

Research Article

How Green Lean Six Sigma and Environmental Dispositions Support Circular Economy Practices

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Abstract

Despite growing interest in the circular economy (CE), strategic frameworks supporting its implementation in the financial sector remain underexplored. This limitation restricts banks' ability to integrate circular principles with sustainability goals, operational efficiency, and long-term value creation. Previous studies have mainly focused on manufacturing and industrial sectors, with limited attention to how Green Lean Six Sigma (GLSS) and managers' environmental beliefs support CE adoption in banking. Addressing this gap, this study investigates the direct effect of GLSS and the mediating role of managers' environmental beliefs in facilitating CE implementation in banks, based on the Resource-Based View (RBV) theory. Data were collected from 713 managers in Malaysian banks and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results show that GLSS has a significant positive effect on CE implementation. Managers' environmental beliefs significantly mediate the relationships between green and lean strategies and CE, while the mediation effect of Six Sigma is insignificant. These findings extend RBV theory by identifying GLSS as a strategic organizational resource and managers' environmental beliefs as an important capability supporting CE implementation in the financial sector.

Keywords: Circular Economy, Green Lean Six Sigma, Environmental Beliefs, Circular Finance, Circular Strategies

JEL Classification: M11, M14, G21

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1. Introduction

The banking sector is at the forefront of contemporary debates on sustainability and value creation. As financial institutions face growing regulatory pressure, increased stakeholder scrutiny, and evolving customer expectations, sustainability has transitioned from a peripheral concern to a core strategic imperative (Tseng et al., 2018). Banks are now assessed beyond financial performance; they must integrate environmental, social, and governance (ESG) principles into their long-term value-creation strategies.

This integration is crucial for competitive positioning and legitimacy (Ali et al., 2021a). Recent reports underscore that addressing ESG issues is vital for affirming ethical, economic, and customer-focused commitments to various stakeholders, including regulators and investors (KPMG, 2021). Consequently, sustainability has emerged not only as a compliance obligation but also as a strategic avenue for banks to rebuild trust, enhance resilience, and strengthen stakeholder engagement (Di Maria et al., 2022).

Despite the increasing strategic need for sustainability, banks find it challenging to convert their ambitions into cohesive business models that foster value creation (Khattak & Saiti, 2021). The current ESG integration and responsible finance literature often emphasizes external compliance, leaving a significant gap in internally focused, actionable strategies for banks to advance sustainability. These difficulties are compounded by the growing expectation that banks will align their sustainability goals with the broader economic transformation agenda. International bodies such as the United Nations and the European Union have identified the circular economy (CE) as a strategic framework for improving organizational sustainability performance and supporting the transition towards sustainable economic systems (Gigli et al., 2019; Gatell & Avella, 2024).

The CE framework emphasizes reducing, reusing, and recycling resources to enhance environmental integrity, economic efficiency, and social value. Despite the CE's significant traction in the industrial and manufacturing sectors, its strategic implementation within intangible, service-based financial institutions remains critically underdeveloped. Current CE research primarily identifies macro-level enablers such as regulatory support, institutional pressures, and financial incentives. However, these studies offer limited insight into how organizations can activate the scientific and technical aspects of CE within complex, intangible service environments, such as banking. Consequently, banks lack clear, data-driven strategic toolkits that can translate CE principles into actionable, replicable practices. The application of these principles in the financial sector presents unique challenges.

Unlike manufacturing, where material flows are tangible, circularity in banking often revolves around data, financial products, and service designs. For example, CE in banking involves financing circular business models, developing green financial products, and optimizing internal resource use. These distinctions underscore the need for tailored strategic toolkits that can translate CE principles into actionable practices in an intangible service environment. The lack of practical, data-driven toolkits for operationalizing CE in banking creates a critical gap. This raises a fundamental question: How can financial institutions effectively internalize circularity? We argue that Green Lean Six Sigma (GLSS), an integrated framework for waste reduction and process optimization, offers a promising yet under-explored strategic toolkit. Additionally, recognizing that strategic change is human-centric, we propose that managers' environmental beliefs are crucial for activating GLSS. This leads to the following central research question.

RQ1: To what extent does the GLSS enable CE implementation in the banking sector?

RQ2: How do managers' environmental beliefs mediate the relationship between GLSS and CE in banks?

To address this research question, this study posits that GLSS is a promising yet under-theorized strategic toolkit for facilitating CE in the banking sector. GLSS combines green management, lean efficiency, and Six Sigma process discipline to minimize waste, optimize resource utilization, and enhance value creation (Gholami et al., 2021). Previous studies have acknowledged GLSS as an integrated strategy capable of addressing environmental, social, and financial performance objectives (Sony & Naik, 2020). However, existing research predominantly views GLSS as an operational or process-improvement tool, offering limited insight into its strategic use to achieve broader CE goals. This strategic perspective is essential, especially for service-oriented organizations, such as banks, where CE adoption necessitates systemic rather than merely operational changes.

Although the GLSS is a potent instrument, prior research has frequently overlooked the human dimension of its strategic application to CE. Recognizing that strategic change is inherently human-centric, this study posits that managers' environmental beliefs are pivotal in utilizing GLSS as a strategic resource. These beliefs influence how managers perceive environmental threats, shape their strategic priorities, and guide the allocation of organizational resources towards sustainability objectives (Ali et al., 2022; Kump, 2021). In the absence of such a cognitive alignment, GLSS initiatives risk becoming fragmented or merely symbolic, thereby constraining their efficacy in promoting CE.

Building on the Resource-Based View (RBV) (Barney, 1991), this study conceptualizes GLSS as a firm-specific strategic resource and posits managers' environmental beliefs as a complementary organizational capability that enhances its effective utilization. This theoretical synthesis allows us to investigate CE implementation as a strategic outcome driven by internal resources and capabilities rather than merely as a response to external pressures, which has predominantly characterized previous CE literature. This internal perspective is vital for the financial sector, where intangible resources and managerial capabilities are essential for strategic adaptation. Empirically, this study focuses on the banking sector in Malaysia, a context marked by a proactive circular economy policy agenda and strategically significant financial system (Zaman et al., 2026; Isa et al., 2021). This study provides a mechanism-based explanation of the circular transformation in banking. It contributes to the discourse on strategic management and sustainable development by investigating the nexus between GLSS and managerial environmental beliefs in facilitating CE.

