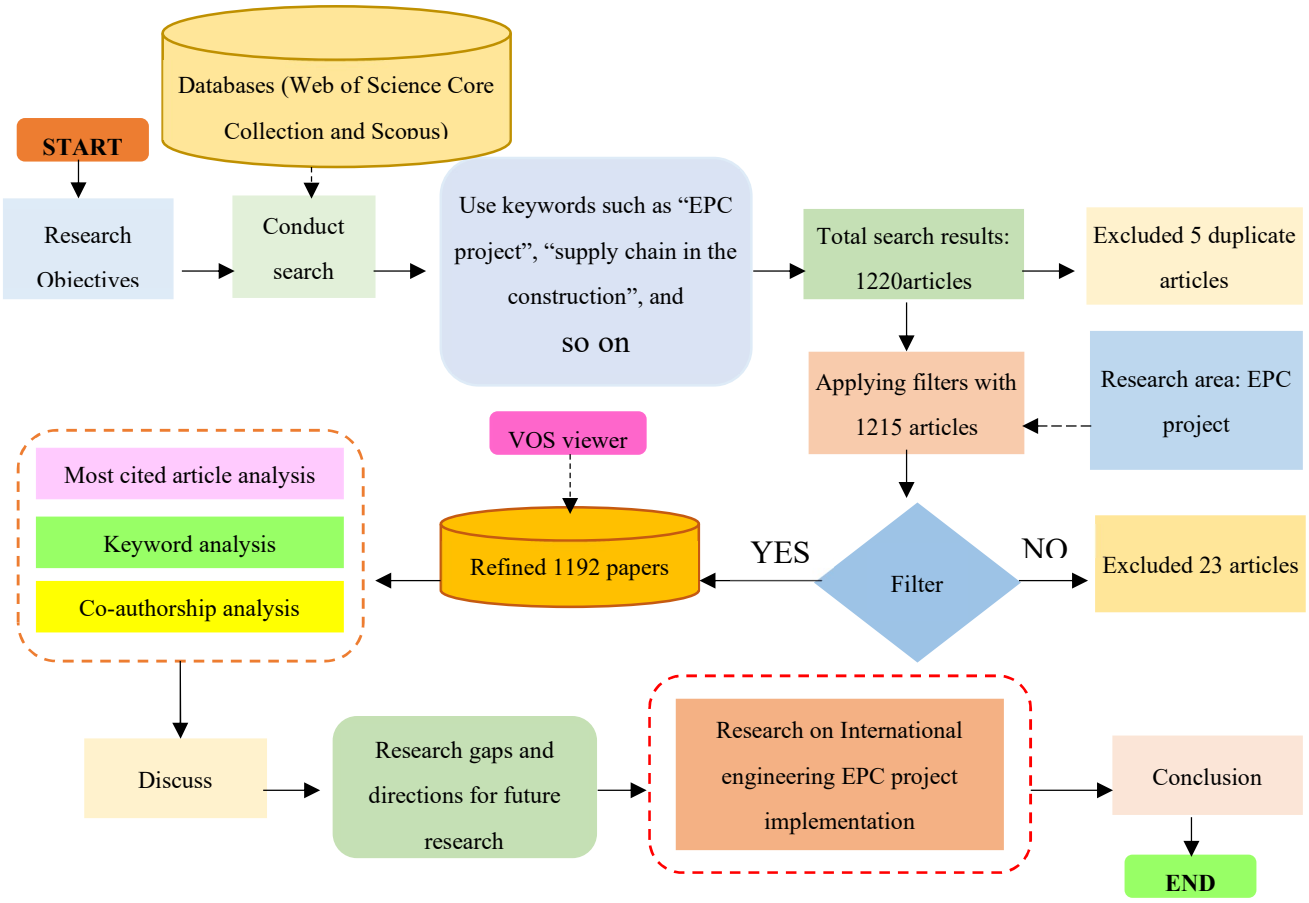

Figure 1. Flowchart illustrating the review procedure and database construction process.

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2.2. Most Cited Papers

Utilizing the citation count metrics sourced from the Web of Science (WOS) and Scopus databases, we conducted a ranking of the scholarly articles pertaining to the management of international engineering EPC projects. This ranking was based on the number of citations each article received, which serves as an indicator of the research's influence and relevance within the academic community. In addition to this bibliometric analysis, we synthesized a summary that encapsulates the research methodologies and principal discoveries of the papers that have garnered the most scholarly attention.

Due to the voluminous literature surrounding the management of international engineering EPC projects, our focus was narrowed to the top 10 most cited papers within each keyword category. These articles represent the forefront of academic thought and have significantly shaped current understanding in the fields of procurement management, supply chain integration, and stakeholder management within the EPC project management discipline. The articles with the highest citation counts were selected to provide a snapshot of the most impactful studies, as detailed in Section 3.1 of our research.

This methodical curation of literature not only underscores the pivotal contributions to the field but also offers a valuable perspective on the diversity of research approaches and the findings that have emerged from these investigations. By examining the most cited works, we gain a comprehensive view of the prevailing methodologies and the insights they have yielded, which are instrumental in advancing the discourse on international EPC project management.

2.3. Semanticsn

In our study, we perform a co-occurrence network analysis of keywords from a range of articles to map the research landscape of international EPC project management. This method uncovers the main themes, connections between concepts, and the direction of scholarly pursuit in the field.

We analyze keyword co-occurrence frequencies and patterns to gain insight into the field's intellectual structure, highlighting active research clusters and identifying literature gaps for potential investigation.

We employ VOS viewer for visualizing and interpreting keyword and author collaboration networks. VOS viewer generates graphs that depict the strength of keyword associations and maps author networks, aiding in understanding research trends and guiding scholars through the complex terrain of EPC project management research.

3. Results

3.1. Results of the Most Cited Articles

In our study, we categorized and analyzed influential articles on EPC projects, procurement management, supply chain integration, and stakeholder theory, based on citation counts. The top 10 papers in each area amassed 622, 351, 1125, and 928 citations respectively.

Our tables present research methods, geographic focus, and key findings. For instance, Table 3 synthesizes the management of EPC projects internationally, highlighting diverse global research including the U.S., China, UK, Africa, Pakistan, and Fiji. This diversity shows the global reach of EPC project management research.

The most cited papers in Table 3 investigate critical success factors for EPC projects. Studies by R Pal et al.[10], and N. D. Caldwell et al.[11] explore supplier services, external risks, and governance mechanisms, enhancing our understanding of EPC projects worldwide[10,11].

Table 4 lists top cited articles on supply chain integration in international engineering. Quantitative analysis dominates these studies, providing statistical insights, while qualitative assessments and case studies offer deeper understanding of supply chain management in construction.

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Table 5 features articles on stakeholder theory, highlighting the importance of stakeholder collaboration and governance in EPC projects. Research by Qrunfleh et al.[12] and Bridoux et al.[13] discusses supplier collaboration and stakeholder governance, while Valentinov examines public sector relationships in Ireland.

In stakeholder theory research, the combination of qualitative and quantitative methods yields a well-rounded view of complex issues. Qualitative analysis explores stakeholder perspectives, while quantitative analysis reveals patterns and interrelationships.

Table 6 reviews the most cited articles on procurement management, with half addressing the topic globally. It discusses sustainable construction, project cost overruns, BIM and GIS integration, relationship management, and the role of trust in interface management, indicating directions for future research and current challenges.

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Table 3. The most cited articles related to International Engineering EPC project.

No.	Authors	Year	Title	Methods	Area	Results	Citations
1	R Pal; P Wang and X Liang[10]	2017	The critical factors in managing relationships in international engineering, procurement, and construction (IEPC) projects of Chinese organizations	questionnaire survey	China	Key factors influencing IEPC project success are supplier service, continuous improvement, delivery reliability, and problem-solving.	113
2	Wenxin Shen[14]	2017	Causes of contractors' claims in international engineering-procurement-construction projects	A combination of qualitative and quantitative methods	Africa and Asia Pacific	The study used SEM to examine external risk, client behavior, project contract definitions, and claims in international EPC projects, analyzing their interrelations.	103
3	N. D. Caldwell, J. K. Roehrich and A. C. Davies[11]	2009	Procuring complex performance in construction: London Heathrow Terminal 5 and a Private Finance Initiative hospital	Case study case analysis	Britain	The study results highlight that the choice of governance mechanisms in upstream relationships critically relates to subsequent project performance outcomes	101
4	Wang, TF; Tang, WZ; (...); Wei, YP[15]	2016	Relationships among Risk Management, Partnering, and Contractor Capability in International EPC Project Delivery	a combination of qualitative and quantitative methods	China	The study indicates that partnerships enhance risk management in international EPC projects by boosting contractor capabilities and directly improving risk handling.	50
5	Shen, WX; Tang, WZ;	2017	Enhancing Trust-Based Interface Management in International	Quantitative Analysis	China	The survey results indicated that trust levels were relatively high between contractors and	47

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	(...); You, RC[16]		Engineering-Procurement-Construction Projects			owners, suppliers, and designers, while trust with local residents was lower.	
6	Rudolf, CA and Spinler, S[17]	2018	Key risks in the supply chain of large scale engineering and construction projects	Questionnaire survey	Global	The findings suggest that generic risk management is prevalent in large-scale projects, yet supply chain risk management (SCRM) is less common, with only 64% of surveyed participants employing SCRM and 72% recognizing the need to tailor processes for supply chain risk in large projects.	31
7	Wang, TF; Tang, WZ; (...); Huang, M[18]	2016	Enhancing Design Management by Partnering in Delivery of International EPC Projects: Evidence from Chinese Construction Companies	Quantitative Analysis	China	The study reveals that partnerships significantly influence design management and outcomes in international EPC hydropower projects. The critical role of partnerships is confirmed, with effective design management being essential to project performance, and partnerships contributing to enhanced design management and improved project results.	31
8	Ishii, N; Takano, Y and Muraki, M[19]	2014	An order acceptance strategy under limited engineering man-hours for cost estimation in Engineering-Procurement-Construction projects	Quantitative Analysis	Global	The findings suggest that balancing engineering man-hours for cost estimation and execution enhances long-term expected profit in EPC projects with competitive bidding.	22

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Table 4. The most cited articles related to Supply chain management in the construction.

