SUPPLY CHAIN MANAGEMENT IN THE GREEN TEA INDUSTRY OF HANGZHOU, CHINA

Jie Wang[*], Chertchai Thurapaeng, Tongtang Tonglim, Noppadol Amdee

Faculty of Industrial Technology, Muban Chombueng Rajabhat University,

Muban Chombueng, Ratchaburi, Thailand, 70150

*Corresponding author e-mail: chengsi.w30@gmail.com

Abstract

The research aims to study the supply chain management and analyze the specific activities in the supply chain management of the green tea industry in Hangzhou, China. A mixed-method approach was adopted, incorporating quantitative surveys of 370 respondents from 15 green tea enterprises and qualitative interviews with 15 senior professionals in Hangzhou's green tea export industry.

Quantitative analysis revealed that 24.2% of respondents identified logistics and supply chain management as key areas requiring innovation, second only to quality control. The overall mean score of 4.07 demonstrates a strong consensus on the importance of nine SCM factors, particularly sourcing strategies, logistics efficiency, and inventory management, which are deemed essential for enhancing competitiveness, sustainability, and export performance in Hangzhou's green tea industry. Qualitative findings reinforced these results, with managers emphasizing the strategic role of long-term supplier relationships, real-time logistics optimization, and predictive inventory control systems. Moreover, it can be illustrated that these key SCM activities occur across interconnected stages, from sourcing to consumer delivery. The integration of sourcing strategy, logistics efficiency, and inventory management enables green tea enterprises to remain competitive, responsive, and sustainable in a global marketplace. Hangzhou's green tea sector can enhance traceability, product quality, and export performance. This research contributes valuable insights for policymakers, producers, and exporters seeking to optimize SCM in China's evolving tea industry.

Keywords: Green tea industry, Supply chain management, Logistics efficiency

1. Introduction

China holds the position of the world's largest producer and exporter of tea, with green tea accounting for a commanding 83% of total tea exports in 2018, as shown in Figure 1.
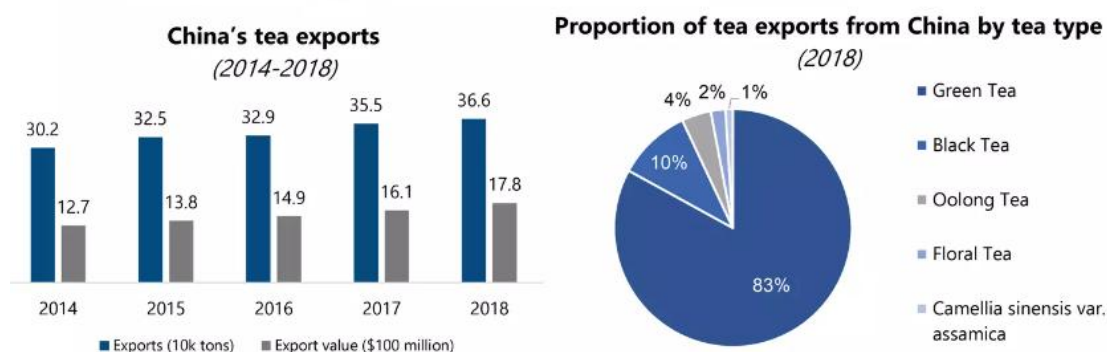
Figure 1 China's tea exports and their proportion by tea type

(Daxue Consulting, 2020)

Figure 1 presents two key insights into China's tea export performance. The bar chart on the left illustrates a steady increase in both export volume and value from 2014 to 2018, with exports rising from 30.2 to 36.6 thousand tons and the export value increasing from $1.27 billion to $1.78 billion. The pie chart on the right illustrates the dominance of green tea in China's tea exports, accounting for 83% in 2018, followed by black tea (10%), oolong tea (4%), floral tea (2%), and Camellia sinensis var. assamica (1%). These trends have indicated that the green tea product plays a crucial role in China's export strategy (Daxue Consulting, 2020).

