Chapter: Unraveling The Influence of Green Development on Environmental Responsibility

SUSTAINABLE DEVELOPMENT PATH OF POST-PROJECT EVALUATION: NEW QUALITY PRODUCTIVITY PERSPECTIVE

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Annotation. The introduction of the concept of new quality productivity in 2023 has precipitated a wave of extensive reforms in various industries. The efficient integration of new quality productivity measures within the context of the new era has become a significant challenge in achieving industry development. Drawing upon the paradigm of new quality productivity, this paper employs the CiteSpace and bibliometric mapping visualisation and analysis methodologies to explore the sustainable development trajectory of post-evaluation of engineering projects. This provides a theoretical foundation and practical recommendations for the sustainable development of engineering projects.

Keywords: new quality productivity, post-project evaluation, CiteSpace; bibliometric mapping.

JEL classification: O31, H43, L11, C6.

Introduction

Post-project evaluation is defined as the research process of applying a series of scientific assessment methods to comprehensively assess and review all aspects of the implementation effectiveness, quality, cost, safety, and the environment after project completion (Sheng *et al.*, 2020). This initiative provides valuable reference and guidance for the planning and implementation of similar projects in the future. Post-project evaluation is of vital significance in project management and sustainable project development (Silvius *et al.*, 2017). For many years, the evaluation of projects post-completion has been the focus of numerous studies in the field of project management (Javalagi, 2014; Song, Letch, 2012).

Nevertheless, such evaluation faces several challenges (Fahri *et al.*, 2015). Firstly, the post-project assessment does not capture the persistence of benefits delivered by the project. Instead, it targets the time immediately after the project phase-out (Barrington *et al.*, 2024). Post-project evaluation is intended to assess the extent to which a project aligns with its stipulated plan, which may encompass cost, time, and performance/quality criteria. Archibald *et al.* (2012) concluded that post-project evaluation requires a flexible amount of time, which is contingent on the product type produced in the project. However, conducting a comprehensive evaluation can be challenging, as project workers are released once the

project is completed (Ahsan and Gunawan, 2010), leading to concerns regarding access to the necessary data.

The second barrier to conducting the post-project evaluation relates to the management support for evaluation, and a lack of support for ongoing improvement (Bowen *et al.*, 2007). In the majority of cases, a project does not have any obligation to undertake a post-project assessment. Project management has thus far largely regarded evaluation as a mere formality, with current procedures and policies restricting the manner in which information is relayed back to decision-makers from post-project reviews (Al-Yaseen *et al.*, 2010). Post-project evaluation constitutes an integral component of a firm's ongoing enhancement process. Though various related studies focus on the level of those stakeholders who were closely involved in this process, the management that supports this evaluation process remains useful to capability development. Nevertheless, this phase of the project has been the subject of only a modicum of scholarly attention (Volden, Welde, 2022).

New Quality Productivity

Given the wide IT application, the upgrading of traditional industries faces exceptional challenges (Salam *et al.*, 2018). During his visit to Heilongjiang in September 2023, General Secretary Xi Jinping proposed a new requirement of 'promoting the formation of new types of productive forces'. The so-called new productivity type stresses quality and acts as the management notion and a production mode that integrates quality elements based on traditional productivity (Hitomi, 2017), emphasising production efficiency and product/service quality, with customer demand as the key objective (Gidey *et al.*, 2014). The new quality productivity underscores continuous improvement and quality management, acting as a brand-new production notion led by quality (Fonseca *et al.*, 2021). The evolution of new quality productivity can be divided into three development stages.

The first is the application stage of IT, meant to improve production efficiency, promote industrial upgrading and economic transformation, and establish a foundation for the transformation of a specific field to new quality production (Du *et al.*, 2021). The second one, the 'Internet+' era, has been defined by the realisation of industrial upgrading and economic transformation through the 'Internet+' mode, leading to the development of new and traditional industries (Yao, 2023). The third is the specific application stage represented by AI, big data, and IoTs (Chander *et al.*, 2022). Such production technologies are the prominent characteristic of new-quality productivity (Varriale *et al.*, 2025), and their deep integration with traditional industries engenders economic transformation, upgrading, and sustainable development by promoting the development of new-quality productivity. The new quality productivity is one of the core directions of existing industrial upgrading and economic development, supported by emerging technologies.

Post-Evaluation of Projects in the Context of New Quality Productivity

With increasing sustainable development concerns, the post-project evaluation has undergone a gradual expansion in scope, encompassing the assessment of environmental, social, and economic dimensions. This evolution underscores the profound comprehension of individuals regarding the impact of engineering projects and the pursuit of sustainable development (Zítková *et al.*, 2022; Streimikiene, 2024; Dat, Hung, 2023). Therefore, integrating the relevant perspectives of new quality productivity and strengthening the research on the development trend of post-project evaluation and its integration and application mode with new quality productivity can provide suggestions for the development direction of

project evaluation. Furthermore, it can offer more effective support and guidance for the economic transformation and upgrading of the engineering field and sustainable development.

The existing literature has made substantial contributions to outlining the research history associated with the post-project evaluation in the context of new quality productivity. However, there are limited research efforts in the literature to use quantitative and objective methods to map out the visualised relationships among the researcher cluster, research institutions, and high-frequency keywords in the context of post-project evaluation. The aim of this study is to undertake a systemic review of the literature to explore the sustainable development path of post-evaluation of engineering projects from the perspective of new quality productivity. This will be achieved by using visualisation and analysis based on CiteSpace and bibliometric mapping. The primary objectives of this research endeavour are threefold. It is necessary to identify and investigate different parts of issues in research processes of post-evaluation of engineering projects in the context of new quality productivity. This includes exploring statistical characteristics of the global relevant scientific literature, proposing key research themes and solutions for enhancing the sustainable development of post-project evaluation in the context of new quality productivity, and identifying related research gaps. The present review encompasses both the internal peer-reviewed journal and the key conference papers, which have been published in English.

The key marginal contributions of this study are as follows. A comprehensive review of the extant literature was conducted, encompassing a range of databases, to ascertain the development trends of post-project evaluation in the future. The study adopted a scientometrics approach to visualise the relevant literature and to establish a quantitative network of authorship, co-citation, institutions/countries, and keywords co-occurrence. This study focuses on literature pertaining to post-project evaluation in the context of new quality productivity. It is evident that the present research strategy is intended to prevent the arbitrariness and subjectivity that is often present in literature reviews. The strategy is designed to facilitate the drawing of more effective and objective conclusions. The study provides a comprehensive classification and elucidation of the academic frontiers and hotspots of post-project evaluation. In addition, the current literature was analysed to identify knowledge gaps and related research agendas, with a view to illuminating future research. To summarise, the study findings contribute to the establishment of comprehensive and accurate information regarding research associated with post-project evaluation over time. They offer valuable insights into existing research frontiers, intellectual landscapes, and emerging trends.

