Project Management in Automotive Manufacturing Enterprises: A Review Based on Bibliometric Analysis

Wang Shuning[1]*, Fu Qiang[2]

[1]FAW-Volkswagen Automobile Co., Ltd., China, [2]Jilin Engineering Normal University, China
*Corresponding Author Email: shuning.wang@faw-vw.com

Abstract

Project management has become increasingly critical in automotive manufacturing enterprises due to rising product complexity, digital transformation, and global supply chain uncertainty. Although a growing body of research has examined project management practices in the automotive sector, existing studies remain fragmented across multiple disciplines, and a systematic synthesis of the knowledge structure is still lacking. To address this gap, this study conducts a comprehensive bibliometric review of project management research in automotive manufacturing enterprises based on 247 publications retrieved from the Web of Science Core Collection. Using performance analysis and science mapping techniques, this study examines publication trends, country collaboration patterns, influential journals and authors, and keyword co-occurrence and clustering structures. The results reveal a sustained growth in research output since the mid-2010s, accompanied by an increasingly international and polycentric collaboration network dominated by Germany, the United States, and China. The cited journal and author analyses indicate that the intellectual foundation of the field is highly interdisciplinary, integrating project management, operations management, production economics, and supply chain research. Keyword co-occurrence and clustering analyses further demonstrate a clear thematic evolution from early emphases on risk management and decision-making models toward more integrated perspectives encompassing supply chain coordination, dynamic capabilities, sustainability, and electric vehicle–related issues. By systematically mapping the intellectual structure and thematic evolution of the literature, this study contributes to a clearer understanding of how project management research in automotive manufacturing enterprises has developed over time. The findings provide valuable insights for both scholars and practitioners and highlight promising directions for future research in the context of an increasingly complex and dynamic automotive industry.

Keywords: Project Management, Automotive Manufacturing, Bibliometric Analysis, Supply Chain Risk, Industry 4.0, Keyword Co-Occurrence

Introduction

The automotive manufacturing industry has long been recognized as one of the most complex and project-intensive industrial sectors due to its high capital investment, technological sophistication, and tightly coupled global supply chains. Automotive enterprises increasingly rely on project-based organizational structures to manage product development, process optimization, production system upgrades, and digital transformation initiatives. As a result, project management has become a critical managerial capability for ensuring cost efficiency, quality assurance, and timely delivery in automotive manufacturing contexts (Kerzner, 2017; Maylor et al., 2018).

Traditionally, project management research in manufacturing focused on the classical "iron triangle" of cost, time, and quality. However, the rapid transformation of the automotive industry driven by electrification, intelligent manufacturing, and Industry 4.0 has significantly altered the nature of projects undertaken by automotive manufacturers. Modern automotive projects are characterized by increased uncertainty, cross-functional integration, and inter-organizational collaboration, particularly in areas such as platform-based vehicle development, modular production systems, and global supplier coordination (Brettel et al., 2014; Liao et al., 2017). These changes have challenged the applicability of conventional project management approaches and stimulated the emergence of new research themes, including agile project management, lean project delivery, and digitally enabled project governance (Tortorella et al., 2020).

In addition to its technical and managerial dimensions, project management in automotive manufacturing enterprises is increasingly recognized as a critical organizational and socio-economic issue. Contemporary social science debates emphasize how organizations adapt to technological disruption, manage institutional complexity, and coordinate interdependent actors in networked production systems. Within this context, project management functions not only as an operational tool, but also as a governance mechanism that shapes decision-making processes, power relations, and knowledge integration across organizational boundaries. The automotive industry represents an especially relevant setting for examining these issues, as firms are simultaneously confronted with digital transformation, electrification, and heightened global uncertainty. These pressures raise fundamental questions about how project-based organizational forms evolve, how coordination is achieved in complex socio-technical systems, and how managerial practices contribute to organizational resilience and innovation capability. However, despite the growing relevance of these debates, existing research on project management in automotive manufacturing remains largely fragmented and lacks a systematic understanding of its intellectual structure and thematic evolution.

In parallel, automotive manufacturing enterprises have experienced a shift from isolated project execution toward portfolio and program management perspectives. Large-scale vehicle development programs often involve multiple interdependent projects spanning design, manufacturing engineering, procurement, and logistics. Scholars have emphasized that effective coordination across project portfolios is essential for managing technological complexity and market volatility in automotive contexts (Killen et al., 2012; Martinsuo, 2013). Moreover, the increasing integration of external partners—such as component suppliers, software vendors, and research institutions—has further amplified the importance of

collaborative project management mechanisms in automotive manufacturing ecosystems (Flynn et al., 2010; Hofmann et al., 2019).

Despite the growing body of literature on project management in automotive manufacturing, existing studies remain fragmented across multiple disciplines, including operations management, engineering management, innovation studies, and supply chain management. While prior research has addressed specific topics such as lean project management, risk management, and supplier integration, there is a lack of comprehensive synthesis that systematically maps the intellectual structure, research hotspots, and evolutionary trajectories of this field. Previous review studies have primarily focused on project management in general manufacturing or construction industries, with limited attention paid to the distinctive characteristics of automotive manufacturing enterprises (Turner, 2014; Joslin & Müller, 2015).