Zhejiang Province, particularly Hangzhou, has long led the green tea industry through innovation, quality control, and integrated supply chain systems. As consumer preferences shift toward high-quality, traceable, and sustainably produced teas, the role of supply chain management (SCM) becomes increasingly central to maintaining and expanding China's export leadership. SCM enables coordination across producers, processors, logistics providers, and exporters to ensure consistent product standards, timely delivery, and compliance with international trade regulations. Moreover, this recent study conducted in Hangzhou identified SCM as a key determinant of export

success (Chen, 2024). This finding underscores the significance of logistics efficiency, inventory transparency, and supplier collaboration in enhancing the competitiveness of tea exports. Hangzhou's ability to integrate blockchain traceability and digital inventory tracking has significantly enhanced its supply chain responsiveness and reliability in global markets.

This article applies the SCM-focused framework developed from the Hangzhou study to the green tea sector in Hangzhou. Hangzhou is a secondary tea-producing region, but it holds untapped potential. Although Hangzhou is considered a secondary tea-producing region compared with China's leading provinces such as Yunnan, Fujian, and Anhui, it holds significant untapped potential due to its established infrastructure, innovation capacity, and integration into Zhejiang's export networks (Shi *et al.*, 2019). Unlike Kenya's tea subsector, which relies heavily on smallholder cooperatives for bulk black tea exports (FAO, 2022), or Sri Lanka's Ceylon tea industry, renowned for its global branding and auction-based distribution system (Khuyen & Yen, 2017), Hangzhou positions itself by leveraging digital traceability, blockchain, and real-time logistics platforms (KPMG, 2023). This trajectory reflects the application of Dynamic Capabilities theory, where firms reconfigure resources to sustain competitiveness in global markets, and User-driven Innovation, which emphasizes aligning tea production with consumer demands for quality, transparency, and sustainability. Moreover, digital transformation, through AI-powered logistics, predictive inventory management, and e-commerce, has accelerated industry development, enabling Hangzhou's enterprises to differentiate themselves from traditional export models. These developments underscore Hangzhou's strategic role in bridging China's traditional tea heritage with modern supply chain innovations. By adopting best practices in SCM, Hangzhou can improve its export readiness, operational efficiency, and alignment with global market expectations.

2. Research Objectives

2.1 To examine the overall supply chain management (SCM) of the green tea industry in Hangzhou, China

2.2 To analyze specific activities within the supply chain, including procurement practices, processing operations, distribution channels, and technology adoption for the success factors and operational challenges of the green tea industry in Hangzhou, China

2.3 To propose policy and managerial recommendations for enhancing the efficiency, resilience, and innovation capacity of Hangzhou's green tea supply chain in alignment with global market expectations

3. Literature Review

This section explores existing literature on China's green tea industry into 2 sections: the tea industry and green tea processing in China, and the supply chain management of Chinese green tea.

3.1 Tea Industry and Green Tea Processing in China

The global tea market has seen consistent growth, with its value projected to reach USD 160 billion by 2028, up from approximately USD 122.2 billion in 2022 (Ridder, 2023). Tea, as a beverage, has been deeply rooted in human culture for centuries, with its earliest documented use traced back to the third century in China. Initially consumed for medicinal purposes, tea gained recreational popularity during the Tang Dynasty and gradually spread across Asia. By the sixteenth century, it had reached Europe through trade routes, further expanding its cultural and commercial significance. Today, China stands as the world's largest tea producer and consumer, contributing roughly 45% of global production in 2022. Other major tea-producing countries include India and Kenya. According to the Food and Agriculture Organization (FAO, 2022), China produced approximately 2.4 million metric tons of tea in 2021, followed by India (900,000 metric tons) and Kenya (305,000 metric tons).

Tea cultivation in China dates back to the Han Dynasty (206 BC – 220 AD), and today, the crop is cultivated in almost every province, with key production regions in Zhejiang, Anhui, Fujian, Yunnan, and Sichuan (Shi *et al.*, 2019). The increasing demand for specialty teas and the rise in disposable income, especially in developing countries, have contributed significantly to the growth of the global tea market (Wu & Chen, 2022). Chinese tea is broadly classified into six basic types based on color and

processing technology: green, white, yellow, red (black), oolong, and dark. Remarkably, all six tea types can potentially be derived from the same tea plant, depending on the plucking method and processing technique employed. For instance, some teas are made exclusively from young buds, while others use larger leaves or full shoots. Each tea variety demands precise harvesting instructions, which are often dictated by technologists to ensure optimal quality (Chazhidao, 2023).