This study makes three main contributions to the literature on strategy and sustainability: First, it significantly advances CE literature by extending the RBV to the underexplored domain of financial services. GLSS is conceptualized as a firm-specific strategic resource and managers' environmental beliefs as a critical organizational capability, offering a novel, internally grounded explanation for circular transformation in banking. In doing so, the study shifts CE research beyond external drivers and normative prescriptions towards an internally grounded, mechanism-based explanation of how banks operationalize circular strategies for value creation. Second, we contribute to the research on strategic change and organizational cognition by empirically demonstrating the critical mediating role of managers' environmental beliefs in translating operational excellence resources into CE results. This underscores the essential human and cognitive foundations of sustainability-oriented strategy execution, addressing a key limitation in prior GLSS–CE research that has largely overlooked micro-level mechanisms. Third, to address the practical need for actionable tools, this study offers an empirically validated strategic framework for banking institutions to implement CSR. This framework integrates GLSS practices and managerial belief systems to provide a concrete roadmap for assessing and enhancing circular readiness in the financial sector. These findings are highly relevant to scholars and practitioners grappling with systemic changes towards a CE globally.

This study contributes to the literature in three important ways. First, it extends CE and RBV literature into the underexplored context of financial services by positioning GLSS as a strategic resource for circular transformation in banking. Second, it addresses inconsistencies in prior GLSS–CE findings by empirically examining the mediating role of managers' environmental beliefs, thereby highlighting the importance of cognitive and human dimensions in sustainability-oriented strategy implementation. Third, this study offers practical implications by providing an empirically validated framework that assists banks in integrating GLSS practices and managerial environmental commitment to strengthen circular-economy implementation and long-term sustainability performance.

2. Literature Review and Hypothesis

CE background, conceptualization, and enablers

The chronological evolution of CE has led to the emergence of multiple definitions (Nobre & Tavares, 2021; Di Vaio et al., 2023). Initial conceptualizations prioritized the '3R' principles: waste reduction, reuse and recycling (Ghisellini et al., 2016). This framework evolved into the '4R' system, emphasizing reduction, reuse, recycling, and recovery, and was further expanded to the

'9R' (Kirchherr et al., 2017) and '10R' typologies (Reike et al., 2018) to accommodate contemporary business models. Although these frameworks underscore broader material retention, their complexity poses implementation challenges, particularly in the non-manufacturing sector.

In intangible service environments such as banking, these 'R' typologies necessitate careful consideration, as the focus shifts from physical materials to processes and financial flows. CE is conceptualized as a business model that minimizes resource outflow. It provides firms with policy guidelines for reducing material waste by contracting economic and ecological loops (Haas et al., 2015). CE-oriented businesses collect raw materials, transform them into consumable goods, and repurpose waste into manufactured materials. Recycling waste into the supply chain generates economic value for CE-based business models (Blomsma et al., 2022a).

The rise of CE in modern economies represents a paradigm shift towards achieving environmental and economic goals (Jabbour et al., 2020). This shift stems from the CE's ability to improve resource efficiency by regenerating and restoring the physical and economic cycles of products, thereby maintaining materials for optimal reuse (Ellen MacArthur Foundation, 2014). Scholars across fields have investigated the potential of CE from the environmental, engineering (Lieder & Rashid, 2016), biological, sociological, financial (Gularte et al., 2024; Sasso et al., 2025), and urban planning perspectives. Recent studies have examined CE strategies in manufacturing (Toxopeus et al., 2021), SMEs (Arsawan et al., 2024), textiles (Schmutz & Som, 2022), and the fashion industry (Abbate et al., 2024). Studies highlight debates about CE's nascent conceptualization (Ghisellini & Ulgiati, 2020), which impedes its organizational implementation (Hussain & Malik, 2020). This nascent state reflects a lack of technical tools and challenges with organizational readiness and strategic integration.

The literature on CE enablers categorizes environmental (Geissdoerfer et al., 2017), economic (Kirchherr et al., 2017), financial (Kunz et al., 2018), institutional goals (Arranz et al., 2022) and capabilities (Seles et al., 2022) as primary CE drivers. Recent studies have predicted digitalization (Kurniawan et al., 2022), blockchain technology (Ranta et al., 2021), and policy-handlers (Neri et al., 2025) as potential CE enablers. However, these drivers inadequately explain the CE's broader sustainability and economic goals, particularly for banks operating in innovative, digital, and competitive environments. Many studies have used normative and conceptual approaches, failing to provide scientific solutions for understanding CE typologies and their connections with organizational resources. This necessitates a disruptive circular approach, using scientific tools and strategic resources, to facilitate the CE transition towards sustainable business (Blomsma et al., 2022b). Banks currently serve mainly as CE initiative funders (Toxopeus et al., 2021); however, with their large customer base, they can significantly promote circular products, supporting CE's social, economic, and value-creation perspectives.

GLSS and its relevance to CE

Prior to the emergence of GLSS as a holistic approach, green, lean, and six sigma typologies were used separately to address environmental and business performance challenges. For example, firms aiming to develop clean processes, services, and recycled products adopt a green philosophy to minimize the negative environmental impacts of their products and services (Shrivastava, 1995). These green philosophies caused an excessive outflow of resources, minimizing their efficiency, which was first highlighted by the Toyota Production System and gained limelight after the publication of a book titled 'The Machine That Changed the World' (Womack et al., 2007). To address waste reduction issues, organizations have begun implementing lean strategies to identify and eliminate waste while advancing green initiatives (Prasad et al., 2016). Despite eliminating waste in the manufacturing of green products and services, organizations have been unable to address economic efficiency, which has hampered their ability to achieve sustainable performance. This issue was addressed by introducing a structured and systematic approach called Six Sigma. It was first identified by Motorola in 1987 and provides a statistical process control (SPC) technique to reduce defects through (define (D), measure (M), analyze (A), improve (I), and control (C)) frameworks (Hilton et al., 2012).