Bibliometric analysis offers a powerful and objective approach to addressing this gap by quantitatively analyzing large volumes of academic literature and revealing patterns of knowledge development within a research domain. By employing techniques such as co-authorship analysis, co-citation analysis, and keyword co-occurrence analysis, bibliometric methods enable scholars to identify influential contributors, dominant research themes, and emerging trends over time (Donthu et al., 2021; Zupic & Čater, 2015). Compared with traditional narrative reviews, bibliometric analysis enhances transparency, replicability, and analytical rigor, making it particularly suitable for synthesizing interdisciplinary research fields such as project management in automotive manufacturing.

Recent empirical studies have examined specific aspects of project management in automotive and advanced manufacturing contexts. For example, Tortorella et al. (2020) empirically demonstrated that Industry 4.0 adoption moderates the relationship between lean practices and operational performance, highlighting the growing importance of digitally enabled project environments. Flynn et al. (2010) provided large-sample evidence that supply chain integration significantly improves firm performance, implying that project coordination across organizational interfaces is a critical capability. More recently, Ivanov (2020) developed and validated models of supply chain viability that integrate resilience, agility, and sustainability, which are highly relevant to automotive project settings characterized by systemic disruptions. While these studies offer valuable insights into particular dimensions of project management and operations, they tend to address isolated topics rather than the overall knowledge structure of project management research in automotive manufacturing enterprises. This study builds on these empirical foundations by providing a systematic bibliometric synthesis that maps the intellectual base, thematic clusters, and evolutionary trajectories of this interdisciplinary field.

Accordingly, this study aims to conduct a comprehensive bibliometric review of the literature on project management in automotive manufacturing enterprises. Specifically, this study seeks to: (1) examine the temporal evolution of publications in this field; (2) identify the most influential authors, institutions, countries, and journals; (3) uncover the core research themes and their interrelationships through keyword co-occurrence and clustering analysis; and (4) propose a future research agenda by highlighting emerging topics and underexplored areas. By systematically mapping the knowledge structure of project management research

in automotive manufacturing, this study contributes to both academic scholarship and managerial practice by offering a holistic understanding of past developments and future directions.

Literature Background

Project Management in Manufacturing Contexts

Project management has been widely adopted in manufacturing industries as a systematic approach to managing complex, time-bound, and resource-intensive initiatives. Early studies on manufacturing project management primarily emphasized planning, scheduling, and control techniques aimed at improving efficiency and reducing operational risks (Kerzner, 2017). In traditional manufacturing environments, projects were often treated as discrete and internally focused undertakings, with success measured predominantly through cost, time, and quality performance indicators.

As manufacturing systems evolved toward greater product variety, shorter development cycles, and increased customization, scholars began to recognize the limitations of conventional project management approaches. Research gradually shifted toward more flexible and integrative frameworks that emphasized cross-functional coordination, stakeholder involvement, and learning-oriented project execution (Maylor et al., 2018). In particular, project-based organizing emerged as a dominant mode for managing innovation, process reconfiguration, and technology implementation in manufacturing firms (Turner, 2014).

Specificity of Project Management in Automotive Manufacturing Enterprises

Automotive manufacturing enterprises represent a distinctive context for project management research due to their high level of technological complexity, capital intensity, and supply chain interdependence. Vehicle development and manufacturing projects typically involve multiple interrelated subsystems, including mechanical design, electronics, software integration, manufacturing engineering, and quality management. Prior studies have shown that such projects are characterized by long development cycles, stringent regulatory requirements, and high coordination costs across organizational boundaries (Ulrich & Eppinger, 2016).

Moreover, automotive manufacturing projects increasingly extend beyond organizational boundaries, incorporating global suppliers, platform partners, and technology providers. Research in operations and supply chain management has highlighted that effective project coordination across organizational interfaces is critical for mitigating risks related to delays, cost overruns, and quality failures (Flynn et al., 2010). As a result, project management in automotive manufacturing enterprises has been closely linked to issues of supplier integration, modularization, and collaborative governance mechanisms (Hofmann et al., 2019).

Emerging Themes: Lean, Agile, and Digital Project Management

With the diffusion of lean manufacturing and Industry 4.0 concepts, project management practices in automotive manufacturing have undergone significant transformation. Lean project management approaches, which emphasize waste reduction, continuous improvement, and value stream orientation, have been increasingly applied to

product development and process improvement projects within automotive firms (Tortorella et al., 2020). These approaches seek to align project execution with broader operational excellence objectives.

In parallel, agile project management has attracted growing attention, particularly in projects involving software-intensive vehicle systems, electrification, and intelligent manufacturing technologies. Studies have suggested that agile principles—such as iterative development, rapid feedback, and adaptive planning—can enhance responsiveness and innovation performance in uncertain automotive project environments (Conforto et al., 2016). More recently, digital transformation initiatives have further reshaped project management practices by integrating digital tools, data analytics, and cyber-physical systems into project planning and control processes (Liao et al., 2017).