No.	Authors	Year	Title	Methods	Area	Results	Citations
1	Pal, R; Wang, P and Liang, XP[10]	2017	The critical factors in managing relationships in international engineering, procurement, and construction (IEPC) projects of Chinese organizations	Quantitative research （Logistic regression and neural network analysis methods were used to analyze）	China	The study pinpoints four key factors affecting IEPC project success: supplier and subcontractor services, continuous improvement, delivery reliability, and effective problem-solving. These findings offer guidance for IEPC project management, suggesting that main contractors prioritize these factors for better relationship management outcomes.	128
2	Kabirifar, K and Mojtahedi, M[20]	2019	The impact of Engineering, Procurement and Construction (EPC) Phases on Project Performance: A Case of Large-scale Residential Construction Project	Quantitative research，TOPSIS	Iran	The findings indicate that engineering design, project planning, and control significantly influence project performance, with design being paramount, followed by construction. Interestingly, procurement is deemed more critical than construction. Consequently, future research should enhance key factors like engineering design, planning, control, and material quality, and compare and refine contractors' project management approaches.	45
3	Liu, KN; Su, YK and Zhang, SJ[21]	2018	Evaluating Supplier Management Maturity in Prefabricated Construction Project-Survey Analysis in China	A combination of qualitative and quantitative	China	The article proposed an evaluation system for assessing supplier management maturity (SMM) and designed a five-level maturity matrix. A questionnaire survey and semi-structured interviews were conducted with 34	34

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				research methods		large prefabricated construction companies in the Yangtze River Delta region of China. The research results show: The overall level of supplier management maturity is relatively low, and there are still problems in supply chain integration. Relationship coordination and strategic collaboration lag behind procurement management and operational efficiency. Single-business contractors, EPC contractors, and contractors with more construction experience have higher SMM levels. In terms of corporate social responsibility, there is no significant difference in the performance of various types of contractors.	
4	Rudolf, CA and Spinler, S[17]	2018	Key risks in the supply chain of large scale engineering and construction projects	A combination of qualitative and quantitative research methods	Global	The study shows that the supply chain risk profile for large-scale projects is distinct, with behavioral risks being prominent. Initial risk assessments are typically biased and underestimated. A specialized risk classification system for large-scale projects was suggested, offering a structured approach to risk management. The research advocates for more quantitative analysis to address the shortcomings of expert opinion in managing volatile supply chain risks in major projects.	27

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5	Lars Bankvall, Lena E. Bygballe, A. Dubois, Marianne Jahre[22]	2010	Interdependence in supply chains and projects in construction	Case Study	unknown	The study identifies issues in construction industry supply chain management, stemming from the sector's complex interdependencies, which current theories and models, focused on sequential dependence, fail to address adequately. Construction projects demand frequent, direct interactions for reciprocal adjustments, beyond what better planning alone can achieve. A deeper comprehension of the various interdependencies and their management is crucial for advancing construction supply chain management understanding.	18
6	A. Segerstedt, T. Olofsson[23]	2010	Supply chains in the construction industry	This article mainly uses literature review and official statistical data	Sweden	The construction industry's distinct nature from traditional manufacturing necessitates tailored solutions. Its volatility and cyclicality present substantial supply chain management challenges. Enhancing productivity requires addressing issues like design-production separation. Future research should test the hypothesis that planning, synchronization, and flexibility outweigh integration and explore the transition to mature lean construction implementation. Investigating strategic alliance success factors, such as central coordination, IT solutions, and trust, is also essential.	18

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7	Lars-Erik Gadde, A. Dubois[24]	2010	Partnering in the construction industry - Problems and opportunities	qualitative literature review analysis method.	Global	Achieving desired outcomes in construction strategic partnerships is difficult due to unique supply arrangements differing from "high-involvement relationships." Revising industry norms may be necessary to realize partnership benefits. A tiered approach at project, regional, and central levels is recommended, with research focusing on establishing partnerships, modifying industry foundations, and coordinating across levels.	15
8	Panchanan Behera, R. P. Mohanty, A. Prakash[25]	2015	Understanding Construction Supply Chain Management	qualitative literature review analysis method.	Global	Construction supply chain management is evolving to address 21st-century challenges, requiring managers to carefully define their supply chains. The study introduces a conceptual model to enhance project progress and meet community expectations via integration, coordination, collaboration, and attention to health, safety, risk, and environmental processes. Future research should empirically test this model and consider varying needs across construction project processes since the proposed measures may not apply universally.	128

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9	D. Aloini, Riccardo Dulmin, Valeria Mininno, S. Ponticelli[26]	2012	Supply chain management: a review of implementation risks in the construction industry	qualitative literature review analysis method.	Global	The article highlights 13 key risk factors impacting construction industry supply chain management, analyzing their attributes and decision-making levels. It notes a paucity of literature on construction supply chain risk management (CSCRM), predominantly concentrating on risk identification. Emphasis should shift to risk quantification and response/control in later stages of risk management. Future studies ought to encompass a broader range of construction supply chain participants beyond the general contractor.	45
10	M. Thunberg, A. Fredriksson[27]	2018	Bringing planning back into the picture – How can supply chain planning aid in dealing with supply chain-related problems in construction?	a qualitative research method, including semi-structured interviews and case studies.	Sweden	The study presents a conceptual model elucidating the link between operational supply chain challenges and inadequate company or pre-planning. It proposes that supply chain planning can address prevalent issues like trust deficits, poor communication, and lack of standardization in construction. Future research should examine how various planning activities can tackle these problems and test the model's relevance across different scenarios.	34

Table 5. The most cited articles related to Stakeholder management.

No.	Authors	Year	Title	Methods	Area	Results	Citations

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1	Qrunfleh, S and Tarafdar, M[12]	2013	Lean and agile supply chain strategies and supply chain responsiveness: the role of strategic supplier partnership and postponement	Quantitative Analysis: SEM and covariance analysis	USA	The findings show that strategic supplier collaboration fully mediates the link between lean strategies and supply chain responsiveness, while postponement partially mediates agile strategies. A positive correlation exists between supply chain responsiveness and business performance, indicating companies should align supply chain practices with their strategy to enhance responsiveness and overall performance.	194
2	Wondirad, A; Tolkach, D and King, B[28]	2020	Stakeholder collaboration as a major factor for sustainable ecotourism development in developing countries	Qualitative Analysis	Addis Ababa, the capital of southern Ethiopia, and three sites	The study shows that ecotourism in southern Ethiopia is underdeveloped and improperly expanding, neglecting the triple bottom line of economic, environmental, and social sustainability. The government prioritizes economic growth, focusing on revenue and tourist numbers over holistic environmental and community impacts, potentially overlooking negative socio-cultural and environmental consequences.	136
3	Wang, ETG; Tai, JCF and Wei, HL[29]	2006	A virtual integration theory of improved supply-chain performance	Qualitative Analysis	China-Taiwan	The results of the study show that virtual integration plays an important role in improving supply chain performance by enhancing manufacturing flexibility and cost advantage	101

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4	Bridoux, F and Stoelhorst, JW[13]	2022	STAKEHOLDER GOVERNANCE: SOLVING THE COLLECTIVE ACTION PROBLEMS IN JOINT VALUE CREATION	Qualitative Analysis	Global	The study's key findings include the identification of three stakeholder governance forms - hub-and-spoke, lead role governance, and shared governance - and their comparative effectiveness in managing joint value creation activities based on complexity and dynamism	66
5	Olsen, AO; Sofka, W and Grimpe, C[30]	2016	COORDINATED EXPLORATION FOR GRAND CHALLENGES: THE ROLE OF ADVOCACY GROUPS IN SEARCH CONSORTIA	probabilistic models and fixed-effect least squares models	Europe	The study shows that search coalitions, including advocacy groups, boost funding for proposed solutions by mitigating knowledge dispersion and aiding coordination. No significant link was found between project costs and funding likelihood, offering strategic guidance to governments, foundations, and coalitions on the positive role of advocacy groups.	62
6	Quintana-García, C; Benavides-Chicón, CG and Marchante-Lara, M[31]	2021	Does a green supply chain improve corporate reputation? Empirical evidence from European manufacturing sectors	Quantitative Analysis	Europe	The study's key findings reveal that adopting green supply chain management practices, including environmentally-focused supplier selection, monitoring, and ending partnerships based on ecological considerations, has a positive effect on corporate reputation.	61

