



Review

Megaproject Management Research: The Status Quo and Future Directions

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Abstract: Megaproject practices worldwide have triggered increasing research in megaproject management issues and led to an increasing number of papers being published during the last decade. However, it is demonstrated by the literature that there is no systematic examination on research development in the discipline of megaproject management, and consequently it is very difficult for scholars to quickly understand and grasp the research trend. Therefore, a research question naturally comes out, i.e., what is the status quo of megaproject management research and what are the research directions worthy of further investigation? This study aims to answer the question by conducting a systematic examination of the research development in the discipline of megaproject management. A total of 117 relevant articles, identified from six major international journals between 2009 and 2021, were analyzed based on the number of papers published annually, main author contributions, citations, categorization of the research methods and data analysis methods adopted, and research topics covered. The results indicated that developed countries, such as Australia, Canada, the United States, and the United Kingdom, have enjoyed significant advantages in terms of megaproject management research. It also revealed that more sophisticated views and theory have been used effectively, rather than only basic qualitative methods, in a number of studies on megaproject management. Future studies on megaproject management will be led globally, where megaprojects will remain designed and built to better built environments. In addition, continuous in-depth research on related topics can promote innovation in megaproject management to achieve sustainable megaproject development. Megaproject management will continue to be a hot research topic in the future; in particular, megaproject investment and finance management have emerged as new challenging topics. The findings can be valuable for both industry practitioners and researchers to gain deeper understanding of the current status and future directions of megaproject management research.

Keywords: megaprojects; megaproject management; sustainability; review



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1. Introduction

Megaprojects are generally defined as large-scale, complex ventures and long-lasting-impact projects [1,2]. Megaprojects can cross diverse sectors, such as the infrastructure, technology, energy, transportation, and business sectors. Typically, examples of megaprojects include motorways, dams, information and communication technology (ICT) systems, high-energy particle accelerators, offshore oil and gas extraction equipment, cross-border oil and gas lines, high-speed rail lines, and the logistics systems used to run large supply-chain-based companies [3]. Their higher costs have become an inherent feature of these projects. However, the project cost threshold has been advocated worldwide in academia as the key criterion for megaprojects [4,5]. A megaproject typically costs more than “100 million euros”, “a billion dollars”, or “0.01% of gross domestic product (GDP)” across all industries [6–8]. Therefore, the launch and development of megaprojects can significantly contribute to the advancement of economic, social, and cultural updating [9–12].

Due to the significant impacts of megaprojects, several research efforts have been devoted to managing such projects to minimize their adverse impacts. Scholars have fo-

cused on the macro and micro perspectives, which can accelerate the formation of mutually complementary knowledge systems and help provide guidance for megaproject practice. From a macro perspective, the research direction mainly focuses on different aspects of megaprojects, including planning [13], strategy [14,15], risk [16], sustainability [17], and the impact of the economy, society, and the environment [18]. Notably, the book Oxford Handbook of Megaproject Management has been identified as the seminal text, which is considered a breakthrough in terms of megaproject management research [19]. Therefore, more researchers along this direction should conduct in-depth research to clearly understand the essence of megaproject management. Moreover, from a micro perspective scholar have paid more attention to detailed concepts related to megaproject management, such as social responsibility [20] and organizational behavior [21], as well as the management of costs [22], contracts [23], performance [24], innovation [25], stakeholders [26], and conflict [27]. They have provided a significant theoretical foundation, similar to general management, for improving megaproject management.

Overall, the research of megaprojects has extended to the construction of different phases. Due to the rapidly increasing number of publications in a short period of time, it is very difficult to completely understand the meaning and process of such research. On the one hand, although most scholars have reviewed the development process of megaproject management research, including risk [28], trust [29], stakeholders [30], performance [22], and organizational behavior [31], research from such a single perspective restricts the possibility of cross-study and limits a comprehensive understanding of megaproject management research. On the other hand, a few scholars have conducted a comprehensive review [17,32], but the studies are mostly based on bibliographic analysis without deep analysis of the research contents. Thus, it is essential to systematically and comprehensively examine the latest research development in megaproject management. A literature review is generally considered an important methodology for critically analyzing research and inspiring the trend of research on a given subject. Yuan et al. (2011) and Wang et al. (2020) adopted similar methods for analyzing the research on construction and demolition waste management and sustainability in megaprojects [33,34]. These reviews have provided clear and complete analyses of the research from different perspectives in these disciplines and have also explored the future research directions, avoiding the duplication of research efforts. Therefore, this study aims to carry out a systematic examination and discreet classification of megaproject management research between 2009 and 2021. The outcomes are expected to assist scholars in gaining an in-depth understanding of previous research efforts on this topic and to grasp the directions for future research. Particularly, this paper strives to answer the following research questions:

- (1) What is the annual publication trend of megaproject management research from 2009 to 2021?
- (2) What is the status quo of megaproject management research from 2009 to 2021?
- (3) What are the research directions worth further investigation?

The rest of the paper is organized as follows: Section 2 provides a general overview of megaproject management research. Section 3 presents the research methodology detailing the methods adopted. Section 4 presents the results and the discussions of future research directions. Section 5 concludes the paper by summarizing the main research findings.

2. Overview of Megaproject Management Research

Megaprojects have been described as the “wild beasts” of the project world [35,36], as they require the investment of plenty of funds and resources during their whole lifecycle. Megaproject management exhibits more unique characteristics than general project management [3,37]. However, the features of megaproject lifecycles are similar to those of general project lifecycles, including planning, design, development, operation, and maintenance [19,24,29]. Thus, the present literature also studies megaproject management in different lifecycle stages.