Green tea, accounting for over 60% of China's total tea production, is the most popular and widely exported tea type (Ridder, 2023). It is processed from unoxidized tea leaves, which preserve its distinctive green hue and delicate, fresh flavor. The key to green tea processing lies in the rapid deactivation of enzymes through heat, a step known as "kill-green," which halts oxidation and fermentation. The typical production process involves several stages: picking young and tender leaves, withering to reduce moisture, fixing via heating to preserve the green color, rolling to break down cell structures, drying to remove residual moisture, sorting for size and quality, and finally packing for distribution (Li & Zhang, 2019). Beyond its use as a traditional beverage, green tea is increasingly utilized in functional foods, beverages, cosmetics, and wellness products, highlighting the need to understand its entire production line. As green tea continues to gain international popularity, optimizing its processing and supply chain remains essential to meeting diverse consumer demands and quality standards worldwide.

3.2 Supply Chain Management of Chinese Green Tea

The supply chain of Chinese green tea is a complex and highly coordinated system involving multiple stakeholders, including tea farmers, processors, wholesalers, retailers, and end consumers. In key tea-producing provinces such as Zhejiang, Anhui, Sichuan, Fujian, and Yunnan, cultivation begins with farmers who carefully tend their tea gardens, ensuring optimal sunlight, water, and soil nutrition. The harvesting stage follows, where young and tender leaves are meticulously hand-picked using specialized tools to preserve their structure and maximize their flavor and aroma potential. These leaves then move to processing centers where they undergo a series of essential steps: withering, fixing to halt oxidation, rolling, drying, sorting, and finally, packing. Once processed, green tea enters the wholesale phase, where wholesalers

consolidate batches from different sources and facilitate large-scale distribution. From there, the tea is distributed to a variety of retail outlets, including traditional tea houses, supermarkets, convenience stores, and increasingly, online platforms. Each link in this supply chain plays a critical role in maintaining product quality and traceability. The flow of this green tea supply chain is illustrated in Figure 2 (Wright, 2016).
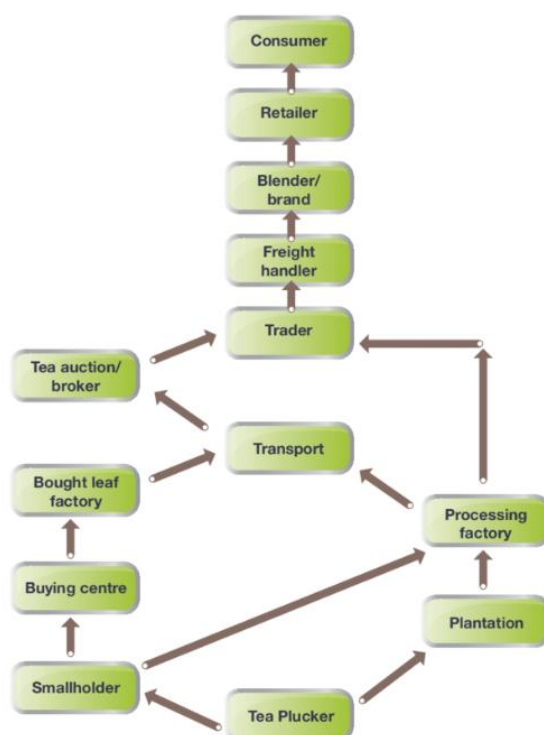
Figure 2 Supply chain of Chinese green tea (Wright, 2016)

Figure 1 illustrates the complex supply chain of the tea industry, beginning at the production level and ending with the final consumer. The process starts with tea pluckers and smallholders who harvest fresh leaves from plantations. These leaves are either sent to processing factories or bought by leaf factories via buying centers. The processed tea is then transported and consolidated by traders. From here, it may follow different paths—either sold through tea auctions and brokers or distributed through freight handlers to branded blenders. After blending, the tea moves to retailers, eventually reaching consumers. Each node in the supply chain plays a specific role: plantations and factories ensure raw material quality, traders and brokers manage market access, and logistics providers ensure timely movement. The presence of

multiple transport and distribution routes highlights the dynamic and flexible nature of tea trade networks. This interconnected structure ensures product flow efficiency, quality maintenance, and responsiveness to market demands.