1. Literature Review

In the post-project evaluation, scholars concentrate on the development of indicator models and systems, behavioral impact, empirical guidance, and application scenarios. Similar to the Chinese research hotspots, foreign studies focus on the development of indicator systems and models. However, foreign literature is more closely combined with new emerging technologies in the construction process, such as 'machine learning' and 'data simulation', and other technologies. The introduction of post-project appraisal thinking into other industries has also been influenced by foreign perspectives. In addition, international experience of post-project evaluation has been used to guide risk perception and decision-making in similar projects. Similarly, foreign and local studies focus on behavioural impacts, that is, on how human factors impact project implementation in carrying out evaluations. A survey of the literature on post-project evaluation, both foreign and domestic, reveals that studies in this field are currently dominated by empirical and theoretical analyses. The theoretical analysis is related to a number of factors, including index systems and evaluation standards, the influential mechanism of stakeholder engagement, and the selection and application of evaluation methods. In the post-project

evaluation phase, the research primarily focuses on methodological innovation and theoretical exploration, thereby extending methodological and theoretical support for empirical analyses. The empirical research principally examines the practical applications of post-project appraisals, including the credibility of assessment outcomes, the influential mechanism of stakeholder participation, and the optimisation effect of evaluation on project decision-making. The research in this domain focuses on effect analysis and practical application, offering case support and empirical data.

Both domestic and foreign scholars have conducted studies on the post-evaluation of different projects. For instance, Chou and Leatemia (2016) examined the intrinsic factors that obstructed the evaluation development in the ex-post appraisal of projects in Indonesia. It was determined that the core aspects of the process were identified by them, which had the effect of reducing the time, cost and resources required for the evaluation. Furthermore, Li *et al*. (2018) adjusted the prioritisation of diverse stakeholders based on the responsiveness degree. This research resulted in the proposition of an updated and in-depth quantitative method for post-occupancy evaluation, with the objective of optimising building designs by integrating stakeholders' inputs. Dikmen and Elias-Ozkan (2016) conducted a study on the development of a permanent disaster appraisal of buildings constructed in the rural region of Cankiri, Turkey. The study offered useful guidelines for the construction of subsequent post-disaster housing. Gonzalez-Gaceres *et al*. (2019) conducted a post-occupancy evaluation of a social housing complex comprising 400 Chinese apartments, with the objective of performing a comprehensive assessment of various aspects of moisture damage. The study ascertained that the primary causes of moisture damage in the project were attributed to the substandard design of the complex and apartments, inadequate thermal regulation of the local climate, overcrowding of the space, and inconsistencies and deficiencies in the construction quality. Several review-oriented studies have been undertaken to integrate the experiences and efforts of post-project evaluation (Hu *et al*., 2019). Lagorio *et al*. (2016) analysed the resources of the general public, the bibliometric citation network, and the main topics from 104 research studies from 2000 to 2015. Furthermore, Allen *et al*. (2012) examined 162 studies over the last 50 years and proposed 12 survey approaches to resolve data-gathering concerns in urban freight deliveries. Neghabadi *et al*. (2019) systematically studied 370 review papers published from 2016 to 2010 and abstracted research topics on the basis of keyword classifications. Likewise, Behrends (2016) reviewed 150 proceedings (2013–2009) of the international conferences on post-project evaluation, confirming that more research is essential to resolve the urban logistics in developing areas. Lindholm (2013) explored 346 related studies and proposed an optimised framework for the estimation, monitoring, and performance indicators of urban freight transport. Besides, Xu and Zhou (2017) investigated the Shanghai Bund renovation project for social ex-post evaluation to confirm the practicality of the evaluation model.

2. Data Sources and Research Methods

2.1 Data Sources

All data has been sourced from authoritative literature databases both domestically and internationally. The international research retrieval data is sourced from the *Web of Science* (WoS) core collection. The search mode has been configured to 'subject search', with 'post-project evaluation' selected as the keyword and 'engineering' set as the keyword. CNKI is the digital library of periodicals with the widest collection of information resources, the largest number of literature sources, the most authoritative and the strongest timeliness in Chinese databases (Xing, Wu, 2022). Therefore, this database is used as the source of domestic research retrieval data, and the subject term is set to 'post-project evaluation' when retrieving data. The subject term was set as 'post-project evaluation'. Following the retrieval of the data,

a manual screening was conducted on both the international and domestic data sets. This process involved the exclusion of literature deemed to be of low relevance. The timeframe for the literature review was set as the last 10 years (2014-2024), and a total of 1,376 valid records were derived.

2.2 Research Methods

The present paper employed the CiteSpace and bibliometric mapping visualisation techniques to conduct a visual metrological analysis of the literature's publication time, research institutions, key scholars, and keyword co-occurrence. The project post-evaluation and the sustainability of future development paths are discussed and summarised in the context of new quality productivity, in conjunction with the relevant literature.

The CiteSpace software integrates a range of data visualisation and analysis functions from multiple academic disciplines, including bibliometrics and statistics. The primary methodology employed in this study involves the utilisation of analytical tools, including co-citation analysis theory and path-finding network algorithms. These techniques are employed to conduct a comprehensive bibliometric analysis of literature within specific academic domains. The objective of this analysis is to identify the critical pathways and pivotal turning points in the evolution of subject areas. By drawing a series of visual maps, the software can deeply analyse the possible dynamic mechanisms of disciplinary evolution and explore the disciplinary development frontiers. The software utilises nodes and lines to illustrate the interconnection between disparate variables, and is distinguished by a clear interface, straightforward mapping, and aesthetically pleasing images. This approach is notable for its efficacy in data organisation and extensive analysis. The software's time-slicing function has been demonstrated to facilitate the visualisation of the knowledge evolution process, historical scope, and development trend of the research field, in addition to providing technical support for researchers and enabling the monitoring of hot issues of disciplinary research, as well as the organisation of the discipline's development (Chen, 2014). Bibliometrics involves the analysis of literature data online, encompassing the entire corpus of literature, collaborative networks, influence, keywords, and citation relationships (Yang, Cao, 2019).