Limitations of Existing Reviews and Research Gaps

Despite the expanding body of literature on project management in automotive manufacturing, existing studies remain dispersed across multiple academic domains, including project management, operations management, engineering management, and innovation studies. Most prior reviews have focused on project management in general manufacturing or construction sectors, offering limited insight into the unique organizational and technological characteristics of automotive manufacturing enterprises (Joslin & Müller, 2015).

Furthermore, previous review studies have predominantly relied on qualitative or narrative synthesis approaches, which may be subject to reviewer bias and lack systematic coverage of the broader knowledge structure. There remains a notable absence of comprehensive bibliometric reviews that quantitatively map research trends, intellectual foundations, and thematic evolution in this specific domain. Consequently, a systematic bibliometric analysis is warranted to consolidate fragmented knowledge, identify dominant and emerging research themes, and support theory development and managerial practice in automotive manufacturing project management.

Research Methodology

This study employed a bibliometric analysis approach to systematically review the literature on project management in automotive manufacturing enterprises. Bibliometric analysis enables quantitative examination of large volumes of scientific publications and facilitates objective identification of research patterns, intellectual structures, and thematic evolution. Owing to its transparency and reproducibility, this method has been widely adopted in management and engineering management research (Zupic & Čater, 2015; Donthu et al., 2021).

Bibliographic data were retrieved exclusively from the Web of Science Core Collection (WoS), which is recognized for its rigorous journal selection criteria and comprehensive coverage of high-quality peer-reviewed publications (Mongeon & Paul-Hus, 2016). A topic-based search was conducted using the following query: TS = ("project management" OR "project-based management" OR "engineering project management") AND TS = ("automotive industry" OR "automotive manufacturing" OR "automobile manufacturing" OR "vehicle manufacturing"). The search was limited to English-language articles and review papers

published between 1997 and 2025. After screening titles, abstracts, and keywords to remove non-relevant records, a total of 247 publications were retained for analysis.

Prior to analysis, all records were exported from WoS in plain text format with full records and cited references. Duplicate records were removed, and minor inconsistencies in author names, institutional affiliations, and keywords were standardized to improve data quality, following recommended bibliometric preprocessing practices (Cobo et al., 2011). Bibliometric analyses were conducted using CiteSpace (version 6.2.R4). The analysis period was divided into yearly time slices (1997–2025), and country, cited journal, cited author, and keyword were selected as node types. The g-index (k = 25) was applied as the selection criterion, and Pathfinder pruning was used to simplify network structures. Keyword clusters were labeled using the log-likelihood ratio method. The quality of clustering results was evaluated using modularity (Q) and mean silhouette values, both of which indicated a well-structured and reliable clustering solution. The g-index (k = 25) was adopted to balance network density and interpretability, which is consistent with common practice in engineering-oriented bibliometric studies.

Through the integration of performance analysis and science mapping techniques, this methodological approach provides a concise yet robust foundation for mapping the intellectual structure and thematic evolution of project management research in automotive manufacturing enterprises.

Results

Annual Publication Trends

Figure 1 illustrates the annual publication trends of research on project management in automotive manufacturing enterprises from 1997 to 2025, based on 247 articles retrieved from the Web of Science Core Collection. The results reveal a clear upward trajectory, indicating a growing academic interest in this research domain over time.

During the initial stage (1997–2005), the number of publications remained very limited, with only one to three articles published per year. Research during this period was largely exploratory, and project management was primarily discussed as a secondary component within broader manufacturing or engineering management studies.

From 2006 to 2014, the field entered a gradual growth stage, characterized by a steady increase in annual publication output. The number of studies published per year rose to between four and nine, reflecting a growing recognition of the role of structured project management in managing manufacturing complexity, supply chain coordination, and process improvement in automotive enterprises.

A more pronounced growth phase emerged between 2015 and 2019, during which annual publications increased to over ten articles per year. This period coincided with intensified research on product development projects, cross-functional integration, and project-based innovation in automotive manufacturing environments.

Since 2020, the literature has experienced a rapid expansion, with annual publication counts exceeding 13 articles and reaching a peak of 30 publications in 2025. This surge reflects

the increasing relevance of project management in addressing the challenges associated with digital transformation, Industry 4.0 implementation, and the transition toward electric and intelligent vehicles. Overall, the observed publication trend suggests that project management in automotive manufacturing enterprises has evolved into a dynamic and rapidly developing research field.
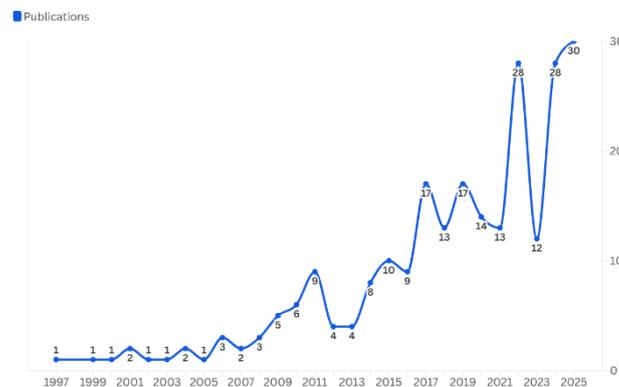

Figure 1. Annual publication trends of project management research in automotive manufacturing enterprises (1997–2025)
Note. The figure shows the annual number of publications retrieved from the Web of Science Core Collection (1997–2025).