Table 1 Summary of Supply Chain Management of Chinese Green Tea

Stage/Aspect	Key Activities	Challenges	Innovations/Practices
Production & Farming	Tea farmers cultivate and hand-pick young leaves in Zhejiang, Anhui, Fujian, Yunnan, and Sichuan	Climate variation, soil quality, labor intensity	Training, sustainable farming, and ethical sourcing verification
Processing	Withering, fixing ("kill-green"), rolling, drying, sorting, packing	Inconsistent tea quality due to processing variability	Adoption of advanced processing standards, eco-certification
Wholesale & Distribution	Consolidation of batches, auctions, brokers, freight handlers, and branded blenders	Market access, price volatility	Use of digital platforms, blockchain for traceability
Retail & Consumer Delivery	Tea houses, supermarkets, convenience stores, and online platforms	Maintaining freshness and traceability, meeting specialty tea demand	E-commerce, direct-to-consumer logistics
Green SCM (GSCM)	Integration of sustainable practices across the supply chain	Ensuring transparency, compliance with sustainability standards	Eco-design, green purchasing, customer cooperation, reverse logistics, investment recovery
Technology Integration	IoT, automation, AI-powered logistics, blockchain for transparency, data analytics for efficiency	High investment costs, digital adoption gaps among smallholders	Digital transformation enabling traceability, predictive inventory, and real-time logistics

As shown in Table 1, the supply chain of Chinese green tea is a multi-stage process involving cultivation, processing, wholesale, distribution, and consumer

delivery, each facing distinct challenges and requiring targeted innovations. The integration of Green Supply Chain Management (GSCM) principles and digital transformation technologies, such as blockchain, IoT, and predictive logistics, is reshaping the sector toward greater efficiency, sustainability, and global competitiveness. This structured overview highlights the dynamic interactions among stakeholders and underscores the strategic importance of technology-driven practices for ensuring quality, traceability, and resilience in Hangzhou's green tea industry.

Furthermore, green supply chain management (GSCM) refers to an environmentally conscious approach to managing the flow of goods—from procurement and production to distribution—by integrating sustainable practices and technologies at every stage. In the context of the Chinese green tea industry, GSCM not only minimizes environmental impacts but also enhances economic viability by balancing ecological preservation with business performance (Dashore & Sohani, 2013; Li, 2011). Despite its benefits, challenges persist. Ensuring traceability throughout the supply chain remains difficult, especially in verifying ethical sourcing and sustainable farming practices. Inconsistent tea quality, affected by variables such as climate, soil, and processing techniques, also poses issues. Furthermore, shifting consumer preferences and demand for specialty teas require suppliers to remain adaptable and innovative (Khuyen & Yen, 2017). To address these obstacles, technological solutions such as IoT devices and blockchain are increasingly employed to monitor storage conditions and provide traceable product histories, fostering transparency and consumer trust.

The evolution of GSCM practices has gained momentum globally, driven by rising environmental awareness and regulatory demands. Businesses are now adopting five core GSCM strategies: integrated environmental management (IEM), eco-design, green purchasing (GP), customer cooperation (CC), and investment recovery (IR) (Aroonsrimorakot *et al*., 2022; Vanalle *et al*., 2017). These practices include initiatives such as environmental certification, eco-efficient design, reverse logistics, and recycling programs. In the Chinese green tea sector, the integration of automation, data analytics, and sustainable sourcing is shaping a modern, efficient, and environmentally

responsible supply chain (KPMG, 2023; ETP, 2023). This transformation ensures long-term competitiveness while meeting the expectations of global consumers.

4. Research Methodology

For the quantitative component, data were collected through a structured questionnaire measuring perceptions of supply chain management (SCM) practices across sourcing strategy, logistics efficiency, and inventory management. A five-point Likert scale ranging from "strongly disagree" to "strongly agree" was employed. The instrument was validated for content by three experts in supply chain and agricultural economics, and reliability testing using Cronbach's alpha produced values above 0.80, confirming strong internal consistency. The study targeted 15 large-scale processing enterprises in Hangzhou, collectively employing approximately 4,850 individuals, from which a sample size of 370 respondents was determined using Taro Yamane's formula (Yamane, 1967). Stratified random sampling was then applied to ensure representation of executives, administrators, and departmental heads. Data analysis employed both descriptive statistics (mean, standard deviation) and inferential techniques, including correlation and regression analysis, to assess relationships among SCM factors and their effects on competitiveness and export performance (Wu & Chen, 2022).