3. Results

3.1 Visual Econometric Analysis of Domestic Research Profiles

3.1.1 Key Research Institutions

At present, research institutions that specialise in post-project evaluation tend to prioritise enterprises, colleges, and universities. The teamwork relationships within these institutions are relatively stable. However, mutual cooperation and citation behaviour between institutions are relatively rare (*Figure 1*).
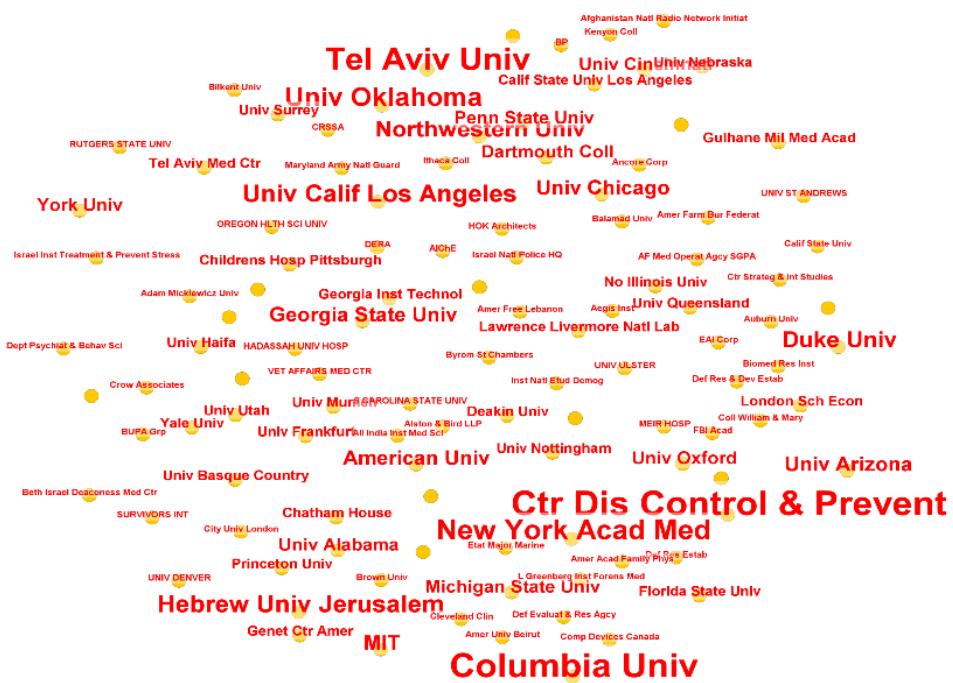
Source: created by the authors.

Figure 1. **Map of Key Research Institutions**

The China National Petroleum Planning Institute (CNPPI) has a slightly higher number of publications than other institutions and has gradually formed a research team centred on Shutong Zhang, Xingjun Fang, and Lixin Hao. The research of this team is chiefly concentrated on oil and gas field projects, encompassing the economic and ecological ramifications of such endeavours, in addition to conducting post-evaluation activities and deriving valuable insights (Zhang *et al*., 2019). The post-evaluation index system constructed by the team of Wu Manman of Hohai University for the social impact of water conservancy projects (Wumanman, Li, 2024) is a more representative example. The research conducted by the team of Wang Xinyu of Shenyang University of Chemical Technology on the post-evaluation system for urban stadium projects using the AHP-FCE model (Wang, Fang, 2023) is another.

3.1.2 Keyword co-Occurrence Analysis

In academic literature, keywords are not only used to mark the topic and field of the literature, but also to summarise the main content and research direction of the article. *Figure 2* shows the co-occurrence network mapping based on keywords.

The size, colour, and thickness of the nodes in the graph demonstrate the frequency of keywords, the occurrence year, and the occurrence frequency in that year, respectively. The thickness of the line between each pair of nodes represents the degree of co-occurrence (Xing and Wu, 2022). It can thus be concluded that the proportion of results labelled 'post-evaluation' is greater in the graph when the search subject term is set to 'post-project evaluation'. This is also the case for similar search terms, which yield analogous results. A similar situation is demonstrated by 'post-evaluation'. However, the frequency of the remaining keywords is low, and the overall scope of the research field is relatively

decentralised. Cross-studies between different segments are relatively scarce, which indicates the existence of certain research limitations. The following aspects are the primary foci of the mapping of hot words.
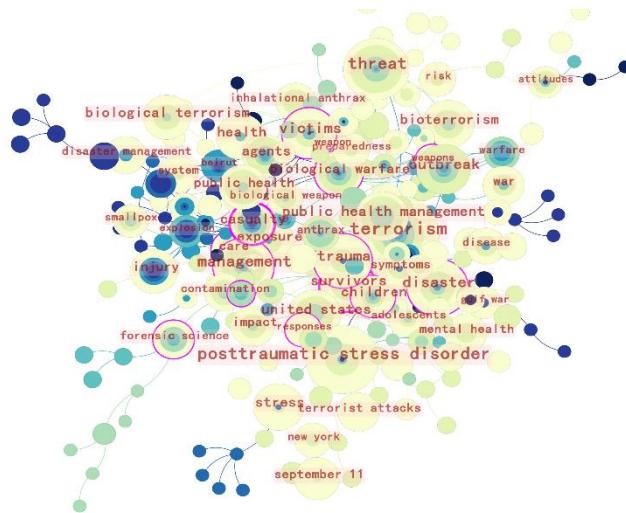
Source: created by the authors.

Figure 2. **Keyword Co-Occurrence Network Mapping**

Methodology. The construction of the evaluation index system exerts a direct influence on the success of the evaluation process and serves as an indispensable quantitative analysis process. In this process, the 'index system', 'evaluation indexes', etc. are still considered to belong to the second echelon of the HF. The following keywords, amongst others, are employed: 'index system' and 'evaluation index'. As a typical representative of the traditional quantitative calculation method in this field, the frequent appearance of these buzzwords reflects the obvious continuity of the discipline tradition and the solidity of the research path in this field.

Application fields. The utilisation of keywords such as 'construction projects', 'small and medium-sized rivers' and 'power grids' serves to identify the primary domains of application for post-project evaluation. This demonstrates the common application of post-evaluation in addressing practical challenges, thereby reflecting its inherent practical significance.