The planning and design phase seem to be the beginning of megaproject management. The bulk of the project costs, the major risks, and contractor selection strategies are defined in this stage [38,39]. Therefore, it plays an essential role in all lifecycle stages and affects the constructed results of megaprojects. Based on the traditional iron-triangle measures of time, cost, and quality, the megaproject management process can be divided into four parts: contract management [23,39,40], cost management [41,42], stakeholder management [22,43], and value management [44–46]. In particular, researchers pay more attention to contract management and cost management during this stage due to the phenomenon of overspending occurring frequently in megaprojects [41]. These factors can effectively serve the target of megaproject management and judge whether megaproject failures occur [38,47,48]. However, to overcome the limitations of the traditional output-focused project management approach, research efforts have been devoted to promoting and developing management frameworks focusing on the value of stakeholders in megaprojects. Stakeholder management differentiates between the management of stakeholders and that of stakeholder approaches in megaproject management [26,49,50] to achieve higher project performance and value cocreation during all lifecycle stages [51,52].

The development phase involves the process of megaproject implementation, which continuously inputs profuse investments and resources. To ensure the implementation and completion of a megaproject, it must be supervised and managed during this stage. Therefore, investments and resources are considered the major nodes for achieving the target of megaproject management, including conflict management [53], quality management [54,55], security management (safety management) [56–59], and schedule management [42,60,61]. Significantly, qualified management strategies and measures result in successful megaprojects. Researchers expend plenty of vigor to resolve the tricky problems of megaproject management. On the one hand, the diversified nature of conflict in construction poses major challenges to conflict management [27,62]. It has attracted scholars' interest in conflict management research based on different theories and methods, including social conflict theory [53,63], alternative dispute resolution (ADR) methods [64], hierarchical hypothesized models [65], system dynamic models [66], structural equation models [67], and evolutionary game models [68]. On the other hand, time delay is one of the primary problems that must be solved urgently in megaprojects [37]. Hence, scholars have focused on schedule management research, which is grouped into two categories: delay analysis [13,60,69–71], and performance management [24,72]. Related studies have addressed practical issues in megaprojects, which are considered indispensable parts of the execution management of construction megaprojects.

The operation and maintenance (O&M) phase is considered an important part of a project's whole lifecycle, which provides effective operational assurance for megaprojects [47]. Although the dramatic increase in the number of megaprojects has yielded considerable socioeconomic benefits, the long-term impacts of O&M management [55,73], such as high energy consumption, high pollutant emissions, and personal hazards, on environmental, economic, and societal problems cannot be ignored during the O&M phase [74,75]. Therefore, researchers have adopted different perspectives to explore and resolve problems during O&M management, including environmental performance [76], social responsibility [63], the evaluation of O&M management [75], and sustainability megaprojects [77]. Specifically, O&M management also faces the constraint of cost, capacity, and quality [78], and such problems should be solved in four aspects in the early phases of planning, design, and development: financial, structural, managerial, and training aspects.

Across all stages, risk management processes should be conducted iteratively because risks will continue to emerge during the megaproject lifecycle [79,80]. Therefore, the effectiveness of risk management is directly related to megaproject success [81]. Risk management includes the process of conducting the identification, analysis, assessment, and monitoring of the risk of the megaproject. The main risks are identified and relate to three aspects in megaproject management: external risks, including political risk [79,82,83], societal risk [55,73,83,84], and construction risk [28,85]; and internal risks, including design

risk [84,86], contractual risk [87,88], operation and maintenance risks [82,89,90], financial risk [91–93], and force majeure risk [94,95].

Admittedly, the research achievements in all stages of megaproject lifecycles cannot be ignored. Each stage contains different types and directions of management, such as process management, goal management, O&M management, and risk management, and all these are essential for enhancing project performance and ensuring project success. Notably, researchers have hardly mastered the various research trends and directions in megaprojects, giving rise to the need for a systematic review of the existing literature in this domain to improve the related research methods and management strategies. This study can assist researchers in gaining an in-depth understanding of previous research efforts on this topic and to grasp the directions for future research.

3. Research Methodology

Literature reviews provide readers with syntheses and analyses of research in specific subject areas [96]. In this study, a selection and analysis of papers with the topic of management in megaprojects was conducted in four phases, following the established systematic literature review (SLR) methodology, which was considered as the essential method in established fields for the review research and was defined as “[...] a referential method to organize, synthesize and identify emerging paths and opportunities, as well as understanding the relevant issues, contradictions and limitations, based on previous studies. [97]”. It provides the timely and effective process for researching the identified issues and the field development.

3.1. Selection of Target Scholarly Journals

In this study, selection and analysis of papers with the topic of megaproject management was conducted in four phases in Figure 1. The identification phase consisted of two sub-phases, namely computer searching and filtering. We conducted research on two large literature databases, namely “Web of science” and “Scopus”. The time span specified for the search was from 2009 to the first half of 2021 (June), this because it cannot search related documents before 2009. The keywords “management” and “megaproject” were jointly researched for the paper title, keyword, and abstracts. The common keywords used as substitutes for “megaproject” are “mega-project”, “mega project”, “large project”, “major project”, and “complex project”, together with their plurals [29,42]. However, the “keyword plus” automatically generated from the titles of the cited articles was also contained in Web of Science databases, which meant that some of retrieved papers were not focused on management and megaprojects and did not contain the searched keywords in their text. In the second sub phase (filtering), we adopted the method advocated by Yuan et al. (2011) for selecting major journals that have published megaproject research, and analyzed a list of 1131 papers and concluded that the megaproject literature is still concentrated in project management journals [33]; therefore, it was necessary to limit the impact factor (IF) ($IF > 2.6$) and the number of publications (items > 25) to include only the main journals in the field. It was possible to include the main journals of project management: *International Journal of Project Management* (IJPM), *Project Management Journal* (PMJ), *International Journal of Managing Projects in Business* (IJMPB), *Journal of Management in Engineering* (JME), *Journal of Construction Engineering and Management* (JCEM), and *Engineering Construction and Architectural Management* (ECAM), which publish broadly on megaprojects and sometimes include papers on megaproject management. These six scholarly journals were finally selected as the target journals for identifying the extant research works on megaproject management. At the end of this phase, a total of 263 papers were collected, which included articles, conference papers, book chapters, reviews, and even articles in press.

