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Smart & Resilient Logistics Corridors Future Gateway to the Green Trade

AGILE, CRITICAL THINKING AND AI-ENABLED MANAGEMENT FRAMEWORKS FOR GREEN LOGISTIC CORRIDORS: A COMPARATIVE ANALYSIS OF TRADITIONAL AND ADAPTIVE APPROACHES

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ABSTRACT

Green Logistic Corridors (GLCs) appear as strategic feedback to the dual challenge of decarbonizing global supply chains while maintaining or enhancing the efficiency, resilience and competitiveness of global trade. However, the dominant management approach used to develop these corridors remains anchored in traditional, linear and highly bureaucratic project management models, which are often too rigid to address the high ambiguity, technological transitions and multi- stakeholder involvement associated with sustainable maritime infrastructure. This paper presents a comparative management framework that examines two distinct approaches to the development of GLCs. The first one is a conventional, plan-driven model based on fixed objectives, sequential execution and hierarchical decision-making, while the second is an adaptive model that integrates Agile practices, structured critical thinking and virtual resources such as AI agents, digital twins and automation to enhance continuous learning, stakeholder alignment and operational performance.

2. INTRODUCTION

International commerce is heading to a transformative era in which sustainability, resilience and digitalization have become central strategic priorities for governments, port authorities, logistics operators and multinational supply chain actors. Maritime transport carries over 80% of world trade volume according to UNCTAD [1], yet it remains heavily dependent on nonrenewable fuel sources and exposed to disruptions caused by geopolitical instability, extreme meteorological events, pandemics and regulatory actions to decarbonize. In response, the approach of GLCs has appeared as a core element to accelerating low- and zero-emission shipping by implementing specific trade routes supported by enabling infrastructure, policy alignment and harmonious stakeholder investment as Global Maritime Forum describes in 2024 [2].

One important scope for GLCs is emissions reducing across the entire transport chain, from maritime operations to hinterland connectivity, through homogeneous integration of all key elements. However, the evolution of such corridors is not exclusively a technical challenge as it is fundamentally a management and governance challenge requiring coordination among diverse actors such as ports, shipping lines, fuel suppliers, technology providers, regulators, financial institutions and local communities. This complexity, combined with uncertainty around future fuel pathways, regulatory evolution and economic viability, may make traditional project management approaches increasingly insufficient. Conventional, linear, plan-driven models, such as Waterfall, provide structure and risk control but are often too rigid and slow to adapt to changing technologies, policies or stakeholder requirements. They rely on fixed scope, long planning phases and delayed feedback, leading to decision lag, rework and missed opportunities as it is described by Moreno et al. [3].

In contrast, Agile project management framework originally developed for software development offers an iterative, collaborative and value-driven approach that can better accommodate uncertainty and complexity. When combined with critical thinking practices, Agile may strengthen strategic decision-making by challenging assumptions, evaluating trade-offs and proactively identifying risks as Paul & Elder states [4]. In agreement with Dash et al., [5], the rapid adoption of AI agents, data analytics, automation tools and digital twins introduces new opportunities to augment human capabilities, streamline administrative tasks, simulate scenarios and support real-time decision-making. These virtual resources can operate as digital collaborators of actual human resources, reducing workload and enabling parallel execution of tasks that were previously sequential and manual. When embedded into an Agile and critical thinking framework, they may significantly enhance performance, sustainability and resilience in corridor development.

Despite these advancements, there is limited research directly comparing traditional corridor management with a hybrid Agile-Critical-AI approach specifically within GLCs. This paper addresses this gap by presenting the conventional management model for GLCs and introducing an alternative framework that integrates Agile practices, critical thinking and virtual resources or AI agents. It further incorporates case examples drawn from real corridor initiatives and port digitalization efforts, alongside a quantitative performance comparison based on key metrics such as time, emissions, stakeholder satisfaction, decision lag and overall efficiency. Finally, the paper highlights potential optimization outcomes and discusses the broader strategic implications of adopting this hybrid approach.