Research theories. Although the figure illustrates the classical theories such as 'hierarchical analysis', 'fuzzy evaluation', and 'Delphi method', they are not as prominent as other keywords. Contrarily, the frequency of emerging research methods shown by 'cloud modeling' is equal to or even greater than that of the above classical theories, showing an overall rising trend. Thus, although the traditional classical theories are still widely adopted, they have begun to be challenged by scholars exploring novel theories, which are more in line with the contemporary needs and have stronger foresight, gradually replacing the status of traditional theories.

Social responsibility. Hot words such as 'environmental symbiosis' and 'sustainable' appear in the post-project evaluation system, thereby illustrating the current low-carbon and energy-saving context. The engineering field has not only assumed the social responsibility of maintaining sustainable development and actively practising the call for green development. In addition, it has established its

evaluation system to supervise the implementation of responsibility in the specific implementation process.

3.1.3 Analysis of Mutative Keywords

Mutative keywords appear in large quantities or have a significantly higher frequency growth rate in a period. These keywords appear frequently in the literature within a specific time (Chen, 2014), indicating that the keywords to be examined jumped in a short time, stressing mutability (Yang, Cao, 2019; *Table 1*).

Table 1. Summary of Mutability Keywords

Keywords	Year	Strength	Begin	End	2014 - 2024
Science and Technology Program	2014	2.6	2014	2016	
Investment projects	2014	1.89	2014	2016	
Economic benefit	2016	3.68	2016	2018	
Project Investment	2016	2.32	2016	2017	
Environmental impact	2014	3.17	2018	2019	
Power distribution network	2018	2.51	2018	2020	
Evaluation methodology	2019	1.8	2019	2021	
Entropy weighting (physics)	2014	2.34	2020	2024	
Cloud model	2017	3.1	2021	2024	
Nationalized business	2014	2.77	2021	2024	
Investment Management	2021	1.98	2021	2024	
Investment decision	2016	2	2022	2024	

Notes: it can be derived from the distribution of mutability keywords.

Source: own calculations.

(1) From 2014 to 2016, the primary areas of concern in the academic world centred on domains such as science, technology, and investment projects. In the context of the historical era, this period is characterised by a rapid advancement in the domains of science and technology, with a particular emphasis on innovation. The engineering discipline, characterised by its capital-intensive nature, technology clustering, and other distinctive attributes, is driven by the imperative to enhance industrial processes through the integration of advanced technologies. The focus of academia on the study of science and technology, as well as investment, has the potential to facilitate the engineering field's transformation and application of high-tech results, thereby promoting technological innovation. The current research direction of theoretical research for post-project evaluation primarily concentrates on problem-solving and the development of project evaluation methods. These methods are targeted at water conservation projects, wind power projects, and other projects with significant technical demands and limited construction experience, with the objective of facilitating the advancement of engineering practice and discipline theory in a reciprocal manner. The post-project evaluation system incorporates the terms 'environmental symbiosis' and 'sustainable', thereby reflecting the prevailing low-carbon and energy-saving context. The engineering field has assumed the social responsibility of maintaining sustainable development and actively practising the call for green development. In addition, it has established an evaluation system to supervise the implementation of responsibility in the specific implementation process.

(2) From 2016 to 2018, research focused predominantly on economic areas, including economic efficiency and project investment. The global economy was facing several challenges, which led to an increased focus on economic issues within the engineering field. In light of the effective promotion of the 'One Belt, One Road' initiative, certain nations have also augmented their infrastructure constructions, including Russia's infrastructure improvement program, India's 'smart city' project, and highway, railway, and port construction in select African countries. Such initiatives have precipitated a shift in the engineering field's focus towards local and foreign investments, resulting in alterations to post-project evaluations.

(3) From 2016 to 2021, the mutability keywords were characterised by a reduction in duration and an increase in frequency. In addition to the aforementioned hotspots, the 'evaluation method' emerged in the summary of mutability keywords for the first time as an emerging buzzword. The accelerated rate of keyword iteration and the rapid progression indicate that this period has entered the phase of rapid development in post-project evaluation, with an increasing number of scholars undertaking post-evaluation research from a more expansive perspective. Conversely, the emergence of the 'evaluation method' signifies a gradual shift in the research perspective of scholars towards a more theoretical dimension. Consequently, there has been an increased emphasis on scientific evaluation methodologies within this field.

(4) From 2020 to 2024, the buzzwords 'entropy weight method' and 'cloud model' provide further support for the aforementioned analysis on the introduction of more scientific evaluation methods into the research. Concurrently, the terms 'state-owned enterprises', and 'investment' will be introduced into this field. The advent of 'state-owned enterprises', 'investment management', and 'investment decision-making' underscores the characteristics of the engineering field and the field of post-evaluation, aligning with prevailing trends. This period is characterised by the onset of an epidemic, followed by a post-epidemic phase, during which the overall economic development of our society has undergone a marked decline. In such an environment, the following issues must be addressed: the realisation of the economy of the project; the reflection of the rationality of the investment; the effective achievement of cost reduction and efficiency; and the role of state-owned enterprises in the economic weakness of the national economy, leading and activating the role of the majority of enterprises and academics. These issues have become the focal point of research.

3.1.4 Clustering Time Zone Analysis

Keyword clustering is a common method of analysing hotspots and future trends within a specific field. Reasonable clustering has been shown to transform excessive disordered text data into a logical and visual form, such as a word cloud or correlation diagram. This facilitates the summarisation and presentation of the information, and helps to identify the concentration pattern of information data and the development trend of the field over time. One such approach involves clustering hot words in the field of post-project evaluation and arranging them in chronological order to form a time-zone word cloud (*Figure 3*).
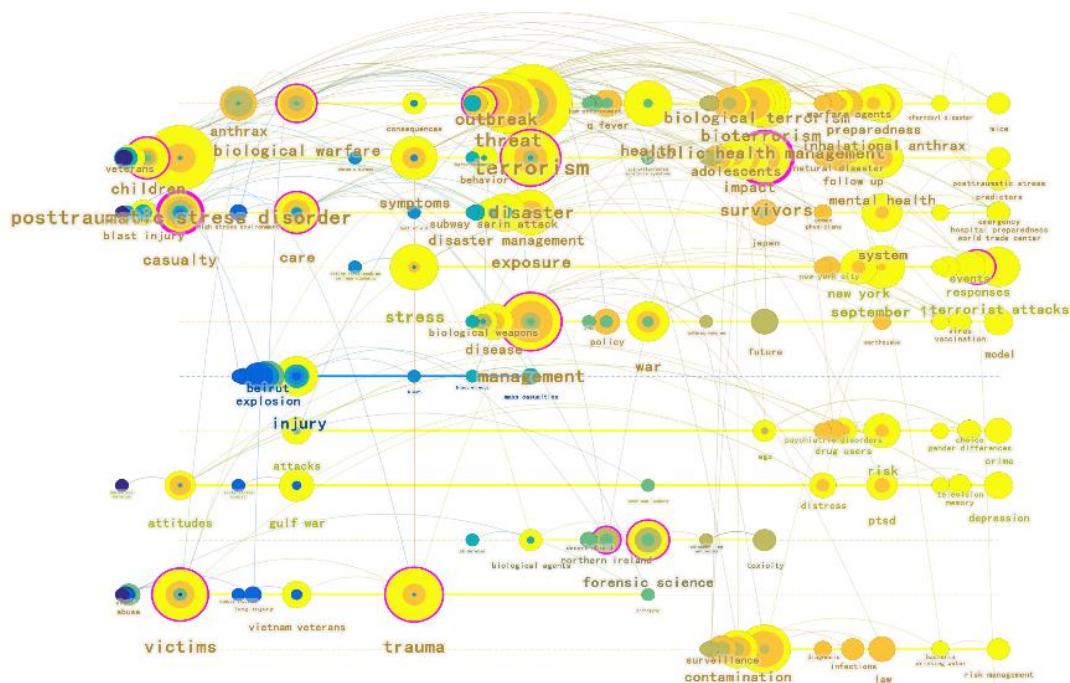
Source: as illustrated in *Table 2*, nine distinct clusters have been identified, namely '#0.

