Hochschule Neu-Ulm
University of Applied Sciences

Master Thesis
in the master program
Business Intelligence and Business Analytics (BIA)
at University of Applied Sciences Neu-Ulm

Decision-Making Model for Overseas Warehousing for Chinese Business Starters in Germany

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Topic received: 29.11.2024
Date of submission: 28.02.2025

Abstract

The current Supply Chain Operations Reference (SCOR) model presents excessive implementation complexity and prohibitive observation costs for individual entrepreneurs and small-to-medium enterprises (SMEs) due to its extensive framework encompassing hundreds of hierarchical metrics and best practices. This study addresses the critical adaptation challenges faced by Chinese entrepreneurs with limited international experience when establishing overseas warehouse operations in Germany. Through systematic field research and industrial surveys conducted within specific geographic clusters, a SCOR model and SAW(Simple Additive Weighting) & AHP (Analytic Hierarchy Process) combined method that strategically prioritizes 6 core operational processes from the complete SCOR v12 architecture that helps to swiftly make decisions was proposed.

The methodology integrates three progressive phases: 1. Development of visualized workflow diagrams for initial operational comprehension; 2. Hybrid analytical modeling combining SCOR's process benchmarking with AHP and SAW multi-criteria decision analysis; 3. Dynamic priority sequencing through empirical weighting coefficients derived from interviews, questionnaires, and peer-discussion in the industry. The synthesized evaluation matrix enables practitioners to systematically verify operational integrity, identify critical performance gaps, and establish resolution priorities.

This method drastically reduces implementation and assessment duration compared to full SCOR deployment while maintaining basic comprehensive model outputs. The practical framework provides found-limited and time-constrained managers with a risk-based triage mechanism for supply chain optimization and establishes a viable pathway for resource-limited enterprises and individuals to achieve operational visibility without disproportionate analytical overhead.

1. Introduction

1.Background: Increasing Need for Overseas Warehouses in Europe

i. The post-pandemic recovery of international trade and the sustained growth of e-commerce.

The post-pandemic era has underscored the critical role of overseas warehouses in Europe's logistics infrastructure, driven by the interplay of shifting consumer behavior, evolving trade dynamics, and systemic supply chain reforms. The COVID-19 pandemic acted as a catalyst for structural changes in global commerce, accelerating pre-existing trends while exposing vulnerabilities in traditional supply models. Lockdowns triggered an unprecedented surge in online shopping, solidifying digital platforms as primary channels for consumer engagement. Although global e-commerce sales experienced a temporary dip in 2022 as economies reopened, the long-term trajectory remains robust, with projections indicating that online retail will account for 22% of total global sales by 2025, up from 16% in 2021 (ITA, 2023). In Europe, sectors such as furniture, health products, and household goods sustained high demand even post-lockdowns, reflecting a permanent shift toward goods-centric consumption (ITA, 2023). This normalization of online shopping habits has necessitated investments in localized logistics infrastructure, including overseas warehouses, to reduce delivery times and enhance cost efficiency.

The pandemic's economic fallout disproportionately affected service industries (e.g., tourism, hospitality), redirecting consumer spending toward physical goods—a shift with significant implications for international trade. Goods consumption exhibits far greater import intensity (45%) compared to services (15%) (ECB, 2024), amplifying cross-border trade volumes. Post-2020 inventory restocking and supply chain rebalancing further strained logistics networks, positioning overseas warehouses as pivotal nodes for managing these flows. Companies are strategically leveraging these distribution hubs to position inventory nearer to key consumer markets, thereby alleviating congestion pressures at international ports and customs clearance nodes. Concurrently, global supply chain disruptions—from port closures to semiconductor shortages—prompted a strategic reevaluation of dependency on distant manufacturing hubs. Firms adopted nearshoring and regionalization strategies to relocate production closer to European consumer markets, reducing lead times and geopolitical risks (BNP, 2023). This shift intensified demand for warehousing solutions that support just-in-time inventory management and last-mile delivery networks, exemplified by historic leasing activity in Europe's logistics real estate market in 2021 (BNP, 2023). These initiatives reflect a broader recognition of warehousing as a linchpin of trade competitiveness in an era of economic uncertainty.

ii. Market Competitiveness and the Rising Demand for Overseas Warehouses in Europe

The intensifying competitiveness of Europe's e-commerce landscape, driven by global marketplaces, direct-to-consumer (DTC) brands, and cross-border platforms, has also significantly amplified the demand for overseas warehouses. Major players such as Amazon, AliExpress, Temu, and Shein are reshaping market dynamics through rapid delivery expectations and localized logistics strategies. Amazon's expansive fulfillment network across Europe, including planned expansions in Sweden, exemplifies the critical role of regional warehouses in maintaining Prime service standards and same-day delivery capabilities. Meanwhile, Chinese platforms like Temu and Shein, which achieved $13 billion in gross merchandise value (GMV) shortly after entering Europe, face mounting pressure to localize their supply chains to compete with established regional retailers. Their reliance on cross-border shipping from China increasingly clashes with consumer demands for faster delivery, prompting investments in EU-based warehouses to reduce transit times and tariffs. Niche platforms such as Vinted and Etsy further underscore this trend, as their cross-border resale models require efficient return logistics and localized inventory management to address high return rates, which average 30% in sectors like fashion (Statista, 2024)

Eurostat data reveals that 22.9% of EU enterprises engaged in online sales in 2022, with large enterprises generating 22.9% of their turnover through e-commerce. This growth is particularly evident in categories like clothing and electronics, which dominate online purchases for 42% of EU consumers. The rise of hybrid sales models—combining owned websites/apps (used by 84.7% of EU enterprises) and third-party marketplaces—has created complex logistics demands. For instance, Lithuania and Poland rely heavily on marketplaces for 82.3% and 59.5% of their e-commerce activity, respectively, necessitating warehouses that cater to both direct and marketplace-driven orders. Cross-border e-commerce, valued at €167 billion in 2022, further stresses the need for bonded warehouses and customs-compliant hubs to manage bulk inventory and comply with EU regulations, such as sustainability mandates and product safety standards.

Regional disparities in e-commerce adoption also influence warehouse localization strategies. While Western Europe leads with 83% of its population shopping online, Eastern Europe shows rapid growth, with Romania and Bulgaria experiencing 41 and 49 percentage-point increases in e-shopper penetration since 2012. However, challenges like cash-on-delivery preferences in Romania require warehouses equipped with advanced return management systems. Southern Europe's focus on omnichannel retail, as seen in Italy and Spain (where 56% of the population shops online), highlights the need for integrated inventory systems that bridge online and offline sales channels. These regional variations are mirrored in infrastructure investments, such as Germany's dominance in EU machinery imports (25% share) and Poland's record warehouse transactions, driven by its strategic position as a logistics gateway.

Policy initiatives like the EU Green Deal and Digital Services Act are accelerating the adoption of sustainable and automated warehousing solutions. Nearly 90% of warehouses plan to implement warehouse management systems (WMS) to optimize energy use and reduce emissions, aligning with Eurostat's emphasis on ICT-driven trade efficiency. Simultaneously, the growth of reverse logistics—projected to expand by 17.58% annually—reflects the need for specialized return hubs to handle repackaging and reselling, particularly in fashion and electronics. As retailers invest in AI-driven logistics, such as predictive analytics and real-time tracking, the integration of automation into warehouses is becoming a competitive necessity, with Europe's logistics sector projected to reach $1.16 trillion by 2029.

The convergence of these factors—global competition, cross-border trade growth, regional disparities, and regulatory pressures—positions overseas warehouses as indispensable infrastructure for businesses aiming to balance speed, cost, and sustainability. With limited warehouse vacancy rates (5% in 2021) and rising rents in key markets like Germany and Poland, securing strategic logistics nodes has become a priority for both established players and emerging DTC brands. As platforms like TikTok Shop prepare to leverage social commerce models and ultrafast fashion, the agility afforded by localized warehouses will remain central to navigating Europe's evolving e-commerce battleground.

iii. The Demand for Quick Delivery and Return

Consumer demand for rapid order fulfillment has intensified due to the proliferation of e-commerce and the normalization of expedited shipping models introduced by leading online retailers. Scholars argue that the rise of same-day or next-day delivery options has recalibrated consumer expectations, making slower shipping times less palatable (Fernie & Sparks, 2019). According to Wollenburg et al. (2018), convenience-driven customers increasingly perceive quick delivery not as an added benefit but as a standard service requirement, linking rapid fulfillment with overall satisfaction. This shift in expectation has been further compounded by growing competition in the European market, where domestic and cross-border e-commerce rivals compete on speed of delivery as a key differentiator (Saeed & Kersten, 2019). Consequently, establishing overseas warehouses becomes critical to positioning products closer to end consumers, thereby reducing last-mile delivery time and enhancing competitiveness (Fernie & Sparks, 2019).