The results reveal that while traditional models offer control, the Agile-Critical-AI approach provides superior adaptability, faster implementation and deeper sustainability integration. Therefore, this study argues that the future of green logistic corridor governance lies not in replacing traditional models entirely but in evolving them toward hybrid, iterative and technology-enabled frameworks that leverage human expertise, critical reasoning and intelligent virtual tools.

3. LITERATURE REVIEW AND THEORETICAL BACKGROUND

Green Logistic Corridors (GLCs) are defined as maritime and intermodal routes where low- or zero- emission fuels, infrastructure, operational standards and aligned policy frameworks are deployed to accelerate decarbonization on a scale. Their prominence increased following the 2021 Clydebank Declaration, which called for initial corridors by 2025 and broader implementation by 2030 [6]. In the years following 2020, there is a noticeable difference between implementation documents and academic literature. For instance, bibliometric analyses identify three theme clusters: policy/regulation, technology/fuels and stakeholder collaboration. This proves the swift expansion of research on green corridors [7].

Simultaneously, reports from industry organizations reveal that initiatives are still in varying stages of development and require cogent coordination and governance systems to transition from "announcement" to practical "delivery" [2].

Following 2020, a large body of applied literature (UN, governments, forums) demonstrates that several forces, including climate targets, changing standards, reporting procedures and transparency requirements, are driving the shift. These factors lead to "dynamic" uncertainty, which penalizes purely linear management systems because regulations change while projects are still being created and implemented. For instance, UNCTAD highlights the importance of quick investment and systemic cooperation in a volatile and "just" transition environment [1]. The Clydebank Declaration did not enforce a single governance "playbook," but it did formally legitimize the notion of corridors as a means of acceleration. This creates a rich field for study: how to convert political intent into a management architecture that can adapt to changes in regulations, funding and technology [6].

Initiatives such as the Getting to Zero Coalition and EU maritime programs advanced the concept through pilots and cross-border collaboration [1][2]. GLCs function as both decarbonization tools and innovation drivers strengthening key sustainability pillars [8]. However, infrastructure investment uncertainty, regulatory misalignment and stakeholder coordination challenges complicate implementation.

The employment of multi-criteria approaches (AHP/fuzzy AHP, etc.) to prioritize routes and implementation conditions (such as fuel supply, port capacity, costs, emissions, risk and stakeholder acceptance) is a promising direction after 2020. One specific example is the research published in 2024, which uses stakeholder consultations and a fuzzy AHP framework to prioritize criteria for a green corridor between ports. This study is helpful as a guide for "operationalizing" the criteria [9]. Traditional project management, as described by PMI [10], follows a linear Waterfall or stage-gate model suited to stable infrastructure requirements. Yet, research in logistics shows that rigid structures struggle amid fast-changing technologies and evolving policy conditions [11], resulting in slow decision cycles, stakeholder misalignment and rework, which are particularly detrimental in GLCs contexts [12].

Agile project management, initially developed in IT, is increasingly adopted in logistics for its iterative delivery and responsiveness [3][13]. Studies show Agile improves adaptability in digitalization and disrupted supply chains [14][15]. Still, on regulated infrastructure projects, Agile alone may lack governance rigor. Thus, integration with critical thinking is needed. Critical thinking supports assumption testing, scenario analysis and strategic justification of sustainability trade-offs [4][16].

Digital twins are viewed in contemporary research as digital infrastructure that can assist prediction, optimization and intervention by simulating port and logistics processes in almost real-time. A digital twin model for port operations and decision support is proposed in a 2024 paper published in Frontiers in Marine Science [17]. This model shows how operational data can feed into helpful management simulations (safety, resource allocation, response to disruptions). The relevance for GLC is straightforward: digital twins (port or fleet) can lessen information asymmetries and promote a "single source of truth" for operational and environmental indicators and the corridor requires cross-port and cross-actor cooperation. As a result, the digitalization literature gives the framework's "AI/digital enablement" component an empirical foundation, but it does not yet adequately link it to Agile (iterative) governance and critical thinking.