Secondly, for the qualitative component, semi-structured interviews were conducted with 15 senior professionals, including company executives and industry experts. An interview guide was developed to ensure consistency while allowing flexibility for probing questions. All interviews were audio-recorded, transcribed verbatim, and analyzed through thematic content analysis. Coding followed an inductive approach, identifying recurring themes across sourcing, logistics, and inventory dimensions. To enhance trustworthiness, researcher triangulation and member checking were employed. Integration of quantitative and qualitative results followed a mixed-method convergence design, allowing cross-validation and deeper insights into SCM practices in Hangzhou's green tea industry.

5. Research Results

This section can be divided into 2 parts: the quantitative and qualitative results as follows.

5.1 The quantitative results

Table 2 Areas in need of innovation in the green tea industry

Scopes of innovation needed	Number of respondents (n=370)	Percentage (%)
Innovation is needed for the industry		
Procurement	37	10.2
Production	40	10.8
Quality control	203	54.8
Logistics and Supply Chain Management	90	24.2
Total	**370**	**100.0**

Table 2 presents data on the perceived areas in need of innovation within the green tea industry, based on responses from 370 participants. The table categorizes innovation needs into four key areas: procurement, production, quality control, and logistics and supply chain management. Respondents were asked to identify where they believed innovation was most urgently required. A majority of respondents, 203 individuals, 54.8%, identified quality control as the area most in need of innovation. This suggests that maintaining consistent product standards and enhancing the quality of green tea products is a primary concern for industry stakeholders. As China continues to position itself as a leader in green tea exports, stringent quality assurance processes become essential for meeting both domestic and international standards. Logistics and supply chain management followed as the second most cited area, with 90 respondents, 24.2%, indicating a need for improvement. This points to challenges related to traceability, timely delivery, and coordination among supply chain actors. In contrast, production, 10.8%, and procurement, 10.2%, received lower response rates, suggesting these areas are either more developed or considered less critical in the current industry context.

Overall, the data highlight a strong emphasis on improving product quality and optimizing supply chain operations, two essential components for sustaining competitiveness and ensuring long-term growth in the green tea sector.

Table 3 presents the mean scores and standard deviations for nine key factors related to Supply Chain Management (SCM) in Chinese green tea processing export companies in Hangzhou. The factors are grouped into three core dimensions: sourcing strategy, logistics efficiency, and inventory management. Respondents rated the importance of each factor on a Likert scale, with all items receiving a "High" level of importance based on their mean scores.

Under the sourcing strategy dimension, the highest-rated item was the belief that optimizing sourcing strategies leads to cost savings and efficiency, mean was 4.10, followed closely by the need to establish long-term supplier relationships, mean was 3.99. The item on sourcing strategy as essential for ensuring a consistent supply of raw materials scored a mean of 3.88. These findings highlight that green tea enterprises place strong emphasis on sourcing reliability and strategic partnerships to support sustainable production.

In the logistics efficiency category, respondents rated all items highly, with logistics perceived as enhancing competitiveness receiving the highest mean score of 4.15. This was followed by views on cost savings and improved customer satisfaction, mean was 4.12, and optimizing delivery times, mean was 3.89. These results underscore the critical role of logistics in maintaining timely exports and customer responsiveness in the competitive tea market.

For inventory management, the operational optimization had the highest mean score (4.04). Investments in inventory systems and software, and the need for robust inventory control policies both scored equally at 3.97. These values reflect a growing awareness among firms of the need to manage inventory more strategically, particularly to avoid stockouts and excess inventory.

The overall mean score across all items was 4.07 with a standard deviation of 0.996, indicating a high and consistent perception of SCM importance across respondents.

