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Potential Application of Lean Management Tools within the Green Project Management Framework: A Systematic Literature Review

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Abstract

Background and objective: Sustainability requirements increasingly affect the way projects are planned and delivered. Green Project Management (GPM) extends classical project management by incorporating environmental and social considerations. The objective of this study is to assess whether selected Lean Management (LM) tools can be applied within the GPM framework.

Study design: The study is based on a systematic literature review conducted in accordance with PRISMA 2020 guidelines. Publications indexed in the Scopus and Web of Science databases from 2000 to 2022 were analysed. Following the screening and eligibility assessment, 21 peer-reviewed studies were included in the qualitative synthesis. The analysis focused on identifying Lean Management tools and examining their conceptual consistency with GPM elements.

Results: The review shows that tools such as Value Stream Mapping, 5S, Kaizen routines, pull-based planning, Poka-Yoke and Jidoka are conceptually compatible with selected aspects of GPM, particularly those related to waste reduction and process transparency. In contrast, tools designed for high-volume manufacturing, including Heijunka, Andon and SMED, show limited applicability in project-based environments without significant adaptation.

Practical implications: Selected Lean tools may support sustainability-oriented project practices, provided that their application is adapted to project conditions.

Conclusion and summary: Lean Management tools can complement Green Project Management in a selective and context-dependent manner. Further empirical research is required to validate these relationships in practice.

Keywords: Lean Management, Green Project Management, GPM, sustainable development, CSR

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1. Introduction

In the era of global environmental challenges and the pressure to meet sustainable development goals, organisations are increasingly looking for management approaches that combine efficiency with responsibility towards society and the natural environment. Green Project Management (GPM) represents a response to this need by extending traditional project management with environmental, social and ethical dimensions. This approach is grounded in the Triple Bottom Line (TBL) framework, which emphasises economic, social and environmental performance (Elkington, 1998) and is closely linked to the three pillars of Corporate Social Responsibility: profit, people and planet (Książak & Fischbach, 2017). In GPM, these dimensions are operationalised through the P5 standard, which integrates People, Planet, Prosperity, Processes and Products into project decision making (Carboni et al., 2020). As a result, projects are expected not only to deliver scope on time and within budget, but also to minimise negative environmental and social impacts while creating long-term value (Maltzman & Shirley, 2010).

At the same time, Lean Management (LM) has become one of the dominant paradigms for improving organisational performance. Originating from the Toyota Production System, LM focuses on creating value from the customer perspective and eliminating waste from processes (Lisiński & Ostrowski, 2006; Womack et al., 2007). Lean Management is associated with shorter lead times, higher quality and more efficient resource use (Chaneski, 2009; Nowosielski, 2015). Over the past two decades, LM has gradually evolved from a purely production-oriented concept towards a broader philosophy that is applied in services, healthcare and project environments (Holweg, 2006; Samuel et al., 2015). This evolution has intensified the discussion on how Lean principles and tools relate to environmental and social sustainability.

A growing body of research suggests that Lean Management, often combined with related approaches such as Total Quality Management (TQM) or Lean Six Sigma, can support sustainable performance. Studies indicate that Lean and Green practices may reinforce each other by reducing waste, energy consumption and emissions while maintaining or improving operational performance (Garza-Reyes, 2015; Ikram et al., 2022). Reviews of Lean Six Sigma tools highlight their potential contribution to sustainable performance measurement and improvement (Hammou & Oulfarsi, 2022). Other empirical works point to the role of process-based models and quality management in measuring and supporting sustainable development (Garza-Reyes et al., 2018). Specific Lean tools, such as Value Stream Mapping, have been adapted to map energy and resource flows and to identify opportunities

for environmental improvement (Fontoura et al., 2023; Ramakrishnan et al., 2023). Further contributions show that Lean and Green thinking can be combined in construction projects and manufacturing systems to reduce environmental risks and improve overall environmental equipment effectiveness (Domingo & Aguado, 2015; El-Sawalhi et al., 2018; Skornowicz et al., 2017).

Despite this growing interest in Lean and sustainable operations, relatively few studies explicitly address how Lean Management tools can be used within GPM. Existing publications tend to focus either on LM or GPM as a separate stream, or on the application of Lean principles in projects without a strong sustainability emphasis (Cruz-Villazón et al., 2019; Caiado et al., 2018). As a result, there is limited knowledge on which specific LM tools are conceptually compatible with GPM, and under what conditions their application supports the objectives of sustainable project management rather than contradicting them.