After 2020, the notion that "agility" is a collection of principles and practices that can enhance governance in public and regulated organizations (particularly in times of crisis and uncertainty) rather than merely an IT delivery method. Even though the field is not marine, Tomaževič et al. [18] demonstrates the connection between digitalization, Agile values and improved governance in public administration. It is helpful as a foundation for the claim that Agile values can mediate governance performance. Large infrastructure is nevertheless limited in practice by set budgets, procurement, standards and compliance. As a result, new research encourages the use of hybrid approaches, which combine plan-based and iterative methods. The following sources are pertinent to your argument even if they are not completely maritime-specific: GLCs require "adapted Agile," not "pure Agile," because they are controlled socio-technical infrastructures.

The post-2020 literature on "green shipping" highlights that decarbonization is a dynamic portfolio (alternative fuels, energy efficiency, infrastructure, policy) rather than a single technology option. Rapid subject expansion and cluster fragmentation are revealed by a bibliometric analysis, indicating a field still in the process of conceptual consolidation [19]. This fragmentation is the main thesis in this paper: a strict management paradigm raises the risk of lock-in and hasty judgments because there are various technological paths and uncertainties. This is where the concept of "structured critical thinking" as a method for questioning presumptions and routinely assessing the corridor's direction fits in.

Since projects are still in their early stages and there is a dearth of academic empirical data, a reliable evaluation for GLCs should also incorporate the "implementation" literature (reports). As proof of the reality on the ground, the Global Maritime Forum regularly releases reports on the state of projects and obstacles (coordination, financing, fuel supply, demand signals) [2]. The macro context (shipping volatility, transition pressures and the need for systemic cooperation) provided by UNCTAD increases the incentive for adaptive management and simulations [20]. These sources are important for demonstrating in the review that the work is not merely theoretical but rather address practical limitations. Digital transformation further enables GLC development. IoT, AI and digital twins enhance monitoring, coordination and parallel task execution, allowing human experts to focus on strategic activities [14][21]. Although each domain is well studied, research integrating Agile, critical thinking and AI into GLC management remains limited, revealing a gap this study aims to address.

4. METHODOLOGY

This study employed a mixed conceptual and exploratory quantitative approach appropriate for emerging and complex domains such as GLCs. Rather than testing predefined hypotheses, the research developed and compared two management approaches, based on literature synthesis, real-world cases and scenario-based performance estimation. As GLCs remain at early development stages globally, empirical data are limited, while conceptual guidance is needed.

The process began with synthesis of research on GLCs, traditional project management, Agile and hybrid governance, critical thinking and AI-enabled digital transformation. This informed theoretical models of both the conventional governance structure and the proposed Agile-Critical-AI framework. Then, a comparative analytical phase then evaluated both approaches across performance dimensions identified in prior studies, including time efficiency, adaptability, decision quality, stakeholder engagement, sustainability alignment and digital enablement. These dimensions informed quantitative indicators. An exploratory assessment using secondary data, benchmarks and case examples estimated performance differences. To address uncertainty, a Monte Carlo simulation with 1,000 iterations applied the Box-Muller transformation to generate normally distributed inputs and assess variability.

Academic sources provided theoretical grounding, while documents from organizations such as the Global Maritime Forum, UNCTAD, OECD, IMO and Deloitte offered empirical insight into emissions reduction, timelines and digitalization trends in corridor development [1][2][6]. Real initiatives such as the Nordic Green Corridor and port digital twins confirmed feasibility. Regulatory guidance including the Clydebank Declaration defined policy context.

The Agile-Critical-AI model emphasized iterative delivery, continuous feedback, structured critical analysis and digital augmentation to mitigate limitations of linear project management in uncertain environments. Findings suggested enhanced operational efficiency, sustainability and resilience relative to traditional models, supporting its suitability for GLC implementation.

