

The Determinants of Renewable Energy Project Delays; A Systematic Review

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Abstract: *The rapid expansion of renewable energy projects has become essential for achieving global sustainability goals, reducing greenhouse gas emissions, and improving energy security. Despite increasing investments in renewable energy infrastructure, many projects continue to experience significant delays during planning, financing, construction, and operational stages. These delays negatively affect project performance, increase implementation costs, reduce investor confidence, and hinder national energy transition objectives. Therefore, understanding the determinants contributing to renewable energy project delays is critical for improving project delivery efficiency and sustainability outcomes. This study systematically reviews the major determinants influencing renewable energy project delays by synthesizing evidence from existing academic literature. A systematic review methodology was adopted to identify, evaluate, and analyze peer-reviewed studies related to renewable energy project implementation challenges and delay factors. Following the application of predefined inclusion and exclusion criteria, 20 studies published between 2020 and 2025 were selected and analyzed. The findings revealed that renewable energy project delays are influenced by interconnected financial, regulatory, technical, managerial, stakeholder-related, and external factors. Financial constraints such as inadequate funding, high capital costs, and investment uncertainty were identified as major delay determinants. Regulatory barriers, including bureaucratic approval procedures and unstable governmental policies, also significantly affected project implementation. In addition, technical limitations, poor project planning, ineffective stakeholder coordination, and inadequate risk management practices contributed substantially to implementation inefficiencies. Social factors such as public opposition and limited community engagement further influenced project continuity, while external disruptions, particularly the COVID-19 pandemic, intensified project vulnerabilities through supply chain interruptions and operational challenges. The study concludes that renewable energy project delays require integrated management approaches involving effective financial planning, stable regulatory frameworks, stakeholder collaboration, and adaptive risk management strategies. The findings provide valuable insights for policymakers, project managers, investors, and researchers seeking to improve renewable energy project implementation and sustainability performance.*

Keywords: Renewable Energy Projects; Project Delays; Systematic Review; Renewable Energy Management; Stakeholder Challenges.

1. Introduction

The global transition toward renewable energy has become one of the most important priorities within contemporary sustainable development agendas. Increasing concerns regarding climate change, greenhouse gas emissions, environmental degradation, and the depletion of fossil fuel resources have accelerated international efforts to expand renewable energy generation and reduce dependence on conventional energy systems (Breyer et al., 2022). Governments, international organizations, and private investors have increasingly promoted renewable energy technologies such as solar, wind, hydropower, biomass, and geothermal systems as essential solutions for achieving environmental sustainability, energy security, and long-term economic resilience. In recent years, rapid technological advancements, declining production costs, supportive policy frameworks, and global carbon neutrality commitments have significantly contributed to the expansion of renewable energy projects across both developed and developing economies (Wang et al., 2023). Renewable energy projects play a vital role in supporting sustainable economic growth and improving national energy infrastructure. Beyond their environmental benefits, renewable energy systems contribute to employment generation, rural electrification, industrial development, and enhanced energy accessibility, particularly in emerging economies and remote regions with limited access to conventional power systems (Benti et al., 2022). Furthermore, the growth of renewable energy investments has become closely associated with green economic transformation and sustainable finance initiatives aimed at facilitating low-carbon development pathways and improving environmental performance (Zhang et al., 2021). Consequently, renewable energy deployment has emerged as a strategic component of national development policies and global sustainability frameworks.

Despite the substantial growth and increasing importance of renewable energy projects worldwide, project implementation continues to face numerous challenges that affect delivery performance and operational efficiency. Among these challenges, project delay remains one of the most critical and persistent issues within the renewable energy sector. Renewable energy projects frequently experience delays during planning, licensing, financing, procurement, construction, commissioning, and operational stages. Such delays often result in cost overruns, contractual disputes, reduced investor confidence, productivity losses, and disruptions to national renewable energy targets and sustainability objectives (ElHamahmy et al., 2025). In many cases, prolonged delays negatively affect project feasibility and may ultimately lead to project suspension or complete failure. The determinants contributing to renewable energy project delays are highly complex and multidimensional. Existing studies indicate that delays are influenced by the interaction of technical, managerial, financial, regulatory, environmental, and socio-political factors. Financial barriers, inadequate investment mechanisms, unstable regulatory policies, bureaucratic approval procedures, and insufficient infrastructure have been identified as significant obstacles affecting renewable energy project implementation and continuity (Obuseh et al., 2025; Othman & Khallaf, 2022). In addition, technological limitations, poor project planning, ineffective communication, weak stakeholder coordination, and inadequate risk management practices have been widely recognized as major contributors to project delays and implementation inefficiencies (Maqbool et al., 2020).