Country Collaboration Network Analysis

This section examines the international collaboration patterns in research on project management in automotive manufacturing enterprises. Figure 2 presents the country-level collaboration network constructed using CiteSpace, while Table 1 summarizes the publication output and betweenness centrality of the most productive countries.

The collaboration network exhibits a polycentric structure, indicating that knowledge production in this field is not dominated by a single country but shaped by multiple influential contributors. Among them, Germany emerged as the most prominent hub, with the highest number of publications (38) and the strongest betweenness centrality (0.61). This suggests that Germany plays a pivotal bridging role in connecting different national research communities, which can be attributed to its strong automotive manufacturing tradition and advanced engineering project management capabilities.

The United States and the People's Republic of China also occupied central positions in the network. The United States demonstrated a high publication volume (24) and substantial centrality (0.43), reflecting its role as a global collaboration intermediary linking research communities across Europe and Asia. Although the People's Republic of China exhibited a slightly lower publication count (18), its relatively high centrality value (0.42) indicates its growing influence and integrative role within the international research network, particularly in recent years.

European countries formed a dense regional collaboration cluster, with France, Italy, Portugal, Poland, Romania, and the Czech Republic showing moderate publication outputs and varying degrees of centrality. This pattern reflects strong intra-European research collaboration, consistent with the integrated structure of the European automotive

manufacturing industry. In particular, Central and Eastern European countries, such as Poland and the Czech Republic, have increasingly contributed to this research domain, likely due to their expanding roles as manufacturing and assembly hubs for major automotive firms.

In addition to traditional automotive powerhouses, emerging economies have demonstrated growing research engagement. Brazil ranked third in publication volume (20), highlighting its increasing academic attention to automotive manufacturing and project management. India also showed a moderate centrality value (0.23), suggesting its rising participation in international collaboration networks. Although Morocco exhibited relatively low centrality, its recent entry into the field indicates potential for future growth.

Overall, the country collaboration analysis reveals that research on project management in automotive manufacturing enterprises is characterized by increasing internationalization and cross-regional collaboration. The prominent roles of Germany, the United States, and China underscore the continued influence of established automotive manufacturing nations, while the growing contributions from emerging economies signal a gradual diversification of the global research landscape.
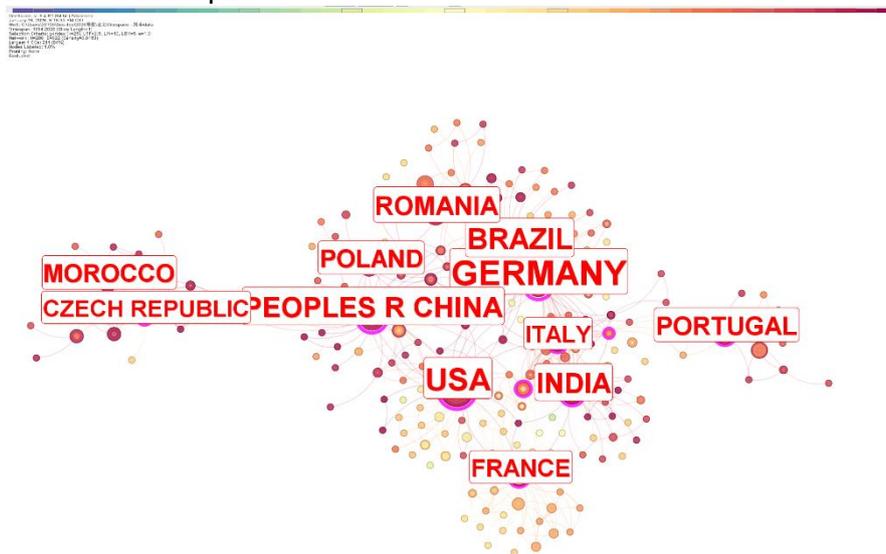

Figure 2. Country collaboration network of project management research in automotive manufacturing enterprises (1997–2025)
Note. Node size represents the number of publications for each country, links indicate international research collaboration, and purple rings denote countries with high betweenness centrality, reflecting their bridging roles in the collaboration network.