5. TRADITIONAL VS. INNOVATIVE MANAGEMENT

Traditional management plans rely on linear processes, fixed requirements and hierarchical oversight which limited responsiveness in complex corridor environments thus creating the need to innovate in some processes to improve the efficiency of organizations. Innovative management plans emphasize adaptability, stakeholder co-creation and proactive risk handling. The growing need for digitalization became demanding, as data-driven systems and automation improved decision speed, operational transparency and sustainability performance in emerging logistics ecosystems.

5.1 Traditional Management Plan

The traditional management plan, grounded in strict methodologies, is the prevailing framework in infrastructure and logistics projects because it prioritizes predictability, control and standardized governance. It follows a linear sequence of phases beginning with initiation, where scope, stakeholders and feasibility are defined. Decisions made at this early stage often become locked in, making later revisions difficult or costly. The extensive planning phase develops detailed schedules, budgets, engineering designs and procurement arrangements, providing clarity but generating rigidity when new information appears. Execution emphasizes delivery of physical infrastructure with long lead times and highly coordinated activities. Changes during this stage are discouraged due to contractual risks and cost escalation. Monitoring and control focus on compliance with the original plan rather than reassessing strategic alignment, resulting in reactive responses to deviations and increased rework. Closure formalizes completion but rarely enables systematic learning, leading to repeated challenges in subsequent corridor development.

The traditional plan has notable strengths. Comprehensive documentation supports traceability and legal defensibility, valued in public and politically sensitive initiatives. Governance structures clarify accountability, while established funding and procurement procedures reduce financial uncertainty. This approach is therefore effective when risks and requirements are stable.

However, its suitability declines in contexts such as Green Logistic Corridors, where technological, regulatory and market conditions evolve rapidly. Limited adaptability can generate outdated infrastructure, while hierarchical governance contributes to decision lag and slow technology adoption. Sustainability is often treated as compliance rather than iterative value creation and rigid communication reduces cross-border collaboration. These constraints lead to high rework, weaker risk responsiveness and insufficient stakeholder alignment. Thus, although traditional project management remains beneficial in stable environments, exclusive reliance on it risks delaying innovation and sustainability outcomes required for GLCs.

5.2 Innovative Management Plan

The possibilities for innovation that technology offers today exceed limits that some time ago seemed to require a substantial effort to overcome. According to recent studies such as the ones conducted by Oonk, Ramirez-Asis et al. or Sanchez-Gonzalez et al. [22][23][24], innovations can be made much easier and, thus, several key parameters of flows can be improved.

The Agile framework, critical thinking and AI-enabled management plan may provide an adaptive alternative to traditional project governance by emphasizing flexibility, iterative progress and intelligent automation. It can be designed for project environments characterized by high uncertainty and rapid technological development, making it particularly relevant for GLCs. Instead of depending on linear planning and delayed feedback, this approach can promote continual learning and close engagement among diverse stakeholders. Its aim is to deliver infrastructure solutions that are faster to implement, more responsive to emerging conditions and better aligned with sustainability objectives.

The model relies on several key principles that can shift how corridor development activities are structured. Iterative delivery through sprints may enable incremental progress rather than waiting for long and rigid milestone cycles. The concept of Minimum Viable Infrastructure supports early deployment of pilot components to validate assumptions and reduce longterm risks. Cross-functional teams can integrate diverse expertise in engineering, environmental performance, operations, policy and technology to break down silos and improve collaboration. Critical thinking methods are thought to be applied continuously to ensure that decisions reflect careful evaluation rather than routine adherence to predetermined plans. AI agents and digital twins can act as supportive virtual resources, carrying out routine analytical tasks, identifying optimization opportunities and enabling real-time simulation of alternative solutions.