This article addresses this gap by shifting the focus from the full integration of two management methods towards the more pragmatic question of the potential application of Lean Management tools within the Green Project Management methodology. The study concentrates on tools that may strengthen GPM, for example by improving process transparency, reducing waste in project activities, supporting ethical and efficient supply chains or enhancing learning from project experience. The purpose of this article is to assess the potential applicability of Lean Management tools within the Green Project Management framework based on evidence from a systematic literature review. The study seeks to answer the following research questions:

- RQ1:** Which Lean Management tools are conceptually compatible with the assumptions of Green Project Management?
- RQ2:** To what extent does the existing literature indicate that LM tools may support Green Project Management practices?
- RQ3:** What conditions, limitations and adaptations are necessary for LM tools to be effectively applied in Green Project Management?

By addressing these questions, the article contributes to the literature on Green Project Management and Lean Management by clarifying how selected Lean tools can be used to support the principles of GPM and by outlining directions for future empirical research.

2. Theoretical background

Lean Management is a business management concept based on a continuous process of organisational rationalisation through the shaping of employee attitudes and behaviours. The practical implementation of Lean Management enables organisations to achieve shorter production times, higher quality, and significantly lower costs than traditional approaches (Nowosielski, 2015).

In the literature, Lean Management is widely characterised as a process-oriented methodology focused on waste elimination, problem solving and continuous improvement. Its operational dimension relies on standardised practices that support transparency, flow stability and quality. Tools such as 5S, Value Stream Mapping (VSM), pull systems, Poka-Yoke, Jidoka and visual management form the core of Lean-based improvement routines (Cruz-Villazón et al., 2019; Garza-Reyes, 2015). These tools enable the identification of inefficiencies and support systematic optimisation, which has led to their application beyond production systems, including in project-based environments (Caiado et al., 2018).

The historical development of Lean Management predates the emergence of sustainability-oriented project frameworks. Lean principles were formalised between the 1950s and early 1990s, evolving from process stabilisation and quality engineering towards comprehensive organisational improvement. Project Management, in turn, expanded as a discipline during the 1960s-1990s, while sustainability-oriented project approaches, including Green Project Management, emerged significantly later as a response to environmental and social concerns. This sequence implies that contemporary GPM approaches build upon, and selectively incorporate, earlier operational and organisational experiences, including those associated with Lean.

Two fundamental Lean principles: flow levelling and continuous improvement, remain relevant in diverse environments. However, tools closely tied to repetitive production (Heijunka, SMED, Andon) are less transferable to project contexts and require modification (Tekin et al., 2018; Al Smadi, 2009). In contrast, tools such as VSM, 5S, Poka-Yoke, standard work or pull-based planning have been increasingly referenced in sustainability-related studies due to their applicability in reducing waste, supporting resource efficiency and improving process transparency.

Given its process orientation, Lean Management has been increasingly positioned in the literature as a foundation for improving environmental performance or supporting sustainable operational practices. These conceptual overlaps are meaningful in the context of Green Project Management, which integrates sustainability into project lifecycles by using tools such as the P5 Standard, PRiSM lifecycle, impact analysis and structured learning mechanisms (Carboni et al., 2020). Although originally developed in different contexts, LM and GPM share several underlying assumptions regarding value definition, process-based thinking and the prevention of unnecessary resource use.

This theoretical background provides the foundation for examining the extent to which specific Lean tools may be applicable within sustainability-oriented project management and supports the analytical framework adopted in the Results section.

3. Methodology

The methodological framework of this study was grounded in a systematic literature review (SLR). The review process followed a predefined procedure, which

encompassed the formulation of the research scope, the selection of data sources, the construction of search queries, the development of inclusion and exclusion criteria and the execution of multi-stage screening and synthesis.

The review began with the definition of the research objectives, which stemmed from the recognised fragmentation of existing knowledge concerning the applicability of Lean Management tools within the Green Project Management methodology. Given the exploratory nature of the topic and the need to consolidate conceptually dispersed evidence, the SLR method was selected as an appropriate analytical approach that ensures transparency and methodological rigour (Czakov, 2020).