Table 1

Top contributing countries in project management research on automotive manufacturing enterprises

Country	Publications	Centrality	First Year
Germany	38	0.61	2003
USA	24	0.43	2001
Brazil	20	0.14	2015
People's R China	18	0.42	2015
India	16	0.23	2005
Romania	14	0.05	2010
Portugal	13	0.10	2014
Morocco	12	0.02	2020
Poland	12	0.06	2014
France	11	0.20	2009

Note. Publications indicate the number of articles contributed by each country. Centrality refers to betweenness centrality calculated by CiteSpace, reflecting the country's role in connecting different research communities. First year denotes the earliest appearance of the country in the dataset.

Journal and Author Analysis

This section examines the **journal outlets** and **cited authors** that have shaped the intellectual foundation of research on project management in automotive manufacturing enterprises. By analyzing cited journals and cited authors using CiteSpace, this study identifies the core knowledge sources and influential scholars underpinning this research domain. To ensure clarity and conciseness, the results are presented in tabular form without additional visualizations.

Cited Journal Analysis

Table 2 summarizes the most frequently co-cited journals in project management research related to automotive manufacturing enterprises. The co-citation profile indicates a distinctly interdisciplinary knowledge base, with strong linkages among project management, operations management, production economics, and supply chain management. In particular, International Journal of Production Economics and International Journal of Production Research show the highest co-citation counts, suggesting that this research stream is strongly anchored in manufacturing systems analysis and operations-oriented performance considerations.

A second tier of influential outlets includes journals emphasizing quantitative modeling and decision support, such as European Journal of Operational Research and Production and Operations Management. Their prominence reflects the reliance on optimization, analytical frameworks, and evidence-based decision-making to address complexity, uncertainty, and coordination challenges in automotive manufacturing projects. Meanwhile, the notable presence of sustainability-oriented outlets (e.g., Journal of Cleaner Production and Sustainability) signals an increasing integration of environmental and sustainability concerns into project management discussions in automotive manufacturing contexts.

Overall, the cited-journal analysis suggests that the field has developed at the intersection of project governance and operational disciplines, gradually extending from

efficiency- and risk-oriented perspectives toward broader themes that incorporate sustainability and system-wide coordination across manufacturing and supply networks.

Table 2

Top 10 cited journals in project management research on automotive manufacturing enterprises (1997–2025)

Rank	Cited Journal	Co-citation Count	Centrality	First Year
1	*International Journal of Production Economics*	97	0.01	2008
2	*International Journal of Production Research*	74	0.04	2005
3	*International Journal of Operations & Production Management*	58	0.07	2005
4	*European Journal of Operational Research*	53	0.05	2008
5	*Journal of Cleaner Production*	53	0.01	2018
6	*Supply Chain Management: An International Journal*	50	0.01	2011
7	*Journal of Operations Management*	49	0.04	2005
8	*International Journal of Physical Distribution & Logistics Management*	47	0.02	2009
9	*Sustainability*	42	0.00	2020
10	*Management Science*	39	0.03	2008

Note. Co-citation count indicates how frequently a journal is cited together with others in the dataset. Centrality refers to betweenness centrality calculated by CiteSpace, reflecting the journal's bridging role in the co-citation network. First year denotes the earliest appearance of the journal in the dataset.

Cited Author Analysis

Table 3 reports the most frequently cited authors in the dataset, highlighting scholars whose work has exerted significant influence on the development of project management research in automotive manufacturing enterprises. Authors with high co-citation counts have contributed foundational concepts, analytical frameworks, or methodological tools that are widely referenced across studies.

The cited-author profile indicates that the intellectual roots of this research field are strongly influenced by supply chain management and risk management scholarship. Influential authors such as Christopher, Tang, and Chopra are well known for their work on supply chain design, resilience, and coordination, underscoring the centrality of supply chain considerations in automotive manufacturing project management. Similarly, authors including Manuj, Zsidisin, and Ghadge have contributed extensively to the literature on risk identification and mitigation in complex global supply networks.

More recent influential contributors, such as Ivanov and Fan, reflect a growing scholarly focus on disruption management, resilience modeling, and systemic risk in manufacturing and project-based environments. In addition, authors with relatively high betweenness centrality, such as Fornell, demonstrate the methodological influence of measurement theory and structural modeling in empirical research within this domain.

Overall, the cited-author analysis suggests that project management research in automotive manufacturing enterprises has evolved through the integration of project-oriented perspectives with operations research, supply chain risk management, and quantitative decision-making traditions.

Table 3

Top 10 cited authors in project management research on automotive manufacturing enterprises (1997–2025)

Rank	Cited Author	Country	Co-citation Count	Centrality	First Year
1	Christopher, M.	United Kingdom	32	0.10	2011
2	Tang, C. S.	United States	26	0.08	2011
3	Ho, W.	United Kingdom	21	0.05	2016
4	Manuj, I.	United States	18	0.04	2011
5	Qazi, A.	United Kingdom	17	0.02	2011
6	Ivanov, D.	Germany	16	0.05	2021
7	Thun, J.-H.	Germany	15	0.06	2011
8	Chopra, S.	United States	14	0.06	2011
9	Zsidisin, G. A.	United States	12	0.00	2011
10	Ghadge, A.	United Kingdom	12	0.01	2017

Note. The country is reported based on the author's dominant affiliation information available in the cited records.