Social acceptance has also emerged as an essential determinant influencing renewable energy project progress and continuity. Public opposition, land-use conflicts, local resistance, and dissatisfaction with decision-making processes frequently contribute to delays in renewable energy project implementation, particularly in large-scale infrastructure developments (Segreto et al., 2020). Susskind et al. (2022) emphasized that social opposition toward renewable energy projects often arises from concerns related to environmental impacts, community participation, fairness, and trust

in governing institutions. Similarly, Zaharuddin et al. (2025) highlighted that local acceptance, stakeholder engagement, and community perceptions significantly influence the success and timely completion of renewable energy initiatives. These findings demonstrate that renewable energy project delays cannot be explained solely through technical or financial dimensions but must also consider broader social and institutional dynamics. External disruptions and global uncertainties have further intensified the vulnerability of renewable energy projects to delays and implementation challenges. The COVID-19 pandemic, for example, exposed major weaknesses in global supply chains, workforce availability, logistics systems, and procurement processes within the energy sector (Elavarasan et al., 2020). These disruptions significantly affected project schedules, material transportation, labor productivity, and construction activities across many renewable energy developments worldwide. Such circumstances demonstrated the importance of resilient project management approaches and adaptive implementation strategies capable of mitigating unexpected risks and ensuring project continuity under uncertain conditions.

Although previous studies have extensively examined renewable energy adoption, deployment barriers, technology integration, social acceptance, and critical success factors, limited attention has been devoted specifically to synthesizing the determinants of renewable energy project delays through a comprehensive systematic review approach. Existing reviews often focus on isolated issues such as financing barriers, policy frameworks, stakeholder acceptance, or technological development without providing an integrated understanding of the multifaceted factors contributing to delays throughout the renewable energy project lifecycle (Kunsakja & Pažèraitė, 2025; Ferdous & Barman, 2025). Consequently, there remains a significant research gap concerning the systematic identification and classification of delay determinants affecting renewable energy projects. Therefore, this study aims to systematically review the determinants of renewable energy project delays by synthesizing evidence from existing academic literature. The study seeks to identify the most significant delay factors, classify them into major thematic categories, and analyze their implications for project performance and implementation efficiency. By developing a comprehensive understanding of these determinants, the study contributes to improving project planning practices, strengthening risk management strategies, enhancing stakeholder engagement, and supporting policy development for more effective and sustainable renewable energy project implementation.

2. Methodology

This study adopted a systematic review approach to identify, analyze, and synthesize the determinants contributing to delays in renewable energy projects. The systematic review methodology was selected because it provides a structured and transparent process for collecting, evaluating, and interpreting existing academic literature related to a specific research topic. Through this approach, the study aimed to develop a comprehensive understanding of the major factors influencing renewable energy project delays across different geographical regions, project types, and implementation environments. The review process was conducted through a comprehensive search of relevant academic literature published in peer-reviewed journals, conference proceedings, and scholarly databases. The literature search focused on studies related to renewable energy project implementation, project delays, renewable energy barriers, stakeholder management, project risk factors, and sustainability challenges. Multiple search strings and keyword combinations were used to ensure broad coverage of the topic. The primary keywords included “renewable energy projects,” “project delays,” “delay factors,” “renewable energy barriers,” “project management,” “stakeholder challenges,” and “implementation risks.” These keywords were combined using Boolean operators such as AND and OR to improve the accuracy and relevance of the search results.

The article selection process followed a systematic screening procedure, as illustrated in Figure 1. Initially, 156 articles were identified through the first search string, while an additional 90 articles were identified through the second search string. After removing 39 duplicate records, a total of 207 articles were retained for further evaluation. The titles, abstracts, and full texts of the identified studies were subsequently screened based on predefined inclusion and exclusion criteria. During this stage, 187 articles were excluded because they did not directly address renewable energy project delays or lacked sufficient relevance to the objectives of the study. Consequently, 20 articles were finally selected and included in the systematic review. The inclusion criteria focused on peer-reviewed studies published in English that examined renewable energy projects and discussed factors influencing project implementation delays, barriers, stakeholder challenges, project risks, or sustainability issues. Studies addressing solar, wind, hydropower, biomass, geothermal, and other renewable energy technologies were considered relevant for inclusion. In contrast, articles unrelated to renewable energy project implementation, studies lacking sufficient methodological rigor, non-academic publications, and duplicate studies were excluded from the review process.