Nonetheless, the GLSS was designed by integrating three compatible strategies (green, lean, and six sigma), complementing and mitigating the deficiencies of others (Garza-Reyes, 2015; Rathi et al., 2022). GLSS is now recognized as an integrated approach for optimizing the environmental and operational performance (Farrukh et al., 2022; Mishra, 2018; Yadav et al., 2023). Broadly, GLSS offers scientifically enabled strategic tools to help firms achieve their environmental and business goals through waste elimination and resource conservation. Several organizations in the manufacturing, healthcare, service, and education industries have deployed GLSS as a strategic tool to confront sustainability (Rathi et al., 2022), economics (Gaikwad & Sunnapwar, 2020), business management (Singh et al., 2022), and value-creation issues (Farrukh et al., 2020).

Recently, some studies have suggested interesting GLSS frameworks that incorporate different digital technologies, further consolidating their significance as strategic tools (Ciliberto et al., 2021; Belhadi et al., 2023). Although researchers have rigorously used the GLSS as a strategic tool to achieve sustainability, business performance, and value-creation goals, new research streams are needed to provide step-by-step guidelines for implementing and understanding its potential to address under-researched areas, such as CE (Gholami et al., 2021).

GLSS's reputation as a systematic booster of firms' operational and environmental performance has motivated CE researchers to use it to understand how CE is operationalized across industries. Prior research has highlighted GLSS's potential as a systematic enabler of CE. Studies have demonstrated its utility in reducing waste, improving processes, enhancing profitability through sustainable product development (Garza-Reyes, 2015), and mitigating defects while promoting resource efficiency and carbon reduction (Kumar et al., 2015).

GLSS has been shown to optimize operations and finances (Pandey et al., 2018), maximize output through pollution control (Sony & Naik, 2020), and facilitate the implementation of CE's 3R concepts (Kaswan & Rathi, 2020). These findings indicate that GLSS offers a robust toolkit aligned with CE objectives, providing a foundation for its application across sectors. These studies used combinations of green lean, green Six Sigma, or lean Six Sigma to support circular business strategies, which might lower CE effectiveness. Following GLSS's credibility as an integrated approach, this study investigates whether GLSS and its individual complementarities enable CE effectively.

Theoretical model and hypotheses development

We employed Barney's (1991) RBV theory to investigate the impact of GLSS and environmental beliefs on banks' CE initiatives. The theoretical framework of this study is illustrated in Figure 1. The fundamentals of the RBV stipulate that a firm's competitive advantage and superior performance are rooted in its resources and capabilities, which can be classified into assets, processes, firm characteristics, information, and knowledge (Conner, 1991). Firms seeking to sustain a competitive advantage need to continuously assess and deploy strategic resources to create value by exploiting distinct opportunities (Barney, 1991). Following the RBV, past studies have examined and proposed theoretical frameworks that emphasize the significance of the GLSS as a strategic resource in designing environmental-based business strategies (Farrukh et al., 2022, 2023a; Seles et al., 2022; Sony & Naik, 2020).

Consistent with the RBV, it is anticipated that initiating CE projects in banks may become a source of competitive advantage by addressing sustainability, ethical, economic, and value-creation issues, as well as promoting sustainable banking through performance optimization (Ali et al., 2022). Furthermore, it is projected that the competitive advantage achieved through the CE banner can be sustained using GLSS as strategic resources and environmental beliefs as managers' capabilities.

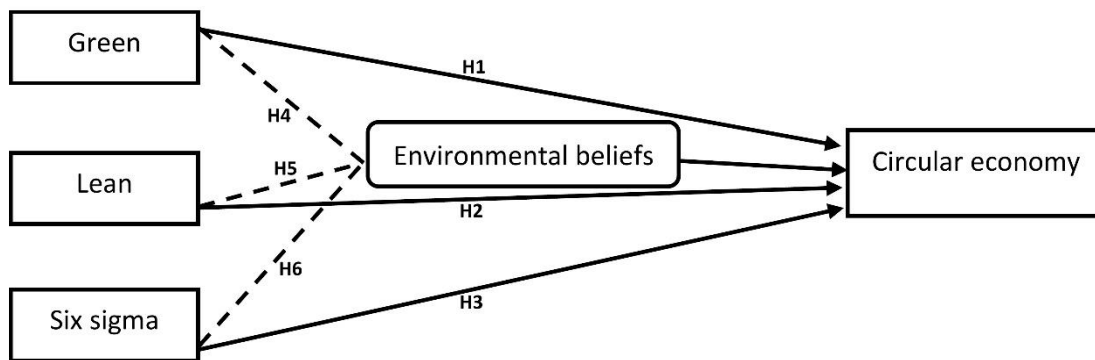


Figure 1. Theoretical model.

CE-based economic systems replace the traditional 'take-make-waste' approach with a 'take-make-regeneration' model, eliminating waste and conserving resources (Ghisellini et al., 2016). This approach closes the production loop, optimizes recycling, and ensures that materials are available for reuse (Ciliberto et al., 2021). While CE proponents expect banks to fund CE projects to demonstrate support for the United Nations' Sustainable Development Goals (Ellen MacArthur Foundation, 2014), banks must generate profits for shareholders. Critics argue that circular models view the world through an engineering lens and ignore economic aspects, potentially undermining CE objectives (Ozili, 2021).

GLSS's green complementarity may help enable banks' CE initiatives by addressing environmental and economic perspectives. Importing RBV logic, a strong 'green strategy' within a bank, characterized by its ability to generate eco-innovations and attract green finance, can be considered a valuable and inimitable resource. Through such a strategy, banks can better plan, design, implement, and advance their CE initiatives, thereby creating a competitive advantage. Past studies have highlighted green as a strategic tool for identifying, estimating, and analyzing its potential to address environmental and economic issues associated with products and processes (Farrukh et al., 2022; Gaikwad & Sunnapwar, 2020; Garza-Reyes, 2015; Mishra, 2018). Green methods positively impact the management and design of environment-based business strategies, helping firms comply with regulatory requirements, offer environmentally friendly products and maximize economic performance (Miroshnychenko et al., 2017). Through a green strategy, banks can plan, design, implement, and advance their CE initiatives. Thus, H1 is hypothesized as follows:

H1: The green strategy positively impacts CE in banks.