Keyword Co-occurrence and Clustering Analysis

This section investigates the research themes and intellectual structure of project management studies in automotive manufacturing enterprises through keyword co-occurrence and clustering analysis. Keyword-based analysis is particularly suitable for identifying core topics and tracing their evolution over time, as keywords reflect the conceptual focus of individual studies.

Keyword Co-occurrence Network

The keyword co-occurrence network was generated using CiteSpace to identify the most frequently used and structurally important keywords in the literature. In this network, node size represents keyword frequency, while links indicate co-occurrence relationships between keywords. Keywords with high betweenness centrality act as conceptual bridges connecting different research themes.
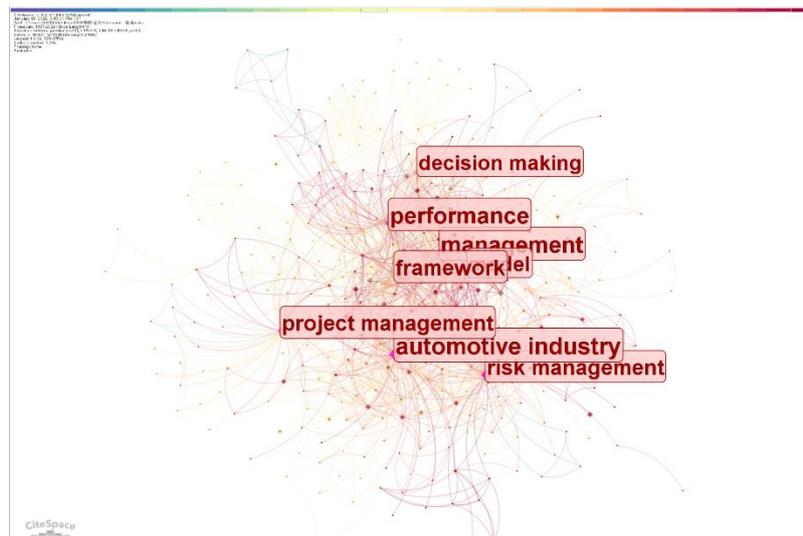
Figure 3. Keyword co-occurrence network of project management research in automotive manufacturing enterprises (1997–2025)

Note. Node size corresponds to keyword frequency, links represent co-occurrence relationships between keywords, and nodes with higher betweenness centrality indicate keywords that serve as conceptual bridges across research themes.

As illustrated in Figure 3, "risk management" emerged as the most prominent keyword, exhibiting the highest frequency (73) and a relatively high centrality (0.26), indicating its foundational role in the research domain. Other highly frequent keywords included "automotive industry", "project management", "management", and "performance", suggesting that existing studies have primarily focused on managerial practices and performance outcomes within automotive project environments.

In addition, keywords such as "decision making", "framework", and "model" demonstrated notable centrality values, reflecting the strong emphasis on analytical modeling, decision-support systems, and conceptual frameworks. Supply-chain-related keywords, including "supply chain risk management", "supply chain", and "integration", further highlight the close integration between project management and supply chain research in automotive manufacturing contexts.

Keyword Frequency and Centrality Statistics

To provide quantitative support for the network analysis, Table 4 summarizes the most frequently occurring keywords along with their corresponding centrality values and first appearance years.

Table 4
Top 10 keywords in project management research on automotive manufacturing enterprises

Rank	Keyword	Frequency	Centrality	First Year
1	risk management	73	0.26	2001
2	automotive industry	69	0.31	2008
3	project management	42	0.25	2004
4	management	41	0.23	2008
5	performance	34	0.24	2008
6	model	22	0.12	2008
7	framework	17	0.15	2008
8	supply chain risk management	16	0.04	2019
9	impact	12	0.03	2011
10	supply chain management	11	0.03	2009

Note. Frequency represents the number of occurrences of each keyword; centrality reflects the keyword's bridging role in the co-occurrence network; first year indicates the earliest appearance of the keyword in the dataset.

The statistics presented in Table 4 further confirm that risk management and project management constitute the core conceptual foundations of the field, while keywords related to decision-making models and supply chain integration play important intermediary roles.