The selected studies were analyzed using qualitative content analysis to identify recurring themes and major determinants associated with renewable energy project delays. The extracted factors were systematically categorized into thematic groups, including financial factors, technical factors, regulatory and policy-related factors, stakeholder and social factors, managerial and organizational factors, and external environmental factors. This thematic classification enabled the identification of the most frequently reported delay determinants and facilitated a comprehensive synthesis of the existing literature.

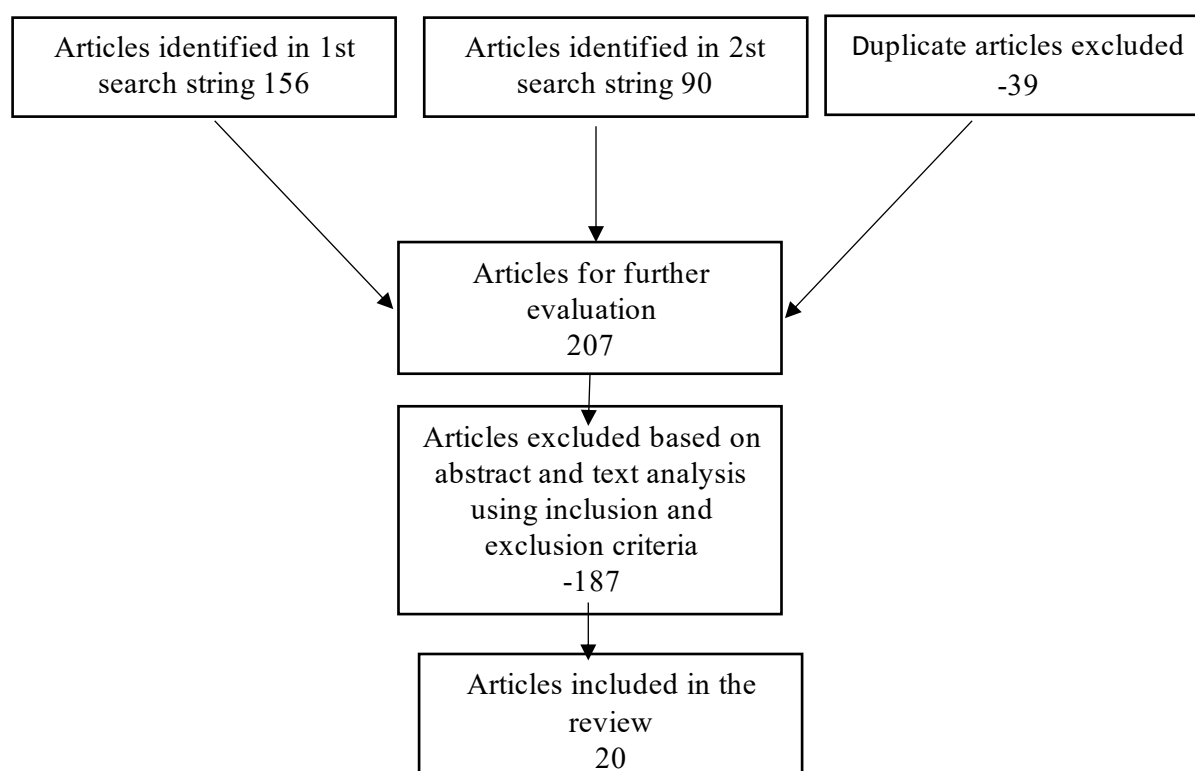


Figure 1. Systematic review article selection and screening process.

The adopted methodology enhances the reliability and transparency of the review by applying a structured article selection process and clear evaluation criteria. Furthermore, the systematic synthesis of previous studies provides a strong foundation for understanding the multifaceted determinants affecting renewable energy project delays and supports the development of recommendations for improving project implementation and management practices within the renewable energy sector.