Alongside the demand for swift delivery, the emphasis on easy and flexible return policies has also intensified. It is estimated that e-commerce return rates are comparatively high in the scope of apparel and consumer electronics products (Wang et al., 2021). A combination of factors—including uncertainty about product quality, fit, and performance—contributes to higher return rates, prompting retailers to streamline the return process to maintain customer loyalty (Rao et al., 2018). Research indicates that “no-questions-asked” return policies and simple return logistics positively influence repurchase intention by enhancing trust in the online retail process (Saeed & Kersten, 2019). For international sellers, facilitating local return points through overseas warehouses can dramatically lower return shipping costs and processing times, thereby reinforcing customer confidence (Wang et al., 2021). This localization strategy is particularly salient in Europe, where fragmented regulations and diverse consumer preferences demand regionally tailored supply chain solutions. By positioning inventory in European warehouses, retailers can not only meet growing expectations for near-immediate delivery but also accommodate smoother returns, aligning both operational efficiency and customer-centric service.

iv. The Pursuit of Cost-Effectiveness

Cost-effectiveness stands as a primary driver for utilizing overseas warehouses in Europe, as it enables both non-local and local sellers to streamline logistics and reduce operational expenditures. Wollenburg et al. (2018) note that by positioning products closer to end customers, retailers can cut transportation distances and minimize last-mile delivery costs, which are often among the most expensive components of the fulfillment process. For non-local sellers, consolidating shipments to a single regional warehouse prior to distributing orders domestically can also lower customs fees and administrative expenses by reducing the frequency of cross-border transactions (Saeed & Kersten, 2019). Meanwhile, local sellers benefit from cooperative arrangements such as shared warehousing spaces and group distribution networks, thereby achieving economies of scale. According to Pereira et al. (2020), this type of collaboration can significantly decrease labor expenses and shorten delivery times, as resources—ranging from workforce to technology—are pooled for mutual advantage. In a multifaceted European market with diverse regulations and consumer preferences, these collaborative and cost-effective measures position both international and domestic merchants to more efficiently meet demand without escalating their overhead (Ickert et al., 2021).

Under this contextual framework and driven by the growth of cross-border e-commerce operations in Europe, there has been a notable increase in investments targeting micro-to-medium scale warehouse facilities across European territories. This development has amplified the imperative for localized distribution solutions, with operational analyses indicating that 20-25% of continental warehouse capacity currently operates through decentralized micro-facilities primarily dedicated to last-mile delivery optimization.

E-commerce platforms actively encourage localized deployment strategies among cross-border merchants to enhance delivery efficiency and reduce transit durations. Crucially, small-to-medium scale warehouse operations demonstrate superior accessibility for new market entrants, manifested through reduced cost control requirements, mitigated risk exposure, lower safety stock thresholds, enhanced operational agility, and flexible contract management frameworks. These emerging alternatives present viable competition against traditional large-scale overseas warehouses, particularly for micro-enterprises and individual cross-border merchants.

Notably, warehouse investors with Chinese cultural backgrounds exhibit distinct collaborative patterns with China-based clients, characterized by mutual selection preferences in supply chain partnerships. This phenomenon stems from multiple factors including communication efficiency, operational accountability in warehouse management, and potential regulatory circumvention strategies. Given that a significant proportion of European imports originate from Chinese manufacturers, this cultural alignment provides Chinese warehouse operators with distinct competitive advantages within peer-group competition across European markets.

v. Opportunities

In the competitive landscape of the overseas warehouse market in Europe, newly established small and medium-sized enterprises (SMEs) may face certain cost disadvantages. However, their competitive edge is often not derived from cost control but rather from revenue growth strategies. Compared to large enterprises (LEs), SMEs may exhibit lower cost efficiency, yet their revenue efficiency is often higher, which means their overall performance is not necessarily inferior.

According to the definition outlined in EU Regulation No. 651/2014, SMEs are classified as (1) companies with fewer than 250 employees, (2) businesses with an annual turnover of less than €50 million, and (3) firms with total assets not exceeding €43 million. However, due to the unique nature of overseas warehouse operations, firms in this sector tend to emphasize factors such as warehouse size, storage capacity, and infrastructure conditions when marketing themselves to the public. Within the network of Chinese overseas warehouse operators, large-scale overseas warehouses typically refer to enterprises that own one or more warehouses exceeding 10,000 square meters in size. Warehouses ranging from 1,000 to 10,000 square meters are categorized as medium-sized warehouses, while those under 1,000 square meters are classified as small overseas warehouses. Additionally, warehouses under 100 square meters are commonly found in shared storage facilities, private residences, gardens, or garages, and are referred to as micro or family-run warehouses. Among the respondents in this study, more than half have previously operated or are currently operating family-run warehouses. However, only a small proportion of them consider medium- and small-sized warehouses unsuitable for development in Europe due to cost and rental concerns. Arbelo, Pérez, and Gómez (2022) have identified three key advantages of SMEs:

> *"SMEs have the advantage of (1) proximity to the customer, which enables them to more easily know their needs and offer more individualized services, (2) flexibility, which gives them greater capacity to adapt to changes, and (3) ease of detecting and taking advantage of protected market niches, which allows them to differentiate themselves, better understand consumers' needs, and support less competition and greater customer loyalty. Therefore, SMEs can grow slightly and are more efficient in revenues than LEs through superior sales management, although they remain relatively inefficient with respect to costs. This higher revenue efficiency of SMEs can offset their cost inefficiency and thus obtain higher profits."*

These advantages enable emerging micro, small, and medium-sized overseas warehouse operators to manage sales strategies more effectively, enhance order fulfillment efficiency, and leverage differentiation, flexibility, and customer-oriented operations to achieve success in fulfillment rates and revenue growth. As a result, their weaknesses in cost control can be mitigated, ultimately leading to profitability. According to the surveys and interviews conducted in this study, these factors have also contributed to the tendency of small and medium-sized or individual Chinese cross-border merchants to prefer smaller-scale warehouses. The specific reasons behind this decision will be detailed in the Results section.

vi. Why A Model is Needed

Warehouses are now more important than ever, serving as an important intermediary between supply chain participants and influencing supply chain costs (Faber et al., 2013). As more and more small and medium-sized sellers seek to take advantage of the expanding market to open overseas positions, standardized operating models are becoming increasingly necessary because when people measure companies using the same metrics, A standardized model helps industry insiders improve communication efficiency to pursue and achieve better performance (Huang, Sheoran & Wang, 2024). While the surge in entrants reflects strong demand, it has also raised concerns about mismanagement and financial risk, especially for inexperienced new entrants. Studies have shown that the lack of warehouse management, such as unreliable transportation efficiency, significantly exacerbates customer dissatisfaction and can cause negative customer mentality in the long run. (Alumbugu, Shakantu & Saidu, 2021) This challenge is compounded for Chinese sellers operating in Germany, who often have limited knowledge of local logistics networks and consumer preferences, creating a cultural understanding gap between China and the West. This is inevitable for Chinese businessmen on the road of globalization and modernization expansion (Zhan, He, 2012), which will also lead to the increased risk of operating inefficiency. In this context, a standardised model provides entry guidance to new entrants while reducing risk, delineating best practices, and streamlining cross-border supply chain processes. This model reduces uncertainty, reduces costly failures, and serves as the basis for a consistent, scalable solution - ensuring that newcomers can compete effectively and with compliance. Without compromising the quality of service or incurring avoidable losses.

By establishing clear steps and specifications for inventory management, order fulfillment, and returns, standardized models effectively reduce the risk of financial loss for all parties in a cross-border supply chain. Warehouses benefit from minimising operational errors because prescriptive guidelines show operators where steps are missing or problems can be identified when using models to optimise the supply chain, reducing the possibility of human error or inaccuracies. Similarly, customers in overseas warehouses embrace greater efficiency, experience less waiting time, and avoid disputes or refund requests that negatively impact customer loyalty and trust. This use of a unified model across the value chain to synergistically reduce risk underscores the strategic need to deploy standardized models, especially for cross-border e-commerce.

vii. Objective

This paper aims to build a standardized decision support framework for small and medium-sized overseas holdings operated by Chinese investors to help new or operating enterprises quickly identify and prioritize operational bottlenecks. Existing traditional supply chain analysis models SCOR are designed for large enterprises to carry out full-chain optimization, which usually takes months to complete and relies on professional teams and large budgets to promote specific implementation. For micro, small and medium-sized enterprises with relatively limited resources and manpower, it often forms a greater pressure in terms of cost and time investment, and it is difficult to achieve significant efficiency improvement in the short term. Based on this practical need, this study proposes a fusion management tool. By combining the core logic of the SCOR model with the SAW (Simple Additive Weighting) and AHP (Analytic Hierarchy Process) in MCDM, enterprises can base their business objectives and market preferences on their own. Pinpoint key obstacles within weeks and quickly develop improvement strategies.

Under this framework, SMEs do not need to invest significant resources or set up a dedicated team to perform lengthy supply chain diagnostics, but rely on simplified processes, key indicators and evaluation criteria to focus on identifying the most urgent areas of improvement, and then achieve rapid improvement in operational performance through relatively flexible improvement initiatives. Not only does this significantly shorten the "problem finding" cycle and reduce economic costs, but it also avoids early confusion due to insufficient information or inexperience. At the same time, for operators who lack sufficient market understanding, the systematic analysis method guided by the program can help them formulate price and service strategies more rationally, and reduce the negative impact of blind competition (such as price war or random quotation) on the development of enterprises. In brief, the integrated decision support framework proposed in this study focuses on the specific needs and practical constraints of micro, small and medium-sized overseas warehouse enterprises, and provides a feasible path for their sustainable and steady development in the field of overseas warehouse.

viii. Structure

1. Introduction

This study first expounds the rapid rise of e-commerce in the post-epidemic era, and then demonstrates the reasons why overseas warehouses have a good development environment in Europe. Specifically, the growth of cross-border e-commerce demand, the increasingly fierce competition in the international market, the continuous improvement of consumers' requirements for e-commerce logistics efficiency, and the willingness and demand of Chinese merchants to carry out localized warehousing operations in Europe have made the expansion of overseas warehouses in Europe an inevitable trend. Based on this background, this paper proposes a scheme that integrates the SCOR model with two multi-criteria decision methods (MCDM, i.e. AHP and SAW), aiming to help SMEs and new entrants adapt to the European market more quickly, in order to timely identify operational bottlenecks and establish priority solutions. Through this solution, enterprises can not only save time and money, but also effectively support the expansion of business scale and improve the efficiency of warehouse management.