Similarly, the concept of waste in CE and its reuse through recycling are controversial for economic and quality reasons. In certain cases, waste recycling is impossible because the cost may exceed the market value of the recycled products (Biakhmetov et al., 2022). This aspect of CE may damage banks' reputations by strengthening the narratives of service replication, inability to offer innovative services, and poor value-creation strategies. Instead of focusing on recycling waste, lean practices promote waste minimization across organizations (Prasad et al., 2016). Previous studies have confirmed that lean is a strategic tool for minimizing waste (Garza-Reyes, 2015), creating value for customers (Gaikwad & Sunnapwar, 2020), offering innovative products and services (Sony & Naik, 2020), and gaining a competitive advantage (Garza-Reyes et al., 2018). Although both CE and lean emphasize maximizing resource value by optimizing stock and throughput, the complexities of lean penetration across organizational levels may hamper the full enabling of CE (Schmitt et al., 2021). Therefore, it would be interesting to examine the impact of the lean strategy on CE. This leads to our second research hypothesis (H2), as follows:

H2: A lean strategy positively impacts CE in banks.

CE promotes the recycling of existing materials instead of acquiring new sources, thereby reducing the production of new resources and consumption. From a banking perspective, this CE aspect affects progress in acquiring resources, leading to poor sustainability, portfolios, innovation, and FinTech (ization) management. Banks may avoid circular projects due to poor waste infrastructure, technology, and product quality, thereby increasing investment risk. The Six Sigma strategy, powered by statistical process control (SPC), may help improve CE product quality through a systematic approach and enhance operations (Singh et al., 2022). Previous studies have confirmed its implementation as a strategic tool and reported that Six Sigma positively contributes to maximizing sustainability and efficiency by reducing environmental waste and resource outflow (Sagnak & Kazancoglu, 2016; Farrukh et al., 2023b). Given its technical nature and strategic significance in achieving CE objectives, we believe Six Sigma can help enable CE in banks. Thus, H3 was hypothesized as follows:

H3: The Six Sigma strategy has a positive impact on CE in banks.

Scholars and practitioners have highlighted the significance of CE in achieving sustainability through the implementation of GLSS strategies (Ciliberto et al., 2021; Schmitt et al., 2021). Considering the CE's sustainability perspective to achieve competitive advantage and the role of GLSS as a strategic CE enabler, RBV logic stipulates that firms and their assets in the form of human capital, information, and knowledge can play a key role in sustaining competitive advantage (Barney, 1991). The findings of previous studies have also confirmed the role of organizational support (Zhou et al., 2021), top management commitment (Seles et al., 2022), and managers' perceptions (Ali et al., 2022) in enabling CE in different industries. We believe that enabling CE through GLSS requires the support of managers who oversee the organization's key operations. Managers' environmental beliefs and perceptions of environmental threats to business motivate them to adopt sustainability-enabling strategies (CE) through strategic tools (GLSS). Based on the preceding argument, managers' environmental beliefs may serve as mediators between CE and GLSS. Accordingly, we postulate H4, H5, and H6 as follows:

H4: The environmental beliefs of managers mediate the relationship between green strategy and CE.

H5: The managers' environmental beliefs mediate the relationship between lean strategy and CE.

H6: The environmental beliefs of managers mediate the relationship between the Six Sigma strategy and CE.

3. Data And Method

Sampling Strategy

To test our hypotheses, we conducted a survey. The initial survey was conducted through a thorough pretesting process. It was shared with seven experts from academia and banking, who were well-versed in CE and GLSS and familiar with CE trends in the Malaysian banking industry. Their feedback on the clarity, wording, and relevance of the questionnaire content was systematically gathered. This input prompted specific changes, including rephrasing unclear items and eliminating redundant questions, to ensure the instrument was suitable for the intended audience. The final survey questionnaire targeted bank executives in key managerial roles in Malaysian banks as the sample population. The stage of crafting a psychometrically sound survey tool and selecting the appropriate population for data collection was deemed essential for achieving the research objectives.

Given that our research questions aimed to quantify the extent of GLSS's influence on CE and the mediating role of managers' beliefs in CE implementation (RQ1 and RQ2), a quantitative, descriptive approach using a survey questionnaire was employed (Khan et al., 2019). This method is well-suited for assessing the relationships between latent variables across a large sample, providing generalizable insights into the proposed theoretical model. The managers of Malaysian banks were targeted for primary data extraction for two reasons. First, the Malaysian government's recent provisions transitioned to circular economic growth through infrastructure development, the CE policy roadmap, and the allocation of RM1 billion to finance various schemes (MIDA, 2021).

The successful transition to CE demands the proactive participation of major economic contributors. Consequently, the financial sector, particularly banks, has been identified as a key CE (Isa et al., 2021). This will allow banks to leverage the opportunity to diversify their portfolios by venturing into circular finance businesses and to improve their image by contributing to environmental and social domains (Ozili, 2021). Second, bank participation in CE initiatives will allow regulators to benchmark the progress of circular finance and operationalize relevant strategies to transition and achieve the objectives of circular economic growth envisioned in the Financial Sector Blueprint-2026 (BNM, 2022).

Measurements

A detailed literature review was conducted to identify the measures for our survey instrument, and the selected measures were modified to suit the context of this study. Consistent with the conceptualization of indicators as manifestations of the underlying latent construct (Hair et al., 2017), all constructs in our theoretical model were operationalized as reflective indicators (Table 1). This approach aligns with the understanding that [Green, Lean, and Six Sigma strategies, CE, and Environmental Beliefs] are abstract concepts whose indicators are expected to covary and are interchangeable.

Robustness Checks and Endogeneity Considerations

Several procedures were implemented to ensure the robustness and validity of the empirical findings. First, reliability and convergent validity were assessed using Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE). Discriminant validity was evaluated using the Fornell–Larcker criterion and the heterotrait-monotrait ratio (HTMT).

Second, common method bias (CMB) was minimized through procedural remedies, including respondent anonymity, item randomization, and clear questionnaire wording. Statistically, Harman's single-factor test and full collinearity assessments were conducted to ensure that common method variance did not threaten the results.

Third, to address potential endogeneity concerns arising from omitted variables or reverse causality, the study used variance inflation factor (VIF) assessments and examined structural relationships via bootstrapping. Additionally, mediation analysis using bias-corrected bootstrapping was conducted to verify the indirect effects and improve the robustness of the findings.

Finally, robustness checks were performed by comparing alternative model specifications and evaluating predictive relevance (Q^2) and effect sizes (f^2) to confirm the consistency and explanatory power of the proposed model.

Table 2. Construct Measurement.