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7	Burke, Richard Demirag, Istemi[32]	2017	Risk transfer and stakeholder relationships in Public Private Partnerships	Qualitative Analysis :semi-structured interviews	Ireland	The results of the study show that there is a positive and inclusive relationship between procurement agencies and special purpose vehicles (SPVs) in road PPP projects in Ireland, as well as partnerships between public sector agencies, which have important implications for risk allocation and management, as well as stakeholder relations.	44
8	Uribe, DF; Ortiz-Marcos, I and Uruburu, A[33]	2018	What Is Going on with Stakeholder Theory in Project Management Literature? A Symbiotic Relationship for Sustainability	Qualitative Analysis	Global	Through descriptive and qualitative literature analysis, this study reveals the relationship between sustainable development, stakeholder theory, and project management. It identifies research trends and directions, highlighting an increasing number of articles on stakeholder theory and project management each year. This underscores the strengthening importance of meeting stakeholder needs as a strategic interdisciplinary focus.	32
9	Valentinov, V and Hajdu, A[34]	2021	Integrating instrumental and normative stakeholder theories: a systems theory approach	Qualitative Analysis	Global	The results show that the normative and instrumental types of stakeholder theory can be enhanced by the methodological guidance of systems theory, so as to improve its consistency with the complexity of modern society. This approach helps to address potential issues in stakeholder theory to make it better adapted to the complex environment of today's society.	16

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Table 6. The most cited articles related to Procurement management in the construction.

No.	Authors	Year	Title	Methods	Area	Results	Citations
1	Pal, R; Wang, P and Liang, XP[10]	2017	The critical factors in managing relationships in international engineering, procurement, and construction (IEPC) projects of Chinese organizations	Quantitative research （Logistic regression and neural network analysis methods were used to analyze）	China	The article explores supplier and subcontractor relationships in international EPC projects, a largely underexplored area. It identifies four key success factors: supplier services, continuous improvement, delivery reliability, and problem-solving. The study suggests trust may be less crucial in IEPC projects and provides valuable insights for main contractors.	69
2	Shen, WX; Tang, WZ; (...); Fang, J[14]	2017	CAUSES OF CONTRACTORS' CLAIMS IN INTERNATIONAL ENGINEERING-PROCUREMENT-CONSTRUCTION PROJECTS	a combination of qualitative and quantitative methods	China	Contractor claims are primarily driven by external risks, owner behavior, and contract definitions, with owner behavior partially mediating the impact of external risks on claims, suggesting that such risks can indirectly influence claims through owner actions.	56
3	Shen, WX; Tang, WZ; (...); You, RC[16]	2017	Enhancing Trust-Based Interface Management in International Engineering-Procurement-Construction Projects	a combination of qualitative and quantitative methods	China	Trust impacts interface management performance both directly and by fostering inter-organizational openness and communication. Social network analysis shows varying influences of stakeholders in trust and interface networks. Grasping the links between trust, openness, and communication can enhance stakeholder coordination and interface management application.	48

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4	Kabirifar, K and Mojtahedi, M[20]	2019	The impact of Engineering, Procurement and Construction (EPC) Phases on Project Performance: A Case of Large-scale Residential Construction Project	Quantitative research ，TOPSIS	Iran	The study finds engineering design, project planning, and control as critical to project performance, with design being most influential, ahead of construction. Procurement is deemed even more crucial. Future research should aim to enhance these key elements and compare contractors' management practices for optimization.	40
5	Zhang, SR; Pan, F; (...); Wang, HX[35]	2017	BIM-Based Collaboration Platform for the Management of EPC Projects in Hydropower Engineering	qualitative research	China	The BIM collaborative management platform addresses issues of information loss, silos, and ambiguity in traditional methods, boosting collaboration efficiency. It enhances the management of EPC hydropower projects, advancing both theoretical and practical aspects of the model.	38
6	Habibi, M; Kermanshachi, S and Safapour, E[36]	2018	Engineering, Procurement, and Construction Cost and Schedule Performance Leading Indicators: State-of-the-Art Review	a combination of qualitative and quantitative methods	Global	Design changes are the primary cause of delays and cost overruns during engineering and construction phases. Resource shortages and price fluctuations significantly impact procurement performance. Additionally, adverse weather conditions, regulations, and inaccurate cost estimates are key factors affecting construction costs.	36

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7	Rudolf, CA and Spinler, S[17]	2018	Key risks in the supply chain of large scale engineering and construction projects	a combination of qualitative and quantitative methods	Global	Large-scale projects have a distinct supply chain risk portfolio compared to general projects, with behavioral risks being pivotal. Initial risk estimation in projects is often biased and underestimated. This study offers a systematic classification of supply chain risks in large-scale engineering projects.	32
8	Jo, SH; Lee, EB and Pyo, KY[37]	2018	Integrating a Procurement Management Process into Critical Chain Project Management (CCPM): A Case-Study on Oil and Gas Projects, the Piping Process	a combination of qualitative and quantitative methods	Korea	This study introduces a method applying critical chain project management (CCPM) in oil and gas projects, including a process flow chart for material management. Results indicate that CCPM reduces pipeline engineering construction time by approximately 35% compared to traditional methods. Neglecting material uncertainty could lead to a potential 5% increase in project schedule.	15
9	Hughes, W., Hillebrandt, P.M., Greenwood, D., & Kwawu, W. [38]	2006	Procurement in the Construction Industry	qualitative research method	UK	This study explores procurement methods in construction, assessing their benefits and costs. It categorizes these methods and evaluates whether collaborative working procedures yield substantial business advantages. The research offers a detailed analysis of procurement processes, integrating relevant economic theories in the construction sector.	11

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10	V. Koscheyev, A. Hakimov[39]	2019	Russian practice of using digital technologies in public procurement management in the construction industry	a qualitative research method	Russia.	Digital technologies are reshaping public procurement in construction, replacing traditional government tools with innovative ones. Implementing electronic procurement tools requires synchronization at federal and market participant levels. These tools should facilitate online exchange of information and documents between buyers and sellers. Blockchain technology in Russian public procurement promises enhanced transparency and reliability.	6

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3.2. Semantic Analysis Results

In constructing the co-occurrence network for keyword co-occurrence analysis, the color of the nodes represents the average duration (historical timeline) of each keyword's occurrence. Recently emerged keywords are depicted in lighter shades of yellow, while those that appeared earlier are represented in deeper shades of purple. This color scheme provides a visual representation of the temporal distribution of keywords within the analyzed literature. We have created a bar chart to illustrate the publication timeline related to research on international engineering EPC project management, including topics such as EPC projects, supply chain integration, stakeholder theory, and procurement management, as shown in Figure 2. Research on stakeholder theory continues to garner scholarly interest, with a steady increase in the number of related studies over the past two decades. A significant surge in research related to supply chain management occurred from 2018 to 2022. With the COVID-19 pandemic having ended in 2023, the corresponding interest in research on supply chain integration has remained relatively consistent with levels prior to 2018. Research focused solely on EPC projects and supply chain management within individual international engineering contexts remains quite limited.