The project lifecycle itself is expected to shift toward adaptability. Each sprint can begin with prioritization of the most impactful work, supported by up-to-date evidence and stakeholder needs. Early pilots can help expose real-world constraints and avoid late discovery of issues. AI automation has proven to be able to enable parallelization of multiple project components, reducing bottlenecks typically caused by sequential approval processes. Sprint reviews are designed to ensure transparency and alignment, while retrospectives and assumption audits should encourage critical evaluation and continuous improvement. When successful, pilots should be scaled progressively to minimize the risk of large-scale implementation failures.

This model can also introduce more distributed governance, reducing reliance on hierarchical decision approval. Shared access to real-time data should improve transparency and enable decisions to be informed by a common understanding of conditions. This collaboration is especially valuable in cross-border Green Logistic Corridors, where alignment across multiple organizations and regulatory settings are of great importance. The paradigm shift is shown in Figure 1.

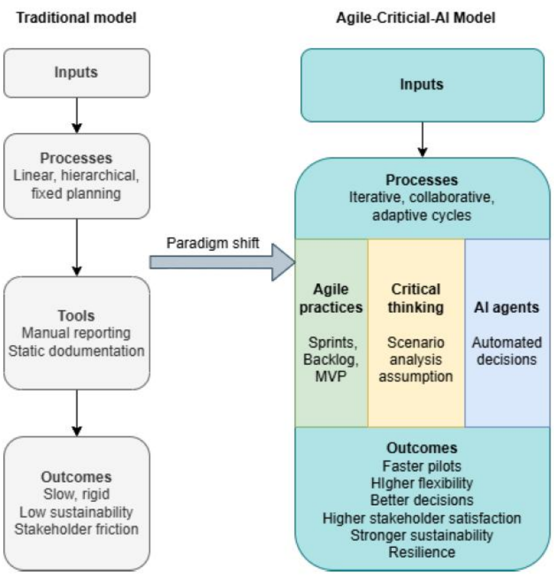

Figure 1: Conceptual framework

6. CASE EXAMPLES

The following examples are not presented as full empirical case studies, but as illustrative scenario- based analyses grounded in real-world initiatives. They demonstrate how elements of the proposed Agile-Critical-AI framework could be integrated into existing or emerging Green Logistic Corridor projects to enhance adaptability, sustainability and governance.

6.1 Nordic Green Corridor (Umeå-Vaasa)

The Nordic Green Corridor between Umeå in Sweden and Vaasa in Finland aimed to establish a cross-border zero-emission maritime route. Although the project focused on regulatory coordination and infrastructure expansion, it relied heavily on long planning cycles and sequential decision structures that limited responsiveness. Applying an Agile-Critical-AI approach in this context would support shorter development iterations informed by AI-driven scenario modeling.

Through the automated virtual agents' capabilities, the corridor could accelerate few workflows, while structured critical thinking methods would help stakeholders validate strategic assumptions. Incremental development through Minimum Viable Infrastructure pilots would offer improved flexibility and stronger stakeholder engagement throughout the process

6.2 Gothenburg-Rotterdam-Ghent Corridor

The collaboration between Gothenburg, Rotterdam and Ghent sought to harmonize infrastructure for alternative fuels across the North Sea region. Current coordination practices may depend on periodic committee meetings that delivered slow feedback and limited real-time learning. The proposed framework would introduce dynamic collaboration cycles in which port authorities, energy suppliers and shipping actors co-develop operational improvements. Implementing digital twins to instantly assess infrastructure alternatives and policy interactions would lead to optimized corridor utilization.

Also, conducting critical thinking workshops would represent a strong pillar in supporting continuous reflection on investment decisions, risks and early failures.

6.3 Port of Rotterdam Digital Twin Project

The Port of Rotterdam digital twin project represented one of the most advanced digital port systems globally according to Duffy et. al [25], yet its delivery model followed traditional governance principles, resulting in elongated review cycles. Integrating Agile and AI capabilities would enable the digital twin to shift from a passive monitoring system to a decision-support engine. Incremental testing of new sustainability features and automated performance analysis through AI agents would strengthen operational efficiency, while human experts would apply critical reasoning to refine strategic direction.