Construct	Construct label	Measure	Source
Green strategy	GS	GS1. Our bank has a Green Network membership and an environmental audit.	(Garza-Reyes, 2015)
		GS2. Our bank offers green products and services to customers.	
		GS3. Our bank participates in pollution reduction projects.	
		GS4. Our bank provides environmental protection and energy conservation training to the staff.	
		GS5. Our bank participates in recycling projects.	
Lean strategy	LS	LS1. Our bank undertakes quality improvement and control programs.	(Kumar et al., 2015)
		LS2. Our bank undertakes programs to improve equipment productivity.	

		LS3. Our bank undertakes actions to implement pull production (e.g., reducing service delivery time, providing efficient over-the-counter (OTC) services, and responding promptly to equipment failures). LS4. Our bank implements strategies to enhance employees' skills and knowledge.	
Six Sigma strategy	SSS	SSS1. Our bank has a reward-and-recognition system for teams. SSS2. Our bank extensively uses statistical and analytical techniques to minimize service variation. SSS3. The charts showing defects are used as a tool for service recovery. SSS4. Our bank frequently provides effective Six Sigma education and training programs.	(Gaikwad and Sunnapwar, 2020)
Environmental beliefs	EB	EB1. Environmental threats negatively affect our bank's business. EB2. Environmental threats have started to worry me about the future of our bank. EB3. Environmental threats are affecting the daily operations of our bank. EB4. Management of environmental threats will incur economic and financial benefits to our bank. EB5. Management of environmental threats will help our bank avoid financial crises.	(Kump, 2021)
Circular economy	CE	CE1. Our bank has access to the resources needed to enable CE. CE2. Our bank employees have the preliminary knowledge and skills to enable CE. CE3. Our bank understands the underlying benefits of enabling CE. CE4. Our bank management is serious about enabling CE. CE5. Sustainability, economic, and customer value creation issues motivate our bank to enable CE.	Ghisellini and Ulgiati (2020.); Ghisellini et al. (2016)

The survey was divided into two sections. Section A covered the demographic profiles of the respondents' gender, age, educational level, job position, and job experience. Section B consists of a 23-item scale designed to explore the impact of the GLSS and the mediating role of environmental beliefs in facilitating CE. In line with the theoretical model discussion, the green strategy was assessed using five items sourced from Garza-Reyes (2015), the lean strategy was evaluated using four items from Kumar et al. (2015), and the six-sigma strategy was measured using four items adopted from Gaikwad and Sunnapwar (2020). CE was gauged using five items from Ghisellini and Ulgiati (2020) and Ghisellini et al. (2016), while managers' environmental beliefs were assessed through five items adopted from Kump (2021). These measurements were modified slightly to fit the context of the present study. Participants responded to these items using a 5-point Likert scale ranging from strongly disagree (1) to agree (5) strongly.

Data collection process

The survey was administered to executives (marketing, customer relationships, business managers, and branch managers) in key managerial positions in Malaysian banks with Green Bank Network membership. This multibank sampling approach enhances the generalizability of the findings. These bank managers were selected as respondents because they had implemented or were expected to implement CE-based initiatives to comply with network requirements and support Malaysia's CE policy roadmap. A total of 1148 samples were distributed to executives at 36 branches of six banks (AmBank, CIMB, HSBC, Maybank, OCBC, and Standard Chartered Bank Malaysia Berhad) in Selangor and Kuala Lumpur. The survey was conducted online, using a secure platform.

Invitations with unique survey links and cover letters explaining the study were distributed through bank email channels and professional groups on LinkedIn, WhatsApp, Facebook and Instagram. Data collection will occur between 10 September 2025 and 28 October 2025. This data collection strategy maintained diversity and randomness in the responses. The Participants returned 723 completed surveys, yielding a response rate of 62.97%. Ten incomplete surveys were excluded during the data preparation. After screening for multivariate outliers using Mahalanobis distance, 713 valid surveys remained for analysis.

Our data collection method and survey response rate verified the validity of the cases, as the valid cases exceeded the minimum threshold for Partial Least Squares Structural Equation Modeling (PLS-SEM), which often ranges from 200 to 400 cases, depending on model complexity (Hair et al., 2017). The sample size of 713 exceeded the recommended minimum of 10 times the largest number of structural paths directed at a latent variable (Hair et al., 2017), ensuring sufficient statistical power for our model. The specific rule of '31 respondents for each indicator' was derived from Ali et al. (2022), further supporting the adequacy of our sample. The non-response bias was checked using a t-test to compare the difference between responding and non-responding participants, and no significant difference was found ($p > 0.05$) (Armstrong & Overton, 1977). The demographic profiles of the respondents are presented in Table 2.

Table 2. Demographic Profiles Of The Respondents.

Demographic character	<i>n</i>	%
<i>Gender</i>		
Male	317	44.46
Female	385	53.99
Others	11	1.54
<i>Age (years)</i>		
Below 30	13	1.82
Between 30-35	92	12.90
Between 36-40	121	16.97
Between 41-45	246	34.50
Between 46-50	169	23.70
Above 50	72	10.09
<i>Education level</i>		
Diploma/certificate	212	29.73
Bachelor	336	47.12
Master	144	20.19
Ph.D.	21	2.94
<i>Job position</i>		
Marketing manager	208	29.17
Customer relationship manager	235	32.95
Business manager	202	28.33
Branch manager	68	9.53
<i>Job experience (years)</i>		
Below 5	78	10.93
Between 5-10	175	24.54
Between 11-15	323	45.30
Between 16-20	82	11.50
Above 20	55	7.71

Data Analysis Procedures

Given the exploratory nature of this research, the PLS technique is considered suitable because it offers higher accuracy in estimating the general model than covariance-based SEM (Henseler et al., 2014). Furthermore, SEM remains unaffected by model misspecification in certain parts of the proposed model. We categorized our study as exploratory because of the limited empirical literature on the influence of GLSS and environmental beliefs on CE. Therefore, we employed WarPLS 7.0 to test our theoretical model and research hypotheses. The PLS technique, also known

as the prediction-oriented method, allows researchers to estimate the probability of exogenous variables (Peng & Lai, 2012).

The current research is expected to measure the predictability or explanatory power of antecedent factors (i.e., GLSS and environmental beliefs). Since the literature has yet to empirically examine the relationship among GLSS, environmental beliefs, and CE, the theoretical foundation for this association is lacking, further justifying the relevance of the PLS-based modeling technique for analyzing our data (Henseler et al., 2014). Finally, the higher accuracy of PLS in estimating a complex structural equation model, as proposed in this study, further supports its use. Model estimation was performed using a two-stage approach in WarPLS 7.0 (Peng & Lai, 2012; Henseler et al., 2014; Moshtari, 2016).

