

Aggressive Low Carbon Innovation (ALCI): A Conceptual Framework for Sustainable Business Competitiveness

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ABSTRACT

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The transition toward sustainability in business operations has become a critical driver for competitive advantage in the modern economy. This study explores the integration of Green Innovation Capability (GIC) and Strategic Aggressiveness (SA) to develop the Aggressive Low Carbon Innovation (ALCI), a conceptual framework designed to enhance sustainable business competitiveness. The study synthesizes literature insights and expert interviews using qualitative research methodology to construct a model that aligns organizational transformation, operational optimization, and system integration. The ALCI conceptual framework identifies key enablers such as technological adoption, supply chain optimization, leadership commitment, cultural shifts, and effective data management. These components are strategically linked to address challenges like cost of transition, resistance to change, and system integration complexities. The framework emphasizes aggressive, proactive strategies for implementing green initiatives, fostering collaboration across departments, and leveraging innovative technologies to optimize sustainability outcomes. The study contributes to sustainability literature by demonstrating how combining GIC and SA can facilitate organizational transformation and operational efficiency, enabling firms to achieve a green business model. This framework provides practical implications for managers and policymakers seeking to implement robust green strategies that align with corporate sustainability goals and enhance competitive positioning in the global marketplace. Further research is recommended to validate this model across diverse industries and geographic regions.



Introduction

The increasing urgency of addressing climate change and environmental degradation has placed sustainability at the forefront of corporate strategy (Alshammari & Alshammari, 2023). Organizations worldwide are transitioning toward eco-friendly practices to remain competitive in an era where consumers, stakeholders, and regulators demand greener solutions. Green innovation is defined as developing and applying

products, processes, and practices that minimize environmental impact, which is a critical mechanism for achieving environmental sustainability and business growth (Ni et al., 2023).

Strategic aggressiveness, characterized by proactive and bold initiatives, complements green innovation by driving its implementation at scale. It enables firms to adopt disruptive technologies, streamline supply chains, and challenge traditional business norms. (Al-Mamary, 2025). By integrating Green Innovation Capability (GIC) with Strategic Aggressiveness, firms can enhance sustainability and maintain competitive advantage in global markets. (Shehzad et al., 2023).

Previous studies highlight the potential of green innovation to improve operational efficiency, reduce resource consumption, and align corporate practices with environmental objectives. (Alshammari & Alshammari, 2023). Similarly, strategic aggressiveness fosters innovation ecosystems by encouraging leadership buy-in, cultural transformation, and cross-departmental collaboration (Alharbi, 2023). However, there remains a gap in understanding how these two constructs can synergize to create a comprehensive, actionable framework for sustainable competitiveness.

This research contributes to the growing literature by proposing the Aggressive Low Carbon Innovation (ALCI), a model that integrates GIC and strategic aggressiveness. This conceptual framework emphasizes operational optimization, organizational transformation, and system integration as critical pathways for achieving green business outcomes.

Green innovation capability refers to a firm's ability to develop and implement sustainable innovations, such as eco-friendly products or processes, while ensuring compliance with environmental standards and maintaining operational efficiency. This capability is vital for fostering competitive advantages, especially in industries facing increasing ecological scrutiny and societal demand for sustainability. (Qingqing et al., 2020; Tarighi & Mokhtarzadeh, 2024).

Strategic aggressiveness, in contrast, represents a proactive and dynamic approach where firms aggressively pursue opportunities, outpace competitors, and adapt to changing market landscapes. This involves bold decision-making, significant resource allocation, and a strong focus on innovation to seize market leadership, particularly in sustainability-driven markets. This approach enables firms to be frontrunners in green initiatives while addressing growing competitive pressures (J. Chen & Liu, 2018; Zimon et al., 2020).

Aggressive Low Carbon Innovation (ALCI) integrates green innovation capability and strategic aggressiveness. It emphasizes excelling in sustainable innovation through assertive and forward-thinking strategies. ALCI enhances a firm's ability to address environmental challenges proactively, leverage innovation as a competitive differentiator, and secure long-term sustainable competitiveness.