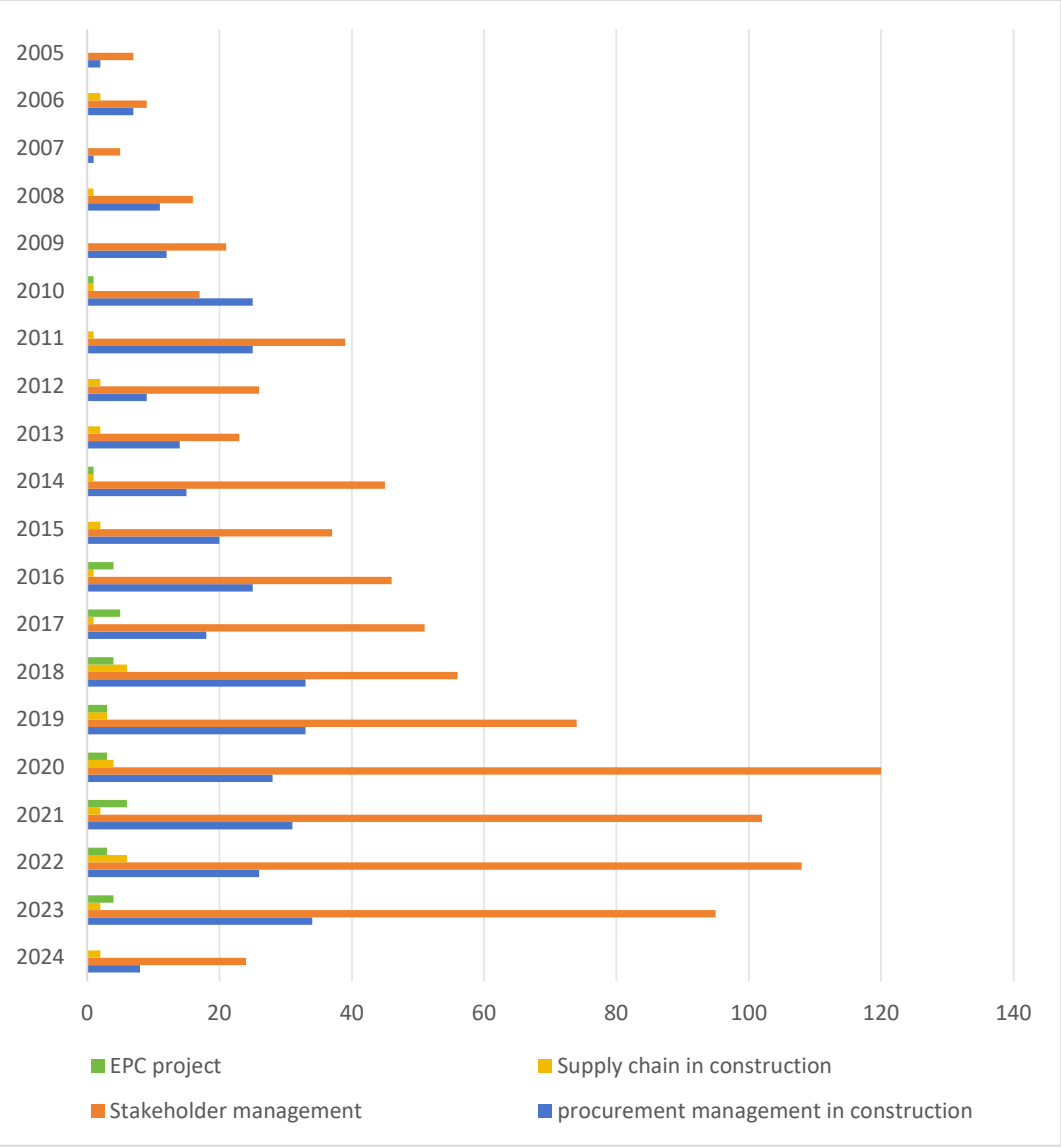

Figure 2. Publication Distribution by years

Figure 4 presents a keyword co-occurrence network for EPC projects in international engineering, featuring 248 terms. Central keywords like "management," "performance," and

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"international EPC projects" highlight their pivotal role in the field's discourse. This network, with a threshold of 2 occurrences, includes 44 prominent keywords, offering a visual guide through the complex themes of EPC project management.

This breadth of terms reflects the field's scope, covering strategic, operational, and cross-border aspects of EPC projects. The network, using full counting, reveals frequent research clusters around EPC-related topics.

EPC, as defined by the ASCE and other authorities, is a general contracting model where the contractor manages the project comprehensively. It's one of several models, including DB and Turnkey, each with distinct applications in various sectors like power, oil, and civil engineering. The structure of the EPC model is detailed in Figure 3.

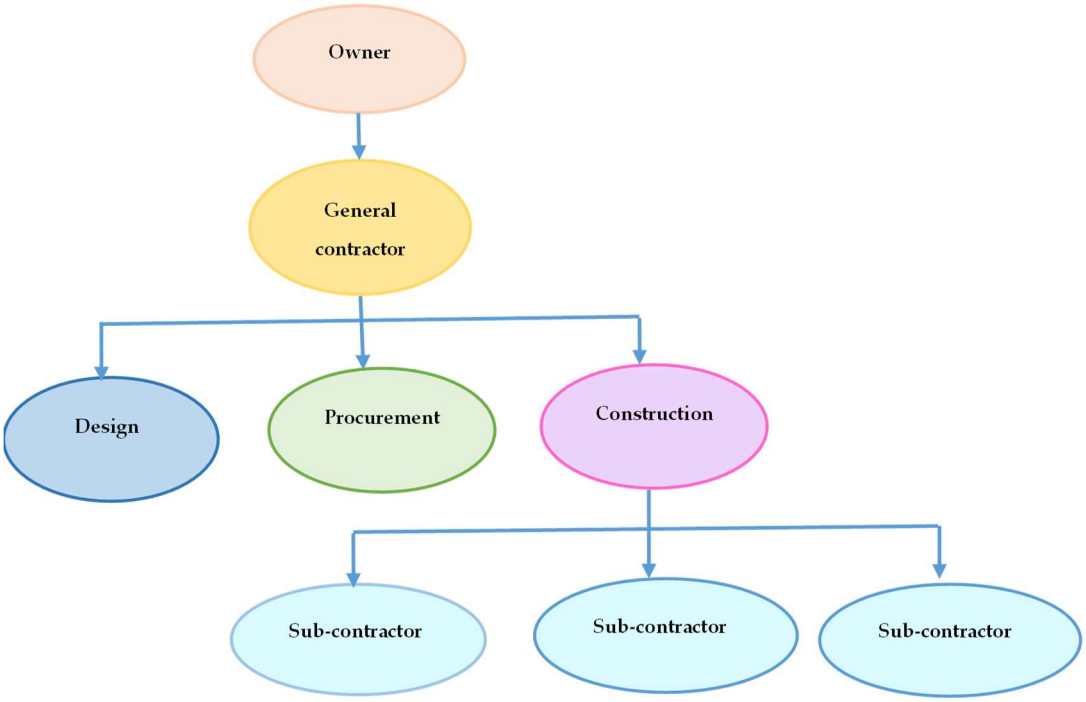

Figure 3. Structural diagram of EPC general contracting mode.

Empirical research has underscored the EPC model's efficiency over traditional construction methods. Konchar and Sanvido's influential study of 351 U.S. construction projects revealed the EPC model's superior time and cost performance, with faster delivery by 33.5%, cost reduction of 5.2%, and duration decrease of 11.37%, without compromising quality.

The integrated design, procurement, and construction processes of the EPC model streamline project management, leading to its widespread adoption in international engineering. Standardized contracts by FIDIC, AIA, ICE, and the World Bank support this uniformity, despite the practical variability due to different project contexts.

However, EPC management faces challenges like scope definition, owner control over design, and contractor expertise demands. Research into these issues is crucial for improving project management, risk mitigation, and governance in international EPC projects.

Enhanced project management can elevate the EPC model's success, optimizing resources, ensuring timely delivery, maintaining quality, and achieving cost-effectiveness. Addressing these challenges will further establish the EPC model's efficacy in global engineering project execution.

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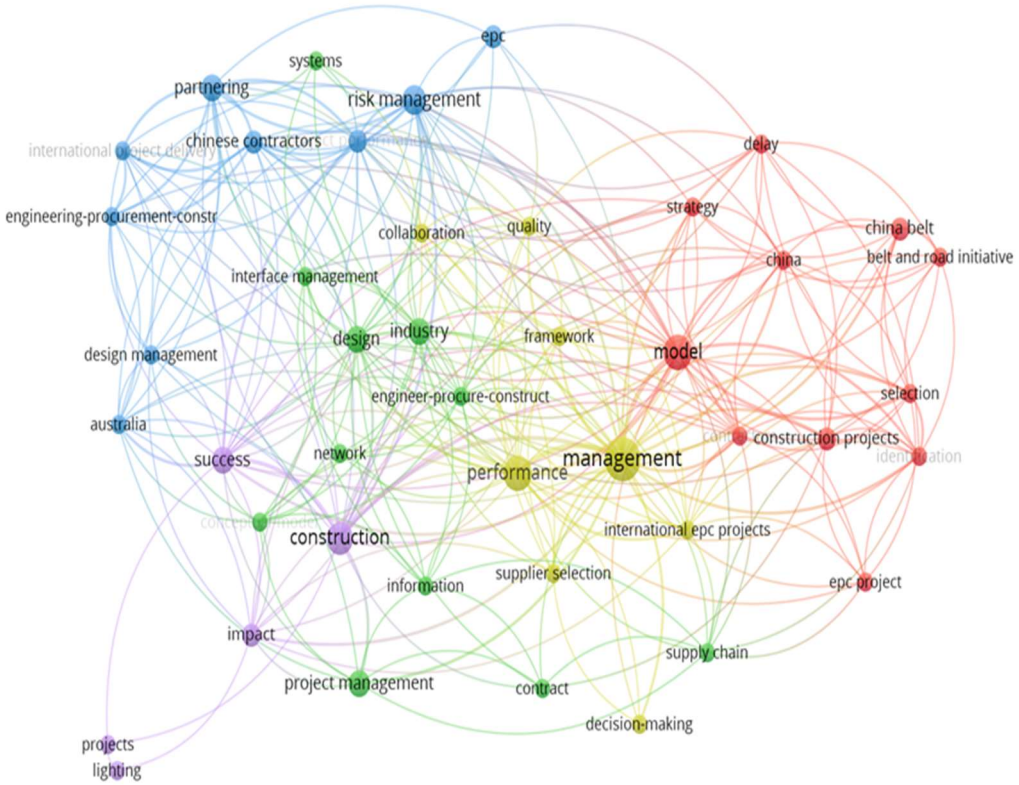

Figure 4. Co-occurrence network of research on International Engineering EPC project.