The PLS algorithm was run with a path-weighting scheme, maximum iterations = 300, and convergence criterion = 10^{-5} . First, the validity and reliability of the measurement model were evaluated. Subsequently, the structural model was estimated using a bootstrapping procedure with 5,000 subsamples to determine the significance of the path coefficients and standard errors (Chin, 1988), using a two-tailed test with a significance level of $p < 0.05$.

4. Results

Model Estimation

The initial phase of the analysis involved assessing the validity and quality of the measurement model. We computed the Scale Composite Reliability (SCR), Cronbach's alpha coefficients, and Average Variance Extracted (AVE) to evaluate the quality of the measurement model (Table 3). Both the SCR and Cronbach's alpha coefficients exceeded the 0.70 threshold for all constructs, indicating strong internal consistency.

However, the AVE for the Six Sigma Strategy (SSS) fell short of the recommended 0.50 threshold (0.46), raising concerns about the construct's convergent validity. The AVE values for all other constructs fulfilled the 0.50 criterion, signifying that the latent constructs accounted for at least 50% of the variance in their respective items. Factor loadings below 0.50 were removed, and SEM analysis was performed to obtain new results (Table 4). The newly obtained factor loadings were satisfactory, exceeding the 0.50 criterion (Hair et al., 2017). Subsequently, the correlations among the major constructs were estimated, and the results are presented in Table 5. In line with the Fornell-Larcker criterion, the square roots of the AVE (diagonal entries in Table 3) were greater than the interconstruct correlations, confirming the satisfactory discriminant validity of our measurement model.

Table 3. The Initial Factor Loadings Of The Indicator Variables (Composite Reliability) (AVE).

Variables	Measurements	Factor loadings	Variance	Error	SCR	AVE
GS	GS1	0.73	0.53	0.57	0.85	0.48
	GS2	0.22	0.06	0.94		
	GS3	0.37	0.08	0.92		
	GS4	0.82	0.64	0.36		
	GS5	0.45	0.31	0.69		
LS	LS1	0.33	0.12	0.88	0.88	0.73
	LS2	0.66	0.57	0.53		
	LS3	0.62	0.58	0.42		
	LS4	0.88	0.38	0.62		
SSS	SSS1	0.67	0.58	0.42	0.80	0.74
	SSS2	0.70	0.62	0.38		
	SSS3	0.42	0.27	0.73		
	SSS4	0.25	0.14	0.86		
EB	EB1	0.75	0.68	0.32	0.83	0.77
	EB2	0.69	0.53	0.47		
	EB3	0.66	0.55	0.45		

CE	EB4	0.80	0.71	0.29	0.92	0.72
	EB5	0.77	0.67	0.33		
	CE1	0.56	0.52	0.48		
	CE2	0.64	0.55	0.45		
	CE3	0.53	0.51	0.49		
	CE4	0.72	0.68	0.32		
	CE5	0.75	0.72	0.28		

Table 4. Factor Loadings Of The Indicator Variables (Composite Reliability) (AVE).

Variables	Measurements	Factor loadings	Variance	Error	SCR	AVE
GS	GS1	0.73	0.53	0.57	0.88	0.57
	GS4	0.82	0.64	0.36		
LS	LS2	0.66	0.57	0.43	0.90	0.78
	LS3	0.62	0.58	0.42		
	LS4	0.62	0.58	0.58		
SSS	SSS1	0.67	0.58	0.42	0.82	0.77
	SSS2	0.70	0.62	0.38		
EB	EB1	0.75	0.68	0.32	0.87	0.83
	EB2	0.69	0.53	0.47		
	EB3	0.66	0.55	0.45		
	EB4	0.80	0.71	0.29		
	EB5	0.77	0.67	0.33		
CE	CE1	0.56	0.52	0.48	0.92	0.76
	CE2	0.64	0.55	0.45		
	CE3	0.53	0.51	0.49		
	CE4	0.72	0.68	0.32		
	CE5	0.75	0.72	0.28		

Table 5. Correlations Among The Major Variables.

Constructs	GS	LS	SSS	EB	CE
GS	0.76				
LS	0.04	0.85			
SSS	0.27	0.37	0.83		
EB	-0.07	-0.02	-0.09	0.86	
CE	0.22	0.31	0.19	0.36	0.79

Common method bias (CMB)

Common method bias (CMB) issues in our self-reported data were addressed by prompting respondents to complete the questionnaire using official bank documents or meeting minutes as references. In addition, Harman's single-factor test was performed. First, respondents were asked to complete our survey in accordance with the banks' meeting minutes or to use information from official documents rather than their personal experiences. Second, a Harman single-factor test was used to assess potential CMB. The maximum covariance explained by a single factor was 40.76%, which was below the 50% threshold, suggesting that CMB was not a significant concern (Table 6). While Harman's test provides an initial indication, more rigorous methods, such as full collinearity assessment (Kock, 2015), were also implicitly considered through the use of PLS-SEM, which is less susceptible to CMB owing to its predictive orientation.

Table 6 Results Of Single-Factor Harman's Test.

Components	Initial eigenvalues			Extraction Sums of Squared Loadings		
	Total	Variance %	Cumulative %	Total	Variance %	Cumulative %
1	14.674	40.762	40.762	14.674	40.762	40.762
2	4.432	4.456	68.792			
3	4.072	4.342	66.578			
4	3.458	3.073	64.518			
5	3.486	3.525	70.621			
6	3.464	3.514	68.563			
7	2.568	2.424	72.618			
8	2.382	2.603	73.673			
9	1.283	1.613	74.513			
10	0.881	1.357	76.667			
11	0.851	1.258	77.628			
12	0.743	2.415	81.736			
13	0.737	2.476	81.734			
14	0.626	1.723	80.539			
15	0.823	1.486	81.537			
16	0.856	1.658	77.854			
17	0.843	2.759	82.541			
18	0.844	3.619	78.624			
19	0.532	3.476	71.581			
20	0.634	5.638	83.673			
21	0.548	2.615	85.627			
22	0.664	2.584	78.636			
23	0.679	3.773	72.752			

Extraction Method: Principal Component Analysis.**Endogeneity Test**

Before proceeding to the second stage of the analysis, it is crucial to examine the endogeneity of the exogenous variables in this study. As emphasized in the literature review, GLSS is identified as an exogenous variable to CE rather than vice versa, suggesting that endogeneity is unlikely to pose a significant issue in this study. Additionally, we utilized the Durbin-Wu-Hausman test to validate our assumption following Davidson and MacKinnon's (1993) methodology. We performed a regression of the GLSS on the mediating (EB) and outcome (CE) variables, using the regression residuals as an additional regressor to test the hypothesized equations. The parameter estimates for the residuals were insignificant, confirming that GLSS was not endogenous in our model, which aligns with the core conceptualization of this study.