Together, these examples are meant to show that existing initiatives often incorporated isolated digital or sustainability components, but lack unified integration around learning, adaptability and intelligence. The Agile-Critical-AI framework addressed this gap by guiding GLC development toward more resilient, data-informed and innovation-driven outcomes.

7. NEW QUANTITATIVE MODEL AND COMPARATIVE PERFORMANCE

The quantitative model applied a comparative performance assessment to evaluate traditional and innovative management approaches in GLCs development. Key performance indicators included time to pilot, decision lag, rework rate, stakeholder satisfaction, administrative overhead and emission or energy reduction. A Monte Carlo simulation with 1,000 iterations was employed to estimate performance variability, considering the methodology described by Raychaudhuri [26].

Baseline parameters were derived from recent studies on corridor feasibility, Agile applications in construction, port digitalization and AI automation, based on the work of Zeng et al. [27]. These inputs were further adjusted to reflect context specific influences such as technological and regulatory complexity, volatility in market and policy conditions and the number of stakeholders involved, which captured coordination challenges. All statistical outcomes were reported with a 95% confidence interval to ensure robustness. The simulation operated under several assumptions, such as the presence of rational stakeholder behavior, sufficient digital infrastructure and organizational capability to adopt Agile methods. For the comparative test case, simulation inputs were calibrated to represent a high complexity scenario, with technical and regulatory challenges set at 75%, moderate uncertainty set at 45% and a stakeholder group of 15 actors. This provided a realistic basis for evaluating performance differences between management approaches.

Table 1 presents a detailed comparison of the traditional and Agile-Critical-AI management models, evaluating performance across five critical dimensions such as time required to reach pilot implementation, the responsiveness of decision-making, the frequency of rework, the level of stakeholder satisfaction and the efficiency of administrative costs relative to emission reductions. The results indicate that the Agile-Critical-AI approach consistently outperformed the traditional model, demonstrating faster project execution, reduced

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delays, lower rework rates, higher stakeholder engagement and greater effectiveness in aligning operational efficiency with sustainability outcomes.

Table 1. Model comparison according to chosen KPIs

KPIs	Traditional Mean (95% CI)	Agile-Critical-AI Mean (95% CI)	Improvement
Time to Pilot (months)	25.4 (18.0 - 32.5)	12.3 (9.0 - 15.6)	-51%
Decision Lag (weeks)	8.4 (4.9 - 11.9)	2.0 (1.2 - 2.9)	-76%
Rework Rate (%)	19.3 (11.3 - 27.8)	10.2 (5.3 - 15.5)	-47%
Stakeholder Satisfaction (0-100)	58.9 (46.5 - 70.5)	88.9 (80.2 - 95.0)	+51%
Admin costs/Emission Reduction (%)	15.0 (6.9 - 23.4)	30.7 (20.7 - 40.0)	+104%

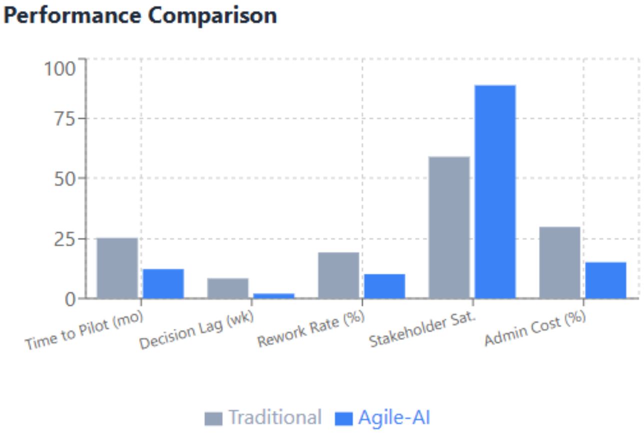

Figure 2: Performance Comparison

A better overview is depicted in Figure 2 that illustrates the comparative performance of the traditional and Agile-Critical-AI management models across the five key indicators. It demonstrates that the innovative framework consistently outperformed the traditional approach, showing faster time to pilot, reduced decision lag, lower rework rates, higher stakeholder satisfaction and more efficient alignment of administrative efforts with emission reduction, thereby highlighting its overall superiority across all measured dimensions.