Figure 3. **Clustered Time Zone Word Cloud**

Post-evaluation', '#1 Construction project', '#2 Indicator system', '#3 Environmental impact', '#4 Economic benefit', '#5 Investment project', '#6 Engineering project', '#7 Investment management', '#8 Planning'. The lines that connect the dots within each cluster demonstrate the fluctuations in research hotspots within the cluster. The linking lines between clusters demonstrate cross-references or cross-studies between various clusters.

Table 2. Clustered Time Zone Word Cloud Table

Serial Number	Keywords
#0	Post-evaluation
#1	Construction Project
#2	Indicator System
#3	Environmental Impact
#4	Economic Benefit
#5	Investment Project
#6	Engineering Project
#7	Investment Management
#8	Planning

Source: own calculations.

As illustrated in the figure, the search keyword '#0 Post-evaluation' exhibits the highest number of subclusters within its domain. The scope encompasses specific implementation projects, including 'comprehensive evaluation of small and medium-sized rivers' and 'Jiangxi petrochemical project', as well as research methods such as 'game theory' and 'traffic simulation'. Research methodologies, including game theory and traffic simulation, are extensively documented, providing a comprehensive overview of this field within a specified timeframe. The '#1 Construction project', '#5 Investment project', and '#6

Engineering project' are not only the primary application scenarios of the post-project evaluation index system, but also reflect the specific operation process of post-project evaluation. The '#2 Indicator system' is not only the primary application scenario of the post-project evaluation index system, but it also reflects the specific operation process of post-project evaluation, i.e. summarising the experience through post-project evaluation of engineering or construction projects, which can be used to guide investment projects beforehand. The '#2 Indicator system' is a quantitative method that is frequently employed in post-evaluation, with the purpose of quantifying the objectives, results, and benefits of the project. It does this by constructing evaluation standards in this manner, thus providing clear standards and bases for the evaluation work, and helping to avoid subjective and arbitrary evaluations.

Conversely, '#3 Environmental impact' and '#4 Economic benefits' signify the prevailing and prospective trajectory of development in the domain of post-project evaluation. The growing prominence of environmental issues, the increasing awareness of social responsibility on the part of enterprises and governments, and the tightening of relevant laws and regulations have tilted the evaluation perspective towards environmental impact. However, the intrinsic requirements of enterprises to reduce costs and increase efficiency in the post-pandemic economic recovery era have elevated the priority of the evaluation of economic benefits. Consequently, the aforementioned two aspects will persist as a prominent research focus in both the corporate and academic domains at this stage of the research field.

3.2 Overview of International Research

#### 3.2.1 Temporal and Spatial Characteristics of Papers

The number of publications. This statistic is representative of the status and trends of specific disciplines. It is a reflection of the intensity of research activity within a specific field and an assessment of that field's research level within the broader discipline. The magnitude of publications in a given field is indicative of its research level and the prevalence of research outcomes. *Figure 4* illustrates the number of international publications on the topic of post-project appraisal between 2014 and 2024.
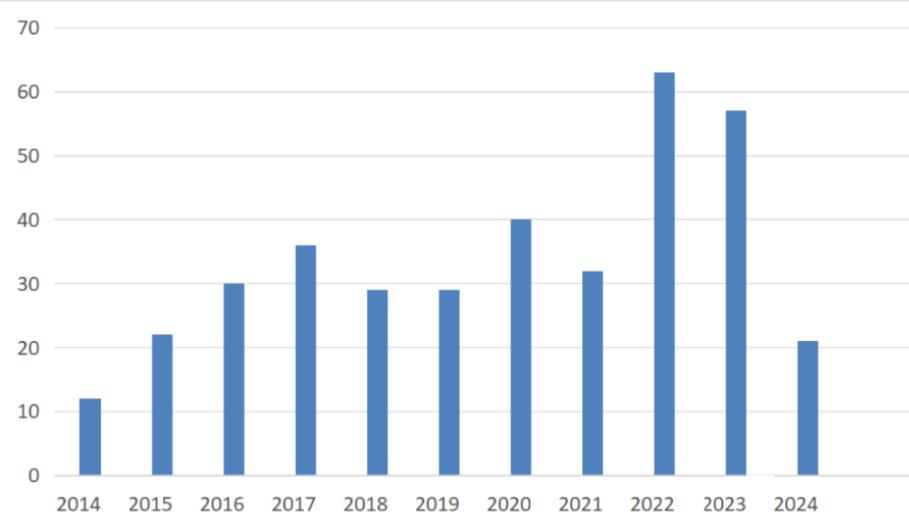
Source: created by the authors.