In our detailed keyword co-occurrence network (Figure 5), we have meticulously cataloged all pertinent keywords under the umbrella of supply chain integration, encompassing both author keywords and index keywords identified within the body of literature. The network showcases a rich tapestry of 173 interconnected keywords that collectively represent the multifaceted nature of the topic. The network is methodically constructed using a full counting method, setting a threshold that requires each keyword to appear at least twice to be included. In total, 25 keywords have met this criterion and are featured within the network.

Figure 5 illustrates not only the keyword "supply chain" as a pivotal node but also other central research themes that resonate with the findings depicted in Figure 4. It highlights the core keywords pivotal to the discourse on supply chain integration management within the construction industry, mapping out the intricate web of relationships between them. The network reveals the primary focus areas of contemporary research, which include, but are not limited to, supply chain management, the EPC model, project management, performance enhancement, cost control, and the crucial elements of integration and collaboration.

The visualization in Figure 5 underscores the research community's concerted emphasis on the interplay between these key areas. It reflects a growing recognition of the critical role that seamless integration and strategic collaboration play in fortifying supply chain networks, particularly within the complex and dynamic environment of construction projects. The research accentuates the significance of harnessing effective management and coordination strategies to foster robust partnerships among supply chain stakeholders, with the ultimate goal of driving project performance to new heights and bolstering the likelihood of project success.

Through delving into the nuances of these relationships and their impact on project outcomes, the network serves as a guide for scholars and practitioners alike, offering insights into the essential components that contribute to a resilient and high-performing supply chain. This, in turn, has profound implications for the development of best practices, the formulation of policies that support supply chain synergy, and the advancement of knowledge in the field of supply chain integration within the context of international engineering and construction projects.

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Research also focuses on building management frameworks and identifying key success factors to further develop and optimize supply chain management in the construction industry. Since the 1980s, integration has been considered the essence of the supply chain, serving as the source of organizational supply chain performance and competitive advantage, and thus has garnered significant attention both in research and in practice. There are many definitions of supply chain integration, but they generally share common themes. Definitions widely accepted from a theoretical perspective often involve interactions and collaborations at both internal and external levels[40,41].

At the level of internal integration, interaction represents the exchange related to activities between different departments; at the level of external integration, some scholars use the concept of "socialization" to represent the process of information flow within and outside organizations. Supply chain integration can be defined as the degree to which an organization engages in strategic cooperation and manages internal and external processes with its stakeholders to achieve efficient and rapid flow of products, services, information, capital, and decisions, ultimately providing the greatest value to customers at low cost and high speed[42,43]. Widely used definitions of supply chain integration include:

Bagchi et al.[44] propose that supply chain integration is the comprehensive cooperation of supply chain network members in strategic, tactical, and operational decisions, characterized by cooperation, information exchange, trust, partnerships, and a fundamental shift from managing individual functional flows to managing integrated process chains.

Flynn et al.[45] define supply chain integration as the degree to which firms engage in strategic cooperation and jointly manage internal and inter-organizational processes with supply chain partners.

Leuschner et al.[46] consider supply chain integration to be the scope and intensity of the links between firms in the supply chain process.

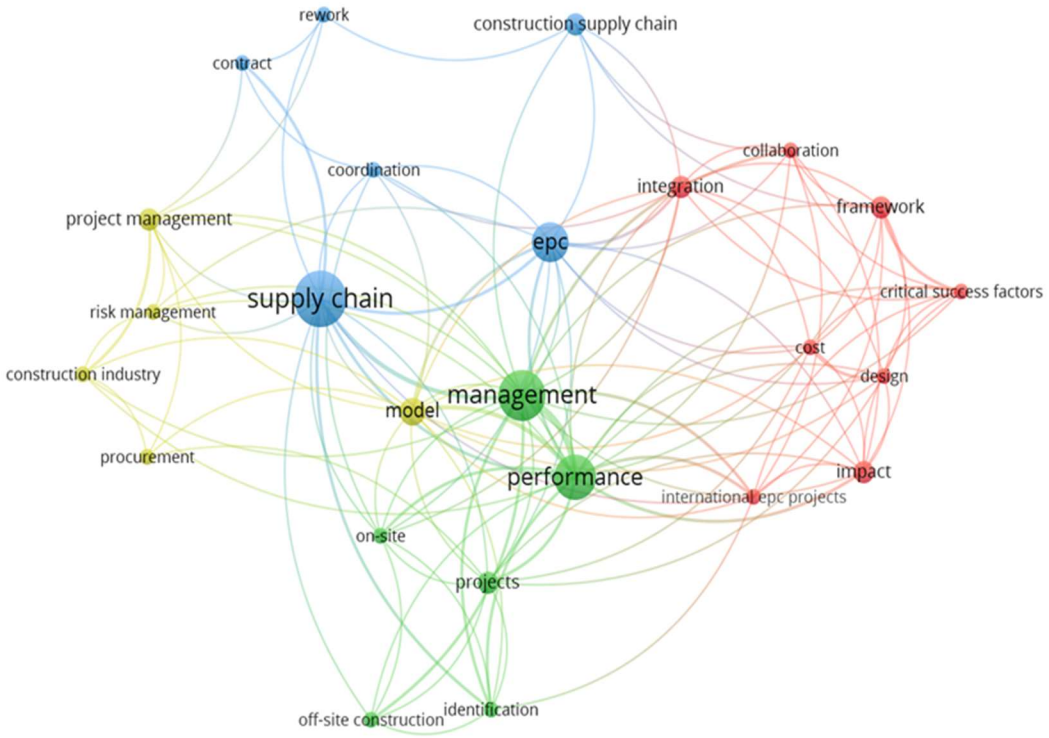

Figure 5. Co-occurrence network of research on Supply chain.

In the keyword co-occurrence network shown in Figure 6, all keywords related to stakeholders, including both author and index keywords, have been tallied. These papers collectively feature 4939 keywords. The network was constructed using a full counting method with a threshold set at a

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minimum occurrence of 5 times. A total of 249 keywords meets this threshold and are included in the network.

As depicted in Figure 6, keywords such as management, performance, and stakeholder engagement remain central within the network. Management and performance are core themes of the research, indicating that management practices and performance outcomes are key focal points in the study of stakeholder management. Sustainable development and innovation are significant research directions, indicating that researchers are focusing on how to achieve sustainability and innovation in projects through stakeholder management. Governance and conservation are important topics within stakeholder management, particularly in projects involving environmental and resource management. Project management and specific implementation strategies are key components in the research, involving how to effectively manage and coordinate stakeholders within a project.

For general contractors, the foundation of implementing supply chain integration is to establish partnerships with stakeholders that share risks and benefits. Since stakeholders are part of the external environment and are the source of scarce and valuable resources needed by the organization, a key task for the organization is to improve relationships with stakeholders to fairly distribute resources, thereby achieving organizational goals[47]. The Project Management Institute defines stakeholder management as systematically identifying, analyzing, and planning related activities to communicate with stakeholders and influence them. Current research on stakeholders in the construction field mainly focuses on three aspects: key elements of stakeholder management, processes and methods of stakeholder management, and stakeholder relationship management.

In the 1980s, partnerships were first applied by the U.S. Army Corps of Engineers in the development and utilization of water resources in Alabama, and after achieving success, the concept was promoted worldwide. In recent years, partnership theory has been an international research hotspot, with its development divided into four stages: conceptual research, characteristic research, theoretical models, and empirical studies. Considering the actual situation of procurement management in international engineering EPC projects, it is possible to recognize the necessity of conducting supply chain integration procurement management based on partnership theory in international engineering EPC projects.

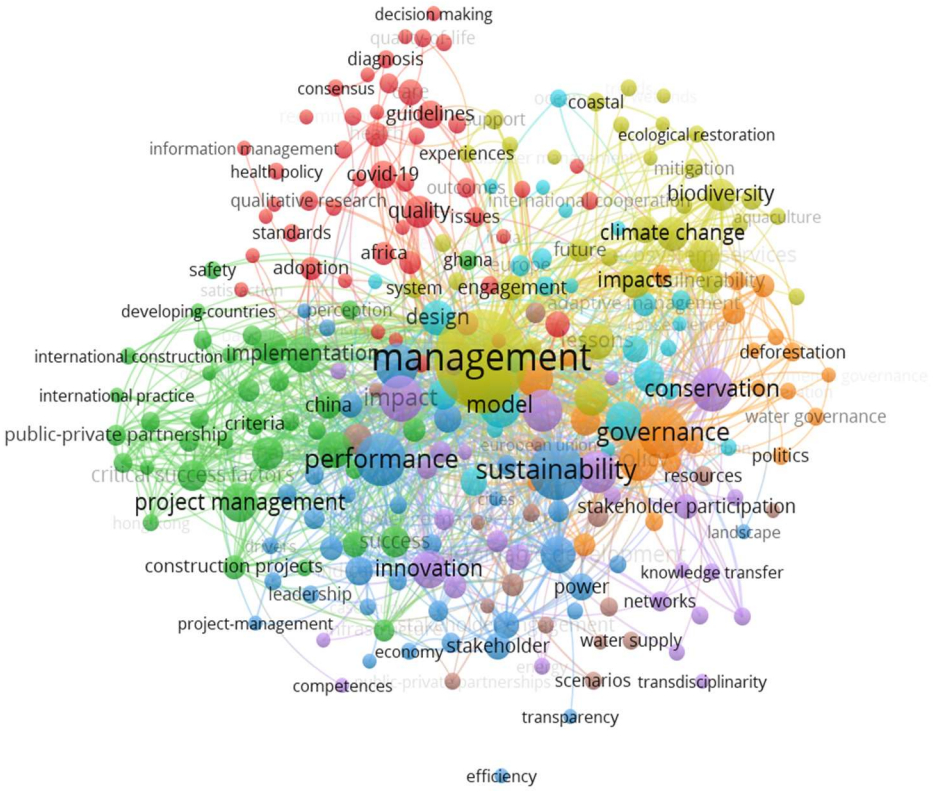

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Figure 6. Co-occurrence network of research on Stakeholder management.