Keyword Clustering Structure
Based on the keyword co-occurrence network, a clustering analysis was conducted to identify major thematic groups within the literature. The clustering solution demonstrated good quality, with a modularity value (Q) of 0.5814 and a mean silhouette value of 0.8395, indicating a well-structured and reliable clustering result.
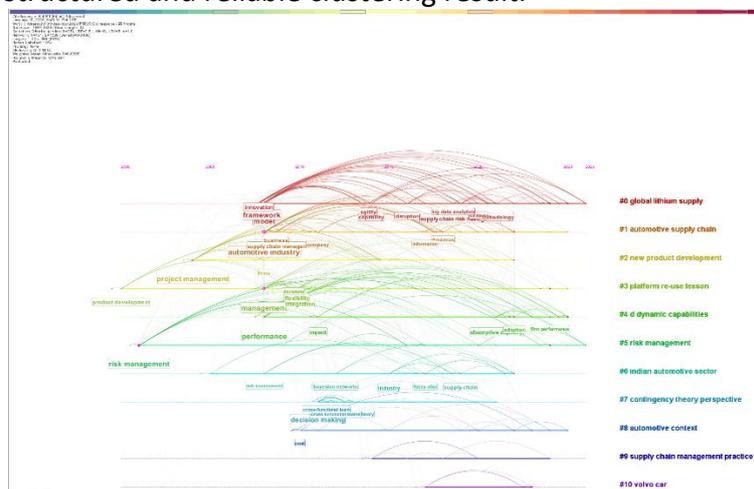

Figure 4. Timeline visualization of keyword clusters in project management research on automotive manufacturing enterprises
Note. *The timeline illustrates the temporal evolution of major keyword clusters generated by CiteSpace, where each cluster represents a distinct research theme and its development over time.*

The clustering analysis identified eleven major thematic clusters, including:
#0 Global lithium supply
#1 Automotive supply chain
#2 New product development

#3 Platform re-use lesson
#4 Dynamic capabilities
#5 Risk management
#6 Indian automotive sector
#7 Contingency theory perspective
#8 Automotive context
#9 Supply chain management practice
#10 Volvo car

Among these clusters, Cluster #5 (Risk management) represents a long-standing research theme focusing on uncertainty identification, assessment, and mitigation in automotive projects. Clusters related to automotive supply chains and supply chain management practices highlight the increasing integration of project management and supply chain perspectives.

Thematic Evolution over Time
The timeline visualization (Figure 4) provides insights into the temporal evolution of research themes. Early studies primarily emphasized risk management, decision making, and cost-related issues. Over time, research attention expanded toward project management frameworks, new product development, and supply chain integration.

Since approximately 2015, emerging themes such as dynamic capabilities, agility, disruption, and big data analytics have gained prominence, reflecting the growing impact of digital transformation, sustainability pressures, and global supply chain volatility on automotive manufacturing projects.

The keyword co-occurrence and clustering analysis reveals a clear thematic evolution in project management research on automotive manufacturing enterprises. The field has progressively shifted from an initial focus on operational risk control and analytical decision-making toward more integrated, dynamic, and capability-oriented research streams. The identified keyword clusters provide a structured foundation for the subsequent discussion of theoretical implications and future research directions.

Discussion
This study conducted a comprehensive bibliometric review of project management research in automotive manufacturing enterprises, based on 247 publications indexed in the Web of Science Core Collection. By integrating publication trends, country collaboration patterns, journal and author analyses, and keyword co-occurrence and clustering results, this section discusses the intellectual evolution, thematic structure, and emerging research directions of the field.

Evolution of Research Attention in Automotive Manufacturing Project Management
The publication trend analysis reveals a clear and sustained growth in scholarly attention to project management in automotive manufacturing enterprises, particularly after 2015. This growth coincides with major structural transformations in the automotive industry, including the diffusion of Industry 4.0 technologies, increasing product complexity, and heightened supply chain uncertainty. Prior studies have emphasized that such

transformations significantly increase project complexity, thereby amplifying the need for systematic project management approaches in manufacturing contexts (Liao et al., 2017; Tortorella et al., 2020).

The surge in publications after 2020 further reflects the impact of global disruptions, such as supply chain interruptions and the accelerated transition toward electric vehicles. These developments have reinforced the strategic importance of project-based coordination in automotive manufacturing, aligning with earlier arguments that project management capabilities are critical for managing innovation and uncertainty in complex industrial systems (Maylor et al., 2018)

International Knowledge Structure and Geographical Concentration
The country collaboration analysis demonstrates that research on automotive manufacturing project management is characterized by a polycentric global structure, with Germany, the United States, and China occupying central positions. Germany's prominence reflects its long-standing leadership in automotive engineering and manufacturing systems, where project management has traditionally been embedded in product development and production planning processes (Ulrich & Eppinger, 2016).

The strong bridging roles of the United States and China suggest complementary research orientations. While U.S.-based research has often emphasized managerial frameworks, decision-making models, and performance measurement, Chinese research has increasingly focused on large-scale manufacturing projects, supply chain coordination, and digital transformation (Liao et al., 2017). This pattern aligns with broader observations that global manufacturing research is increasingly shaped by cross-regional collaboration rather than isolated national traditions (Flynn et al., 2010).

Intellectual Foundations: Journals and Influential Authors
The cited-journal and cited-author analyses indicate that project management research in automotive manufacturing enterprises is grounded in a strongly interdisciplinary knowledge base. Core journals such as International Journal of Production Economics, International Journal of Production Research, and International Journal of Project Management highlight the convergence of operations management, production economics, and project governance perspectives.