Hypotheses Testing

We tested our hypotheses using the PLS-based bootstrapping technique and measured the standard errors and significance of the parameter estimates (Chin, 1988; Peng & Lai, 2012; Moshtari, 2016). The significance of parameter estimates was assessed using bootstrapping procedures rather than traditional parametric techniques, as the latter cannot assume normality in multivariate data (Henseler et al., 2014). The results of the PLS output obtained from WarPLS 7.0 are presented in Figure 2. Notably, $R^2 = 0.648$, which indicates that GLSS explained a significant amount of variance in CE. To test our hypotheses, we analyzed the standardized β and ρ values of PLS output. The PLS estimates indicate that H1 (GS \rightarrow CE) is supported ($\beta = 0.653$; $\rho \leq 0.001$). Similarly, H2 (LS \rightarrow CE) was supported ($\beta = 0.683$; $\rho \leq 0.001$).

The structural estimates for H3 (SSS \rightarrow CE) were positive ($\beta = 0.042$; $\rho > 0.001$), supporting H3. Our findings, which demonstrate GLSS's significant positive impact on CE, corroborate and extend prior research that posits GLSS as a strategic enabler (e.g., Ciliberto et al., 2021, in manufacturing; Sony & Naik, 2020, in diverse sectors). Specifically, our study confirms that the integrated

approach of green, lean, and Six Sigma principles, previously validated in tangible production environments, is equally effective in the intangible service context of banking, where process optimization and waste reduction are critical to circular finance initiatives.

The mediation results indicate that H4 (GS → EB → CE) is supported ($\beta = 0.535$; $\rho \leq 0.001$). In addition, the structural estimates for H5 (LS → EB → CE) were significant and positive ($\beta = 0.560$; $\rho \leq 0.001$), confirming its acceptance. Contrary to our prediction of H6 (SSS → EB → CE), the structural estimates were insignificant ($\beta = 0.048$; $\rho > 0.001$), indicating that H6 was not supported.

The path coefficients of PLS were obtained by running 500 bootstrap samples, and the results for the standardized β and their p-values are summarized in Table 7.

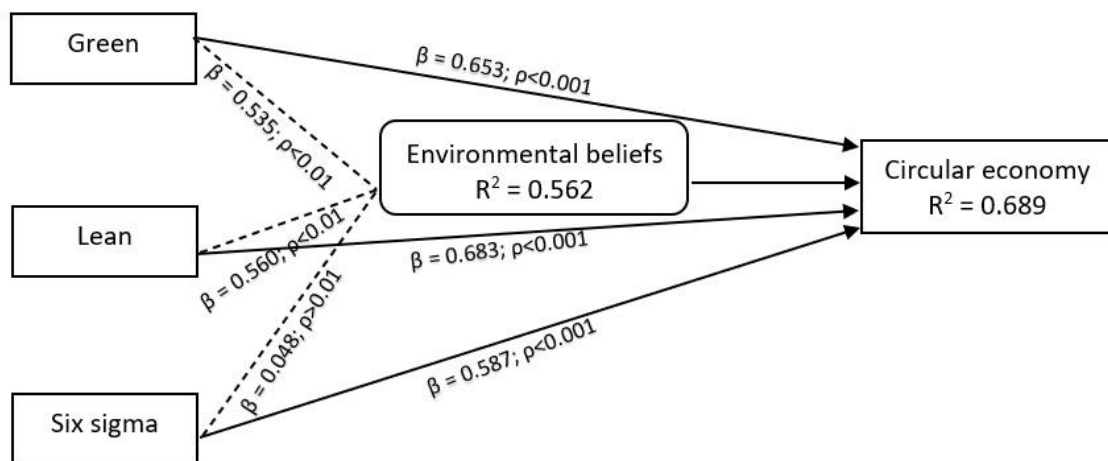


Figure 2. PLS Results

Table 7. Structural Estimates.

Hypothesis	Effect of	On	β	ρ	Supported/not supported
H1	GS	CE	0.653	< 0.001	Yes
H2	LS	CE	0.683	< 0.001	Yes
H3	SSS	CE	0.587	< 0.001	Yes
H4	GS → EB	CE	0.535	< 0.001	Yes
H5	LS → EB	CE	0.560	< 0.001	Yes
H6	SSS → EB	CE	0.048	> 0.001	No

The effect size of the variance in each variable, when endogenous latent variables are involved, remains unexplored and can be evaluated using Cohen's f^2 formula. Cohen's (1988) approach was used to estimate the effect size, with large (0.35), medium (0.15), and small (0.02) values used as thresholds to assess the effect size of GLSS on our endogenous variables. The results of f^2 (effect sizes) for the GLSS effect on EB (0.584) and CE (0.703) were considered large because these values were above the acceptable criteria for a large effect. We also estimated the predictive performance of our model using Stone–Geisser's Q^2 method and found that all our endogenous variables had acceptable predictive relevance, as their Q^2 values were greater than zero (Peng & Lai, 2012; Moshtari, 2016). The results for R^2 , f^2 , and Q^2 are presented in Table 8.

Table 8. Summary Of The Structural Estimates.

Constructs	R^2	f^2	Q^2
EB	0.562	0.584	0.597
CE	0.689	0.703	0.712

5. Discussion

Note: EB and CE represent environmental beliefs and circular economies, respectively.