What is more, Figure 3 presents a multi-dimensional evaluation using a radar diagram to compare the traditional and Agile-Critical-AI management models across six performance dimensions such as delivery speed, quality, sustainability, resilience, stakeholder engagement and operational efficiency. The diagram illustrates that the Agile-Critical-AI framework consistently outperformed the traditional approach in all dimensions, demonstrating faster delivery, higher quality outcomes, stronger sustainability integration, greater resilience, enhanced stakeholder participation and improved overall efficiency.

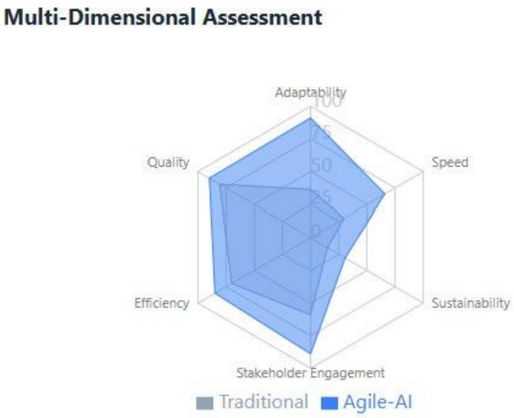

Figure 3: Multi-Dimensional Assessment

The comparative implementation timeline toward the first pilot demonstrates a pronounced difference between the two management approaches. The Agile-Critical-AI model reached this milestone in approximately 12 months, nearly half the 25 months required by the traditional approach. The accelerated timeline reflects the framework's iterative planning, early testing through Minimum Viable Infrastructure, rapid feedback incorporation and adaptive decision-making, all of which reduced delays, improved coordination among stakeholders and enabled faster translation of strategic objectives into operational results. The visualization underscores how the innovative model transforms project delivery from a sequential, rigid process into a dynamic and learning-oriented system. The substantial rise in stakeholder satisfaction from 59 to 89, as Figure 4 states, within the Agile-Critical-AI model could be attributed to a shift away from infrequent, hierarchical communication typical of traditional approaches toward continuous stakeholder engagement, transparent decision processes and collaborative solution development. Iterative Agile practices, supported by AI-enabled coordination tools, can facilitate sustained alignment, enhance trust and strengthen shared ownership throughout the project lifecycle. Therefore, the integration of Agile methods, artificial intelligence capabilities and critical thinking can support sustainable improvements in project delivery speed, quality of deliverables, sustainability performance and overall system resilience.

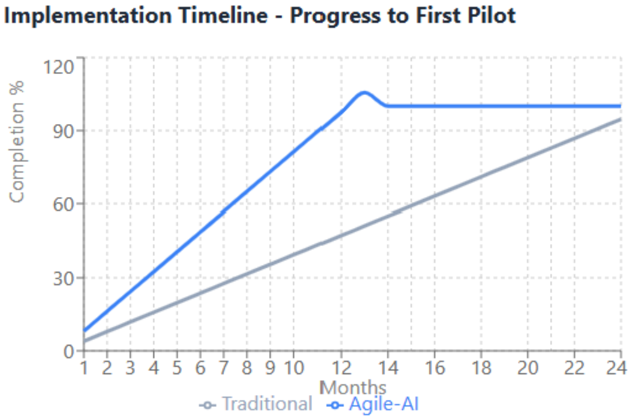

Figure 4: Implementation Timeline - Progress to First Pilot

The comparative analysis's findings show that the suggested adaptive Agile-Critical-AI framework and the conventional project management approach consistently differ, particularly in situations like Green Logistics Corridors (GLCs) that are marked by high levels of uncertainty, institutional complexity and rapid technological change. In contrast to the sequential rigidity of traditional models, the Agile- Critical-AI architecture is iterative and flexible, which explains its anticipated greater performance. The suggested framework enables ongoing decision recalibration based on operational data, technological advancements and regulatory changes, in contrast to traditional techniques that rely on set targets and thorough forward planning. Since low-emission technology, energy infrastructure and emission reporting requirements are still developing, this is important to the growth of GLCs.