During the screening and eligibility phase, we screened out the publications which were not the document type of “Articles” and “Review Articles” and assessed the full paper content for eligibility. This resulted in the exclusion of 146 items. If the paper was not a scientific journal paper associated with management and/or megaprojects, written in English, and available in a full text version, we excluded it from further analysis.

Furthermore, identified papers would not affect the results of this review significantly and did not provide any valuable conclusion on its connection with megaprojects (architectural rather than activity).

Phases		Input	Process	Output
Identification	Computer search	Database: Web of Science Core Collection Scope: ALL records Time span: 2009–2021 (June)	Web of Science CODE: (IS=(management)) AND "IS=(megaproject* OR "mega project" OR mega-project OR "major project" OR "complex project")	Web of Science: 1131 items
	Filtering	Web of Science: 1131 records Item time span: 2009–2021 (June)	– selected the publications of top six journal (more professional)	263 items
Screening		263 items: articles, conference papers, book chapters, reviews, articles in press Item time span: 2009–2021 (June)	Screening: title, author, source, keywords, abstract – selected the document type of Articles and Review Articles	257 items
Eligibility		257 items: journal articles and reviews Item time span: 2009–2021 (June)	Assessing the full text articles for eligibility – remove if not: written in English; available in full text version; associated with megaprojects and/or management	117 items
Content analysis		117 items: journal articles and reviews Item time span: 2009–2021 (June)	Grouping the data into categories – chronology of papers – measuring main authors' contributions – classification of the identified papers – research methods – research topics	Result: – descriptive results – conceptual results – future research directions

Figure 1. Research methodology.

Finally, in the content analysis phase, the contents of 117 eligible papers were considered for a content analysis. This study employed both qualitative and quantitative content analysis methods. On the one hand, for the qualitative content analysis, we focused on the identified classification of the research topic and the research method used by the re-

searchers, especially qualitative method. On the other hand, a quantitative content analysis was conducted to measure the main authors' contributions, and statistically categorize (frequently cited researchers, affiliation, and geographical distribution) and count the identified contents.

3.2. Measuring Main Authors' Contributions

Publication works normally reflect the contributions of researchers to promoting communication and development within a specific discipline. To determine the main direction of the research in this discipline, it is necessary to identify the main research scholars and their units. By tracing the research path of contributors to the discipline, it is possible to deepen the research from where they left off. This study adopted a similar approach to that employed by Yuan (2011) for identifying the lead authors in specific disciplines (i.e., PFI/PPP and construction and demolition waste management) to count an author's total number of papers published across the given time period [33].

Measuring the contribution of main authors is primarily achieved by calculating the total number of citations of a specific paper [82,98] and assigning a contribution score to the authors, which is derived from all involved papers [99,100]. The scoring method developed by Howard et al. (1987) is used to assess the contribution value of each author in multi-authored articles [98,101]. In line with this method, the crediting of authorship of the authors listed in the same article is calculated based on the order of authorship, as shown in Equation (1):

$$Score = \frac{1.5^{n-i}}{\sum_{i=1}^n 1.5^{n-i}} \quad (1)$$

A detailed score matrix for the authors is provided in Table 1. This scoring method has been widely adopted, including by Yuan et al. (2011) and Hong et al. (2012) [33,102].

Table 1. Authors' contribution score matrix for multi-authored papers.

Number of Authors	Order of a Specific Author				
	1	2	3	4	5
1	1.00	N/A	N/A	N/A	N/A
2	0.60	0.40	N/A	N/A	N/A
3	0.47	0.32	0.21	N/A	N/A
4	0.42	0.28	0.18	0.12	N/A
5	0.38	0.26	0.17	0.11	0.08

3.3. Classification of the Identified Papers

3.3.1. Research Methods of the Identified Papers in Megaproject Management Research

The development trend of the research on megaproject management should be brought to light by analyzing the identification and classification of papers so that scholars can gain insights into this discipline. The first objective is to identify the understanding of the data collection methods and data analysis methods used in the literature, and the second objective is to determine the number of papers on megaproject management published each year in the selected period.

Through analysis, three types of research methods were observed in the identified papers. A detailed description of the research methods is as follows:

- **Qualitative analysis:** This method enables the deep exploration of megaproject management and has satisfied the exploration of the management theories behind real megaproject cases with various characteristics. Multiple methods, such as interviews, case studies, and content analyses (text-based or audio-based encodings), have been adopted by researchers to conduct an in-depth and holistic exploration of the research topics [8,71,103].
- **Quantitative analysis:** At present, this method is relatively infrequently adopted in megaproject management research. It generally compares the properties, characteris-

tics, and interrelations of several objects to understand the quantitative relationship of the components contained in the research objects [11,88,104].

- Mixed analysis: This type of method combines qualitative and quantitative analyses to more comprehensively comprehend the typical management strategies for different megaprojects [105–107].

As mentioned above, the majority of the research methods used is qualitative. Researchers have further examined the type of qualitative methods adopted, including case studies, content analyses, interviews or questionnaire surveys, and literature reviews, in conducting megaproject management research.