Table 3 Mean and standard deviation of Supply Chain Management

Item	Supply Chain Management	$\bar{x}$	S.D.	Levels of importance
	Sourcing strategy			
1	You consider sourcing strategy to be in ensuring a consistent and reliable supply of raw materials for Chinese green tea processing export companies in Hangzhou.	3.88	1.034	High
2	Optimizing sourcing strategies can lead to cost savings and improved efficiency in the supply chain of Chinese green tea processing export companies in Hangzhou.	4.10	1.010	High
3	Chinese green tea processing export companies in Hangzhou need to establish long-term relationships with suppliers to ensure a stable and sustainable supply of raw materials.	3.99	0.997	High
	Logistics efficiency			
4	You perceive logistics efficiency to be in enhancing the competitiveness of Chinese green tea processing export companies in Hangzhou.	4.15	1.101	High
5	Improving logistics efficiency can lead to cost savings and improved customer satisfaction for Chinese green tea processing export companies in Hangzhou.	4.12	1.059	High
6	Optimizing logistics efficiency can lead to faster delivery times and reduced lead times for Chinese green tea processing export companies in Hangzhou	3.89	0.992	High
	Inventory management			
7	It is essential for important inventory management to optimize the operations of Chinese green tea processing export companies in Hangzhou.	4.04	0.972	High
8	Chinese green tea processing export companies in Hangzhou are likely to invest in implementing inventory management software and systems to enhance efficiency.	3.97	1.049	High
9	Chinese green tea processing export companies in Hangzhou need to establish robust inventory control policies and procedures to mitigate risks associated with overstocking or stockouts.	3.97	1.037	High
	Total	4.07	0.996	High

The quantitative findings revealed an overall mean score of 4.07, signifying a strong and consistent consensus among respondents that supply chain management (SCM) is highly important to Hangzhou's green tea industry. This high score indicates that SCM practices are not merely supplementary but central to sustaining competitiveness and export readiness in an industry under increasing global scrutiny. A comparison across different management levels (executives, administrators, and departmental heads) revealed no statistically significant differences in perceptions ($p > 0.05$), suggesting a shared recognition of SCM's critical role throughout organizational hierarchies.

When compared with findings from other Chinese tea-producing regions, such as Fujian and South Anhui, where prior studies emphasize traditional procurement and processing efficiency, Hangzhou's emphasis on digital logistics and blockchain traceability illustrates a more innovation-driven orientation. This aligns with broader supply chain modernization trends observed in Zhejiang's industrial clusters.

Statistical hypothesis testing further confirmed that logistics efficiency (mean = 4.15) had a significantly higher influence on perceived competitiveness than sourcing strategy (mean = 3.99) or inventory management (mean = 3.97) at the 0.05 significance level. This finding emphasizes logistics as the most decisive factor for ensuring international responsiveness.

5.2 The qualitative results

The qualitative findings from interviews with 15 senior professionals in Hangzhou's green tea processing export industry reveal that Supply Chain Management plays a critical role in ensuring competitiveness, quality consistency, and global market responsiveness. The interviews highlighted three major SCM themes: sourcing strategy, logistics efficiency, traceability, and inventory control.

Several general managers and factory owners emphasized the importance of establishing strategic supplier partnerships to maintain a stable and sustainable supply of raw tea leaves. Long-term contracts and multi-tier supplier models were reported to help mitigate procurement risks and support consistent quality.

Logistics optimization emerged as a recurring priority. Managers underscored the need for logistics automation, freight scheduling, and real-time transport

monitoring systems to enhance delivery speed and reduce operational costs. Data-driven logistics and AI-powered freight management systems were widely adopted to respond to international market demands efficiently.

On the traceability front, blockchain technology was frequently cited as a game-changing innovation. It enables transparency from farm to cup, enhancing both consumer trust and compliance with export regulations. Several firms also integrated predictive inventory control to reduce stockouts and overproduction, thereby improving supply chain resilience.

Overall, these insights reflect a strong industry shift toward smart, sustainable, and technology-driven supply chain models, positioning Hangzhou's green tea exporters to meet evolving global standards and consumer expectations. The qualitative analysis reinforced these results, with managers emphasizing traceability technologies and predictive inventory controls. Together, these findings demonstrate that Hangzhou's SCM practices are positioned not only as operational necessities but also as strategic levers for differentiation in global markets, providing stronger resilience than more traditional models seen in Fujian and Anhui.

6. Discussion

The results emphasize three core dimensions of supply chain management (SCM)—sourcing strategy, logistics efficiency, and inventory management—that are consistently perceived as highly important, with an overall mean score of 4.07. Yet, the presence of standard deviation values exceeding 1 for certain items, such as logistics efficiency (Item 4, SD = 1.101), reveals notable variation in respondent perspectives. This suggests that while SCM practices are broadly valued, their degree of implementation differs across enterprises, reflecting disparities in technological adoption, resource availability, and managerial capabilities.