For instance, firms adopting ALCI integrate green technologies into their core strategies while leveraging aggressive market tactics, such as rapid scaling, partnerships, and bold branding initiatives. By synthesizing these elements, ALCI creates a framework

that allows firms to transition from reactive to proactive sustainability strategies. (Asiaei et al., 2023; Mo et al., 2022; Qingqing et al., 2020; Tarighi & Mokhtarzadeh, 2024).

ALCI acts as a mechanism for transforming green innovation investments into tangible economic benefits. Firms with strong green dynamic capabilities and aggressive strategic postures tend to outperform market and environmental performance competitors, especially under conditions of high ecological dynamism. These firms can effectively navigate regulatory changes, market disruptions, and evolving customer expectations.

ALCI refers to a proactive and assertive approach where firms integrate environmental sustainability into their core business strategies while adopting bold, innovation-driven actions to outperform competitors. This innovation combines green innovation capability, the ability to develop and implement sustainable, eco-friendly innovations, with strategic aggressiveness, which involves pursuing opportunities quickly, making significant investments, and pushing for rapid market disruption (J. Chen & Liu, 2018).

ALCI emphasizes:

- a. **Bold Decision-Making:** Firms taking aggressive stances on sustainability pursue ambitious environmental goals and are willing to make substantial investments in green technologies, even in uncertain markets (Moosavy et al., 2023).
- b. **Rapid Market Positioning:** Firms leverage innovative green products or processes to establish themselves as leaders in environmentally sustainable industries quickly, outpacing competitors with aggressive tactics such as strategic partnerships, branding, and scaling (Sun & Sun, 2021).
- c. **Proactive Innovation:** ALCI focuses on not just innovating in response to regulatory or market pressures, but also seizing opportunities to disrupt existing market structures by implementing cutting-edge green technologies and business models (Moosavy et al., 2023).

Green Innovation Capability and Strategic Aggressiveness complement each other to form a comprehensive Aggressive Low Carbon Innovation framework. Below is a detailed synthesis of how these dimensions interconnect to shape the innovation:

Green innovation capability refers to a firm's ability to create and implement eco-friendly innovations such as sustainable products, processes, or services—while ensuring these innovations align with environmental goals and maintain economic viability (J. Chen & Liu, 2018; Moosavy et al., 2023). This dimension encompasses several critical components:

- a. **Technological and Process Innovation:** Firms must integrate new technologies and processes that reduce environmental impact. This includes cleaner production methods, energy-efficient technologies, and renewable energy use. Green innovation capability helps firms adopt practices like waste reduction, sustainable product design, and efficient resource management, thus fostering long-term sustainability (J. Chen & Liu, 2018).
- b. **Product and Service Innovation:** Companies must create new eco-friendly products and incorporate green criteria into their existing products and services. This could

involve enhancing recyclability, eco-friendly sourcing of materials, or ensuring products' lifecycle sustainability (Sun & Sun, 2021).

- c. Sustainability as Competitive Advantage: By integrating sustainability into their core competencies, firms differentiate themselves from competitors. This strategic advantage enables firms to appeal to environmentally conscious consumers, comply with regulatory standards, and attract investment, thereby positioning themselves for market leadership in a sustainability-driven economy.
- d. Organizational Knowledge and Learning: Firms with strong green innovation capabilities invest in employee training, R&D, and knowledge-sharing practices to foster innovation. These investments ensure that green innovation is continuously enhanced, improving the firm's ability to respond to environmental challenges and market opportunities (Moosavy et al., 2023).

Strategic aggressiveness is characterized by a proactive, bold, and risk-taking approach to market competition. Firms with high strategic aggressiveness pursue aggressive market positioning through innovation, rapid execution, and market disruption. (J. Chen & Liu, 2018). This dimension includes:

- a. Proactive Market Positioning: Strategic aggressiveness emphasizes leading rather than following market trends. Firms using ALCI don't wait for competitors to lead in green innovation but actively seek opportunities to be the first movers in sustainability-driven markets (Sun & Sun, 2021). By aggressively pursuing green innovation, they set new industry standards and capitalize on early adopter advantages.
- b. Resource Allocation and Risk-Taking: Strategic aggressiveness requires significant resource investment, often involving bold decisions about funding, scaling, and market expansion. This includes committing substantial financial and human resources to green innovation projects that may have high upfront costs but are anticipated to yield significant long-term returns in the form of market leadership, regulatory compliance, and brand loyalty (Moosavy et al., 2023).
- c. Adaptation to Market Dynamics: Aggressive firms are highly adaptive, responding swiftly to shifts in consumer preferences, environmental regulations, and technological developments. By prioritizing innovation and sustainability, these firms adapt to market trends and actively shape them, gaining competitive advantages through their forward-thinking approaches (J. Chen & Liu, 2018; L. Chen et al., 2019).
- d. Strategic Partnerships and Alliances: Aggressive low carbon innovation often involves collaborations with other organizations to leverage complementary strengths. These partnerships can include joint ventures for R&D, alliances with sustainability-focused suppliers, or partnerships with non-governmental organizations to enhance environmental credibility. These relationships help firms scale their green innovations quickly and expand their market reach (Ha et al., 2024).

Dimensions of Aggressive Low Carbon Innovation

The Aggressive Low Carbon Innovation (ALCI) integrates Green Innovation Capability and Strategic Aggressiveness that work collectively to foster sustainable

business growth and operational competitiveness. These dimensions maximize the potential for green innovation while ensuring that firms leverage strategic aggressiveness to achieve market dominance and long-term resilience. The synthesis of these dimensions reflects how ALCI can create value not only through environmental initiatives but also by embedding sustainability into business practices in a transformative manner, which creates these 9 (nine) dimensions:

a. Technological Adoption and Efficiency

This dimension emphasizes adopting cleaner, more energy-efficient technologies and production processes that reduce environmental footprints. It involves lowering operational costs while driving sustainability. Successful ALCI requires firms to adopt green technologies early, which reduces energy consumption, integrates sustainable materials, and minimizes waste production (Mokhtarzadeh et al., 2023; Jiawen & Linlin, 2019). Moreover, this technological shift aligns with cost-saving measures and long-term profitability through resource-efficient production (J. Chen & Liu, 2018).

b. Supply Chain Integration

Integrating sustainable practices within the supply chain is critical for an ALCI framework. Companies adopting ALCI should focus on reducing carbon emissions, improving logistics, and sourcing green materials. By doing so, they create a supply chain that is not only environmentally responsible but also more resilient to disruptions, while improving logistical efficiency. This is especially important in sustainability-driven markets, where consumers and stakeholders increasingly value green supply chain practices. (Sun & Sun, 2021).

c. Cost of Transition

Transitioning to green innovation comes with initial and long-term costs, including investments in new technologies, processes, and systems. A critical component of ALCI is ensuring that green technologies' return on investment (ROI) is calculated and managed correctly. Firms need to consider the payback period for these investments, conducting cost-benefit analyses to justify the financial commitment. This requires effective strategic planning, especially for organizations operating in highly dynamic and competitive markets (Moosavy et al., 2023).

d. Cultural Shift and Leadership Buy-In

ALCI requires a profound organizational transformation, starting with a cultural shift towards sustainability. Leadership plays a pivotal role by promoting sustainability-focused goals, which must be supported across all organizational levels. Employee engagement in green initiatives, training on sustainability knowledge, and developing a corporate sustainability policy are essential for embedding sustainability in the corporate culture. The presence of a dedicated sustainability-focused leadership team is fundamental for driving this transformation and ensuring broad organizational commitment (J. Chen & Liu, 2018; Sun & Sun, 2021).

e. Skill Gaps and Training Needs

Skill gap and training needs dimension is put into the Aggressive Low Carbon Innovation (ALCI) framework to ensure that firms can innovate sustainably and with the

knowledge and skills necessary to execute bold, forward-thinking strategies. Investing in targeted training programs that bridge these gaps strengthens a firm's competitive advantage, drives internal transformation, and positions the firm as a leader in green innovation and market sustainability.

f. Internal Resistance to Change

One challenge of implementing ALCI is overcoming internal resistance to change. This is a common hurdle in organizations undergoing green transformations, as employees and departments may feel uncertain or threatened by the changes. Effective change management strategies such as employee surveys, training sessions, and clear communication are necessary to reduce resistance and ensure smooth implementation. High levels of employee engagement and buy-in are crucial for ensuring the long-term success of green innovation initiatives.