3. Results

3.1 Descriptive Analysis of the Reviewed Studies

The descriptive analysis provides an overview of the studies included in the systematic review and highlights the general characteristics of the selected literature related to renewable energy project delays. A total of 20 studies were selected and analyzed following the application of the inclusion and exclusion criteria described in the methodology section. The selected studies represent diverse perspectives on renewable energy project implementation and cover multiple dimensions associated with project delays, including financial barriers, policy challenges, stakeholder conflicts, technological limitations, managerial inefficiencies, and social acceptance issues. The classification of the reviewed studies according to the major determinant categories is presented in Table 1. The reviewed studies were published between 2020 and 2025, indicating growing academic interest in renewable energy project implementation challenges in recent years. The increasing number of publications during this period reflects the rapid expansion of renewable energy investments worldwide and the corresponding need to address implementation risks and project delivery challenges. Recent studies particularly emphasized the importance of sustainability, stakeholder engagement, risk management, and policy stability in improving renewable energy project performance (ElHamahmy et al., 2025; Zaharuddin et al., 2025).

The selected literature covered multiple renewable energy technologies, including solar energy, wind energy, hydropower, biomass, and integrated renewable energy systems. However, solar and wind energy projects were the most frequently discussed technologies in the reviewed studies due to their widespread global adoption and increasing infrastructure investments. Several studies also focused on renewable energy systems within developing countries and emerging economies, where implementation challenges are often intensified by financial limitations, regulatory uncertainty, and institutional weaknesses (Obuseh et al., 2025). Geographically, the reviewed studies represented a broad international distribution. Some studies focused on Europe and the United States, particularly regarding public opposition, social acceptance, and policy-related challenges affecting renewable energy projects (Segreto et al., 2020; Susskind et al., 2022). Other studies examined renewable energy implementation challenges in developing regions, including Asia, Africa, and the Middle East, where inadequate infrastructure, financing constraints, and governance issues significantly affect project delivery efficiency (Othman & Khallaf, 2022). This geographical diversity enhances the comprehensiveness of the review and provides broader insights into the determinants of renewable energy project delays across different socio-economic and institutional environments.

The reviewed studies employed various research methodologies, including systematic reviews, case studies, qualitative analyses, quantitative analyses, and mixed-method approaches. Systematic review studies were particularly useful for identifying recurring implementation barriers and synthesizing existing knowledge related to renewable energy deployment challenges (Kunskaja & Pažėraitė, 2025; Ferdous & Barman, 2025). In contrast, empirical studies and case analyses provided practical insights into real-world project implementation experiences and highlighted the operational difficulties encountered during renewable energy project execution. The literature also demonstrated significant

variation in research focus and analytical perspectives. As illustrated in Table 1, financial, regulatory, and technical determinants were the most frequently discussed factors across the reviewed studies, reflecting their critical influence on renewable energy project implementation. Several studies concentrated primarily on financial and policy barriers affecting renewable energy development, while others emphasized stakeholder satisfaction, social acceptance, technological deployment, or project management practices. For example, Maqbool et al. (2020) highlighted the importance of stakeholder satisfaction and critical success factors in renewable energy projects, whereas Segreto et al. (2020) and Susskind et al. (2022) focused extensively on social acceptance and public opposition as critical influences on project continuity and implementation efficiency.

The descriptive analysis reveals that renewable energy project delays are multidimensional phenomena influenced by interconnected technical, financial, managerial, regulatory, and social factors. The diversity of the reviewed studies summarized in Table 1 provides a comprehensive foundation for identifying the major determinants contributing to project delays and supports the thematic analysis presented in the following section.

No.	Author(s) and Year	Financial Factors	Regulatory & Policy Factors	Technical Factors	Managerial Factors	Stakeholder & Social Factors	External Factors
1	Kunsakja & Pažėraitė (2025)	✓	✓	✓	✓	✓	
2	Obuseh et al. (2025)	✓	✓	✓	✓	✓	✓
3	Wang et al. (2023)	✓	✓	✓			
4	Maqbool et al. (2020)				✓	✓	
5	Zaharuddin et al. (2025)		✓			✓	
6	Othman & Khallaf (2022)	✓	✓	✓	✓	✓	
7	Segreto et al. (2020)		✓			✓	
8	Wuni et al. (2022)	✓		✓	✓		✓
9	Susskind et al. (2022)		✓			✓	
10	Lak Kamari et al. (2020)	✓	✓	✓	✓		
11	ElHamahmy et al. (2025)	✓	✓	✓	✓	✓	✓
12	Pelt (2025)		✓			✓	
13	Marzouk (2025)	✓	✓	✓	✓		✓
14	Tsagkari (2022)		✓		✓	✓	
15	Breyer et al. (2022)	✓	✓	✓			✓
16	Ferdous & Barman (2025)	✓	✓	✓	✓	✓	✓
17	Elavarasan et al. (2020)	✓		✓	✓		✓
18	Zhang et al. (2021)	✓	✓				✓
19	Li et al. (2023)	✓	✓	✓			
20	Benti et al. (2022)	✓		✓	✓		