Figure 7's keyword co-occurrence network, comprising 353 terms, reveals the thematic landscape of procurement management research. With a threshold of two occurrences, 62 keywords form clusters that reflect core research themes, color-coded for clarity.

Clusters range from design and decision-making (red), emphasizing strategic procurement planning, to EPC and supply chain optimization (green), risk management techniques (blue), BIM integration (orange), project management for procurement success (yellow), operational efficiency in construction (purple), and empirical case studies and knowledge organization (gray).

This network offers a panoramic view of procurement management, guiding researchers in identifying trends and areas for future study.

In international EPC projects, procurement is pivotal, linking design and construction, accounting for a significant contract value, and relying heavily on suppliers and logistics[48,49]. Challenges include communication with external parties, limited contractor control over long-lead items[50], and procurement of non-standard parts without buffer stock[51]. Efficient procurement is crucial for project performance[52].

Procurement complexity arises from interdependent activities and stakeholder diversity[53,54], causing fragmentation and potential conflicts[52]. Global procurement faces unpredictable timings, especially for mechanical and electrical equipment, adding to the uncertainty[55]. Coordination of technical specifications among suppliers is also a challenge

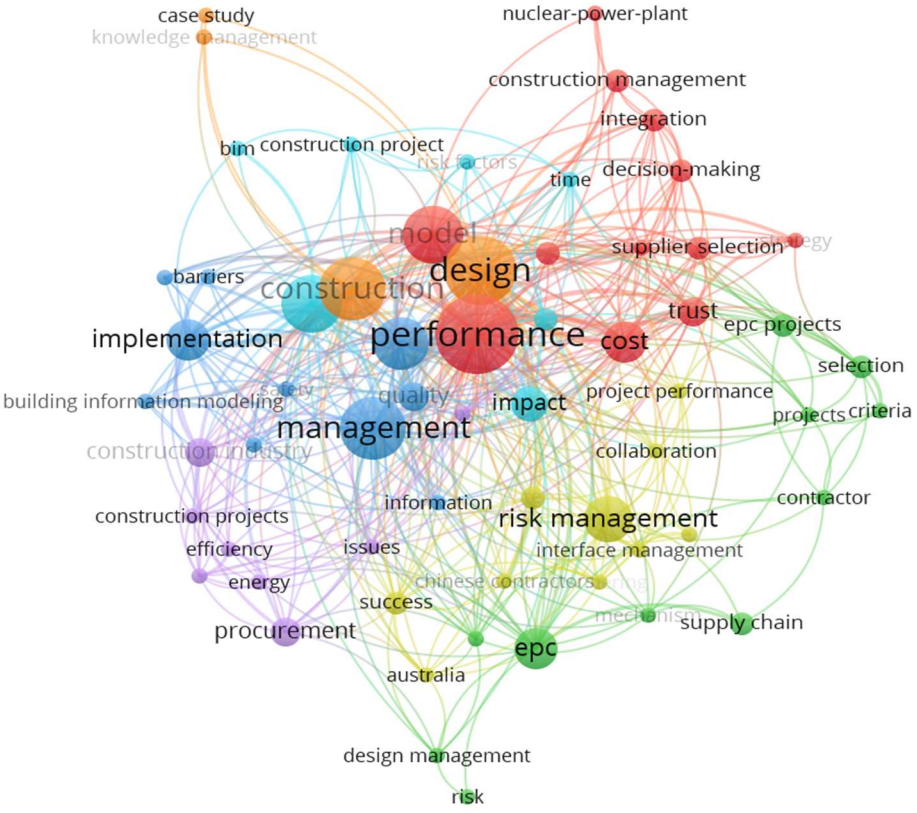

Figure 7. Co-occurrence network of research on Procurement management.

3.3. Science Collaborations

Figures 8–11 present a comprehensive visualization of the literature coupling network of authors from our database, shedding light on the intricate web of co-authorship among scholars in the field of EPC (Engineering, Procurement, and Construction) projects within international engineering. In

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these figures, each solid circle symbolizes an individual author, with the circle's size being proportional to the number of research papers the author has contributed to. The connecting lines signify co-authorship links, with the thickness of each line denoting the frequency and strength of collaborations between pairs of authors.

To create a meaningful and focused network of collaborating authors, we established a weight threshold for inclusion, necessitating that authors have a minimum count of published articles to their name. This threshold serves as a filter to ensure that only authors with a significant presence in the field, as indicated by their publication count, are featured in the network. This strategic choice mirrors the approach taken with the keyword co-occurrence network and is designed to streamline the network, allowing for a concentrated view of the most influential and active research communities and individuals within the domain.

In conducting the co-authorship network analysis for research areas such as supply chain integration management, the application of stakeholder theory, and procurement management in the context of international EPC projects, we adopted a full counting method. This method permits the inclusion of up to 25 authors per publication, reflecting the collaborative nature of research in this field. For publications specifically related to EPC projects, the threshold was set at a minimum of 2 papers per author, resulting in a network of 12 authors who met this criterion. In the case of supply chain integration, the same threshold of 2 papers per author identified 44 authors who qualified for inclusion. Similarly, for stakeholder theory, a minimum of 2 papers was required, with 107 authors reaching the threshold. Lastly, for the area of procurement management, a more inclusive threshold of at least 1 paper per author was applied, leading to a network comprising 170 authors who crossed this threshold.

These figures collectively map out the collaborative landscape of EPC project research, highlighting the most prolific authors and the strength of their academic partnerships. This network analysis is instrumental in understanding knowledge within the field, as well as identifying key players whose work drives the research agenda in the complex and cross-disciplinary arena of international engineering projects.

As shown in Figure 8, within the co-authorship network of research in EPC projects in international engineering, research teams revolve around Tang, Wenzhe, who is a central author in the co-authorship network, demonstrating significant influence in the field of EPC projects. Tang, Wenzhe is the author with the highest number of published documents, totaling 7, and has accumulated 264 citations, with a total link strength of 23, indicating his importance in the research domain. Shen, Wenxin has published 5 documents, with a cumulative total of 204 citations and a total link strength of 18, also displaying substantial research impact. Duffield, Colin F. and Hui, Felix Kin Peng each have published 3 documents, with cumulative citation counts of 152 and 112, and total link strengths of 12 and 9, respectively. Authors with higher link strengths often play pivotal bridging roles in the network, facilitating communication between different research directions and researchers.

Tang, Wenzhe and colleagues aim to quantitatively and systematically study how trust, openness, and communication are interrelated to improve performance in interface management within international EPC projects. Data were collected through surveys and interviews to develop and test a conceptual model. Path analysis indicated that trust can not only directly promote interface management but can also have a positive impact on interface management by enhancing inter-organizational openness and communication. Social network analysis visualized the industrial relationships of contractors, revealing the different impacts that stakeholders have within the trust and interface networks of international EPC contractors.

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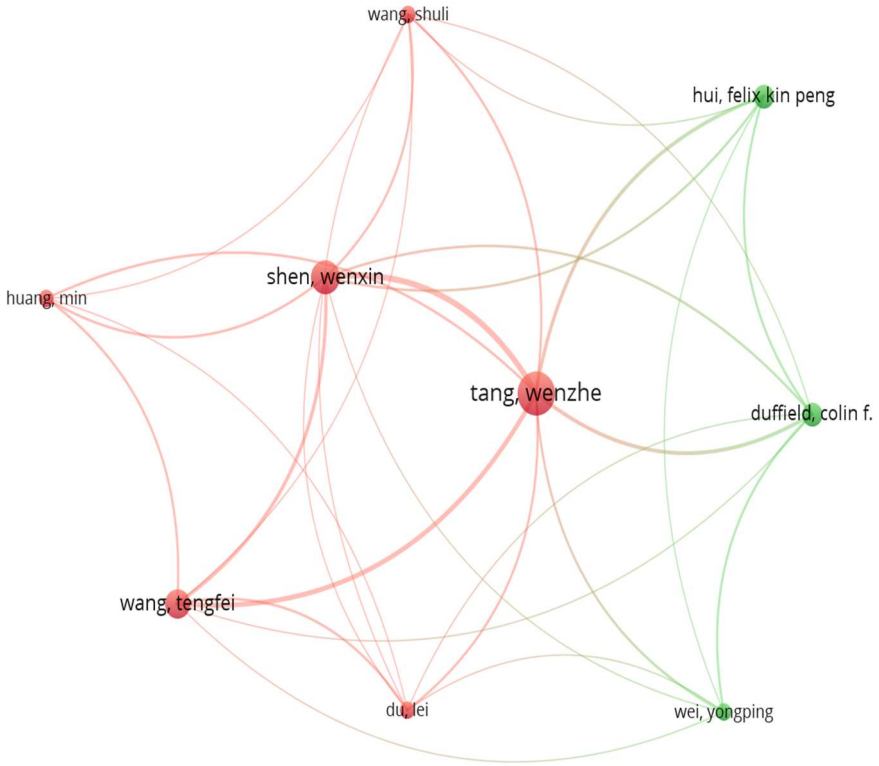

Figure 8. Co-authorship network of research on EPC project.