2. Literature Review

In the literature review part, this paper will focus on the following topics: 1. Explore the basic concept, main functions and values of overseas warehouses, as well as their strategic significance for cross-border sellers; 2. Combined with the search and analysis of relevant literature, explain the business preferences of Chinese businessmen, especially why they are more inclined to choose overseas positions supported by Chinese investment background in the European market; 3. Pay attention to the existing research on overseas warehouses, including the use of SCOR model alone in the supply chain field, and the relevant practice of combining it with other MCDM methods; 4. Existing research will also be used to summarize the criteria for SME evaluation in Europe, and to point out the gaps in current research: the lack of an integrated approach specifically for SMEs to support their rapid transformation and development when they first enter the European market.

3. Methodology

This section will clearly introduce the research methods adopted, including the core logic of the SCOR model and the basic principles of AHP and SAW in the multi-criteria decision method. Then, the paper discusses how to build an overall framework based on SCOR model, and integrates AHP and SAW into the framework, aiming at providing operable and easy to implement analytical ideas and practical solutions for enterprises in making business decisions.

4. Research Results

In the results section, the paper directly applies the data collected from the case study and questionnaire survey, and scores and analyzes each supply chain process according to the proposed methodology. Through this empirical process, it not only shows the operation mechanism of the whole analytical framework in the actual situation, but also provides a solid basis for judging its effectiveness and application scope.

5. Discussion and Conclusion

Finally, in the discussion and conclusion part, this paper evaluates the feasibility and advantages of the fusion analysis method, and points out its possible shortcomings from both theoretical and practical aspects. Based on this, the direction of future improvement is proposed in order to help more SMEs obtain more targeted and sustainable competitiveness in the field of overseas warehouses.

2. Literature Review

1. Overseas Warehouses: Definition and Operational Scope

i. Main Functions & Values

Overseas warehouses serve as strategic nodes in global supply chains, providing inventory buffering, order fulfillment acceleration, and customs compliance management. Their value lies in reducing lead times (Jayathilaka, 2020) and mitigating cross-border trade risks (Cao & Xu, 2013). During the COVID-19 pandemic (2019–2021), Amazon’s cross-border sellers in Germany achieved a 26% expansion rate. While this surge placed considerable pressure on existing Fulfilled by Amazon (FBA) services (Amazon Annual Report, 2022), it also created significant expansion opportunities for locally operated overseas warehouses, serving as intermediaries to relieve the fulfillment burden on the platform’s own facilities.

ii. Significance for Overseas Sellers

Drawing on Cao and Xu’s (2013) analysis of the overseas warehouse model, there are several key reasons why this approach is pivotal for cross-border e-commerce sellers:

a. Reduced Logistics Timelines

Conventional cross-border shipping methods (e.g., direct mail or international couriers like UPS or DHL) are heavily influenced by customs clearance procedures, shipping/air transport schedules, and local regulations. These complexities can stretch delivery times anywhere from five to thirty days. In contrast, the overseas warehouse model positions bulk shipments in the target market’s warehouse in advance. Once a purchase is made, goods are dispatched directly from the local facility, typically cutting international shipping to three to five days—or even as few as one to two days. This expedited delivery not only enhances the buyer experience but also minimizes complaints and return requests tied to lengthy shipping periods. Also, by localizing inventory, sellers bypass lengthy international shipping, and customer satisfaction is positively correlated with excellent inventory management (Poi, Opara, 2021).

b. Lower Shipping and Operational Costs

When relying on international express services (e.g., UPS, DHL), per-item shipping costs can be exorbitant. For instance, sending a microwave worth a certain amount may incur transportation fees up to three times its value, thus undermining the product's competitiveness. By consolidating cargo through sea or air in advance, overseas warehouses significantly reduce per-unit logistics expenses. Faster delivery further allows for more flexible pricing, sparing sellers from steep discounts to attract customers.

c. Enhanced Customer Satisfaction and Repeat Purchases

Extensive shipping times—often ten to fourteen days or longer—frequently trigger high rates of complaints or refund demands. Overseas warehouses leverage local or "quasi-local" logistics solutions that approximate domestic-level delivery speed, thereby increasing consumers' trust and satisfaction. Positive feedback loops generated from such reliable delivery can boost store ratings, attract additional orders, and ultimately raise repeat purchase rates.

d. Market Expansion and Economies of Scale

Storing inventory ahead of time in the target market enables rapid fulfillment and also supports data tracking. By monitoring shipment volume and inventory fluctuations over specified intervals, businesses can accurately gauge local consumer preferences and swiftly adjust product selection, pricing, or marketing tactics. As orders and warehouse operations expand, sellers can achieve broader economies of scale and cultivate a stronger brand presence, driving further market penetration (Liu, Wu, and Jayetileke, 2022).

e. Greater Resilience Against Uncertainty

International logistics often faces challenges such as tariff policies, customs inspections, holiday peaks, and geopolitical events. The overseas warehouse model separates bulk international transport from local distribution, thereby allowing proactive inventory planning and more flexible responses to seasonal surges or unforeseen disruptions. Because the international shipping segment is effectively minimized, any external delays in the target market can be mitigated by tapping into multiple local shipping channels (Lin, 2019).

iii. Supply Chain Mapping

Figure 1 and Figure 2 illustrate a step-by-step process that Chinese sellers typically undertake when entering the European Union (EU) market through local warehousing solutions. The process begins with an exploration of the EU market, where cost efficiency, faster delivery times, and reverse logistics opportunities act as primary motivators for choosing overseas warehouses. After establishing the need for such facilities, sellers identify potential warehouse partners via social media channels or personal recommendations. They then negotiate service terms by requesting quotations, clarifying business and geographical requirements, and confirming the mode of transport—often ranging from sea freight for bulk shipments to air transport for urgent deliveries. Following the arrangement of logistics, the warehouse receives goods from various sources, including shipments sent directly from China or returned items forwarded from FBA or private addresses. Once in the warehouse, the products undergo inspection, repair, or refurbishment if necessary, and may be stored, disposed of, or shipped onward to end customers. Finally, payment is settled through methods such as local bank transfers or third-party payment platforms, completing a process designed to streamline cross-border operations and improve overall customer satisfaction.