3.2 Major Determinants of Renewable Energy Project Delays

The findings of the reviewed studies indicate that renewable energy project delays are influenced by multiple interconnected determinants that collectively affect project planning, implementation, and operational performance. The analysis revealed that financial, regulatory, technical, managerial, social, and external factors represent the most significant contributors to delays in renewable energy projects. These determinants vary across geographical regions, project scales, and renewable energy technologies; however, several recurring patterns were consistently identified throughout the literature. Financial factors emerged as one of the most frequently reported determinants affecting renewable energy project implementation. Many renewable energy projects require substantial initial capital investments, making financing availability and economic stability critical components for successful project execution. Several studies emphasized that insufficient funding, limited access to investment, high capital costs, inflation, and unstable financial support mechanisms significantly contribute to project delays (Obuseh et al., 2025; Wang et al., 2023). Financial uncertainty often affects procurement processes, contractor performance, equipment acquisition, and construction schedules, particularly in developing countries where renewable energy financing mechanisms remain relatively underdeveloped. In addition, fluctuations in material prices and inadequate financial planning further increase implementation risks and delay project completion timelines.

Regulatory and policy-related factors were also widely identified as major determinants of renewable energy project delays. The reviewed literature highlighted that bureaucratic approval procedures, inconsistent energy policies, regulatory uncertainty, and lengthy licensing processes frequently hinder project implementation and reduce investor confidence (Othman & Khallaf, 2022). In many countries, renewable energy developers encounter delays associated with land acquisition approvals, environmental permits, grid connection authorizations, and changes in governmental regulations. Studies further indicated that unstable policy environments and the absence of long-term renewable energy strategies negatively affect project continuity and discourage private sector participation (Kunskaja & Pažeraitė, 2025). Consequently, effective regulatory frameworks and policy consistency are essential for improving project delivery efficiency within the renewable energy sector. Technical determinants also played a significant role in influencing renewable energy project delays. Several studies reported that technological limitations, inadequate infrastructure, equipment failures, and integration difficulties contribute substantially to implementation challenges (Li et al., 2023). Renewable energy projects often rely on advanced technologies and specialized infrastructure that require technical expertise, reliable supply chains, and effective maintenance systems. In some cases, delays occur due to insufficient grid infrastructure, limited technological compatibility, and operational inefficiencies during system installation and commissioning. Furthermore, rapidly evolving renewable energy technologies may create additional implementation complexities related to technical adaptation, training requirements, and system integration processes.

Managerial and organizational factors were consistently identified as critical contributors to project delays across the reviewed studies. Poor project planning, ineffective communication, inadequate coordination among stakeholders, weak leadership, and insufficient risk management practices frequently undermine project implementation efficiency (Maqbool et al., 2020). Renewable energy projects typically involve multiple stakeholders, including governments, private investors, contractors, engineers, local communities, and regulatory authorities. Ineffective coordination among these actors often creates misunderstandings, contractual disputes, scheduling conflicts, and decision-making delays. Additionally, several studies emphasized that deficiencies in project monitoring, resource allocation, and strategic management negatively affect construction progress and operational readiness (ElHamahmy et al., 2025). Stakeholder and social factors also emerged as major

determinants affecting renewable energy project continuity and implementation performance. Public opposition, local resistance, land-use conflicts, and limited stakeholder engagement were frequently reported as key sources of delay in renewable energy developments (Segreto et al., 2020; Susskind et al., 2022). The reviewed literature demonstrated that community acceptance significantly influences the success of renewable energy projects, particularly in large-scale infrastructure developments such as wind farms and hydropower facilities. In many cases, delays arise when local communities perceive renewable energy projects as environmentally harmful, socially unfair, or economically exclusionary. Studies further highlighted that inadequate public participation and weak communication strategies often intensify distrust between project developers and local stakeholders (Zaharuddin et al., 2025). Therefore, social acceptance and stakeholder satisfaction represent essential components for improving implementation efficiency and minimizing project delays.