Two multidisciplinary and peer-reviewed academic databases were selected: Scopus and Web of Science (WoS), which collectively cover the majority of international publications in management, engineering and sustainability-related domains. The search strategy was developed iteratively. For Scopus, two independent query structures were applied to capture both Lean Management production, the sustainability intersection and publications linking LM to GPM processes. In WoS, an extended expression was used to account for differences in database syntax and controlled vocabulary. The complete search protocol, including query structures, search fields and limitations, is presented in Table 1.

Table 1. Search protocol

	Scopus	Web of Science (WoS)
Search date	01.10.2023	
Queries	1) ("lean management" OR tqm*) AND ("green project management" OR sustainable*) AND process* AND production* 2) ("lean management" OR lm*) AND ("green project management" OR sustainable AND project AND management*) AND process*	1) ((ALL=(lean Management AND green*)) AND ALL=(lean Management AND (green* OR sustain*) AND project management*)) AND ALL=(lean Management AND (green* or sustain*) AND (green project management) AND Process)
Search fields	Article title, Abstract, Keywords	Topic (Title, Abstract, Author, Keywords, and KeyWords Plus)
Limitations	Year: 2000–2022 Subject area: Business, Management, Operations, Engineering, Environmental Sciences Language: English Open access: All open access	Year: 2000–2022 WoS Categories: Management, Green and Sustainable Science, Engineering, Industrial, Business Language: English Open access: Open Access

Source: Author's own elaboration.

Following the database searches, all retrieved records were consolidated and duplicates were removed. Screening was conducted in two stages. First, titles and abstracts were assessed in accordance with predefined inclusion criteria focused on explicit references to LM tools or principles and the presence of sustainability-oriented or project-related contexts. Second, full texts of the remaining publications were evaluated to verify conceptual relevance and methodological sufficiency. Publications with purely technical engineering content, without any connection to LM or sustainability/project management, or lacking methodological clarity, were excluded.

The selection process followed the PRISMA 2020 guidelines (Page et al., 2021). Across all queries in Scopus and WoS, 264 records were identified. After removing 127 duplicates, 137 publications remained for title and abstract screening. A total of 70 records were excluded at this stage. Full-text assessment was performed for 67 publications, of which 46 were excluded due to the lack of LM tool discussion, the absence of a sustainability- or project-related context, purely technical orientation or insufficient methodological detail. Ultimately, 21 publications met all criteria and were included in the qualitative synthesis. The full selection flow is presented in Figure 1.

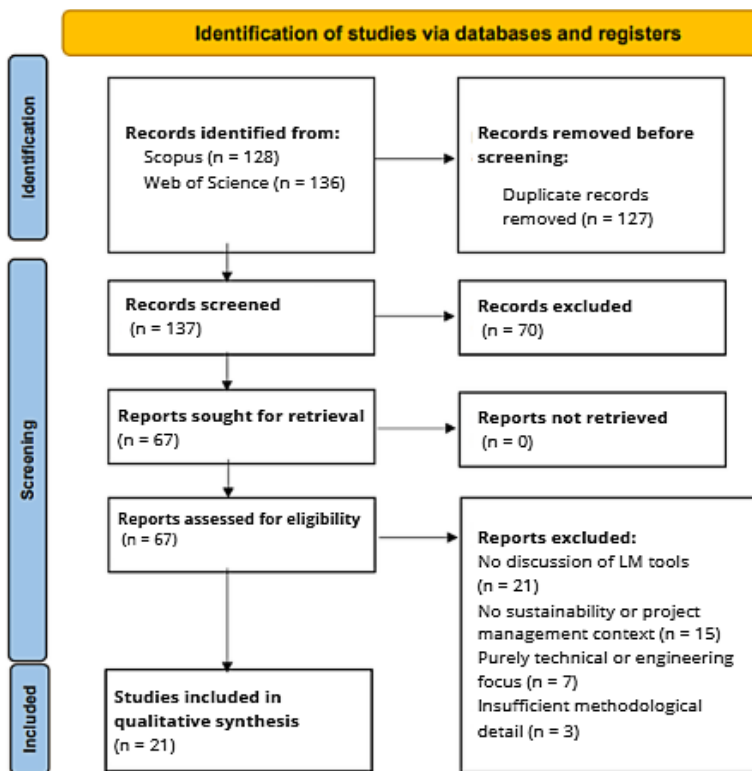


Figure 1. PRISMA flow diagram

Source: Author's own elaboration based on (Page et al., 2021). Licensed under CC BY 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

The final set of 21 publications was analysed using thematic coding. Two analytical dimensions were adopted:

1. Lean Management tools and principles referenced in the literature, and
2. their theorized or documented relevance to Green Project Management practices.