- Case study: This is conducted by analyzing one or more real-world megaprojects and management issues (e.g., [108–110]).
- Content analysis: This is conducted by analyzing and coding the main research content from either the literature or open-source text (e.g., [46,111]).
- Interview or questionnaire survey: This is carried out through single or mixed approaches, including questionnaire surveys, in-depth interviews, and Delphi surveys, to gather opinions from industry practitioners (e.g., [31,112,113]).
- Literature review: The aim of these types of papers is to provide a deep understanding and insights through a rigorous analysis of the literature on a specific topic (e.g., [31]) or to deliver a new perspective for managing megaprojects in any given country/region (e.g., [28,109,114]).

3.3.2. Research Topics of the Identified Papers in Megaproject Management Research

Analysis of the research topic is also essential in review-related research because by doing so, it can not only describe the future research trend of research topics but also provide an overview of previous research topics during the selected period. Thus, this study was based on the process of the project management that expanded and conformed similar research topics into one cluster [8,115]; for example, cluster 2 (megaproject sustainability) mainly contains the topic of promoting the sustainable development of megaprojects, including megaproject success, advanced technology, and lifecycle in megaprojects. It can avoid the impalpable and arbitrary result. Therefore, the analysis showed that the identified papers could be categorized into five clusters: megaproject management in general [29,116–119], megaproject sustainability [27,34,120–123], megaproject governance [22,124–129], megaproject investment and finance [44,48,92,130–132], and megaproject risk management [95,112,133–136]. When the topic of a paper was related to multiple clusters, the paper was classified into the most closely related cluster. Table 2 tabulates the subtopics included in each of the clusters.

Table 2. Research topics in megaproject management research.

Clusters of Topics	Subtopics
(1) Megaproject management in general	Megaproject management practices in different countries/regions, strategies and tactics for megaproject management (plan, construction, and operation and maintenance).
(2) Megaproject sustainability	Megaproject success, advanced technology applied in megaprojects, megaproject lifecycle, sustainable development.
(3) Megaproject governance	Stakeholder management, megaproject decisions, government policies in megaproject management, social response, megaproject cooperation and conflict management, megaproject performance and assessment.
(4) Megaproject risk management	Risk identification, risk evaluation, risk control, risk management.
(5) Megaproject investment and finance	Megaproject investment, megaproject finance, partnering, PPP.

4. Results, Analyses, and Discussion

4.1. Number of Published Papers

Table 3 shows the number of megaproject management papers published annually during 2009 and the first half of 2020. There were 123 megaproject management related

papers among the 6048 papers in the six journals. Although the publication of megaproject management accounted for only 2.03% of the total papers in the target journals, the annual number of megaproject management related papers increased from 2 in 2010 to 18 in the first half of 2021, showing that megaproject management has increasingly attracted the efforts of researchers.

Table 3. Megaproject-management-related papers published between 2009 and 2021.

		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total
Target journals	Total	287	276	276	309	400	436	547	561	573	535	564	764	520	6048
	MP related	2	2	2	1	1	5	5	9	17	21	18	22	18	123
	Ratio (%)	0.70	0.72	0.72	0.32	0.25	1.15	0.91	1.60	2.97	3.93	3.19	2.88	3.46	2.03
IJPM	Total	83	83	100	87	103	129	152	130	128	87	68	42	52	1244
	MP related	1	2	2	1	1	1	2	5	8	8	5	4	7	47
	Ratio (%)	1.20	2.41	2.00	1.15	0.97	0.78	1.32	3.85	6.25	9.20	7.35	9.52	13.46	3.78
PMJ	Total	50	62	65	67	67	67	73	63	47	42	60	50	21	734
	MP related	1	0	0	0	0	2	1	1	5	1	2	4	1	18
	Ratio (%)	2.00	0.00	0.00	0.00	0.00	2.99	1.37	1.59	10.64	2.38	3.33	8.00	4.76	2.45
IJMPB	Total	0	0	0	0	0	0	49	50	41	55	74	84	42	395
	MP related	0	0	0	0	0	0	0	0	0	6	5	3	3	17
	Ratio (%)	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	10.91	6.76	3.57	7.14	4.30
JCEM	Total	120	103	80	105	174	161	112	179	197	173	144	211	202	1961
	MP related	0	0	0	0	0	2	0	2	1	1	1	3	5	15
	Ratio (%)	0	0	0	0	0	1.24	0	1.12	0.51	0.58	0.69	1.42	2.48	0.76
JME	Total	34	28	31	50	56	79	118	93	88	97	62	130	64	930
	MP related	0	0	0	0	0	0	2	1	2	3	2	2	1	13
	Ratio (%)	0	0	0	0	0	0	1.69	1.08	2.27	3.09	3.23	1.54	1.56	1.40
ECAM	Total	0	0	0	0	0	0	43	46	72	81	156	247	139	784
	MP related	0	0	0	0	0	0	0	0	1	2	3	6	1	13
	Ratio (%)	N/A	N/A	N/A	N/A	N/A	N/A	0	0	1.39	2.47	1.92	2.43	0.72	1.66

The first appearance of megaproject management papers was in IJPM and PMJ in 2009. With the development of the research in this area, a growing number of journals published more than 15 related papers between 2009 and the first half of 2021. IJPM published 47 megaproject-management-related papers, followed by 18 in PMJ, 17 in IJMPB, and 15 in JCEM. Therefore, these journals contributed more significantly to publishing megaproject management research than did other journals. It should be noted that IJPM published the largest number of megaproject-management-related papers among other related journals during the study period.