Figure 4. **Chronological Distribution of International Post-Project Evaluations in terms of Number of Articles Issued**

The number of international publications in this field has shown an overall upward trend (however, it should be noted that the sample size of publications in 2024 is not statistically adequate, and thus it will not be considered in this study). Internationally, the primary research results in the field of post-project evaluation can be traced back to the 1970s. Concurrently, a proliferation of global development initiatives emerged, accompanied by novel challenges of international complexity, including environmental damage, social conflicts, and economic unsustainability. In order to resolve these contradictions and to better utilise the unique advantages of international projects in terms of high volume and low regional dependency, while at the same time reducing the emergence of problems associated with them, the need for the development of the field of post-project evaluation arose. Since that time, the field has undergone significant expansion in various areas of practice and theoretical development. During the period 2014–2016, the environmental compatibility of projects became a primary focus for numerous international organisations. The question of whether projects met the requirements of sustainable development emerged as an increasingly significant component of project evaluation indices. This shift in the international perspective has also prompted a transition towards sustainability-oriented evaluation standards and methods.
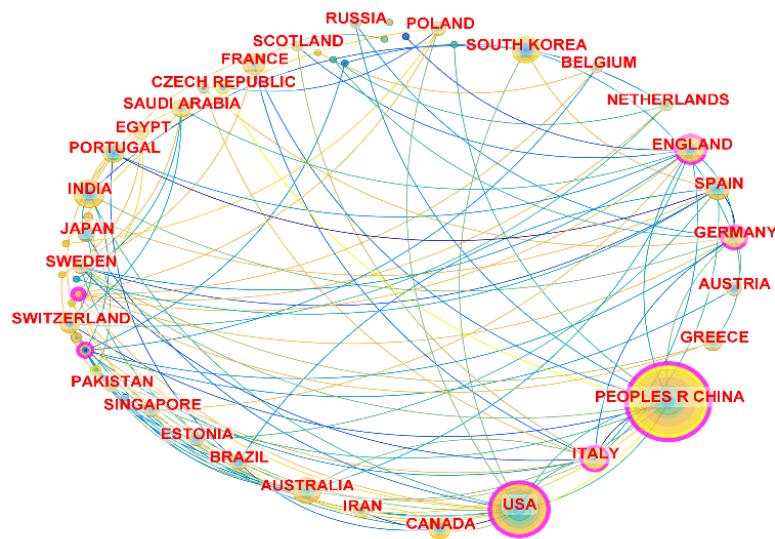

Source: created by the authors.

Figure 5. **Map of Cooperative Research Relationships between Countries**

Collaborative research relationships among different countries. *Figure 5* illustrates the cooperative research relationship between different countries (regions) in the field of post-project evaluation. In this figure, the size and colour of the nodes are used to indicate the proportion of articles issued and the time of issuance, respectively. The connecting lines represent the degree of cooperation between different countries (regions). The top three countries are China (134 articles), the United States (73 articles), and the United Kingdom (27 articles), with a proportion of 24.28%, 13.22%, and 4.89%, respectively. From the geographical perspective, the number of publications in this field is more evenly distributed across developed regions, such as Asia and Europe. While the remaining regions experience a slight disadvantage in terms of the number of publications, the cooperation and citation activities between these regions and between them and the developed regions of Asia and Europe remain relatively close. Overall, research participation is in line with the overall level of international research.

3.2.2 Major Researchers and their Representative Results

Figure 6 illustrates the main foreign and domestic scholars in this field and their mutual cooperation. In comparison to their Chinese counterparts, foreign scholars appear to demonstrate a heightened propensity to seek collaborative endeavours with a diverse range of organisations, thereby establishing larger research teams for the purpose of conducting joint research through multi-party cooperation. For instance, Wang and Fang (2023) utilised the South-to-North Water Diversion Project, incorporating public opinion into the post-project evaluation. This approach contributed to the understanding of how to conduct an ex-post evaluation of the project and study the public participation level. The study also offered suggestions for the realisation of the inclusive development of such projects. Chou and Leatemia (2016) analysed the intrinsic factors that hindered the development of evaluation in the ex-post evaluation of PPP projects in Indonesia. Descriptive statistics were used to identify the key aspects of the process, with the ultimate aim of reducing the time, cost, and resources needed for the optimised evaluation. Li *et al*. (2018) modified the prioritisation of stakeholder groups according to their responsiveness level and proposed an updated comprehensive quantitative methodology for post-occupancy assessment work. This methodology assists clients and design teams in improving their building designs by integrating stakeholders' inputs. Dikmen and Elias-Ozkan (2016) undertook a comprehensive analysis of the construction of a permanent disaster assessment of a building constructed in the rural area of Cankiri, Turkey.
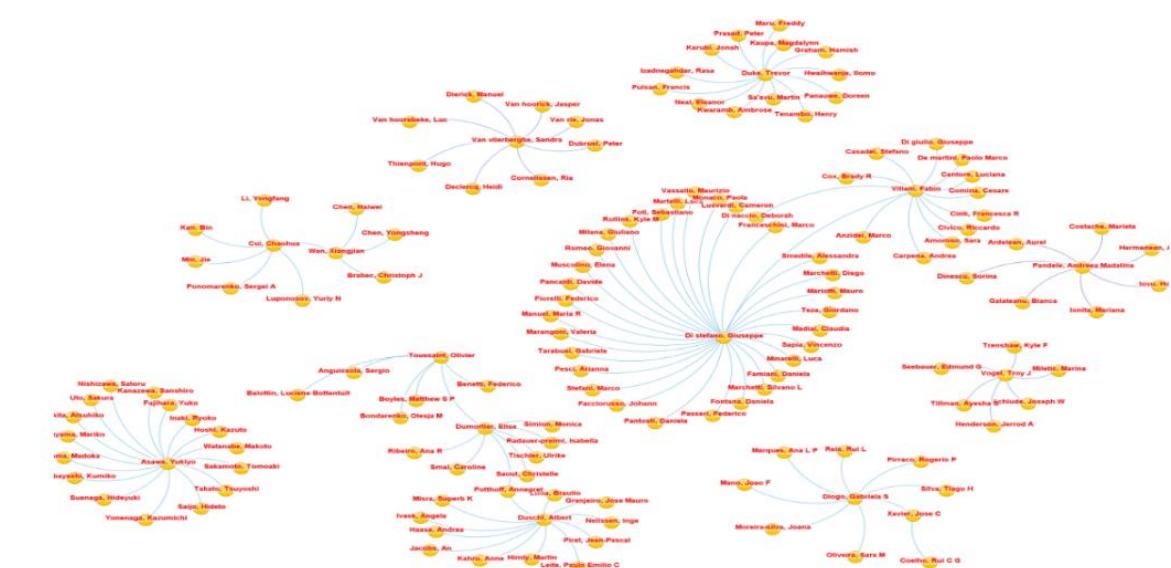

Source: created by the authors.