This approach allowed the identification of recurring conceptual patterns and conditions under which LM tools may support or complement the GPM methodology.

4. Results

According to the Green Project Management approach, a project is defined as an investment that requires a set of coordinated activities executed within a defined timeframe to achieve a unique outcome that supports a desired result (Carboni et al., 2020). However, for a project to be classified as sustainable, its business case must demonstrate benefits linked to the mitigation of adverse environmental, social and economic impacts. Moreover, the project should be oriented towards the efficient and minimal use of resources, the optimal utilisation of limited budgets, and the implementation of environmentally friendly techniques to generate cost savings and maximise resource effectiveness (Maltzman & Shirley, 2010; Dai & Xu, 2011).

The systematic literature review resulted in the identification of 21 publications that met the inclusion criteria. In line with these criteria, the analysed studies explicitly addressed Lean Management tools in sustainability-oriented, project-based or hybrid contexts and provided conceptual or empirical insights relevant to Green Project Management objectives. The analysis of the selected studies was structured according to the research questions and focused on identifying: (RQ1) which Lean Management tools were discussed, (RQ2) what types of sustainability- or project-related outcomes were reported, and (RQ3) under what conditions these tools were considered applicable in project environments. Across the reviewed studies, several LM tools appeared consistently. The most frequently mentioned tools included Value Stream Mapping (VSM), 5S, Kaizen-based improvement routines, pull systems, Kanban, and error proofing methods such as Poka-Yoke and Jidoka. These tools were identified across the 21 publications as recurring elements of Lean-based interventions analysed in relation to environmental, operational or learning-oriented outcomes. They were most often associated with waste elimination, greater transparency of material and information flows, the stabilisation of processes and the reduced consumption of resources (Cruz-Villazón et al., 2019; Caiado et al., 2018; Garza-Reyes et al., 2015; Ikram et al., 2022).

The reviewed publications also reported research achievements that correspond to core elements of Green Project Management, even when GPM was not explicitly named as a formal framework. These achievements included the incorporation of

environmental and social criteria into project justification, attention to impacts occurring throughout the project lifecycle, shaping responsible relations with suppliers and the use of mechanisms supporting organisational learning (Carboni et al., 2020; McClory et al., 2017; Caiado et al., 2018). A representative example of combining LM tools with sustainability-related objectives is the adaptation of Value Stream Mapping to identify environmental inefficiencies in processes implemented within projects. In such applications, VSM includes additional indicators, such as unnecessary movement, waiting time or energy consumption, and is used to identify opportunities for reducing resource use and losses (Cruz-Villazón et al., 2019; Garza-Reyes et al., 2015). Similar patterns of adaptation were reported for other Lean tools, where their original production-oriented logic was adjusted to support sustainability-related or project-specific objectives. Other publications highlighted the role of workplace organisation and standardisation (for example 5S) in creating conditions that support the implementation and maintenance of environmentally-oriented practices (Kamieński & Sieczkowski, 2019), as well as the potential of Just-in-Time and pull-based planning to reduce excess inventory and overproduction (Taghipour et al., 2020).

The analysis also showed that not all LM tools can be directly transferred to project environments. Techniques such as takt time measurement, Kanban or pull-based scheduling may be useful mainly for repetitive or cyclical tasks performed within projects. Tools created primarily for high volume production, including SMED, Andon or Heijunka, were described in the literature mainly in the context of manufacturing processes and their applicability to project work appears limited or requires substantial adaptation (Tekin et al., 2018; Emuza et al., 2015). To provide a structured presentation of the research achievements identified in the 21 analysed publications, Table 2 presents representative examples of research achievements identified across the reviewed literature.

In summary, the results indicate that a selected group of Lean Management tools may support the implementation of sustainability-related objectives in projects, particularly in areas such as process transparency, waste reduction, the stabilisation of work standards and continuous improvement. At the same time, their usefulness depends on the specificity of the project and the need to adapt tools originating from production systems to project-based conditions. These findings establish the basis for comparing selected Lean Management tools with the methodological elements of Green Project Management, which is presented in the next section.