External factors were additionally identified as important determinants influencing renewable energy project delays. Global crises, supply chain disruptions, political instability, economic uncertainty, and environmental conditions frequently affect project implementation schedules and operational performance. The COVID-19 pandemic was particularly highlighted as a major external disruption that negatively affected renewable energy projects worldwide through labor shortages, transportation restrictions, procurement interruptions, and construction delays (Elavarasan et al., 2020). Similarly, geopolitical conflicts, inflationary pressures, and fluctuations in global energy markets have created additional uncertainties that influence renewable energy project execution. These findings demonstrate the importance of resilient project management strategies capable of adapting to unexpected external disruptions and maintaining project continuity under uncertain conditions. The reviewed literature demonstrates that renewable energy project delays are multidimensional phenomena shaped by the interaction of financial, regulatory, technical, managerial, social, and external determinants. Although some factors appear more dominant within specific regional or technological contexts, the findings suggest that project delays typically result from the combined effects of multiple interconnected challenges rather than isolated individual factors. Consequently, addressing renewable energy project delays requires integrated management approaches, effective policy frameworks, stakeholder collaboration, financial stability, and adaptive implementation strategies capable of responding to both internal and external project risks.

4. Discussion

The findings of this systematic review demonstrate that renewable energy project delays are influenced by a complex combination of financial, regulatory, technical, managerial, social, and external determinants. The reviewed studies collectively indicate that project delays cannot be attributed to a single factor; rather, they emerge from the interaction of multiple interconnected challenges that affect different stages of renewable energy project implementation. This finding aligns with previous renewable energy literature emphasizing the multidimensional nature of infrastructure project risks and implementation barriers (Kunskaja & Pažeraitė, 2025; Obuseh et al., 2025). One of the most significant findings of this review is the dominant influence of financial factors on renewable energy project performance. Financial barriers were among the most frequently reported determinants across the reviewed studies, particularly in developing economies where access to investment and funding mechanisms remains limited. The findings suggest that renewable energy projects are highly sensitive to capital availability, investment stability, and economic uncertainty due to the substantial upfront costs associated with renewable energy infrastructure. This observation supports the findings of Wang et al. (2023), who argued that financial support mechanisms and economic conditions strongly influence renewable energy development and deployment. Furthermore, unstable financing

environments may increase project vulnerability to procurement delays, contractual disputes, and implementation inefficiencies.

The review also highlights the critical role of regulatory and policy-related determinants in shaping renewable energy project implementation. Bureaucratic approval procedures, inconsistent governmental regulations, and policy instability were repeatedly identified as major contributors to delays. These findings indicate that renewable energy projects require stable institutional environments and efficient regulatory systems to ensure timely implementation. Othman and Khallaf (2022) similarly emphasized that ineffective policy frameworks and administrative complexities significantly undermine renewable energy project success. In many developing countries, weak governance structures and prolonged approval processes continue to hinder project execution and discourage private sector investment. Therefore, regulatory reform and long-term policy consistency are essential for accelerating renewable energy deployment and minimizing implementation delays. Technical and infrastructural limitations also emerged as important determinants affecting project continuity and operational efficiency. The reviewed studies demonstrated that renewable energy projects often face implementation challenges associated with technological complexity, inadequate infrastructure, insufficient technical expertise, and integration difficulties. These findings are consistent with the observations of Li et al. (2023), who highlighted the growing technological demands associated with clean energy systems and innovation processes. The dependence on advanced technologies and specialized equipment increases the importance of technical planning, infrastructure readiness, and supply chain reliability in renewable energy project management.