Figure 6. **Diagram of Main Research Scholars and Mutual Cooperation Relationship**

This pioneering study provided guidelines for subsequent post-disaster housing construction, thus laying the foundation for future research in this field. Gonzalez-Caceres *et al*. (2019) conducted a post-occupancy evaluation of a social housing complex consisting of 400 apartments located in Chile and carried out a detailed study of the aspects of moisture damage. Subsequent analysis of the data indicated that the primary factors contributing to moisture-related damage in the project were

overcrowding of space, inadequate thermal regulation of the local climate, substandard apartment design, and deficiencies and inconsistencies in the quality of construction. Xu and Zhou (2017) developed a mathematical attribute measurement model for the post-occupancy evaluation of the social aspect by integrating the quantitative relationships between different evaluation indicators. The model was employed to empirically analyse the Shanghai Bund renovation project for social ex-post evaluation, with a view to verifying the practicality and effectiveness of the established valuation index system and model.

3.2.3 Analysis of Research Hot Spots

A global research perspective on the post-project evaluation process highlights the construction of indicator systems, application scenarios, empirical guidance, and behavioural impact (see *Figure 7*).
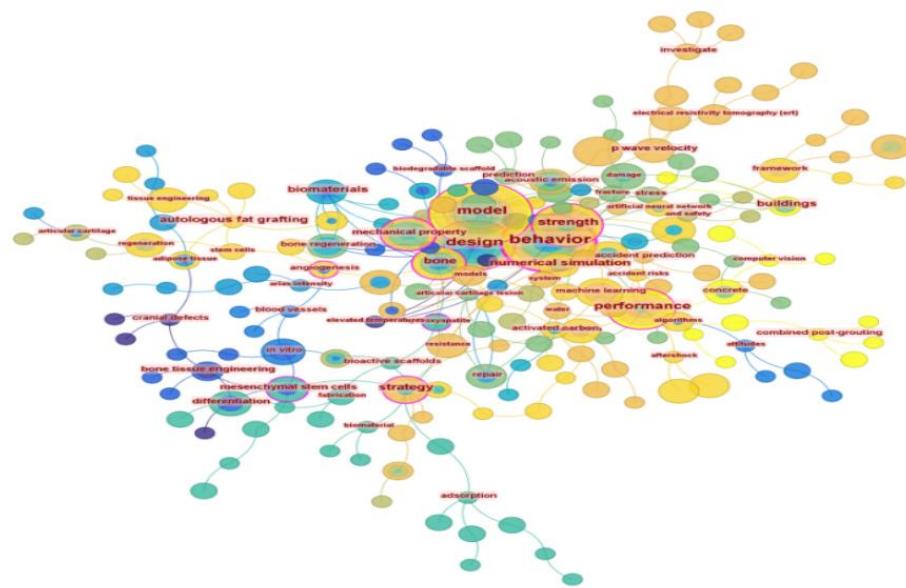
Source: created by the authors.

Figure 7. **International Research Buzzword Cloud**

As is the case with the domestic research hotspots, both of these focus on the construction of indicator systems and models. Variation in the construction process is observed. Foreign research is increasingly intertwined with emerging technologies, such as 'data simulation' and 'machine learning'. The adoption of global perspectives has led to the integration of post-project appraisal thinking into other industries, with the aim of summarising the drug-induced effects. This experience also provides a valuable foundation for informed decision-making and risk prediction in analogous projects. Consequently, international research has recently shifted its focus towards the behavioural impacts.

4. Discussion

4.1 Overall Development Evolution

4.1.1 Summary of Current Development

In accordance with the global literature on the post-project, research on post-project evaluation encompasses theoretical and empirical research. Theoretical research encompasses fundamental theories, methodologies, and applications of post-project evaluation. These include evaluation standards and index systems, the selection and application of evaluation methods, and the mechanism and impact of stakeholder participation. The related research is oriented towards theoretical exploration and methodological innovation, with a view to offering theoretical support for empirical research.

Empirical research in this field primarily explores the practical applications of post-project evaluation, with a focus on the optimisation effect of appraisal on project decision-making and the influential mechanism of stakeholder participation. Case studies are employed to support these theoretical explorations.

Domestic post-project evaluation still maintains a high degree of disciplinary inheritance, taking economics and management as the root fields and engineering as the practical position, based on which it conducts in-depth research on project economics, management efficiency, decision-making optimisation, technological feasibility, risk management, etc. Conversely, the global field of project evaluation has expanded research based on the horizontal extension of disciplinary traditions from the engineering field to the law, political science, pedagogy, medicine, etc., which offers more avenues for the application of post-project evaluation.

4.1.2 Analysis of Future Evolution

It is anticipated that research in the field of post-project evaluation will evolve in the following directions.

Evaluation focusing on environmental and social sustainability aspects. The escalating environmental crisis will necessitate the establishment of a post-evaluation standard and index system that incorporates a greater degree of ecological protection measures. In the Ivanpah Peak wind power project in California, the project owner adopted several environmental protection measures, which ultimately demonstrated positive environmental outcomes in the project evaluation. The *Environmental Impact Assessment Directive*, issued by the European Commission, stipulates the standards and procedures for evaluating the environmental impact of projects, which should be incorporated into the project's comprehensive indicators. Moreover, *the Environmental and Social Framework of the International Financial Institutions* (IFIs) stipulates that all projects receiving IFIs' financing must conduct environmental and social assessments and disclose their reports. Presently, China has issued several official policy documents on the evaluation of environmental and social sustainability of projects, such as the 'Outline for the Construction of Ecological Civilisation' and the 'Agenda for Sustainable Development 2030', which have put forward specific requirements in this regard. However, the depth and breadth of the relevant documents are slightly insufficient. It is therefore recommended that future research should constantly pay attention to the environment, socio-economy, and cultural inheritance.

Focus on stakeholder evaluation. In key infrastructure projects, stakeholder participation is highly imperative. For example, in China's highway construction, state departments, enterprises, civil entities, and other parties participate to ensure the project's sustainability. Active stakeholder participation also

improves project transparency, reducing unnecessary disputes. Therefore, realising the protection of stakeholders is a key link and the rightful meaning of post-project evaluation.

Focus on data analysis and technical support evaluation. Given the rapid development of IT and AI, engineering and other industries have faced subversive reforms. Engineering evaluation is realising the transformation from 'high quality' to 'better' and 'faster', leading to technologies beocming crucial and increasingly vital in the future post-project evaluation. Further data analysis methods can help evaluators efficiently understand the impact and risk of the project. The excessive application of AI and IoT makes the automation of data analysis more convenient.