Table 2. Research achievements identified in the reviewed literature

Author(s), year	Lean Management tools analysed	Sustainability / GPM-related focus	Reported research achievement
Cruz-Villazón et al. (2019)	VSM, Kaizen	Environmental waste identification	Adaptation of VSM to project sustainability analysis
Caiado et al. (2018)	5S, Pull system	Resource efficiency, stakeholder value	Lean–Green integration in project environments
Garza-Reyes et al. (2015)	VSM, Kaizen	Energy and material reduction	Identification of Lean–Green synergies
Kamieński, Siczkowski (2019)	5S	Workplace standardisation	Support for environmentally oriented practices
Taghipour et al. (2020)	JIT, Pull planning	Inventory and waste reduction	Reduction of overproduction and excess inventory

Source: Author's own elaboration based on (Taghipour et al., 2020; Cruz-Villazón et al., 2019; Kamieński & Siczkowski, 2019; Caiado et al., 2018; Garza-Reyes et al., 2015).

5. Discussion

RQ1: Which Lean Management tools are conceptually compatible with the assumptions of Green Project Management?

Building on the results presented above, publications examining LM in project-driven or hybrid environments highlighted the role of selected Lean practices in improving process flow, reducing operational waste and supporting decision making in complex project settings (Hussain & Figueiredo, 2023; Pearce et al., 2018; Meiling et al., 2012). At the same time, studies addressing GPM pointed to overlaps with Lean principles in areas related to continuous improvement, value-oriented planning and stakeholder-focused execution (Domingo & Aguado, 2015; Viles et al., 2021; Zhu et al., 2022; Zoubek et al., 2021).

Although only a small subset of the included publications explicitly integrated LM tools with environmentally-oriented project frameworks, those that did (Cruz-Villazón et al., 2019; Caiado et al., 2018; Garza-Reyes, 2015) confirmed that LM tools may contribute to environmental and resource-efficiency benefits when applied in project contexts. Documented effects included reductions in energy consumption, water usage, emissions and material waste. These findings demonstrate that Lean tools aligned with waste elimination, process transparency and structured improvement routines can conceptually support GPM assumptions.

RQ2: To what extent does the existing literature indicate that LM tools may support Green Project Management practices?

Several publications emphasised that Lean interventions can support sustainability benefits even when not directly implemented within a GPM methodology. Improvements in energy use, water consumption, emissions reduction, material efficiency and process transparency were consistently documented across different studies (Viles et al., 2021; Domingo & Aguado, 2015; Zhu et al., 2022; Zoubek et al., 2021).

Additionally, the broader literature on Lean, Green and quality-oriented management provides multiple conceptual anchors for potential integration. Publications addressing Total Quality Management and sustainability demonstrate that continuous improvement can be aligned with environmental and social performance metrics (Popkova et al., 2023; Nguyen et al., 2022). Other studies highlight the potential benefits of combining Lean, Green and resilience-oriented practices in supply chains or food systems (Das, 2019; Zhu et al., 2022). These findings together indicate that LM tools may enhance environmentally-oriented project outcomes, although the reviewed literature does not yet offer a consolidated integration framework.

RQ3: What conditions, limitations and adaptations are necessary for LM tools to be effectively applied in Green Project Management?

To facilitate this comparison, Table 3 presents a structured summary of how selected Lean Management tools correspond to the key elements of the Green Project Management methodology, indicating where full, conditional or limited integration is feasible based on the analysed literature. This table remains an essential component of answering RQ3, as it captures the practical boundaries, adaptation needs and contextual conditions under which LM tools may support the GPM methodology.

Table 3. Similarities and Differences Between Lean Management and Green Project Management Methods and Tools

Lean Management	GPM	Analysis of Similarities and Differences
Takt Time Measurement	PRiSM Project Lifecycle	It is possible to measure the duration of a specific project phase, but measuring the takt time of every individual task can be challenging. In the case of repetitive project phases (e.g. during execution), takt time measurement is feasible. However, such measurement should not be applied to unique, one-time tasks.