4.2. Main Authors' Contributions to the Identified Publications

Table 4 shows that a total of 10 researchers contributed more than three megaproject-management-related papers from 2009 to 2021 (June). Their publications accounted for 31.62 percent (37 papers) of the target papers. The contribution scores of these 11 scholars were calculated by applying Equation (1). Significantly, Li, Y.K. received the highest total contribution score (1.68), publishing the largest number of papers (4 papers). Four researchers came from China, and half of the researchers were from Tongji University, devoting their efforts mainly to the investigation of megaproject management problems in China. In fact, the Chinese government has paid more attention to the development of national infrastructures and has made a higher proportion of investments without interruption in megaprojects over the twenty-year study period. Therefore, numerous megaprojects, including the Hong Kong–Zhuhai–Macao Bridge, South-to-North Water Diversion, and West–East electricity transmission project, provide fertile soil for megaproject management research. Meanwhile, Tongji University has provided essential support for megaproject management research, which relies on the research institute of complex engineering and management as well as a sophisticated research group.

Table 4. Researchers who have contributed more than two papers.

Researchers	Papers	Score	Affiliation
Li, Y.K.	4	1.68	Tongji University, China
Sankaran, S.	4	1.61	University of Technology Sydney, Australia
Flyvbjerg, B.	2	1.6	University of Oxford, England
Soderlund, J.	2	1.47	BI Norwegian Business School, Norway
Kwak, Y.H.	5	1.47	George Washington University, United States
Davies, A.	4	1.46	Imperial College London, England
Wang, D.D.	3	1.41	Shandong Jianzhu University, China
Locatelli, G.	5	1.35	University of Leeds, England
Hu, Y.	3	1.27	Tongji University, China
Chan, A.P.C.	5	1.21	Hong Kong Polytechnic University, China

4.3. Citation Analysis for the Identified Publications

Citation analysis, as mentioned above, is another effective way to reflect author contributions. Table 5 further shows the results of the top 10 cited researchers who are the first authors of the identified papers (117 papers). Most of these articles were published in IJPM, PMJ, and JME, reinforcing the observation that these three journals have published not only more megaproject papers but also the most important and influential articles in the selected period. Significantly, Flyvbjerg (2014) only relied on one article to reach the peak of the total times identified papers had been cited, namely, “*What you Should Know about Megaprojects and Why: An Overview*”, which was published in PMJ in 2014 (retrieved on 30 June 2021) 3. Moreover, the papers by Toor, S.U.R. and Mok, K.Y., which have been cited more than 150 times, cannot be neglected. The more highly cited articles conducted research on the core concepts of megaproject management, including megaproject overview, megaproject performance, and stakeholder management. The articles can provide in-depth academic influence from an unprecedented theoretical perspective and play a leading role in megaproject management research. Although these analyses may not fully reflect the citation status of journal articles published recently, megaproject management research can be construed as an increasingly important area in the megaproject field.

Table 5. Most frequently cited researchers.

Researchers	Affiliation	Journal	Total Times Cited
Flyvbjerg, B.	University of Oxford, UK	PMJ	384
Toor, S.U.R.	University of New South Wales, Australia	IJPM	200
Mok, K.Y.	Hong Kong Polytechnic University, China	IJPM	157
Hu, Y.	Tongji University, Hong Kong Polytechnic University, China	JME	107
Eweje, J.	Shell Nigeria Exploration and Production Company, Nigeria	IJPM	76
Di Maddaloni, F.	Kingston University, United Kingdom	IJPM	58
Zhai, L.	Fudan University, China	IJPM	56
Kwak, Y.H.	George Washington University, United States	IJPM	54
Boateng, P.	Robert Gordon University, United Kingdom	IJPM	53
Liu, Z.Z.	Xi’an Jiao Tong University, China	IJPM	52

4.4. Geographical Spread

The identified papers were further examined in terms of research origin; in terms of geographical distribution (see Figure 2), Asia (47%) and Europe (35%) were the most prominent regions, followed by North America (8.5%), Australia (7.7%), and Africa (1.7%). Table 6 shows the eight countries with most contributions from a wide spread of countries, wherein China was ranked first with 39 articles and approximately one-third of the target papers, for a contribution score of 17.31 during the period. China has been doing increasingly well in promoting megaproject management research compared to developed countries. Four countries received a total contribution score greater than 5 for having published more than 9 papers between 2009 and 2021, namely China, the United Kingdom, the United States, and Australia. However, the contributions of other countries should not be

ignored, as they are in a stage of steady development in terms of megaproject management research. There are multiple reasons for the phenomenon of megaproject management research becoming a focal point for an increasing number of countries. Soaring populations and economies experience social conflicts and lags in land resources, so large and complex megaprojects can be built to solve these problems.

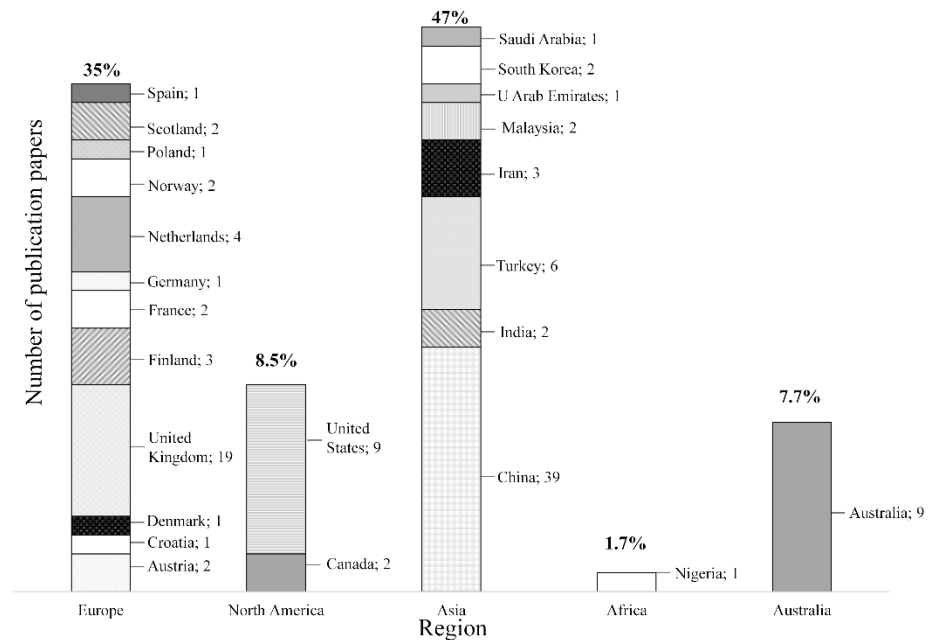


Figure 2. Geographical distribution of publications (region and country).