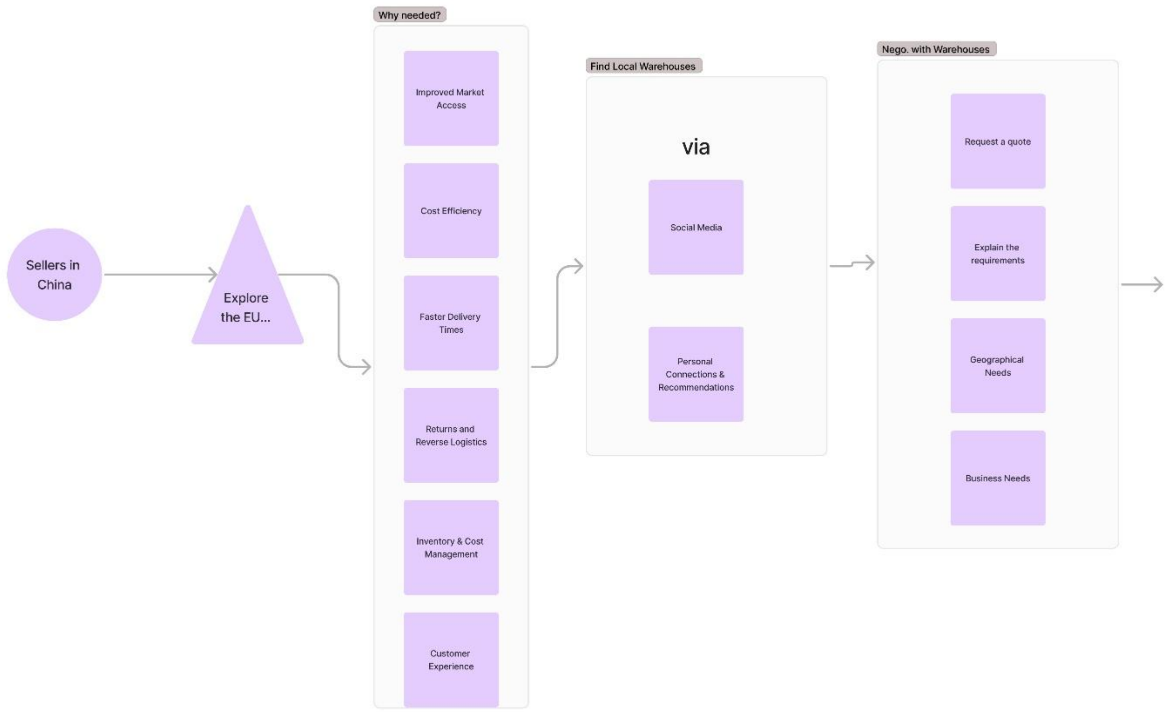


Figure 1

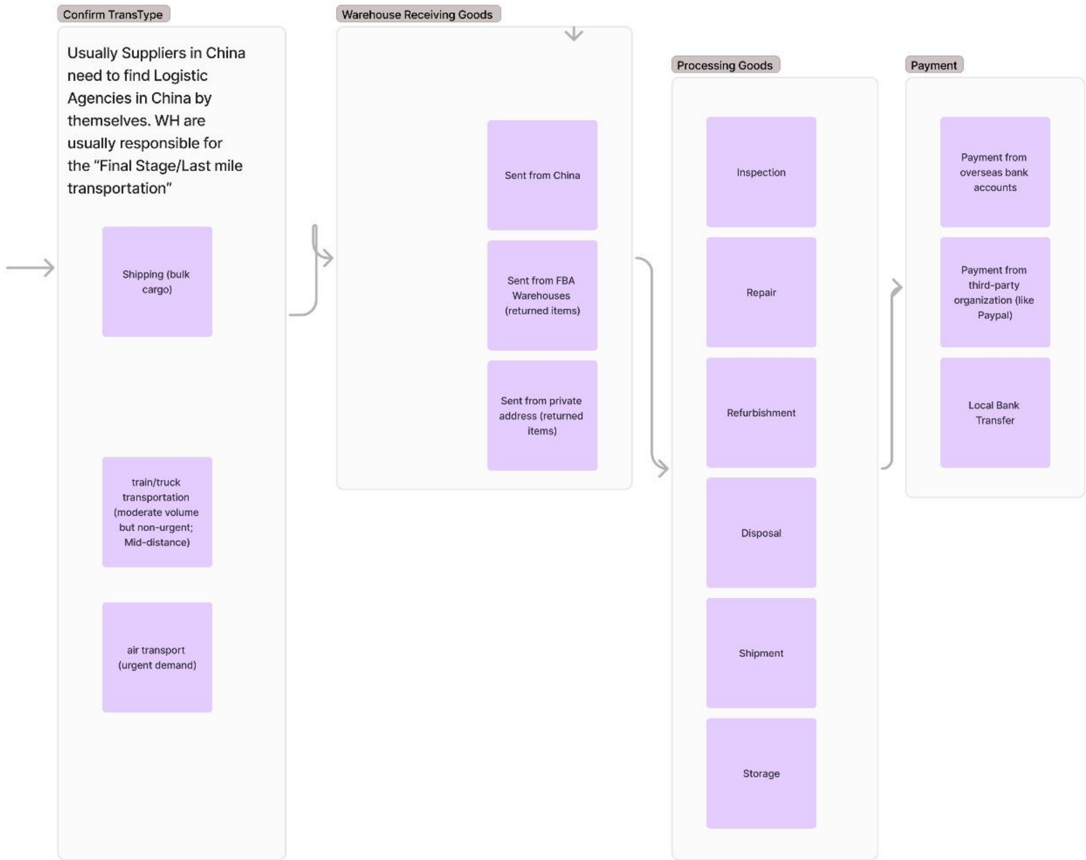


Figure 2

Figure 3 depicts a business process model that guides newcomers in the overseas warehousing industry through setting up and managing a warehouse operation. It highlights three main layers: Overall Business Management, In-Warehouse Management, and Customer Relationship Management. At the business level, individuals with limited experience decide whether to start from a small scale, partner with existing warehouses, or seek investors. This decision informs subsequent tasks such as renting and partitioning warehouse space, preparing essential equipment (e.g., shelving, office devices, and forklifts), and calculating breakeven points before generating pricing structures. The warehouse layer focuses on delineating functional areas—such as unloading, loading, and office zones—and ensuring that the necessary tools or consumables are in place to handle incoming shipments and operational tasks. Meanwhile, the customer relationship level addresses customer acquisition—either via personal networks or broader channels like social media—and proceeds to understand client needs and develop suitable service quotes.

Figure 4 continues the process flow once a quote has been accepted by the customer. It intertwines four key layers: the Information System, In-Warehouse Management, the Customer, and Data Exchange. Upon receiving orders, the system records relevant stock and operational data, calculates accounts receivable, and tracks payments. At the in-warehouse level, personnel coordinate receipt of goods—either in bulk or container form—sort and store items, and determine if further handling is required. If additional services (e.g., special labeling or quality checks) are performed, these are recorded for billing purposes, and an invoice is then sent to the customer. The customer, in turn, dispatches goods to the warehouse based on created tasks, receives and settles the invoice, and provides feedback on the service. Finally, the information system recommends transitioning to a more formal Warehouse Management System (WMS) tool once operators have mastered the core workflow.

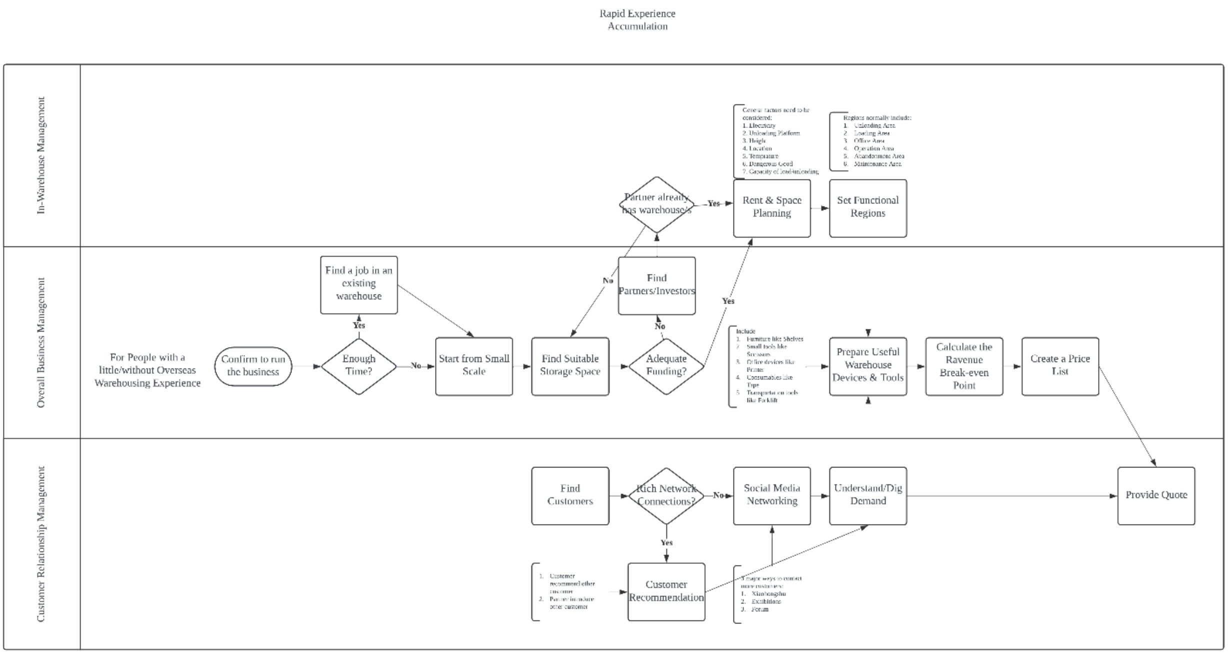


Figure 3

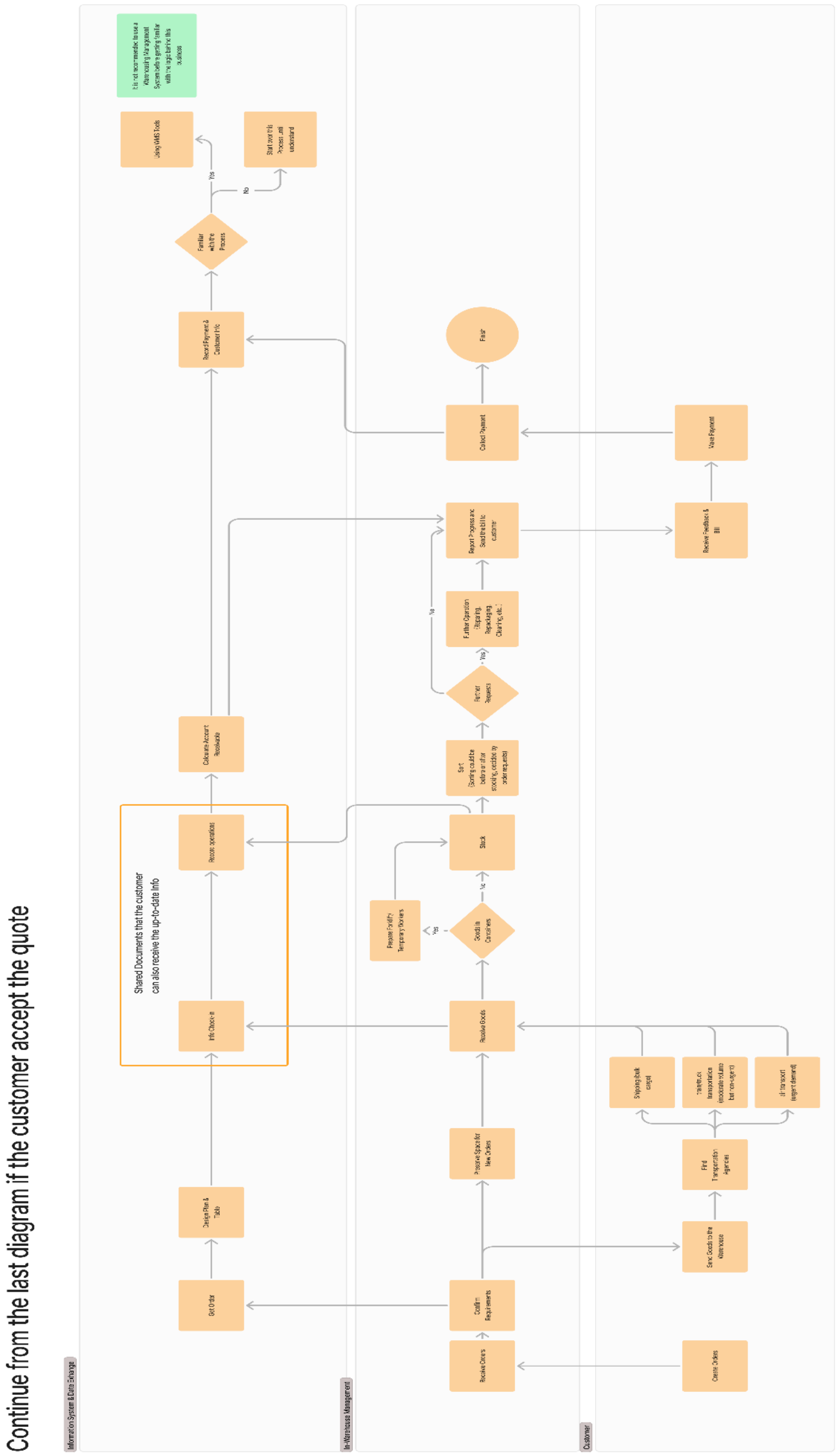

Continue from the last diagram if the customer accept the quote
Shared Documents that the customer can also receive the up-to-date info