g. Integration of New and Existing Systems

The integration of green innovation into both existing and new systems is a key ALCI dimension. Firms must harmonize green technologies with their current systems to minimize disruption and ensure that sustainability initiatives are scalable and maintainable. This involves aligning systems and processes with sustainable practices, ranging from supply chain management to energy usage in production. The speed and compatibility of system integration are essential to achieving operational efficiency and supporting the overall strategic goals of green innovation. (Moosavy et al., 2023); (Sun & Sun, 2021).

h. Data Management and Reporting

Effective data management and sustainability reporting are critical components for ALCI. Firms must have systems in place for accurately tracking and reporting sustainability metrics. This includes the implementation of environmental data management systems and the automation of sustainability reporting. Transparency and accurate reporting are vital for compliance with regulations and maintaining trust with stakeholders, investors, and consumers who are increasingly scrutinizing firms' environmental impacts.

i. Collaboration and Communication Across Departments

ALCI requires strong cross-departmental collaboration to communicate green initiatives effectively throughout the organization. Collaborative projects that involve sustainability efforts, such as shared green initiatives across departments, can enhance the success of sustainability strategies. Departments must work together to integrate sustainability into every aspect of business operations, ensuring that all teams are aligned with the company's green goals and initiatives (Moosavy et al., 2023; Sun & Sun, 2021).

j. Aggressive Low Carbon Innovation Conceptual Model

The Aggressive Low Carbon Innovation (ALCI) is a comprehensive framework that integrates Green Innovation Capability and Strategic Aggressiveness to create a robust approach to sustainability-driven business success. The concept leverages proactive and bold innovation processes to drive market dominance while ensuring

environmental impact reduction. Below, the model expands upon the core dimensions, detailing how each works in concert to shape ALCI.

This study focuses on the integration of Green Innovation Capability (GIC) and Strategic Aggressiveness (SA) to develop the Aggressive Low Carbon Innovation (ALCI) conceptual framework. By combining these two constructs, firms can enhance their sustainability efforts while maintaining competitive advantage. Specifically, GIC refers to the ability of a firm to develop and implement green innovations that reduce environmental impact. At the same time, SA involves adopting bold, proactive strategies that enable firms to lead in sustainability-driven markets.

The novelty of this research lies in proposing a new framework, ALCI, which combines these two constructs to address the challenges of transitioning to sustainability while ensuring organizational competitiveness. The framework not only focuses on technological and process innovations but also incorporates strategic aggressiveness to accelerate the adoption of green practices. ALCI offers a unique approach by highlighting the importance of a proactive, integrated strategy for achieving sustainability and competitiveness simultaneously.

The urgency of this research stems from the increasing pressure on businesses to transition toward greener practices amidst global environmental challenges. Given the rapidly evolving market and regulatory landscape, firms that fail to adapt may risk falling behind their competitors. Therefore, understanding the factors that drive successful green innovation and the role of strategic aggressiveness in fostering this innovation is crucial for businesses seeking to secure a competitive position in a sustainability-focused future.

This study aims to develop a comprehensive framework that integrates GIC and SA into a model that supports firms in achieving sustainable business practices. The objective is to provide actionable insights for firms and policymakers on implementing green innovations while effectively maintaining a competitive advantage. The findings of this study contribute to the growing body of literature on green innovation by offering practical strategies for firms seeking to navigate the complexities of sustainability transitions.

Method

This study employs a qualitative research methodology to explore the conceptual framework and practical implications of Aggressive Low Carbon Innovation (ALCI). The qualitative approach allows an in-depth understanding of the interplay between green innovation capability and strategic aggressiveness, as depicted in the conceptual model (see Figure 2). The method is chosen to capture the dimensions of every business stage: operational optimization, organizational transformation, and system integration in achieving sustainable business practices.

The qualitative design focuses on gathering insights from key stakeholders, analyzing organizational practices, and synthesizing literature to establish patterns and relationships within the ALCI framework. Key methods include:

1. Interviews: Semi-structured interviews with executives, sustainability managers, and industry experts to gather diverse perspectives on green innovation and strategic decision-making.
2. Document Analysis: Review corporate sustainability reports, policy documents, and market data to understand the operationalization of eco-driven strategies.