Table 6. Research origin of the published megaproject management papers (score ≥ 1).

	Papers	Researchers	Institute/University	Score
China	39	28	19	17.31
United Kingdom	20	16	13	12.66
Australia	9	9	7	5.74
United States	9	9	8	5.49
Turkey	6	6	6	3.56
Netherlands	4	4	3	2.19
Finland	3	3	3	1.36
Iran	3	3	3	1.36

4.5. Categories of the Research Methods to the Identified Publications

Table 7 shows the relationship between research methods and the number of articles in the eight selected journals in the selected period. It is clear that qualitative methods were employed at a high frequency (77.78%) in the relevant studies, indicating that megaproject management research constitutes an intermediate research area, which is well served by a blend of qualitative and quantitative methods [137]. However, megaproject management is an issue that is closely connected to megaproject building practice. It is impossible to provide a correct theoretical foundation and constructive suggestions without understanding industry practices [33]. Therefore, interviews, questionnaires, and case studies appear to be the most appropriate methods for obtaining research data in previous studies [104,129,130].

This result indicated that the case study approach was the most popular qualitative method among the analyzed studies (adopted 38 times), as shown in Table 8. On the one hand, case studies can quickly and accurately allow for the understanding of megaproject management requirements during megaproject practice [46]. On the other hand, subjective data are easier and more available than objective data in megaprojects through case studies, interviews, and questionnaires [72]. Although megaprojects are regarded as the research

objects in case studies, the fundamental management problem and the resolution are in dissimilar states due to megaproject practices in different countries or regions and include various economic, social, and environmental features. Therefore, the orientation of practice is regarded as the fundamental element and necessary route of megaproject management research. Significantly, here, it should not be concluded that a given method being adopted by a large number of papers is more popular than other methods, since some methods are more general and broader in scope than others.

Table 7. Research methods in the identified publications.

Methods	Number of papers	Percentage (%)
Qualitative	91	77.78
Quantitative	15	12.82
Mixed	11	9.40
Total	117	100.00

Table 8. Types of qualitative methods in the identified publications.

Qualitative methods	Number of papers	Percentage (%)
Case	38	41.76
Content analysis	24	26.37
Literature review	16	17.58
Interview or questionnaire survey	13	14.30
Total	91	100.00

Notably, megaproject management studies have preferred to adopt more complicated methods recently, rather than simple analysis methods, which appeared in most earlier studies. These include social network analysis [138], system dynamic models [76], and partial least squares structural equation models. By applying these newly developed mathematical techniques and theoretical approaches, the multiple elements, complexity, and dynamics of megaproject management can be explained to better advance the research on megaproject management theory [34,138]. Therefore, the increasing trend of research will become more apparent in the future by adopting different research approaches in megaproject management.

4.6. Research Topic

4.6.1. Numbers of Publications on Different Research Topics

Table 9 indicates topics covered by the majority of megaproject management research. The related publications have been devoted to research on “megaproject governance” (36.75%), “megaproject management in general” (28.21%), “megaproject sustainability” (19.66%), “megaproject risk management” (11.96%), and “megaproject investment and finance” (3.42%). Research interest in some topics, such as “megaproject management in general” and “megaproject governance”, has exhibited an increasing trend.

Table 9. Number of publications distributed among different research topics in the period 2009–2021.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total	%
Megaproject management in general	1	1	1	1	0	0	1	4	4	7	2	7	4	33	28.21
Megaproject sustainability	0	1	0	0	0	3	1	1	1	7	5	3	1	23	19.66
Megaproject governance	0	0	1	0	1	2	2	2	8	5	10	6	6	43	36.75
Megaproject risk management	1	0	0	0	0	0	1	2	3	1	1	4	1	14	11.96
Megaproject investment and finance	0	0	0	0	0	0	0	0	0	1	0	2	1	4	3.42

Research on “megaproject governance” accounts for the largest portion of all topics, since this topic covers a relatively wide range of subtopics, such as stakeholder manage-

ment, megaproject decisions, government policies in megaproject management, social responsibility, megaproject cooperation and conflict management, and megaproject performance and assessment. Until 2017, the identified papers showed a significant increase in governance topics, as shown in Table 9. This result indicates that megaproject governance is the most preferable method for managing megaprojects from the social and stakeholder perspectives.

The second most popular topic—“megaproject management in general”—was covered by 25 papers. This topic deals with the development of megaproject management and innovation management. It received steady interest from researchers from 2009, as shown in Table 9. This indicates that hot research issues will be continued in the subtopics of the “megaproject management in general” category.

The third most popular topic was “megaproject sustainability”. This topic addresses megaproject success, advanced technology applied in megaprojects, megaproject lifecycle, and sustainable development. Table 9 shows that the relevant studies were published through most of the study period and received an increasing level of interest. Thus, it is considered that this topic will continue to be an important focus.