Figure 4

iv. Extra Services

According to the investigation and interviews of this study, as well as Mou and Wang's research (2023), an integrated overseas warehouse delivers a suite of value-added services (VAS) beyond basic logistics and storage operations. These services include:

a. Initial Transport: Coordination and execution of the first-leg shipment from the origin to the overseas warehouse.
b. Local Warehousing and Handling: Comprehensive in-warehouse activities such as receiving, sorting, packaging, and inventory control, thus ensuring readiness for rapid fulfillment in the destination market.
c. Domestic Delivery: Final-mile distribution from the overseas facility to end consumers, enabling faster and more reliable delivery (Chen & Notteboom, 2012).
d. Labeling and Re-Labeling Services: Attaching or replacing SKU labels for goods, either before outbound shipping or after returns, particularly when products are sold via multiple e-commerce platforms.
e. Repair and Inspection for After-Sales Service: Consolidating and examining returned or defective items, performing necessary repairs or quality checks, repackaging them for resale as second-hand products, or arranging for disposal where appropriate.
f. Customs Brokerage: Assistance with import/export documentation, customs declarations, and compliance, thereby reducing cross-border bottlenecks (Gomez-Herrera et al., 2014).
g. Supply Chain Optimization: Integrated advisory services on inventory placement, transportation strategies, and systems coordination, which help streamline overall cross-border operations.

h. Product Identification and Traceability: Measures for anti-counterfeiting and verification, such as blockchain-based solutions to enhance consumer trust in product authenticity (Lee & Yeon, 2021).
i. Real-Time Tracking: Ongoing visibility into shipment status and warehouse processing, often facilitated by IoT-enabled tools (Wamba & Queiroz, 2020).
j. Rapid Response to Consumer Demand: Leveraging local warehousing and distribution networks to shorten delivery windows and minimize returns-related expenses.
k. Customized Solutions: Tailored offerings based on the product category—such as fashion apparel versus electronics—as well as the unique requirements of individual sellers.

Collectively, these value-added services offered by overseas warehouses are recognized as critical enablers of competitiveness for cross-border e-commerce retailers, especially in sectors with short product life cycles, such as fashion and consumer electronics (Escobar-Rodríguez & Bonsón-Fernández, 2017). Through these comprehensive service bundles, overseas warehouses not only provides greater fulfillment efficiency but also facilitates a superior consumer experience, thereby bolstering sales and market acceptance.

v. Chinese investors' business preference

Chinese cross-border e-commerce enterprises consistently display a strong inclination to partner with Chinese-invested overseas warehouse operators, largely because these providers align more readily with the culturally grounded "guanxi gateway" approach to business (Gao et al., 2012). As Liao (2016) elucidates, key dimensions of Chinese relational culture—such as "RENGQING" (favor exchange), reciprocity, and an acute awareness of social face—shape both the pace and the tenor of commercial interactions. By choosing warehouse partners who share language and cultural reference points, these e-commerce firms foster faster trust-building, reduce ambiguity in contractual obligations, and maintain a higher level of operational agility in navigating logistical challenges.

Moreover, the “guanxi gateway” concept, which highlights how personal connections bridge insider and outsider networks, becomes particularly advantageous in overseas contexts where local regulations, customs procedures, and consumer expectations differ considerably. The cultural familiarity inherent in these partnerships not only mitigates potential misunderstandings but also allows both parties to handle inevitable contingencies—such as shipment delays or policy shifts—with fewer obstacles. This joint problem-solving ethos is further reinforced through recurrent social interactions that honor face-saving norms and a shared sense of collective responsibility, ensuring enduring cooperation and strategic alignment. Consequently, by leveraging these guanxi-oriented channels, Chinese cross-border e-commerce ventures can more effectively localize their operations, sustain seamless product flows, and deepen consumer trust in diverse international markets.

Another notable finding, derived from both the survey data and interviews, is that Chinese merchants often prioritize convenience and speed in their business transactions, to the extent that they frequently begin providing services or delivering goods before any formal agreement has been signed. In addition, cash-based dealings—at times regarded as forms of unrecorded or “gray” income—are not unusual in these early-stage engagements. Over half of the study’s participants reported having commenced work for Chinese clients without a contract, and nearly forty percent of those respondents noted that they successfully maintained these contract-free arrangements over the long term. This practice illustrates both the reliance on personal trust and the practical emphasis on expediency that characterize many Chinese business interactions.

vi. Existing discussions

Integrating SCOR, AHP, and SAW can create a powerful decision support framework that combines process-oriented performance metrics with multi-criteria evaluation and straightforward ranking. In literature, pairwise integrations of these methods are common, each bringing complementary strengths. A well-documented approach is the integration of SCOR and AHP for supply chain performance measurement. In this approach, the SCOR model first defines a comprehensive set of performance metrics (structured by SCOR's levels and attributes), and then AHP is used to weigh these metrics according to strategic priorities or expert judgment. This helps focus on what performance aspects matter most. Tutuhatunewa et al. (2023) demonstrate how seamlessly SCOR and AHP can be combined, using SCOR to identify 21 KPIs for a shipyard's supply chain and AHP to determine that the *Plan* process was the most critical phase in that context. Similarly, Fauziyah et al. (2020) applied AHP to assign importance weights to SCOR metrics (including special halal criteria) in a food supply chain, enabling an objective, weighted performance evaluation. In both cases, SCOR provided the *what to measure* and AHP provided the *how important each measure is*, resulting in a nuanced performance score or rating for the supply chain.

On the other hand, the integration of AHP and SAW is frequently used in decision support systems to combine rigorous weight elicitation with simple alternative ranking. In an AHP+SAW system, AHP generates the weights for each criterion, and those weights feed into the SAW computation to rank the alternatives. This approach leverages AHP's ability to capture decision-maker preferences and SAW's ease of obtaining a final decision. Kurniawati et al. (2021), for instance, implemented a decision model where AHP calculated weights for five criteria according to user preferences, and then SAW produced optimal recommendations aligned with those preferences. The result was a more user-centric decision recommendation – the alternatives ranked highest truly reflected what the decision maker valued, which wouldn't be guaranteed if weights were assigned arbitrarily. Rojakul et al. (2024) also report a complementary relationship between AHP and SAW: AHP ensures each criterion (such as member activity, savings, guarantees in their credit scenario) has an appropriate priority, and SAW uses those to clearly identify the top alternative, thereby optimizing the selection outcome. These studies affirm that combining AHP with SAW yields a structured yet user-aligned decision process.

Fully integrating SCOR, AHP, and SAW involves using all three: SCOR to structure and benchmark performance criteria, AHP to weight these criteria, and SAW (a weighted sum calculation) to aggregate performance or scores of alternatives. Some research implicitly follows this approach. For example, Raja et al. (2017) developed an AHP-SCOR Integrated Model (ASIM) for supplier selection, effectively translating SCOR performance attributes into evaluation criteria and then using AHP to prioritize them. In their model, each supplier was scored by multiplying the AHP-derived weights with the supplier's performance on SCOR criteria, a process analogous to SAW aggregation. The final outcome was a ranking of suppliers by score – in their case, "Supplier 1" emerged as the best choice with the highest weighted score (0.483). This integrated approach proved more comprehensive than using AHP or SCOR alone, because it captured the company's strategic performance objectives (via SCOR metrics) and quantitatively evaluated each supplier against those objectives. Decision makers thus gained a more holistic and strategically aligned evaluation**,** attaining a competitive edge through the credible new method.

The effectiveness of such integrations is evident in the improved quality of decisions and clarity of recommendations. By combining these methods, organizations can ensure that all relevant performance dimensions are considered (thanks to SCOR), weighed appropriately (via AHP), and aggregated into an actionable decision (via SAW). However, limitations and challenges have been noted. One limitation is the complexity of handling a large number of metrics and pairwise comparisons – for instance, evaluating 41 criteria in the ASIM model required significant expert input and consistency checks. Additionally, the models can be sensitive to the weights: if the business environment changes, the AHP weights need to be updated to keep recommendations optimal. Researchers have suggested incorporating dynamic updates and risk assessments into these frameworks to enhance robustness. For example, periodically re-running AHP to adjust criterion weights and including risk factors in the evaluation could make the decision support system more resilient to uncertainty. Integrating SCOR, AHP, and SAW offers a comprehensive decision support approach that aligns operational metrics with strategic decision-making and provides clear rankings of alternatives. The literature to date shows promising results in various domains (supplier selection, performance improvement), while also indicating the need for careful design to manage complexity and maintain accuracy.

vii. How SMEs are defined in EU

The classification criteria outlined in Annex I to EU Regulation 651/2014 define small and medium-sized enterprises (SMEs) through three quantitative thresholds: (1) workforce size not exceeding 250 full-time equivalents, (2) annual turnover below €50 million, and (3) total assets under €43 million on the balance sheet.