Interview has been held with 7 (seven) stakeholders consisting of:

Table 1. Participants for Interview

No	Stakeholders	Level	Number of participants
1	Customers	C level	3
2	Firms	Vice President (C level -1)	2
3	Experts	Senior Consultant	2

Source: Data processed

This multi-method approach ensures a comprehensive exploration of ALCI, aligning theoretical underpinnings with real-world applications. Data is analyzed using thematic coding, where patterns are identified across the dimensions of every business stage:

1. Operational Optimization: Includes technological adoption, supply chain greening, and cost-efficiency themes.
2. Organizational Transformation: Explores cultural shifts, leadership roles, and employee engagement in green initiatives.
3. System Integration: Focuses on system compatibility, collaboration, and data management for sustainability.

This iterative process allows for refining the conceptual model and linking qualitative insights to theoretical constructs.

Results and Discussions

Based on interviews with those stakeholders and several document analyses, the study's findings provide insights into the multidimensional factors influencing Aggressive Low Carbon Innovation (ALCI), categorized into Customer-Based, Firm-Based, and Context-Based Factors.

Customer-Based Factors Affecting ALCI

Customer-based factors are essential for understanding how demand and consumer behavior shape ALCI. The increasing awareness among consumers regarding environmental issues directly influences firms to adopt sustainable innovation strategies. Market preferences, consumer awareness, and growing demand for green products drive these factors.

Table 2. Customer-Based Factors Affecting ALCI

No	Factor	Description
1	Environmental Awareness and Consumer Demand	As consumers become more conscious about environmental sustainability, they push firms to innovate to reduce their environmental impact. Consumer-driven demand is a key motivator

		for firms to adopt ALCI as it helps align their offerings with what consumers seek (Chen et al., 2019; Abdul et al., 2022).
2	Brand Loyalty and Reputation	Environmentally aware consumers tend to develop loyalty towards brands that prioritize sustainability. Firms benefit by using green innovation to build stronger reputations, as these brands are perceived as more responsible and trustworthy (Hossain et al., 2021).
3	Pressure from Environmentally Conscious Consumers	The increasing trend of eco-conscious consumerism forces firms to reevaluate their product offerings and adopt greener practices (Sun & Sun, 2021).

Source: Data processed

Firm-Based Factors Affecting ALCI

Firm-based factors refer to an organization's internal characteristics and capabilities that enable it to adopt an Aggressive Low Carbon Innovation (ALCI). These include the organization's culture, leadership, resources, and capacity for innovation.

Table 3. Firm-Based Factors Affecting ALCI

No	Factor	Description
1	Organizational Commitment to Sustainability	Top management's commitment to sustainability is vital for successful green innovation. The leadership must foster a culture of innovation and sustainability that cascades through the organization (Mokhtarzadeh et al., 2023; Abdul et al., 2022).
2	Innovation Capabilities	The firm's ability to generate and implement new ideas, particularly regarding technology and process innovation, is a key enabler of ALCI. Companies with strong R&D capabilities are more likely to innovate aggressively in green technologies (Chen et al., 2019).
3	Resource allocation	Effective resource management, especially financial resources and skilled human capital, is crucial for driving green innovation. Firms must invest in green technologies and training programs to fill skill gaps (Jiawen & Linlin, 2019).
4	Employee Training and Skill Development	Continuous training is critical to develop green innovation capabilities. Firms must invest in skill development to enable employees to contribute to the success of ALCI (Mokhtarzadeh et al., 2023).

Source: Data processed

Context-Based Factors Affecting ALCI

Context-based factors are the external environmental forces that influence a firm's ability to implement Aggressive Low Carbon Innovation (ALCI) successfully. These factors include regulatory environments, market conditions, and societal trends that enable or restrict a company's ability to engage in aggressive low carbon innovation.

Table 4. Context-Based Factors Affecting ALCI

No	Factor	Description
1	Regulatory environment	Government policies and environmental regulations have a significant impact on green innovation. Regulations that incentivize sustainability practices, such as subsidies for renewable energy or penalties for pollution, encourage firms to adopt green innovation strategies.