Four subtopics of “megaproject risk management”, including risk identification, risk evaluation, risk control, and risk management, have received significant attention. This topic plays an important role in the lifecycle of megaprojects and can influence megaproject success. Notably, assessing and analyzing risk factors from successful megaprojects or failing megaprojects can improve the risk management level to help avoid these risks as much as possible [61,112]. Therefore, the best avoidance of risk management depends highly on the construction process rather than the post-analysis process.

One unexpected finding is that studies on “megaproject investment and finance” are far fewer in number than the other topics, although they are considered a source of megaproject plans. It was not until 2018 that two related papers were published. This implies, to a certain extent, that researchers have started to recognize the important role of investment and finance factors in megaproject management.

4.6.2. Future Research Directions

From the current status and classified research topics of megaproject management, there are many research areas missing or that require further and deeper investigations. Several potential and promising future research directions are illustrated in Figure 3, which are worth noting and highlighting. The following section mainly focuses on future research directions through an analysis of what has been done and what remains to be done in the research field of megaproject management.

Within the topic “megaproject management in general”, two major themes need to be further explored:

1. *How can the megaproject management process be understood in depth?* Previous papers indicated two features of megaproject management, namely high complexity and unstable performance, since megaprojects are affected by both internal and external factors. Such complexity cannot be understood by ignoring various factors and their interconnections. Therefore, attention should be paid to the coupling relationship between internal and external factors, as well as the uncertainty of management. Further research is needed to identify the connotation of megaprojects and their internal mechanism.
2. *To manage the innovation of megaproject management.* Megaprojects need to carry out management innovation similarly to general management. It helps to understand megaproject management processes and guide management decisions based on past experience. Therefore, it is critical for future research in this area to be continuous to develop the theory of megaproject management innovation.

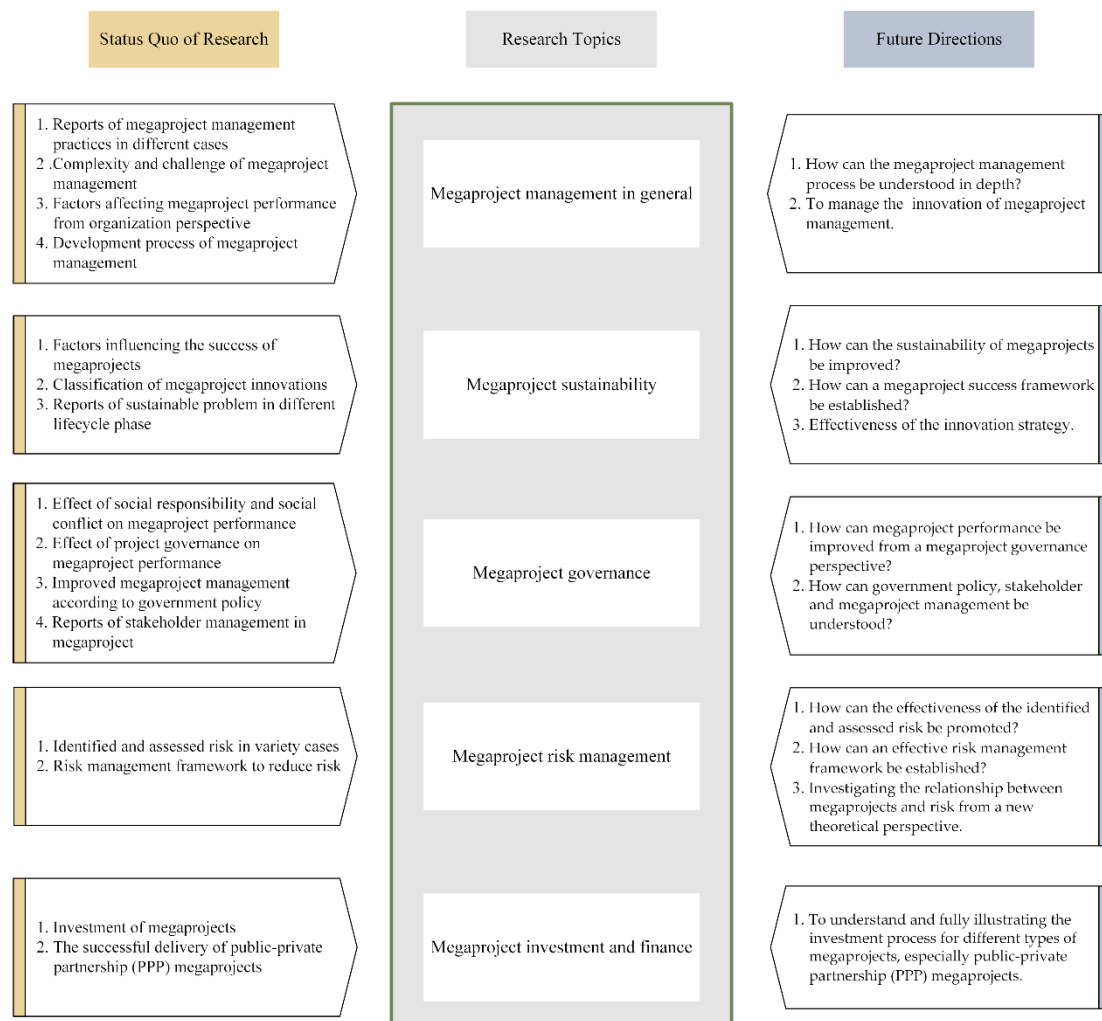


Figure 3. Future research directions in megaproject management.