Another important finding concerns the influence of managerial and organizational factors on renewable energy project delays. Ineffective project planning, poor communication, weak coordination among stakeholders, and inadequate risk management practices were repeatedly identified across the reviewed literature. These findings suggest that managerial capabilities play a crucial role in determining project implementation efficiency and overall project performance. Maqbool et al. (2020) emphasized that stakeholder satisfaction and effective project governance are essential components of successful renewable energy project delivery. Similarly, ElHamahmy et al. (2025) argued that sustainable project management practices are necessary for improving infrastructure resilience and implementation outcomes within renewable energy sectors. The findings further reveal that stakeholder and social factors significantly influence renewable energy project continuity and acceptance. Public opposition, local resistance, land-use disputes, and inadequate stakeholder engagement frequently contribute to delays, particularly in large-scale renewable energy developments. This result reinforces the arguments presented by Segreto et al. (2020) and Susskind et al. (2022), who identified social acceptance as a central challenge affecting renewable energy implementation. The review demonstrates that technical and economic feasibility alone are insufficient for ensuring project success; community trust, transparent communication, and stakeholder participation are equally important for minimizing resistance and improving implementation efficiency.

In addition, the findings emphasize the growing importance of external factors and global uncertainties in renewable energy project implementation. The COVID-19 pandemic exposed vulnerabilities within global supply chains, workforce management systems, procurement operations, and construction activities, leading to significant delays across renewable energy projects worldwide (Elavarasan et al., 2020). Economic instability, geopolitical tensions, and market fluctuations further intensified implementation risks and highlighted the necessity for adaptive and resilient project management approaches. These findings suggest that renewable energy projects require greater flexibility and contingency planning to mitigate the effects of external disruptions and maintain project continuity under uncertain conditions. The discussion demonstrates that renewable energy

project delays are multidimensional and context-dependent phenomena that require integrated management strategies and collaborative governance approaches. Addressing these delays requires the combined efforts of policymakers, investors, project managers, regulatory authorities, and local communities. The findings of this study contribute to the existing body of knowledge by providing a comprehensive synthesis of the determinants influencing renewable energy project delays and by highlighting the importance of adopting holistic approaches that simultaneously address financial, regulatory, technical, managerial, social, and external challenges.

5. Conclusion

This study systematically reviewed the major determinants contributing to delays in renewable energy projects by synthesizing evidence from 20 selected studies published between 2020 and 2025. The findings demonstrate that renewable energy project delays are complex and multidimensional phenomena influenced by the interaction of financial, regulatory, technical, managerial, social, and external factors. These determinants affect various stages of project implementation, including planning, financing, procurement, construction, commissioning, and operational integration. The review identified financial constraints as one of the most significant determinants affecting renewable energy project delivery. High capital requirements, inadequate funding mechanisms, investment uncertainty, and economic instability were repeatedly highlighted as major challenges influencing implementation efficiency. Regulatory and policy-related barriers, including bureaucratic procedures, unstable governmental policies, and lengthy approval processes, also emerged as critical factors contributing to project delays. In addition, technical limitations, infrastructure deficiencies, and technological integration challenges significantly affected project continuity and operational readiness. The findings further revealed the substantial influence of managerial and organizational factors on renewable energy project performance. Poor project planning, ineffective communication, inadequate coordination among stakeholders, and weak risk management practices frequently undermined implementation efficiency and increased project vulnerability to delays. Moreover, stakeholder and social determinants such as public opposition, local resistance, land-use conflicts, and limited community engagement were identified as major barriers affecting renewable energy project acceptance and continuity. External disruptions, particularly the COVID-19 pandemic, additionally exposed the vulnerability of renewable energy projects to supply chain interruptions, labor shortages, and global economic uncertainty.

The study highlights that renewable energy project delays cannot be addressed through isolated interventions or single-dimensional solutions. Instead, improving project implementation efficiency requires integrated management approaches that combine effective financial planning, stable regulatory frameworks, advanced technical capabilities, efficient project governance, stakeholder collaboration, and adaptive risk management strategies. Policymakers, investors, project managers, and regulatory authorities must work collaboratively to establish supportive institutional environments capable of reducing implementation barriers and enhancing renewable energy project resilience. This study contributes to the existing body of knowledge by providing a comprehensive synthesis of the determinants influencing renewable energy project delays through a systematic review approach. The findings may support future researchers, policymakers, and industry practitioners in understanding the critical challenges affecting renewable energy project implementation and in developing strategies aimed at improving project delivery performance and sustainability outcomes. Future research may further investigate the relative impact of specific delay determinants across different renewable energy technologies, geographical contexts, and project scales using empirical and quantitative approaches.