As illustrated in Figure 9, the co-authorship network for research on supply chain integration management features a prominent red cluster, which includes Tang, Wenzhe and colleagues as key contributors. Their research delves into critical aspects of relationship management, trust, and interface management within the context of International Engineering Procurement and Construction (IEPC) projects. Shen, Wenxin, alongside Tang, Wenzhe, underscores the pivotal role of trust in IEPC projects in their studies and articulates strategies to bolster trust among project participants. This emphasis on trust is congruent with the dense collaborative ties observed within the red cluster, reflecting a concerted effort and substantial scholarly output in this specialized area of research. These authors have directed their investigative efforts toward the nuances of relationship management, risk mitigation, and the overarching project management dynamics that are central to effective supply chain integration.

The network also identifies a green cluster led by Duffield, Colin F., where the research is particularly concentrated on enhancing project performance and managing risks within the supply chain. The collaborative work of Hui, Felix Kin Peng and Duffield, Colin F. underscores the importance of integration and collaboration in supply chain management. Their research offers insights into how fostering collaborative relationships and facilitating information sharing among supply chain members can lead to significant improvements in project outcomes. This focus on collaborative synergy aligns with the interconnectedness of the green cluster, showcasing their joint research endeavors and the contributions they have made to the field.

The research outputs from these authors extend into exploring the integration and collaborative mechanisms within the supply chain, with a view to advancing project performance through improved management practices. Their work often involves developing and testing theoretical models, conducting empirical studies, and applying advanced analytical techniques to understand the complex interplay between various supply chain entities. By doing so, they contribute to the body of knowledge on how to effectively manage the intricate web of relationships and processes that define supply chain integration in large-scale international EPC projects.

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Overall, the detailed analysis of the co-authorship network in Figure 9 reveals a landscape of academic collaboration that is both rich and dynamic, highlighting the key researchers and their interconnected efforts to push the boundaries of supply chain integration management within the challenging and globally distributed environment of international engineering projects.

Within the red cluster, the authors are deeply engaged in investigating the intricate dynamics of relationship management, the cultivation of trust, and the strategies for risk management, all within the sphere of supply chain integration management. Their research probes into how these factors interconnect to influence the efficacy of supply chain operations and the successful delivery of projects. Shen, Wenxin and Tang, Wenzhe are pivotal figures in this cluster, with their work providing valuable insights into the mechanisms through which trust can be established and maintained in the complex environment of IEPC projects. They explore the multifaceted nature of trust, examining its impact on collaboration, risk sharing, and overall project governance.

On the other hand, the green cluster's authors direct their scholarly attention towards optimizing project performance and delving into the critical components of supply chain integration and collaboration. Their research encompasses an array of topics, from the development of integrated supply chain frameworks to the analysis of collaborative networks that enhance operational efficiency and drive project success. Hui, Felix Kin Peng and Duffield, Colin F. stand out in this cluster for their collaborative work that has significantly contributed to the understanding and advancement of integrated supply chain management. They have examined how synergistic practices and information sharing among supply chain members can lead to improved project performance metrics and a more cohesive project management approach.

The work of these authors, particularly within their respective clusters, is characterized by a methodological rigor and a commitment to advancing theoretical and practical knowledge in supply chain integration. They conduct empirical research, develop theoretical models, and engage in case study analyses to provide evidence-based recommendations for managing the complex web of stakeholder relationships and processes that are inherent in international EPC projects. Through their contributions, they have helped to shape the discourse on supply chain integration, offering strategies for overcoming the challenges associated with managing large-scale, multi-faceted projects in a globalized context.

In summary, the detailed examination of the red and green clusters within the co-authorship network reveals a collaborative academic landscape where key researchers understanding of supply chain integration management. They are addressing critical questions on how best to manage relationships, build trust, manage risks, and foster collaboration to achieve superior project outcomes in the demanding realm of international engineering and construction.

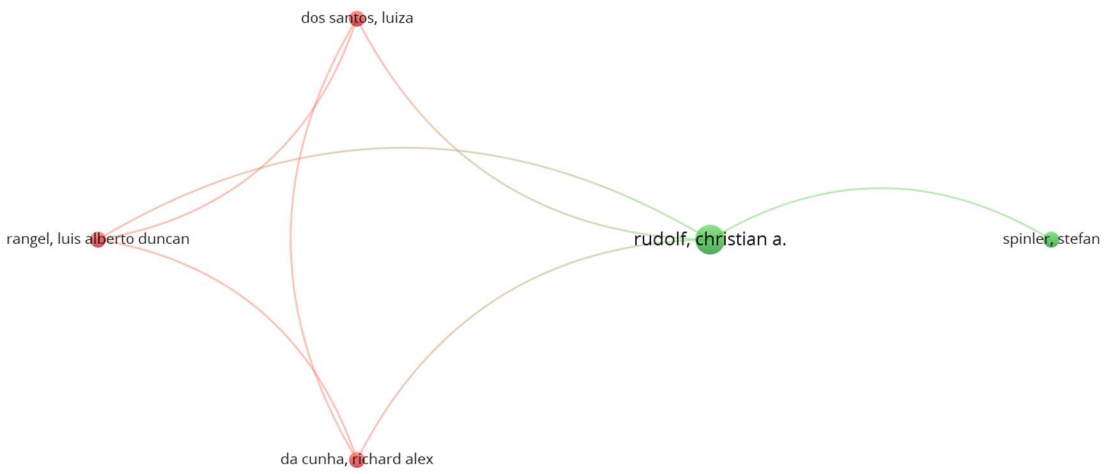

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Figure 9. Co-authorship network of research on Supply chain.

As depicted in Figure 10, the co-authorship network for stakeholder theory research in international engineering projects demonstrates a nascent but growing body of work. Within this network, a few key authors stand out for their contributions to the field.

Osei-Kyei's research delves into the nuances of stakeholder management, advocating rates by advocating for equitable stakeholder benefit distribution and effective management practices. His work often explores frameworks and strategies designed to engage stakeholders proactively and ensure that their interests are adequately represented and managed throughout the project lifecycle.

Chileshe's focus on knowledge management and risk management in construction and project management highlights the critical role that systematic knowledge sharing and comprehensive risk assessments play in project success. His research emphasizes the need for robust knowledge management systems that facilitate the capture, storage, and dissemination of project-related information, thereby enabling better decision-making and risk mitigation.

Chan has made significant inroads in the areas of project management and construction management, with a special emphasis on project risk management and the development of stakeholder strategies. His work often involves identifying potential risks early in the project and developing contingency plans, as well as understanding the complex web of stakeholder interests and how they can be aligned with project objectives.

Dansoh focuses on the aspects of collaboration and communication within project management, underscoring the vital importance of teamwork and the sharing of information for project success. His research suggests that effective communication channels and collaborative practices are essential for synchronizing efforts among various project teams and stakeholders, thereby facilitating a more integrated and cohesive approach to project execution.

Collectively, these authors contribute to a broader understanding of how stakeholder theory can be applied to enhance project and supply chain management outcomes. Their work underscores the importance of collaborative efforts, effective communication, and the adoption of technological tools in navigating the complex stakeholder landscapes typical of international EPC projects. By integrating stakeholder perspectives into the management process, these researchers provide valuable insights into achieving more efficient, effective, and successful project delivery in the challenging context of global engineering endeavors. Their contributions not only advance academic knowledge but also offer practical implications for industry professionals seeking to optimize stakeholder engagement and project performance.