The empirical findings of this study confirm the significance of GLSS and the mediating role of managers' environmental beliefs as a strategic tool for enabling CE in banks. Previous studies have conceptualized GLSS and environmental beliefs as normative constructs (Ciliberto et al., 2021; Farrukh et al., 2022; Kaswan & Rath, 2020; Kump, 2021; Sony & Naik, 2020), whereas our research highlights the operationalization of GLSS and environmental beliefs as formative latent constructs, eliminating complexities linked to measuring formative constructs (Henseler et al., 2014). The results of the estimation model suggest that all three GLSS complementarities (green, lean, and Six Sigma) have a significantly positive impact on CE (H1, H2, and H3).

Our findings underscore that the GLSS is a potent strategic organizational tool for accelerating CE initiatives, particularly in the banking sector. For instance, the 'green' component (H1) can enable banks to develop eco-friendly financial products and services or optimize their internal energy consumption, directly aligning with the CE principles of resource minimization. 'Lean' strategies (H2) facilitate the elimination of non-value-added processes in banking operations, such as reducing paperwork, streamlining digital workflows, and optimizing customer service delivery, thereby minimizing resource outflow in an intangible context. The 'Six Sigma' component (H3), through its focus on defect reduction and process variation control, ensures the quality and reliability of circular finance mechanisms and data management, which are crucial for building trust and efficiency in CE-related investments.

This finding strongly aligns with Barney's (1991) RBV logic, which posits that firm-specific resources are crucial for a sustained competitive advantage. We argue that GLSS, with its integrated approach to waste reduction, process optimization, and quality improvement, represents a valuable, rare, and potentially inimitable strategic resource for the banking industry. Its systematic methodology provides a unique pathway for banks to address sustainability, economic efficiency, and value creation simultaneously, effectively acting as a tool for circular disruption that transforms traditional linear processes into circular ones. Competitors cannot easily replicate this capability without the same internal expertise or organizational commitment. Consequently, this result leads us to extend the findings of recent studies claiming that GLSS is a strategic organizational tool to improve sustainability and enable CE in different organizations, including banks (Ali et al., 2022; Blomsma et al., 2022b; Seles et al., 2022; Sony & Naik, 2020; Schmitt et al., 2021).

The financial sector faces major transformations driven by changes in customer needs, regulations, market conditions, and digital technologies, which have forced banks to reconsider their business models and address criticisms of poor environmental, social, and customer management practices, as well as inefficiencies and instability. Scholars and consultants have suggested strategies for sustainability (Yip & Bocken, 2018), regulation, market competition (Khattak & Saiti, 2021), customer management (Tseng et al., 2018), and technology management (Ali et al., 2021a) in banks. However, these strategies do not embed CE, which has gained prominence in improving the sustainability, financial performance, and value creation of banks (Ozili, 2021).

Some studies have attempted to show that enabling CE in banks and associated technology (Ozili, 2022), financial factors (Toxopeus et al., 2021), and personal factors (Ali et al., 2022) are drivers of CE. Our findings extend the literature by proposing GLSS as a strategic enabler for banks to forge a disruptive circular finance strategy. This disruption goes beyond funding external CE projects, implying that banks leverage the GLSS to optimize internal operations (e.g., greening data centers and lean loan processing), design innovative circular financial products (e.g., financing take-back schemes and green bonds for circular businesses), and develop new business models that promote circularity among clients. By fostering efficiency, quality, and environmental consciousness, GLSS provides banks with the capability to become proactive agents in the circular economy, not just funders, thereby redefining their value propositions and competitive landscapes.

The results on the mediating role of managers' beliefs showed a positive relationship between green and lean strategies and CE (H4 and H5), indicating that managers' perceptions of environmental threats motivate them to acquire strategic tools to support sustainability, performance, and value-creation initiatives (CE) in banks. This finding extends previous studies (see Ali et al., 2022; Kump, 2021; Sönnichsen et al., 2022) that identified environmental perceptions as drivers of environmental beliefs, motivating managers to identify relevant strategies for strategic change.

Contrary to our hypothesis, the insignificant mediating effect of environmental beliefs on the Six Sigma-CE relationship (H6) offers a nuanced extension of the RBV. While green and lean strategies tied to organizational culture and environmental initiatives are influenced by managerial perceptions and beliefs as critical capabilities, Six Sigma's standardized, data-driven nature may make it less susceptible to individual managers' environmental beliefs. Its CE enablement stems more from technical rigor and systematic problem solving than from managers' environmental convictions. This suggests that while beliefs activate 'softer' green and lean capabilities, 'harder' Six Sigma process discipline operates more autonomously, challenging the view of managerial beliefs as a universal mediating capability for all GLSS components.

6. Conclusion

This study applied the Resource-Based View (RBV) to examine the roles of Green Lean Six Sigma (GLSS) and managers' environmental beliefs in enabling Circular Economy (CE) practices in the banking sector. The findings demonstrate that GLSS significantly supports CE implementation, while managers' environmental beliefs positively mediate the relationship between green and lean strategies and CE. However, the mediating effect was not significant for Six Sigma, suggesting that process-oriented quality strategies may operate independently from managerial environmental cognition.

The study contributes to theory by extending the RBV through the integration of strategic resources (GLSS) and organizational capabilities (environmental beliefs) to explain CE enablement in banks. It also enriches sustainability and organizational change literature by highlighting the importance of managerial cognition in translating sustainability-oriented strategies into operational CE outcomes.

From a policy perspective, the findings support the development of regulatory frameworks and financial policies that encourage banks to adopt GLSS practices and strengthen environmental competencies within the financial sector. Policymakers and regulators may use these insights to accelerate circular finance initiatives and support sustainable economic transformation, particularly in developing economies.

Managerially, the results provide practical guidance for bank executives on integrating GLSS into sustainability strategies and on investing in environmental training and awareness programs for managers and employees. Such initiatives can strengthen organizational readiness for CE implementation, improve sustainability performance, and enhance long-term value creation. Future studies are encouraged to employ longitudinal and mixed-methods approaches to explore further contextual and organizational factors influencing CE adoption.

Recommendation

Based on the findings of this study, Banks should strengthen the integration of green and lean practices within the GLSS framework through sustainability training, environmental competency-based recruitment, and the development of a sustainability-oriented organizational culture. Regulators and policymakers are encouraged to provide incentives, regulations, and sustainability guidelines that support the implementation of the circular economy in the financial sector. Future research should incorporate additional factors, such as digital capabilities and organizational culture, and employ longitudinal or mixed-methods approaches to provide more comprehensive insights into CE implementation.

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