viii. Research Gap

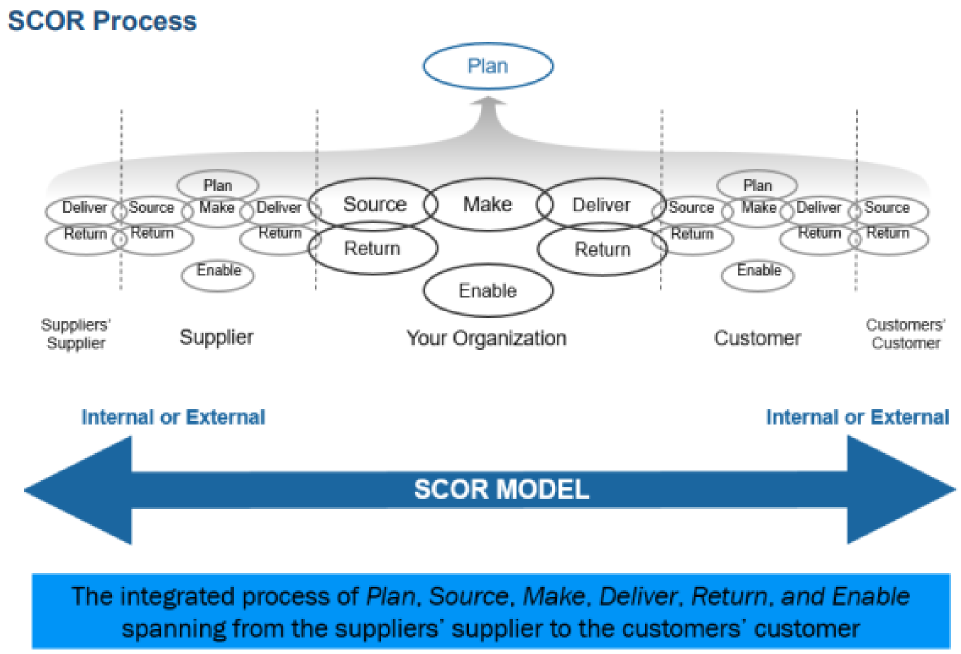
As mentioned above, existing research has explored the use of SAW and AHP in DSS models, SAW in conjunction with TOPSIS within SCOR, and the integration of SAW with new versions of SCOR standards and various MCDM methods. However, the combined use of SAW and AHP within SCOR has not been extensively studied. This combination is not redundant. Compared to their use in DSS models, where SAW emphasizes optimal value outcomes and AHP focuses on determining criterion weights to ensure logical consistency in subjective judgments.

3. Methology

1）SCOR

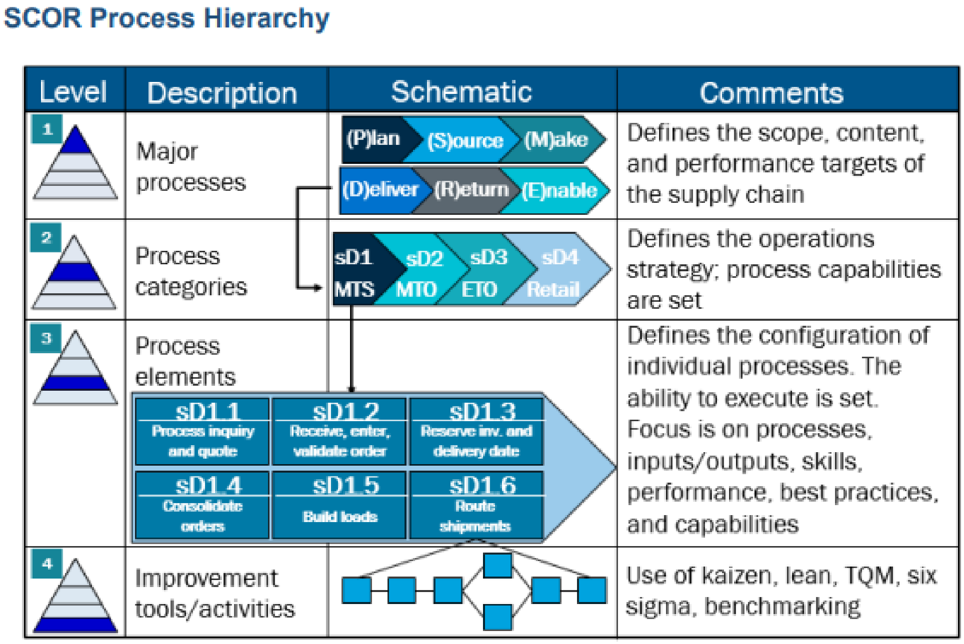
The SCOR (Supply Chain Operations Reference) model is a globally recognized framework for supply chain management, standardizing core processes (Plan, Source, Make, Deliver, Return, Enable) across hierarchical levels (Level 1 strategic, Level 2 tactical, Level 3 operational) to systematically define KPIs and operational metrics. For instance, in optimizing overseas warehousing, SCOR identifies Level 1 priorities (e.g., Deliver at 48.4% weight) and drills down to Level 3 execution details (e.g., "Order Fulfillment Cycle Time" or "Return Processing Cost"), integrating methods like AHP to assign weights and quantify impacts. Known for its standardization and scalability, SCOR enables benchmarking against industry practices and bottleneck diagnosis, though its static nature requires dynamic adaptation to market shifts. It is often paired with decision tools (e.g., SAW, AHP) to enhance agility in complex supply chain decision-making.

As the” Graphic 1: Overview of SCOR Model Integrated Supply Chain Processes” illustrates the core framework of the Supply Chain Operations Reference (SCOR) model, highlighting its role as an integrated process system spanning from "suppliers' supplier" to "customers' customer." The model consists of six core processes: Plan, Source, Make, Deliver, Return, and Enable. "Plan" serves as the overarching process coordinating resources and objectives. "Source," "Make," and "Deliver" form the operational backbone, with their repeated sequences (e.g., "Source-Make-Deliver") reflecting dynamic execution. The frequent repetition of "Return" emphasizes the criticality of reverse logistics and after-sales services. "Enable" underpins all processes, focusing on supplier management, organizational collaboration, and internal-external resource integration. The model also defines roles across the chain, including suppliers, the organization itself, and customers, while distinguishing internal and external interactions to underscore the complexity and collaboration needs of end-to-end supply chains.



Graphic 1: Overview of SCOR Model Integrated Supply Chain Processes

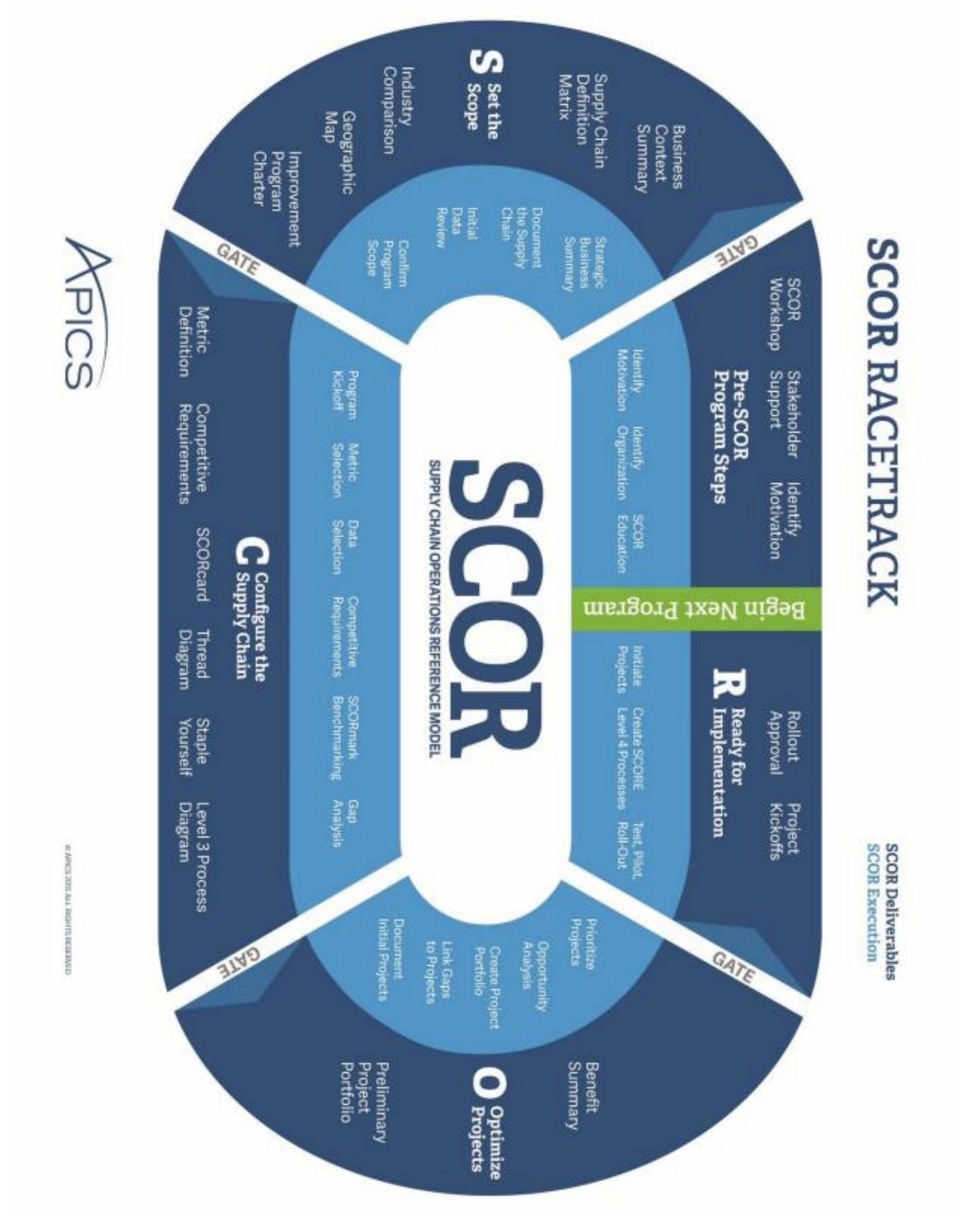
the Supply Chain Operations Reference (SCOR) model, outlining a systematic progression from strategy to execution. The model is divided into four levels: Level 1 defines the core processes (Plan, Source, Make, Deliver, Return, Enable), establishing the scope, content, and performance metrics of the supply chain. Level 2 categorizes operational strategies (e.g., sD1, MTS, MT0) to set process capabilities. Level 3 details process elements (e.g., "Process inquiry and quote," "Validate order," "Confirm inventory"), specifying execution through inputs/outputs, skills, and best practices. Level 4 integrates improvement methodologies (kaizen, lean, Six Sigma) to drive continuous optimization. This hierarchy reflects a coherent logic from strategic alignment to operational implementation, combining standardized processes with dynamic enhancements to enhance supply chain agility and efficiency.