Focus on interdisciplinary and cross-field research cooperation. In the future, post-project evaluators will pay greater attention to interdisciplinary and cross-field cooperation. In turn, evaluators must proactively explore avenues for collaboration, establishing interdisciplinary cooperation mechanisms to enhance the evaluation process. The impacts and risks of certain projects have already transcended national boundaries. Consequently, global cooperation and comparative research must be integrated into the project evaluation to develop globally unified appraisal standards.

4.2 Exploration of Integration Model

The new quality productivity is significant in promoting economic transformation. Its integration with the field of post-engineering evaluation is even more important to promote industrial upgrading, production efficiency, and employment.

4.2.1 Updating Evaluation System

The independent innovation ability is the endogenous power of the new quality productivity development. Thus, greater emphasis should be placed on the evaluation of the project's capacity for independent innovation. In the evaluation of the project, it is imperative to consider not only the conventional criteria of quality, risk, and progress, but also the necessity of actively researching and developing innovative processes. The 'evaluation content' is designed to promote the 'working method', which is intended to assist the engineering industry in its gradual transition towards a more innovation-focused approach.

4.2.2 The Evaluation and Accumulation of Experience in 'New Infrastructure'

New quality productivity is widely applied to emerging technologies that require numerous 'new infrastructures' to offer infrastructure support. Consequently, the acceleration of 5G deployment, AI, and the Internet, with the promotion of high-tech infrastructure for cloud computing centers and smart computing clusters, is a crucial step for the engineering sector. Amidst this, the introduction of post-project evaluation makes a scientific analysis of the project implementation and timely optimises project management. It can also accumulate experiences in the evaluation process to identify the key and weak points to rapidly lay new quality productivity.

4.2.3 Building an Integrated Multi-Purpose Evaluation System

The post-project evaluation system has been expanded to incorporate the concepts of 'evaluation to help utilisation' and 'evaluation to help teaching'. This has been achieved by developing a multi-faceted evaluation system based on the new quality productivity background. The purpose of this development is to guide practice and cultivate talents. The post-project evaluation system has two functions: it can serve as an 'assessment to help with utilisation' and, conversely, an 'assessment to help teach'. The

introduction of an index system and other measures can reverse the effect on talent cultivation. The system can ensure that all parties to the project understand the new quality productivity.

Conclusions

In 2023, the introduction of the new quality productivity notion resulted in extensive reforms in industrial sectors. It has become imperative to establish a sustainable development trajectory for various industries by effectively integrating the implementation of new quality productivity standards in the new era. From the standpoint of new quality productivity, this study examines the sustainable development path of post-evaluation of engineering projects. The CiteSpace and Bibliometric mapping visualisation tools are utilised to analyse the understudied relationship. This study provides practical and theoretical implications for the post-project appraisal of engineering projects, which are based on the new quality productivity.

The key implications of this study are as follows. Research in the post-project evaluation focuses on social and ecological sustainability aspects, since the increasingly severe ecological consequences force the post-appraisal systems to incorporate more environmental protection measures. A notable disadvantage inherent to field development is the absence of comprehensive analysis of the interactions and influential mechanisms within the segmentation field when conducting program evaluation. The issue of a highly homogenous research viewpoint on interactions remains, though post-project appraisals increasingly stress the assessment of social governance and stakeholder involvement. Consequently, the focus of researchers and policy-makers has shifted to stakeholder evaluation, as stakeholder engagement is of paramount importance in major infrastructure projects. In the context of rapid advancements in AI and IT, engineering industries have undergone extensive subversive reforms. It is imperative to allocate adequate attention to the analysis of data and the evaluation of technical support. In China, small-scale groups still represent the mainstream platform for conducting research in the domain of post-project evaluations. However, these groups exhibit a low level of mutual cooperation and interaction. In contrast, the engineering field is gradually evolving into a multidimensional field. In light of the increasing ecological complexity, it has become impractical to thoroughly evaluate the risks associated with projects using a single field evaluation method. Consequently, this study also suggests that essential measures should be taken to strengthen interdisciplinary research cooperation. In order to develop globally uniform standards of post-project appraisal, it is also essential to integrate comparative research and international cooperation into the project evaluations.

The following research limitations must be noted. The lack of an in-depth comprehension of the interactions within the segmentation field may lead to limited evaluation outcomes. The evaluation results may become unreliable due to the failure to understand the influential mechanism. The derived conclusions may be impacted when the interactions between diverse factors cannot be recognised, thereby leading to wrongful decisions. Further studies may emphasise promoting knowledge exchange between different fields to effectively comprehend the interactions within segmented fields. Likewise, future studies may use advanced models to study influential mechanisms to more precisely evaluate the project's sustainability path. A more homogeneous research context fails to match new features of the engineering field's complex domain. In addition, small research teams are unable to have multidisciplinary expertise.

In the future, studies should focus on developing a joint evaluation system by connecting different organisations and integrating them based on their expertise fields. Such studies ensure effective post-evaluations in the context of new quality productivity. The homogenous research perspective of

interaction is essentially manifested in the lack of in-depth research on the interaction between stakeholders when assessors evaluate social governance and stakeholders' engagement. Future studies may assert the appraisers to uncover the interactions between diverse stakeholders and the engagements between various levels of social governance, as various stakeholders may be involved in the project implementation process.

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TVARUS VERTINIMO VYSTYMAS PASIBAIGUS PROJEKTUI: NAUJOJO KOKYBĖS PRODUKTYVUMO PERSPEKTYVA

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Santrauka. 2023 m. pradėjus taikyti naujojo kokybės produktyvumo koncepciją, įvairiose pramonės šakose kilo plataus masto reformų banga. Pastaruoju metu efektyvus naujojo kokybės produktyvumo priemonių integravimas tapo dideliu iššūkiu siekiant pramonės plėtros. Remiantis naujojo kokybės produktyvumo kontekstu, šiame straipsnyje taikomi „CiteSpace" ir bibliometrinio planavimo vizualizacijos ir analizės metodai. Siekiant ištirti tvarias inžinerinių projektų vertinimo pasibaigus projektui vystymo strategijas, šie metodai suteikia teorinį pagrindą ir leidžia formuluoti praktinius pasiūlymus, skirtus tvariai vystyti tokius projektus.

Reikšminiai žodžiai: naujas kokybės produktyvumas; vertinimas pasibaigus projektui; CiteSpace, bibliometrinis planavimas.