continued Table 3

5S	ADKAR Model	The ADKAR model shares common features with the 5S method. Both involve introducing changes through an aware and willing workforce that supports and sustains improvements. The ADKAR model includes the stages of awareness, desire, knowledge, ability and reinforcement. These stages aim to achieve successful change and standardisation, which aligns with the objectives of the 5S method. While both support standardisation, they differ in their scope of application.
Pull System	Resource Requirement Definition and Ethical Supply Chain	The pull system functions effectively when resource demand is clearly defined and supported by a well-organised supply chain. A key success criterion in both approaches is end-user satisfaction. Since the pull system is based on producing only what is needed by the end customer, the satisfaction of this stakeholder group is also essential. The ethical supply chain ensures environmentally and socially responsible logistics practices by the organisation and its partners. Integration of the pull system and ethical sourcing requires collaboration with local suppliers.
Poka-Yoke + Jidoka	Lessons Learned	Considering that an organisation is a „dynamically evolving system” requiring ongoing adaptation and correction, combining Poka-Yoke and Jidoka with the Lessons Learned process can enhance error identification and learning. This can reduce risks and increase client satisfaction in future projects, while also helping to identify potential problems already during the planning phase.
Just-in-Time	Resource Requirement Definition and Ethical Supply Chain	Similar to the pull system, Just-in-Time relies on resource availability and an efficient supply chain. Cooperation with local suppliers is crucial to integrate Just-in-Time with GPM tools, as it minimises environmental harm and supports sustainability.
Value Stream Mapping (VSM)	Project Management as a Process, Earned Value Management, 5P Impact Analysis.	VSM can be used to graphically illustrate the entire project process and show the time required for each task. If the project is managed as a process, and ongoing 5P impact analysis and earned value monitoring are performed, integration is feasible. VSM would require some adaptation, but its integration with GPM tools would not diminish the value or benefits of either approach.

Source: Author’s own elaboration.

The analysis presented in the Table 3 highlights that full integration is possible particularly in the case of the pull system combined with resource requirement definition and ethical supply chain practices. This results from the similarity in the underlying assumptions governing their application. The supply chain in Green Project Management should generate minimal environmental harm, which makes collaboration with local suppliers a necessary condition for integration. As the customer is a key stakeholder in every project, a pull-based approach should simultaneously fulfill sustainability criteria and ensure stakeholder satisfaction (Khodeir & Othman, 2018).

The analysis further indicates that the conditional integration of tools such as Value Stream Mapping (VSM), Poka-Yoke and takt time measurement is possible. VSM requires modifications to incorporate environmental indicators such as emissions, water use or energy intensity (Hussain & Figueiredo, 2023; Viles et al., 2021; Zoubek et al., 2021). Poka-Yoke aims to prevent defects and errors, with employees playing a crucial role in their elimination. Observational methods such as the Gemba Walk help identify and correct sources of waste and may be used within the GPM approach to improve project outcomes (Emuza et al., 2015). GPM's emphasis on Lessons Learned supports continuous improvement and learning, potentially reducing errors and risks in future projects.

Takt time measurement is not a practical solution for every activity within project work. However, it may be effectively applied in repetitive project phases or tasks performed cyclically by the project team. This observation aligns with studies highlighting the importance of separating stable and unstable process zones when applying Lean practices (Linnik et al., 2013). Regarding 5S, the method enables systematic workplace improvements, promotes order, standardisation and continuous improvement. Its success depends on employee awareness and engagement. The ADKAR model used in GPM supports change implementation through awareness, desire, knowledge, ability and reinforcement, making its integration with 5S feasible (Hung et al., 2010; Frahm, 2016; Cancho-Álvaro et al., 2023).

However, a comparative analysis of some Lean tools remains infeasible. Tools such as Andon, SMED or Heijunka are strongly tied to production system stability and equipment-based processes. The reviewed literature does not provide sufficient evidence of their direct applicability to project-based environments with sustainability-oriented objectives (Crema & Verbano, 2016; Crema & Verbano, 2017; Birkie et al., 2018). This confirms that LM-GPM integration is selective, context dependent and requires adaptation rather than the direct transfer of manufacturing-based solutions.

6. Conclusions

The aim of this study was to examine the potential for applying selected Lean Management tools within the Green Project Management methodology based on a systematic review of 21 publications. The findings show that a defined set of Lean tools demonstrates conceptual compatibility with sustainability-oriented project practices and may support selected elements of the GPM methodology.