2	Market dynamics	Market conditions, such as the demand for green products, competitive pressures, and economic factors, play a critical role in shaping ALCI. Firms are likelier to adopt green innovations if they perceive a competitive advantage or a growing demand for sustainable products .
3	Technological Advancements	The rapid pace of technological innovation provides new opportunities for green innovation. The emergence of new green technologies, such as electric vehicles or renewable energy systems, influences firms to adopt aggressive strategies to stay ahead of competitors (J. Chen & Liu, 2018) (Wüstenhagen & Menichetti, 2012).
4	Social and Cultural Trends	Social pressures and consumer expectations can drive firms to innovate sustainably. A shift toward sustainability in consumer behavior and societal support for green initiatives creates a favorable environment for aggressive low carbon innovation.

Source: Data processed

Integration of Results with the Conceptual Model

The findings validate the conceptual model:

- a. Firm-level capabilities like green innovation and strategic aggressiveness drive Operational Optimization.
- b. Organizational Transformation occurs when cultural and workforce factors align with sustainability goals.
- c. System Integration involves overcoming internal and contextual barriers, enabling seamless implementation of green business practices.

Consequences for Customers, Firms, and Other Stakeholders

Adopting Aggressive Low Carbon Innovation (ALCI) has significant implications for customers, firms, and other stakeholders. Below is a detailed breakdown of these consequences:

Consequences for Customers

Table 5. Consequences for Customers

No	Consequence	Description
1	Improved Product Quality and Sustainability	ALCI often results in the development of high-quality, eco-friendly products that meet consumer demands for sustainability. Products with lower environmental footprints and higher efficiency provide tangible benefits to customers.
2	Increased Costs	Green innovations and eco-friendly products can sometimes come at a premium cost due to the expenses associated with sustainable raw materials and processes. However, many consumers are willing to pay this premium for sustainable options.
3	Enhanced Trust and Brand Loyalty	Customers perceive eco-conscious firms as more trustworthy, leading to increased loyalty. Green branding improves the emotional connection between companies and their customers.

Source: Data processed

Consequences for Firms

Table 6. Consequences for Firms

No	Consequence	Description
1	Market Differentiation	Firms that implement aggressive low carbon innovation strategies achieve differentiation by positioning themselves as leaders in sustainability, thereby gaining competitive advantages.
2	Increased Profitability	While initial investments in green innovation initiatives can be high, firms often experience cost savings and higher revenues in the long term due to operational efficiencies and new market opportunities.
3	Enhanced Employee Engagement	Firms emphasizing sustainability often see higher employee morale and retention as workers align with the organization's values.
4	Reputational Benefits	ALCI enhances the public perception of firms, positioning them as socially responsible and environmentally conscious, which reduces reputational risks.

Source: Data processed

Other consequences**Table 7. Other Consequences**

No	Consequence	Description
1	Broader Environmental Benefits	ALCI contributes to reducing global carbon footprints and minimizing waste, aligning corporate activities with environmental sustainability goals.
2	Regulatory Compliance and Advantages	Firms adopting ALCI are better equipped to meet stricter environmental regulations, avoid penalties, and gain government incentives.
3	Social impacts	ALCI drives societal benefits, promoting sustainable consumption patterns and fostering community environmental awareness.
4	Challenges in adoption	While ALCI has numerous benefits, it poses challenges such as organizational resistance to change and high upfront costs. Firms need robust change management strategies to overcome these hurdles.

Source: Data processed

Conclusions

This study explores the concept of Aggressive Low Carbon Innovation (ALCI). This novel paradigm combines green innovation capability and strategic aggressiveness to enable firms to lead markets while addressing environmental and social challenges. The research offers a conceptual framework highlighting critical dimensions in each business stage, such as operational optimization, organizational transformation, and system integration, as foundational pillars for achieving ALCI. There are 3 (three) drivers of ALCI which are customer-based factors - consumers' preferences for sustainability, willingness to pay for eco-friendly products, and trust in eco-conscious brands significantly shape the demand for green innovations, firm-based factors - firms achieve ALCI through proactive green R&D investments, sustainability-focused leadership, employee engagement, and aggressive market strategies that prioritize eco-friendly practices, and context-based factors - external forces, including regulatory frameworks, market dynamics, and societal pressures, play pivotal roles in shaping and accelerating

the adoption of aggressive low carbon innovation strategies. Implementing ALCI is not without challenges. Firms must overcome barriers such as resistance to organizational change, high initial costs, and the need for cross-functional integration of green initiatives. Leadership commitment, employee training, and robust technological systems are crucial for overcoming these hurdles.

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