The prominence of authors such as Christopher, Chopra, Tang, and Ivanov underscores the central role of supply chain management and risk research in shaping this field. Prior literature has consistently argued that automotive manufacturing projects are deeply embedded in global supply networks, making them particularly vulnerable to disruptions and coordination failures (Christopher & Peck, 2004; Tang, 2006; Ivanov, 2020). The presence of methodologically influential scholars, such as Fornell, further indicates the importance of robust measurement and modeling approaches in empirical project management research (Fornell & Larcker, 1981).

Dominant Themes and Thematic Evolution
The keyword co-occurrence and clustering analyses provide deeper insights into the thematic evolution of the field. Early research predominantly focused on risk management,

decision making, and cost control, reflecting a traditional project management orientation centered on minimizing uncertainty and optimizing performance. This finding is consistent with classical project management literature that emphasizes control-oriented approaches in complex engineering projects (Kerzner, 2017).

Over time, research themes expanded toward new product development, platform reuse, and supply chain integration, highlighting a shift from isolated project execution to system-level coordination. This evolution mirrors broader trends in manufacturing research, where project management is increasingly viewed as an integrative mechanism linking product development, operations, and supply chain strategy (Martinsuo, 2013).

More recently, emerging clusters related to dynamic capabilities, agility, disruption, and global lithium supply reflect the growing influence of digital transformation, sustainability concerns, and the electrification of vehicles. Scholars have argued that dynamic capabilities enable firms to reconfigure project resources and processes in response to environmental turbulence, which is particularly relevant in the context of electric vehicle development and battery supply chains (Teece et al., 1997; Teece, 2014).

Research Implications and Future Directions

The findings of this bibliometric review suggest several important directions for future research. First, there is a need to move beyond descriptive and model-based studies toward micro-level empirical investigations that examine how project management practices are implemented within automotive manufacturing organizations. Qualitative and mixed-method approaches could provide deeper insights into project governance mechanisms and cross-functional coordination processes.

Second, future research should further integrate digital technologies, such as big data analytics and artificial intelligence, into project management frameworks. Prior studies have highlighted the potential of data-driven decision support systems to enhance project planning and risk management, yet empirical evidence in automotive contexts remains limited (Wamba et al., 2017).

Third, the increasing prominence of sustainability- and electrification-related themes indicates a need for project management research that explicitly addresses environmental and social objectives alongside traditional performance metrics. This aligns with recent calls for sustainability-oriented project management in manufacturing industries (Silvius & Schipper, 2014).

This study reveals that project management research in automotive manufacturing enterprises has evolved from a control-oriented focus on risk and decision-making toward more integrated, dynamic, and sustainability-aware perspectives. The field is increasingly shaped by interdisciplinary knowledge exchange, international collaboration, and emerging technological challenges. By synthesizing the intellectual structure and thematic evolution of the literature, this study provides a foundation for advancing theory development and guiding future research on project management in automotive manufacturing contexts.

Conclusion

This study conducted a comprehensive bibliometric review of project management research in automotive manufacturing enterprises based on 247 publications retrieved from the Web of Science Core Collection. By systematically analyzing publication trends, international collaboration patterns, influential journals and authors, and keyword co-occurrence and clustering structures, the study mapped the intellectual foundations and thematic evolution of this research domain. The results indicate that scholarly attention to project management in automotive manufacturing has increased steadily over time, particularly since the mid-2010s, reflecting the growing complexity of automotive projects driven by digital transformation, global supply chain integration, and the transition toward electric and intelligent vehicles.

The findings further reveal that research in this field is characterized by a polycentric and internationally collaborative knowledge structure, with Germany, the United States, and China playing central roles. The intellectual base of the field is strongly interdisciplinary, drawing primarily from project management, operations management, production economics, and supply chain research. Keyword analysis demonstrates a clear thematic evolution from early emphases on risk management and decision-making models toward more integrated perspectives encompassing supply chain coordination, dynamic capabilities, sustainability, and emerging electric vehicle–related issues. These patterns suggest that project management in automotive manufacturing has gradually shifted from a control-oriented function toward a strategic capability for managing uncertainty and enabling organizational adaptation in turbulent environments (Maylor et al., 2018; Teece et al., 1997; Ivanov, 2020).

Despite its contributions, this study has several limitations. It relied on a single bibliographic database and focused exclusively on English-language publications, which may have excluded relevant research from other sources or regions. In addition, bibliometric analysis emphasizes structural patterns in the literature rather than the substantive depth of individual studies. Future research may therefore benefit from combining bibliometric approaches with qualitative or empirical investigations to explore how project management practices are implemented within automotive manufacturing enterprises. Further attention to digital technologies, sustainability-oriented project management, and electric vehicle supply chains would also contribute to advancing theory and practice in this evolving field (Silvius & Schipper, 2014; Wamba et al., 2017).

Overall, this study provides a structured and integrative overview of the development of project management research in automotive manufacturing enterprises. By clarifying its knowledge structure and research trajectories, the findings offer a useful foundation for future scholarly inquiry and managerial decision-making in the context of an increasingly complex and dynamic automotive industry.

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