The results are in line with current research demonstrating the necessity of adaptive governance models for sustainable transition as well as the body of literature on the shortcomings of traditional project management in complex infrastructures. By specifically applying these ideas to the developing topic of GLCs, where conceptual guidance is still scarce, the paper simultaneously expands this body of literature.

8. CONCLUSIONS

The results of this study indicated that the traditional management approach may have difficulties coping with the uncertainty and rapid change that characterize Green Logistic Corridors, while the Agile-Critical-AI framework fundamentally altered how infrastructure could be conceived and delivered. The observed gains in time-to-pilot, decision speed and stakeholder engagement are not incremental improvements but reflect a structural shift in knowledge generation and decision-making across the development process. By integrating agile iteration, critical inquiry and AI-supported analytics within a unified management logic, the framework enables continuous learning, adaptive decision-making and real-time feedback.

Decision quality can be improved since critical thinking practices may help teams challenge assumptions, expose potential risks earlier and assess multiple pathways before committing resources. The incorporation of AI-driven virtual resources further distinguishes the framework by enabling predictive analysis and scenario testing at a scale and speed not achievable within traditional corridor management structures.

Collectively, these elements position the proposed framework as an original contribution that reframes Green Logistic Corridors as intelligent, anticipatory systems rather than static infrastructure projects. These results indicate that successful Green Logistic Corridors require more than regulatory compliance or low emission technologies, as they depend on redesigned governance, processes and management culture. The Agile-Critical-AI framework promotes cross sector collaboration, embeds sustainability throughout implementation and supports adaptive, digitally enabled decision making.

Organizations adopting this approach are better positioned to manage complexity and align corridor development with evolving technologies, market demands and climate policy objectives.

As any exploratory study in an emerging field, this research presents a few limitations that need to be acknowledged. The first one refers to the scarcity of empirical data. Since the majority of GLCs are in the pilot or planning stages, secondary data, literature benchmarks and scenario-based estimations were required. Even while Monte Carlo simulation aids in uncertainty management, the outcomes are still reliant on the initial assumptions about the variable distributions. A second constraint is methodological character. Longitudinal case studies or complete Agile-Critical-AI framework implementations in actual operating corridors have not been used to validate the comparative model. As a result, the findings should be viewed as suggestive rather than conclusive. The suggested approach is best applicable to large logistics systems with numerous institutional actors and challenging sustainability goals in terms of generalizability. It might not be as applicable to projects with less uncertainty or straightforward logistics chains.

While future research would benefit from empirical testing of the hybrid framework in real corridor deployments to assess performance under operational conditions and diverse governance settings, the future scope of this paper is to serve as a conceptual foundation for interdisciplinary inquiry, policy experimentation and AI-driven decision-support system development aimed at enhancing the sustainability, resilience and adaptability of green logistic corridors in post-2020 supply chain ecosystems. Additional studies should explore how procurement and contracting practices can evolve to support iterative development while maintaining accountability. Ethical and regulatory considerations for AI assisted decision making also require further investigation, particularly where automation influences environmental and social outcomes. Research into workforce skills and change management will be necessary to ensure that project teams can integrate critical thinking and digital competencies effectively. Expanding this model to large-scale trade corridors would provide broader insights into its scalability and global applicability.

9. DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES:

During the preparation of this work, the authors used OpenAI Inc. ChatGPT and Perplexity AI Inc. tools for minor assistance with grammar, spelling, punctuation or formatting. No substantive content or analysis was generated by artificial intelligence. After using those tools, the authors reviewed and edited the content as necessary and took full responsibility for the content of the publication.

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