In response to RQ1, the study confirms the conceptual compatibility of selected Lean Management tools with key components of Green Project Management, as demonstrated by the synthesis of findings from the reviewed literature. These include Value Stream Mapping, 5S, Kaizen routines, pull systems, Kanban, and error-proofing methods such as Poka-Yoke and Jidoka. Their compatibility is primarily related to a focus on waste reduction, the transparency of work processes, continuous improvement and the identification of non-value-adding activities, which overlap with GPM elements such as impact analysis, lifecycle planning and process-based project management.

With regard to RQ2, the findings indicate that Lean tools may support sustainability-oriented project management practices, primarily through improvements in resource efficiency, process transparency and learning mechanisms. Publications included in the review demonstrated improvements in resource efficiency, reduced material and energy use, increased process stability and enhanced decision-making transparency when Lean tools were applied in project or hybrid environments. These effects were most evident in studies using adapted forms of Value Stream Mapping that incorporated environmental indicators, as well as in research linking workplace organisation or standardisation to environmentally-oriented behaviours.

In response to RQ3, the findings indicate that the effective application of Lean Management tools within GPM requires specific conditions and adaptations. Tools originating from high-volume or equipment-dependent production systems, such as SMED, Andon or Heijunka, showed limited applicability to project-based environments and may require substantial modification. Other tools, such as takt time measurement, pull systems and Kanban, can be useful under conditions of task repetitiveness or process stability. The integration of Lean and GPM also depends on organisational readiness, the ability to incorporate sustainability metrics into process analysis and the need to align improvement activities with stakeholder expectations.

Overall, the results indicate that selected Lean Management tools may support the implementation of sustainability-oriented project management practices. However, their applicability remains context-dependent, requires adaptation and is shaped by the characteristics of both the project environment and the tools themselves. The study contributes to a more structured understanding of the conceptual links between Lean Management and Green Project Management and provides a foundation for further research on integrating these approaches.

Building on these findings, the study also offers several theoretical and practical implications. The findings of this review contribute to a clearer theoretical understanding of the relationship between Lean Management and Green Project Management. The study shows that the main conceptual foundations of Lean Management, such as waste elimination, continuous improvement and process transparency, correspond meaningfully with the lifecycle-oriented, stakeholder-focused and process-based components of the Green Project Management methodology. The analysis also positions specific Lean tools within the broader landscape of sustainability-oriented managerial approaches. In particular, tools such as Value Stream Mapping, 5S, and error-proofing routines can complement the assumptions of Green Project Management when they are adapted to project-based contexts. The review additionally clarifies an emerging area of research by identifying where the literature provides strong evidence of compatibility and where empirical confirmation is still lacking. As a result, the study contributes to theory by outlining the current boundaries of Lean Management and Green Project Management integration and indicating which relationships require further investigation.

From a practical perspective, the results offer practical insights for project managers, sustainability officers and Lean practitioners who wish to apply Lean Management tools in sustainability-oriented project environments. The review indicates that selected Lean tools can enhance resource efficiency, improve transparency in planning processes and strengthen decision making in projects that include sustainability-related criteria. Adapted forms of Value Stream Mapping may be used to identify environmentally significant tasks, while 5S and standardisation practices can support environmentally responsible behaviours and promote process discipline. Pull-based planning, Kanban systems and takt-time measurement can support project execution when key tasks are repetitive or relatively stable. In addition, error-proofing techniques may reduce risks and facilitate organisational learning within the Lessons Learned structures used in Green Project Management. The successful application of these tools requires appropriate staff competencies, the ability to incorporate environmental indicators into improvement routines and alignment with the organisation's sustainability objectives.

This review has several limitations. Only 21 studies met the inclusion criteria, which can limit the generalisability of the findings. The selected publications also varied in methodological quality and differed in the extent to which they explicitly addressed sustainability or Green Project Management. As a result, the conclusions presented in this study reflect an emerging and fragmented research landscape rather than a consolidated theoretical framework. Future research should therefore focus on the empirical validation of the relationships identified in this review, particularly in organisations that apply both Lean Management and sustainability-oriented project methodologies. Comparative case studies may help clarify how selected Lean tools function in manufacturing and service-based project environments. Longitudinal

analyses could determine whether Lean interventions produce lasting operational or environmental benefits in project settings. Research that examines cross-cultural or cross-sector differences would also be valuable, as it could explain how contextual factors influence the compatibility between Lean Management and Green Project Management.

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