SCOR Process Hierarchy

Level	Description	Schematic	Comments
1	Major processes	(P)lan (S)ource (M)ake (D)eliver (R)eturn (E)nable	Defines the scope, content, and performance targets of the supply chain
2	Process categories	sD1 MTS, sD2 MTO, sD3 ETO, sD4 Retail	Defines the operations strategy; process capabilities are set
3	Process elements	sD1.1 Process inquiry and quote; sD1.2 Receive, enter, validate order; sD1.3 Reserve inv. and delivery date; sD1.4 Consolidate orders; sD1.5 Build loads; sD1.6 Route shipments	Defines the configuration of individual processes. The ability to execute is set. Focus is on processes, inputs/outputs, skills, performance, best practices, and capabilities
4	Improvement tools/activities		Use of kaizen, lean, TQM, six sigma, benchmarking

Graphic 2: Analysis of SCOR Model Process Hierarchy



2）Analytic Hierarchy Process（AHP）

The Analytic Hierarchy Process (AHP) is a structured multi-criteria decision-making method designed to quantify the relative importance of factors by decomposing complex problems into hierarchical levels (goal, criteria, alternatives). Its core logic involves constructing pairwise comparison matrices (e.g., using Saaty’s 1-9 scale) to prioritize elements at each level, followed by weight calculation and consistency verification (CR < 0.1). For instance, in supply chain optimization, AHP can decompose objectives into criteria such as cost, timeliness, and quality, assign weights to sub-processes (e.g., Delivery Cycle Time at 48.4%, Return Management at 28.7%), and synthesize results to identify optimal solutions. While AHP relies on subjective input and involves computational complexity, its structured framework and quantitative rigor make it widely applicable in project management, resource allocation, and other domains requiring trade-offs among conflicting objectives.

3)The Simple Additive Weighting (SAW)

The Simple Additive Weighting (SAW) method is a multi-criteria decision-making technique that ranks alternatives by normalizing heterogeneous data (e.g., via min-max scaling or vector normalization) and aggregating weighted criterion scores (formula:$V_i = \sum w_j \cdot r_{ij}$). For instance,in supplier selection, SAW assigns weights to criteria like cost (30%) and quality (50%),standardizes their values, and computes total scores to prioritize options efficiently. Known for its simplicity, transparency, and computational speed, SAW excels in scenarios with independent criteria and easily quantifiable data. However, its reliance on linear additive assumptions limits applicability to problems requiring handling of complex interdependencies or non-linear trade-offs, necessitating complementary methods in intricate decision contexts like supply chain optimization.

4. Result

1.1 Interview result

1) investigate

To ensure robustness, the investigation adopted a triangulation approach across four data sources, rigorously aligned with ethical and empirical research standards. Semi-structured interviews, guided by SCOR Level 1-2 metrics (e.g., "order fulfillment cycle time"), engaged 11 stakeholders, including warehouse founders, logistics managers, and investors, selected for geographic diversity (Germany, U.S., China) and operational heterogeneity (scale, focus areas). This design aimed to capture both universal challenges (e.g., customs delays) and context-specific nuances. The survey, distributed to 15 multinational practitioners, quantified SCOR dimension priorities (e.g., "cost" vs. "responsiveness"), revealing implicit trade-offs: German operators prioritized compliance costs, whereas U.S. respondents emphasized supply chain resilience. Participatory observation in two Düsseldorf warehouses provided immersive insights into daily operations, such as inventory audits and supplier conflicts, addressing unspoken challenges not captured in interviews. All participants provided informed consent, with anonymization protocols for sensitive data. Qualitative data were analyzed via thematic coding, cross-validated with quantitative survey results. While the study's European-centric sample and limited size may affect generalizability, the multi-layered methodology enriched understanding of supply chain robustness and set a foundation for future cross-regional comparative studies.

2)Analyse

Based on the five core processes of SCOR, this study enumerates the influencing factors related to overseas warehousing as shown in the table below. From the company's vision and mission, it is evident that the objective is to achieve maximum business value by prioritizing effectiveness and efficiency. This is applied to the distribution of metrics through SCOR perspectives. Additionally, at this level, weighting is performed according to the five SCOR perspectives: Plan, Source, Deliver, Return, and Make. As seen in Table 1, the table is structured in the SCOR hierarchy, where Level 1 represents the perspective of warehouse supply chain processes, Level 2 categorizes KPIs based on SCOR dimensions as referenced from the SCOR Reference Book Version 12.0, and Level 3 defines the scope of the supply chain through performance measurement criteria required for the company's supply chain evaluation. The analysis is conducted in stages or levels, establishing interrelationships through weighting.

Core Process	Hierarchy	Performance Attributes （level2）	Metrics	KPI Description(level3)	Unit
Plan	sP1.1: Identify, Prioritize and Aggregate Supply Chain Requirements	Responsiveness	RS.3.44	Identify, Prioritize and Aggregate Supply Chain Requirements Cycle Time	Day
	sP1: Plan Supply Chain	Responsiveness	RS.3.98	Plan Cycle Time	Day
	sP1: Plan Supply Chain	Cost	CO.3.1	Cost to Plan Supply Chain	€
	sP4: Plan Deliver	Cost	CO.3.4	Cost to Plan Deliver	€
Make	sM1.1: Schedule Production Activities	Reliability	RL.3.49	Schedule Achievement	-

	sM1.3: Release Product to Deliver	Reliability	RL.3.59	Yield Variability	%
	sM1.3: Release Product to Deliver	Reliability	RL.3.36	Fill Rate	%
	sM1: Make-to-Stock	Responsivenes s	RS.1.1	Order Fulfillment Cycle Time	Day
	sM1: Make-to-Stock	Agility	AG.3.38	Current Make Volume	-
	sM1: Make-to-Stock	Cost	CO.3.13	Direct Labor Cost	€
	sM1: Make-to-Stock	Asset Management	AM.1.1	Cash-to-Cash Cycle Time	Day
Deliver	sD1.1: Process Inquiry and Quote	Cost	CO.3.14	Order Management Cost	€
	sD1.7: Select Carrier and Rate Shipments	Cost	CO.3.15	Order Delivery and / or Install Costs	€
	sD1.12: Ship Product	Reliability	RL.2.1	% of Orders Delivered in Full	%
	sD1.12: Ship Product	Reliability	RL.3.35	Delivery Quantity Accuracy	%

Return	sDR1.1: Authorize Defective Product Return	Responsiveness	RS.3.5	Authorized Defective Return Cycle Time	Day
	sDR1.1: Authorize Defective Product Return & sSR1.1: Identify Defective Product Condition	Cost	CO.2.5	Cost to Return	€
	sSR2.2: Disposition MRO Product	Asset Management	AM.3.29	Percentage Defective Inventory in Disposition	%
	sDR2.3: Receive MRO Product	Responsiveness	RS.3.106	Receive MRO Product Cycle Time	Day
	sR: Return	Asset Management	AM.1.1	Cash-to-Cash Cycle Time	Day
Enable	sE3: Manage Data & Information	Responsiveness	RS.3.53	Maintain Source Data Cycle Time	Day

Metric Weighting Level 1

1. Criterion Layer Construction

At this level, surveys of relevant enterprises were conducted, along with questionnaires and interviews involving related personnel. The Saaty 1-9 scale method was applied to evaluate the aforementioned factors, determining the assessment of the criterion layer relative to the objective layer. This process generated the judgment matrix presented in Table 1.

Table 1: Saaty's 1-9 Scale Method

scale	information
1	Indicates that two factors are equally important compared to each other
3	Indicates that one factor is slightly more important than the other when comparing the tw
5	Indicates that one factor is significantly more important than the other when comparing the
7	Indicates that one factor is more strongly important than the other when compared to the t
9	One factor is more important than the other when comparing the two factors.
2,4,6,8	Median of the above two neighbouring judgements
reciprocal	Judgement aij of factor i compared to j, then judgement a_{ji} of factor j compared to a_{j}

For Constructing Criterion Layer A：

$$A = (a_{ij})_{m\times n} = a_{11} \quad a_{12} \quad \ldots \quad a1n \;)$$

1) $a_{ij}>0$
2) $a_{ij}=1/a_{ji}$
3) $A_{ii}=1$

Table 2: Comprehensive Evaluation of Primary Hierarchical Metrics at Level 1

a_{ij} a_{ji}	Plan	Make	Deliver	Return	Enable
Plan	1	1.25	0.142857143	0.2	1.5
Make	0.8	1	0.111111111	0.111111111	1
Deliver	7	9	1	1.428571429	4
Return	5	3	0.7	1	2.5
Enable	0.666666667	1	0.25	0.4	1