Under the umbrella of “megaproject sustainability”, three questions need to be answered:

1. *How can the sustainability of megaprojects be improved?* Previous studies have indicated that the sustainable development of megaprojects depends highly on managers rather than on the megaproject itself [138], which undoubtedly emphasizes the importance of the attitudes of stakeholders and managers toward sustainable megaprojects. Therefore, investigating these attitudes toward sustainable megaprojects is helpful to further understand the ways of sustainability and the defects of sustainable behavior, thus providing strategies for improving the implementation of sustainable megaprojects.
2. *How can a megaproject success framework be established?* During the past decade, researchers have analyzed and summarized the driving factors of successful megaproject cases to enhance the chance of future megaproject success [47]. Nevertheless, the driving factors classified in different lifecycle phases of megaproject success have been ignored. In this regard, further studies should be launched to establish a megaproject success framework for the entire lifecycle, which could aid participants in effectively managing megaprojects.
3. *Effectiveness of the innovation strategy.* The present research has established a number of innovation strategies. To what extent these strategies can effectively address the innovation problems that face megaproject management processes, however, is still an unsolved question. Therefore, developing innovation strategies for all lifecycles and examining their effectiveness is probably a promising research direction.

In the future, two subtopics on the topic “megaproject management governance” should be studied:

1. *How can megaproject performance be improved from a megaproject governance perspective?* During the past few decades, considerable efforts have been devoted to dealing with the management of social responsibility [15] and social conflict [53] in megaprojects to resolve the problem of megaproject performance from a governance perspective. However, the decentralized research perspective has not formed a complete theoretical framework. Therefore, it is critical for future research in this area to establish a governance framework for improving megaproject management performance.
2. *How can government policy, stakeholder, and megaproject management be understood?* It has been reported that government policy and stakeholder management have been widely occurring in the management of most megaprojects. Generally, these factors all affect the development of megaprojects [3,107]. On the one hand, government policy influences stakeholders and megaprojects themselves [127]. On the other hand, megaproject management takes constraints from stakeholder management and government policy [139]. Therefore, while acknowledging these foundational situations, further in-depth research to understand the relationship among them is urgently needed.

In addition, three directions related to the topic “megaproject risk management” are worth noting:

1. *How can the effectiveness of the identified and assessed risk be promoted?* The improvement of the effectiveness of the identified and assessed risk deserves more attention. It plays a crucial role in megaproject risk management and success [86]. Further studies should be carried out to develop ways to improve the effectiveness of the identified and assessed risk, such as improving the present identified and assessed risk methods and categorizing risk in megaproject management in a detailed way.
2. *How can an effective risk management framework be established?* The risk management framework is regarded as the key to resolving risk problems in megaprojects and should be suitable for extensive megaprojects, thus providing a framework for improving the performance of risk management. However, researchers have focused on special cases to establish risk management frameworks based on case characteristics, such as tram networks [112], mega transportation [86], industrial parks [136], and wind farms [38]. It is worth noting that to what extent similar project risk management frameworks should be resolved, however, is still an unsolved question. Therefore, the development of a framework that can suit the universality of different megaprojects is probably a promising research direction.
3. *Investigating the relationship between megaprojects and risk from a new theoretical perspective.* The present study clearly indicates the relationship between megaprojects and risk from different perspectives, including cultural sense-making [140] and temporary organizations [40]. However, megaprojects are more complex and include unclear relationships involving risk. Therefore, it is necessary to rely on different theoretical perspectives to understand the relationship among them, thus realizing more effective megaproject management and easy megaproject success.

There are numerous challenges in the investment process of megaprojects because researchers have again begun to recognize the investment and finance of megaprojects since 2016, which demonstrates the results of a number of publications on different research topics. Existing research efforts are committed to the comments of megaproject investment and the successful delivery of public–private partnership (PPP) megaprojects [94]. To clearly understand these topics, further research should be devoted to dealing with the following topic: *To understand and fully illustrating the investment process for different types of megaprojects, especially public–private partnership (PPP) megaprojects.* The ultimate purpose should be an in-depth comprehension of megaproject investment and avoidance of financial risk.

5. Conclusions

A total of 117 relevant papers identified from the six selected journals were analyzed in terms of the number of publications annually, regional contributions, citations, and categorization of research interests and methods. The analysis results reveal the increasing research efforts toward megaproject management research, particularly in the past five years. It can be predicted that an increasing amount of research in this discipline will be conducted by researchers in the future. It should be noted that major developed countries, such as Australia, Canada, the United States, and the United Kingdom, have enjoyed an enormous advantage in terms of megaproject management, while megaproject management research in developing countries, such as China, Turkey, and India, has started to promote and establish their research institutions.

The research interests and methods in megaproject research have been categorized to assess the state of this field and identify future directions. The major research topics in this discipline include “megaproject management in general”, “megaproject sustainability”, “megaproject governance”, “megaproject investment and finance”, and “megaproject risk management”. Among them, “megaproject governance” and “megaproject management in general” have been identified as very promising areas for future research. Furthermore, the topic of megaproject sustainability has received more attention from researchers since 2014 and will be considered a hot issue in megaproject management in future research. Other topics are in the development stage, which will enhance the theory of megaproject management.

The findings suggest several potential research directions, including identifying the connotation of megaprojects and their internal mechanism, developing the theory of megaproject management innovation, improving the sustainability of megaprojects, proposing a framework for evaluating megaproject success, understanding the relationships among government policy, stakeholder, and megaproject management, promoting the effectiveness of megaproject risk identification and evaluation, obtaining an in-depth comprehension of megaproject investment, and protecting megaprojects from financial risks. Investigation of these research directions would not only contribute to the body of knowledge of megaproject management but is also helpful for promoting megaproject management practices around the globe.

The paper has its limitations. Firstly, the selection of papers was only based on two literature databases, i.e., Scopus and WoS, and furthermore, the six journals referred to may not cover all related journals publishing megaproject management works. Secondly, although this paper covered a relatively long period for paper searching, we did not provide an evolution of the research on megaproject management. Future research can be directed to revealing the evolution of megaproject management research and the interrelationships among different research topics.

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