When compared with other Chinese tea-producing regions such as Fujian and South Anhui, which remain more reliant on traditional procurement and processing methods (Shi et al., 2019), Hangzhou demonstrates a distinctly innovation-oriented trajectory, particularly through digital logistics integration and blockchain-enabled traceability. On the global scale, Kenya's tea subsector, dominated by cooperative-

based exports (FAO, 2022), and Sri Lanka's auction-driven Ceylon tea industry (Khuyen & Yen, 2017) illustrate contrasting models. By leveraging predictive logistics and digital platforms, Hangzhou positions itself between these traditional approaches and modern digital supply networks.

The findings further resonate with Dynamic Capabilities theory, underscoring firms' ability to reconfigure resources, and User-driven Innovation, highlighting consumer demand for sustainability, transparency, and quality. Digital transformation, enabled through IoT, AI-based logistics, and e-commerce, emerges as a decisive force shaping industry development. From a policy perspective, government support in digital infrastructure and training programs can accelerate adoption, while managers should emphasize strategic investments in technology and workforce skills. Together, these measures strengthen Hangzhou's resilience and global competitiveness in the tea industry.   This study analyzed the activities within the supply chain management (SCM) of the green tea industry in Hangzhou, China, drawing on empirical insights from Hangzhou's export-driven model. The second research objective guided a detailed exploration of three critical SCM components: sourcing strategy, logistics efficiency, and inventory management, as visually represented in Figure 3. These components function across interconnected actors from smallholders and tea pluckers to processing factories, traders, freight handlers, and retailers, each contributing to the flow of products and information throughout the supply chain.

Findings indicate that sourcing strategy plays a foundational role in ensuring a consistent and sustainable supply of high-quality raw materials. Establishing long-term supplier relationships and multi-tier procurement contracts emerged as crucial activities in stabilizing upstream operations. Logistics efficiency was identified as a key enabler of competitiveness, with activities such as real-time transport monitoring, automated freight scheduling, and digital delivery systems supporting timely distribution and export readiness. Inventory management practices, including predictive inventory control and digital tracking, help mitigate risks of stockouts or overstocking, enhancing both operational efficiency and market responsiveness.

Figure 3 Activities of supply chain management of
the green tea industry in Hangzhou
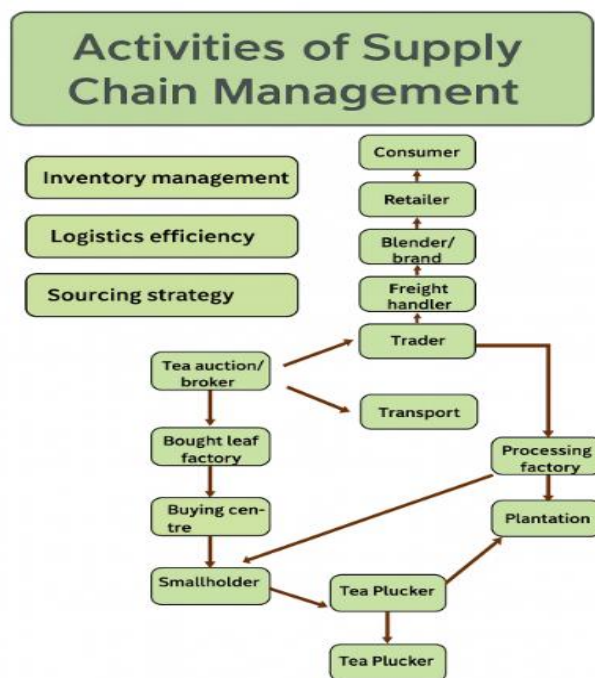
The integration of these SCM activities, as reflected in Figure 3, supports a dynamic and adaptable supply network capable of responding to shifting global demand. Hangzhou's green tea industry, by adopting this structured and technology-driven approach, can strengthen its position in the international market while ensuring quality, traceability, and sustainability throughout the supply chain.