References

- Benti, N. E., Mekonnen, Y. S., Asfaw, A. A., Lerra, M. D., Woldegiyorgis, T. A., Gaffe, C. A., & Aneseyee, A. B. (2022). Techno-economic analysis of solar energy system for electrification of rural school in Southern Ethiopia. *Cogent Engineering*, 9(1), 2021838.
- Breyer, C., Khalili, S., Bogdanov, D., Ram, M., Oyewo, A. S., Aghahosseini, A., ... & Sovacool, B. K. (2022). On the history and future of 100% renewable energy systems research. *IEEe Access*, 10, 78176-78218.
- Elavarasan, R. M., Shafiullah, G. M., Raju, K., Mudgal, V., Arif, M. T., Jamal, T., ... & Subramaniam, U. (2020). COVID-19: Impact analysis and recommendations for power sector operation. *Applied energy*, 279, 115739.
- ElHamahmy, A., Gohar, H. T. H., & Galal, A. (2025). Sustainable project management in renewable energy and infrastructure projects: Challenges and opportunities. *International Journal of Engineering Research & Technology*, 14(05).
- Ferdous, Z., & Barman, S. C. (2025). A Systematic Review of Sustainable Renewable Energy Applications, Procedures, Challenges, and Limitations.
- Kunsakaja, S., & Pažeraitė, A. (2025). Determinants of renewable energy technology deployment: A systematic review. *Sustainability*, 17(23), 10538.
- Lak Kamari, M., Isvand, H., & Alhuyi Nazari, M. (2020). Applications of multi-criteria decision-making (MCDM) methods in renewable energy development: A review. *Renewable Energy Research and Applications*, 1(1), 47-54.
- Li, D., Alkemade, F., Frenken, K., & Heimeriks, G. (2023). Catching up in clean energy technologies: a patent analysis. *The Journal of Technology Transfer*, 48(2), 693-715.
- Maqbool, R., Deng, X., & Rashid, Y. (2020). Stakeholders' satisfaction as a key determinant of critical success factors in renewable energy projects. *Energy, sustainability and society*, 10(1), 28.
- Marzouk, O. (2025). Summary of the 2023 report of TCEP (tracking clean energy progress) by the International Energy Agency (IEA), and proposed process for computing a single aggregate rating. Available at SSRN 5099325.
- Obuseh, E., Eyenubo, J., Alele, J., Okpare, A., & Oghogho, I. (2025). A systematic review of barriers to renewable energy integration and adoption. *Journal of Asian Energy Studies*, 9, 26-45.
- Othman, K., & Khallaf, R. (2022). Identification of the barriers and key success factors for renewable energy public-private partnership projects: a continental analysis. *Buildings*, 12(10), 1511.
- Pelt, M. V. (2025). The Influence of Power on the Social Acceptance of Renewable Energy-A Case Study Analysis (Master's thesis).
- Segreto, M., Principe, L., Desormeaux, A., Torre, M., Tomassetti, L., Tratzi, P., ... & Petracchini, F. (2020). Trends in social acceptance of renewable energy across Europe—a literature review. *International journal of environmental research and public health*, 17(24), 9161.
- Susskind, L., Chun, J., Gant, A., Hodgkins, C., Cohen, J., & Lohmar, S. (2022). Sources of opposition to renewable energy projects in the United States. *Energy Policy*, 165, 112922.
- Tsagkari, M. (2022). Local renewable energy projects on remote islands: Impacts, ethics, and transformative potential.

- Wang, Y., Wang, D., Yu, L., & Mao, J. (2023). What really influences the development of renewable energy? A systematic review and meta-analysis. *Environmental Science and Pollution Research*, 30(22), 62213-62236.
- Wuni, I. Y., Shen, G. Q., & Mahmud, A. T. (2022). Critical risk factors in the application of modular integrated construction: a systematic review. *International Journal of Construction Management*, 22(2), 133-147.
- Zaharuddin, H. H., Alviani, V. N., Majid, M. A., Kubota, H., & Tsuchiya, N. (2025). Identifying Factors Influencing Local Acceptance of Renewable Energy Projects: A Systematic Review. *Sustainability*, 17(14), 6623.
- Zhang, D., Mohsin, M., Rasheed, A. K., Chang, Y., & Taghizadeh-Hesary, F. (2021). Public spending and green economic growth in BRI region: mediating role of green finance. *Energy policy*, 153, 112256.