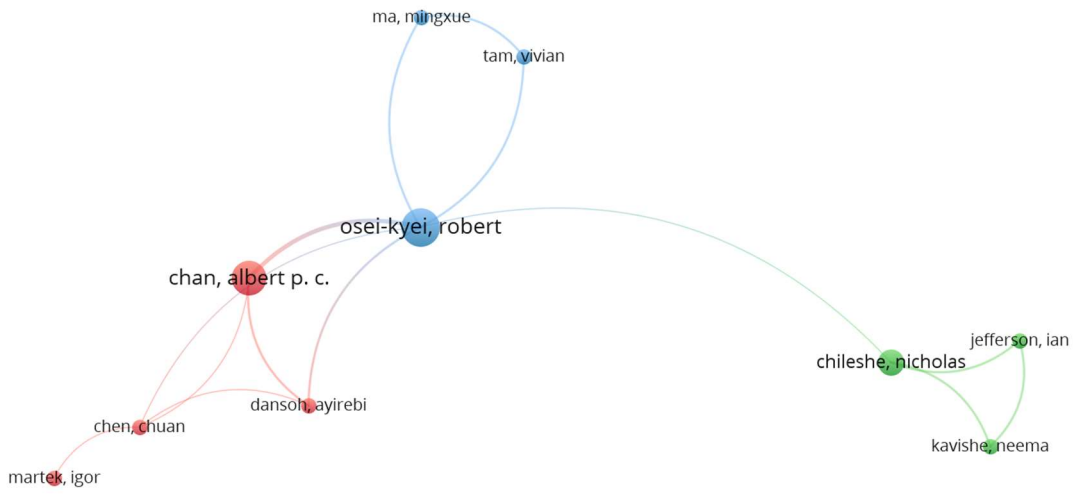

Figure 10. Co-authorship network of research on Stakeholder management.

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The co-authorship network for procurement management depicted in Figure 11 showcases a notable research team dedicated to this theme. The red cluster primarily focuses on relationship management, risk management, and trust management, with core authors such as Tang, Wenzhe and Shen, Wenxin. Authors in this cluster demonstrate a tight-knit collaborative relationship, mainly concentrating on areas such as supply chain management, project management, risk management, and trust management. Tang, Wenzhe and Shen, Wenxin, in particular, have a substantial body of collaborative research within this domain, covering key management factors in International Engineering Procurement and Construction (IEPC) projects. Wei, Yongping and Wang, Tengfei have also been involved in several collaborative projects, mainly concerning how to enhance project performance through improved management practices.

The green cluster is focused on supply chain integration and collaborative management, with core authors including Hui, Felix Kin Peng and Duffield, Colin F. This cluster emphasizes the importance of integrated processes and teamwork within the supply chain, and how these can contribute to the overall efficiency and success of projects.

The blue cluster represents a more independent set of collaborative relationships, with main authors such as Wang, Shuli and You, Richun. The work within this cluster likely addresses specific aspects of procurement management, possibly including innovative procurement strategies, contract management, and the integration of new technologies into procurement processes.

Overall, the network in Figure 11 illustrates the collaborative efforts and intellectual contributions of researchers in the field of procurement management, highlighting the interconnectedness of their work and the collective impact it has on advancing knowledge and practices in the procurement of international engineering projects.

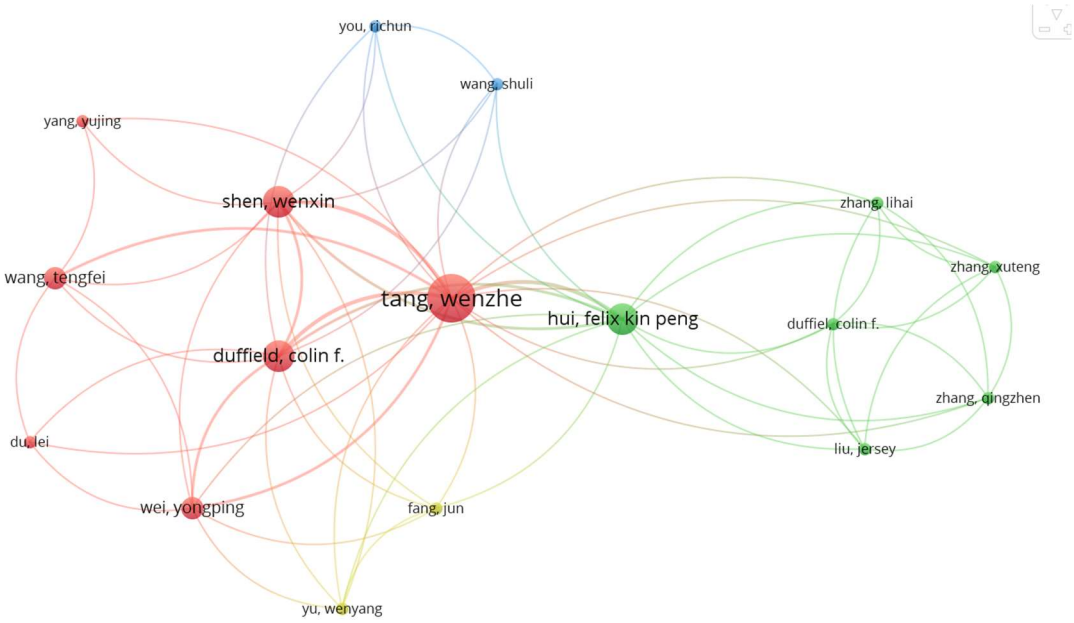

Figure 11. Co-authorship network of research on Procurement management.

4. Discussion

Our analysis reveals trends in international EPC project development, underscoring the need for research on supply chain maturity and risk management[17]. While successful in manufacturing, supply chain integration in construction, particularly for international EPC, is less mature. Future studies should adapt manufacturing insights to construction's unique context, creating flexible integration strategies.

Construction supply chains, project-specific and temporary, demand adaptable management tools. Research should focus on developing and applying such tools in practice, improving their construction industry relevance.

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Cross-cultural challenges in international EPC projects also require attention. Research should investigate the impact of cultural differences on supply chain management and procurement, drawing on multinational case studies.

Additionally, aligning supply chain practices with diverse legal frameworks is essential for smooth international EPC project execution. Addressing company reluctance to share sensitive data is crucial; partnerships or anonymized data may offer solutions.

Broad empirical research, beyond theoretical exploration, can better assess applicability in the construction industry. Innovative methods like big data analytics could provide new insights into supply chain challenges.

Tailoring theoretical frameworks to the construction industry's project-based nature will guide effective supply chain optimization. Addressing these gaps will enhance scholarly work's relevance, offering EPC managers tools for global supply chain management, thereby improving project efficiency and success in the international arena.

To augment the pertinence of our findings, it is essential to correlate the insights on supply chain management in multinational EPC projects with the tenets of sustainable development. The construction sector is under growing pressure to reduce its environmental impact; thus, including sustainable practices into supply chains can enhance project efficiency and ensure long-term profitability. Future study should investigate the successful integration of green technologies and sustainable procurement practices into supply chain strategies, ensuring that multinational EPC projects conform to global sustainability objectives. By addressing these factors, scholars and practitioners may enhance the resilience and responsibility of the building sector, ultimately promoting a balance between economic development and environmental stewardship.

5. Conclusions

This study provides a bibliometric review of the international engineering contracting market, focusing on the EPC model, procurement management, and supply chain integration. International EPC projects are intricate, involving significant financial investment and multiple stakeholders. Effective procurement, which includes supplier selection and contract management, is fundamental to project success, as highlighted by Pal et al.[10] (2017), who note the importance of quality services from suppliers and subcontractors.

Supply chain integration is crucial for EPC project performance, with Frank et al.[56] demonstrating that digital platforms can enhance efficiency. Flynn et al.[57] identify supply chain uncertainties that can be addressed through integrated IT systems, improving overall efficiency.

Effective stakeholder management is also essential in EPC projects, with Bridoux and Stoelhorst[13] exploring governance models for value creation. However, research gaps exist in supply chain maturity and risk management for large-scale projects.

Currently, supply chain integration in construction is more theoretical than practical. Literature suggests various strategies, such as building long-term relationships with suppliers and emphasizing information sharing[4,58,59], all underscoring the importance of cooperation.

Construction supply chain management requires flexibility to meet project-specific demands. Real-time information is key for managing flows among stakeholders[60]. Innovations are needed to meet contemporary procurement challenges and manage stakeholder interests effectively[61].

Enhanced supply chain integration is imperative for international EPC contractors to utilize procurement stakeholders' resources[5,60]. This research aims to guide contractors in integrating advanced supply chain management techniques into procurement for international EPC projects, thereby improving project efficiency and economic performance.

The implementation of advanced supply chain management solutions in global engineering project construction (EPC) is essential for improving project efficiency and financial results [62]. These tactics enable the effective distribution of resources, optimize procurement procedures, and promote cooperation among diverse stakeholders [63]. By maximizing these factors, EPC contractors may guarantee timely project completion and enhanced overall performance, which are critical in the current competitive construction environment [64].

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Additionally, as the construction industry confronts rising environmental issues, it is essential to incorporate procurement strategies aligned with sustainability principles. This alignment facilitates more judicious resource use and reduces ecological consequences [65]. By prioritizing sustainable practices, including the utilization of eco-friendly materials and energy-efficient technologies, contractors may comply with regulatory mandates while simultaneously enhancing their reputations and attracting environmentally aware clients [66].

Future research should investigate how the integration of sustainability into supply chain practices might foster innovation and develop lasting relationships among stakeholders [67]. Examining these processes might yield insights into optimal strategies for collaboration and resource sharing, thereby facilitating the achievement of overarching global sustainability goals. By addressing these factors, EPC contractors may guarantee the economic viability of their operations while maintaining environmental and social responsibility, so facilitating a more sustainable future in engineering contracting.

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