7. Conclusion

This study demonstrates that integrating sourcing strategies, logistics efficiency, and inventory management, illustrated in Figure 3, provides a holistic framework for strengthening Hangzhou's green tea supply chain. Logistics efficiency emerged as the most decisive factor, reflecting global demands for speed, traceability, and transparency. These findings align with the Dynamic Capabilities theory, highlighting firms' ability to reconfigure resources for competitiveness, and User-driven Innovation, which emphasizes consumer influence on sustainability and quality. Compared with Kenya's cooperative-driven exports and Sri Lanka's auction-based Ceylon tea model,

Hangzhou's orientation toward digital traceability and predictive logistics illustrates a more innovation-driven approach. By adopting sustainable SCM and digital solutions, Hangzhou can enhance resilience, competitiveness, and global positioning despite limitations of regional scope and uneven digital adoption.

8. Suggestion

For stakeholders, several policy and managerial directions emerge from this study. Policy measures should support the Belt and Road Initiative in expanding tea exports while providing guidelines for the development of Intelligent Warehousing Systems and Intelligent Communication platforms. Strategic initiatives may also promote Tea Tourism and Rural Revitalization, foster Public–Private Partnerships for advancing technology, and implement greenhouse gas reduction strategies to align with sustainability goals. At the managerial level, enterprises are encouraged to adopt advanced marketing strategies, integrate Blockchain and IoT applications into supply chain operations, and develop a Responsive–Sustainable–Resilient Tea Supply Chain Network that strengthens competitiveness and transparency.

For future research, scholars should focus on designing sustainability indicators tailored to the tea sector, applying Machine Learning to improve operational efficiency, and developing conceptual frameworks adaptable to other agricultural industries. Moreover, the findings could contribute to broader agendas, including Smart Cities and the Digital Economy, by positioning tea supply chains as models of innovation-driven rural development.

9. Acknowledgement

10. Reference

Aroonsrimorakot, S., & Laiphrakpam, M. (2023). Green supply chain management practices and their impact on sustainability performance: A comprehensive framework. **International Journal of Sustainable Business Strategies**, 18(2), 102–118.

Aroonsrimorakot, S., Phimonsathien, T., & Wanthiraphan, N. (2022). Evaluating green supply chain management performance: Empirical evidence from manufacturing firms in Asia. Journal of **Cleaner Production**, 342, 130933. Doi: https://doi.org/10.1016/j.jclepro.2022.130933

Chazhidao. (2023). **Chinese tea classification and processing methods.** Tea Institute of China. Retrieved from https://www.chazhidao.com

Chen, Q. (2024). **Supply chain management in the green tea export industry of Hangzhou: A structural equation modeling approach.** China: Zhejiang Agricultural University Press.

Dashore, K., & Sohani, N. (2013). Green supply chain management: A review. **International Journal of Engineering and Innovative Technology**, 3(5), 478–484.

Ethical Tea Partnership. (2023). **Sustainable tea supply chains: Innovations and impact.** Retrieved from https://www.ethicalteapartnership.org

Food and Agriculture Organization. (2022). **Top 10 tea exporting countries in the world 2021.** Retrieved from https://www.fao.org

Khuyen, T.L., & Yen, N.T. (2017). Challenges in the tea value chain in developing economies: A review. **Asian Journal of Agriculture and Development**, 14(1), 105–118.

KPMG. (2023). **Driving supply chain resilience through digital transformation.** KPMG International. Retrieved from https://home.kpmg

Li, J., & Zhang, Y. (2019). Green tea processing techniques and their impact on quality. **Journal of Tea Science and Technology**, 35(2), 89–96.

Li, Y. (2011). Green supply chain management in China: The case of tea manufacturing. **Asian Business Review**, 3(1), 15–22.

Ridder, M. (2023). **Global tea market value and China's export structure.** Statista. Retrieved from https://www.statista.com

Shi, M., Narasaj, R., & Mattarigamond, S. (2019). Regional tea cultivation and production development in China. **Asian Journal of Agricultural Economics**, 44(1), 101–114.

Vanalle, R.M., Ganga, G.M.D., Filho, M.G., & Lucato, W.C. (2017). Green supply chain management: An investigation of pressures, practices, and performance within the Brazilian automotive supply chain. **Journal of Cleaner Production**, 151, 250–259. Doi: https://doi.org/10.1016/j.jclepro.2017.03.066

Wu, L., & Chen, Y. (2022). Market dynamics of specialty teas in developing economies. **International Journal of Beverage Studies**, 17(4), 215–229.

Yamane, T. (1967). **Statistics: An introductory analysis.** (2nd ed.). New York: Harper & Row.