The integration of variables into the model yields：

$$A_1 = \begin{Bmatrix} 1\frac{5}{4}\frac{1}{7}\frac{1}{5}\frac{3}{2} \\ \frac{4}{5}1\frac{1}{9}\frac{1}{9}1 \\ 791\frac{1}{7}4 \\ 53\frac{7}{10}1\frac{5}{2} \\ \frac{2}{3}1\frac{1}{4}\frac{2}{5}1 \end{Bmatrix}$$

$$\bar{w}_i = \sqrt[m]{\prod_{j=1}^{m} a_{ij}}$$

The integration of variables into the model yields：

$$\bar{W}_{plan} = \sqrt[5]{1 \times \frac{5}{4} \times \frac{1}{7} \times \frac{1}{5} \times \frac{3}{2}} = 0.5569$$

$$\bar{W}_{make} = \sqrt[5]{\frac{4}{5} \times 1 \times \frac{1}{9} \times \frac{1}{9} \times 1} = 0.3971$$

$$\bar{W}_{deliver} = \sqrt[5]{7 \times 9 \times 1 \times \frac{10}{7} \times 4} = 3.2453$$

$$\bar{W}_{Return} = \sqrt[5]{5 \times 3 \times \frac{7}{10} \times 1 \times \frac{5}{2}} = 1.9223$$

$$\bar{W}_{Enable} = \sqrt[5]{5 \times \frac{2}{3} \times \frac{1}{4} \times \frac{2}{5} \times 1} = 0.5818$$

Subsequently, the vector is normalized according to the following formula to derive the weight vector, thereby obtaining the weights

$$w_i = \frac{\bar{w}_i}{\sum_{j=1}^{m} \bar{w}_j}$$

get：

$$w_{plan} = \frac{0.5569}{0.5569 + 0.3971 + 3.2453 + 1.9223 + 0.5818} = 0.0831$$

$$w_{make} = \frac{0.3911}{0.5569 + 0.3971 + 3.2453 + 1.9223 + 0.5818} = 0.0592$$

$$w_{deliver} = \frac{3.2453}{0.5569 + 0.3971 + 3.2453 + 1.9223 + 0.5818} = 0.4841$$

$$w_{Return} = \frac{1.9223}{0.5569 + 0.3971 + 3.2453 + 1.9223 + 0.5818} = 0.2868$$

$$w_{Return} = \frac{0.5818}{0.5569 + 0.3971 + 3.2453 + 1.9223 + 0.5818} = 0.0868$$

Therefore, the weight distribution of Level 1 criteria is presented in the table below. As derived from the Analytic Hierarchy Process (AHP) and pairwise comparisons, Table 3: Weight Distribution of SCOR Level 1 Core Processes summarizes the normalized weights for Plan (8.3%), Make (5.9%), Deliver (48.4%), Return (28.7%), and Enable (8.7%). These values reflect their relative significance in achieving supply chain optimization objectives.

Table 3:Weight Distribution of SCOR Level 1 Core Processes

	weight
Plan	8.31%
Make	5.92%
Deliver	48.41%
Return	28.68%
Enable	8.68%

2. Single-Level Prioritization and Consistency Verification

1）Single-Level Prioritization

Single-level prioritization refers to the pairwise comparison of all elements within the current level relative to a specific element in the upper level, followed by hierarchical ordering to rank their relative importance. The calculations are based on the judgment matrix A, which must satisfy the eigenvalue and eigenvector condition AW=λmaxW. Here,λmax represents the maximum eigenvalue of A, and W denotes the normalized eigenvector corresponding to λmax.The components w_i of W represent the weights, which correspond to the single-level prioritization of the respective elements. The weights (weight coefficients) of each factor relative to the objective layer are calculated using the judgment matrix.

("Following the *Geometric Mean Method* outlined in Table X, the priority weight vector W and maximum eigenvalue λmax were derived. For instance, Step a involved calculating row-wise geometric means, while Step b normalized these values to ensure$\sum w_i$=1. Finally, λmax was computed to validate consistency (CR < 0.1), confirming the reliability of the hierarchical weights.")

The computational steps for deriving the weight vector (W) and maximum eigenvalue (λmax) via the geometric mean method or sum method are outlined in the table below:

Table 4: Computational Steps for Deriving the Weight Vector (W) and Maximum Eigenvalue

Step	Procedure	Formula
a)	Calculate the product of elements in each row, then compute the n-th root.	$\bar{W}_i = \sqrt{\prod_{j=1}^{n} \quad a_{ij}}(i, j = 1,2,\cdots,n)$

b) Normalize W (ensuring the sum of elements equals 1) to obtain the priority weight vector W, where W represents the eigenvector of the judgment matrix.

$$w_t = \frac{\bar{W_t}}{\sum_{i=1}^{n} W_i}$$

c) Compute the maximum eigenvalue (λmax) of the judgment matrix.

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n}\frac{(AW)_i}{W_i}$$

2）Computation of the Maximum Eigenvalue and Consistency Index

Let **B** be an ***n***×***n*** judgment matrix. Its maximum eigenvalue (λmax) can be computed using the following method:

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n}\frac{(AW)_i}{W_i}$$

Here,W is the eigenvector of the judgment matrix B, and the Consistency Index (C.I.) is utilized to evaluate the logical consistency of the pairwise comparison judgments。

$$C.I. = \frac{\lambda max - n}{n - 1}$$

"Where:

- C.I.==indicates perfect consistency in the judgment matrix.
- A higher C.I.value signifies greater inconsistency in the judgment matrix."

3）Compute the Consistency Ratio (CR) to Verify Consistency Acceptability

$$C.R. = \frac{C.I.}{R.I.}$$

Table X presents the Random Index (R.I.) values obtained from Saaty's 1,000 simulated random pairwise comparison matrices, as shown below.

Table 3: Random Index (R.I.) Values

Matrix Size(n)	1	2	3	4	5	6	7	8	9	10	11	12	13
R.I. value	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.54	1.56

When ***C.R.***<0.1,the consistency of the judgment matrix **A** is deemed acceptable, and its eigenvector can be utilized to compute the weight vector. If ***C.R.***≥0.1, he judgment matrix A should be revised to resolve inconsistencies.

Table 4: Distribution of Level 1 Factors

	Plan	**Make**	**Deliver**	**Return**	**Enable**	**weight**	**aw**	**aw/w**
Plan	0.0831	0.0741	0.0692	0.0574	0.1302	0.0827	0.4138	1.0009
Make	0.0665	0.0592	0.0538	0.0319	0.0868	0.0590	0.2981	1.0113
Deliver	0.5815	0.5332	0.4841	0.4097	0.3472	0.4929	2.3557	0.9558
Return	0.4154	0.1777	0.3389	0.2868	0.2170	0.2790	1.4357	1.0291
Enable	0.0554	0.0592	0.1210	0.1147	0.0868	0.0864	0.4372	1.0121

The sum of the eigenvalues is calculated as follows:：

$$\lambda_{max}=1.0009+1.0113+0.9558+1.0291+1.0121=5.0091$$

then：

$$C.I. = \frac{5.0091 - 5}{5 - 1} = 0.0023$$

From **Table 3: Random Index (*R.I.*) Values** (Saaty, 1980), the R.I. value for a matrix of order n=5 is 1.12,then：

$$C.R. = \frac{0.0023}{1.12} = 0.0020 < 0.1$$

Since ***C.R.***=0.0020<0.1,the judgment matrix satisfies the consistency requirement, confirming the logical validity of pairwise comparisons。

Metric Weighting Level 2

At this level, surveys were conducted across relevant enterprises, supplemented by questionnaires and interviews with stakeholders. The Saaty 1-9 scale method was employed to evaluate the aforementioned factors, determining the priority of criteria relative to the objective layer. The Analytic Hierarchy Process (AHP) was applied to construct the judgment matrix $\mathbf{A_1}$, subsequently generating a subset matrix $\mathbf{A_2}$. However, due to insufficient data for certain indicators, consistency verification via AHP was infeasible. For these indicators, ad-hoc weighting was implemented based on survey results. The derived weights, validated through adjusted judgment matrices, are summarized in Tables 5–8

1）Evaluation of Level 2 Hierarchical Metrics

$$B_1 = \left\{ \begin{matrix} 1\frac{1}{5}\frac{1}{7}\frac{1}{9}1 \\ 51\frac{1}{4}\frac{1}{7}\frac{5}{4} \\ 741\frac{1}{5}\frac{5}{3} \\ 97515 \\ 1\frac{4}{5}\frac{3}{5}\frac{1}{5}1 \end{matrix} \right\}$$

Table 5: Evaluation Results of Level 2 Metrics under the Make Process (B_1)

	Reliability	Responsiveness	Agility	Cost	Asset Management
Reliability	1	0.2	0.142857143	0.111111111	1
Responsiveness	5	1	0.25	0.142857143	1.25
Agility	7	4	1	0.2	1.666666667
Cost	9	7	5	1	5
Asset Management	1	0.8	0.6	0.2	1

$$B_2 = \left\{ \begin{matrix} 1 & \frac{1}{3} & \frac{10}{3} \\ 3 & 1 & \frac{5}{2} \\ \frac{3}{10} & \frac{2}{5} & 1 \end{matrix} \right\}$$

Table 6: Evaluation Results of Level 2 Metrics under the Return Process (B_2)

	Responsiveness	Cost	Asset Management
Responsiveness	1	0.333333333	3.333333333
Cost	3	1	2.5
Asset Management	0.3	0.4	1

Table 7: Evaluation Results of Level 2 Metrics under the Plan Process

	Responsiveness	Cost
Responsiveness	1	0.5
Cost	2	1

Table 8: Evaluation Results of Level 2 Metrics under the deliver Process

	Cost	Reliability
Cost	1	9
Reliability	0.111111111	1

2）Consistency Verification through Computation

Following the methodology outlined in preceding sections, the consistency of Level 2 sub-processes B_1 and B_2 (extracted from Tables 5 and 6) relative to the Level 1 criterion A_1 was validated. The computational results, including the Consistency Ratio (CR) and corresponding acceptability thresholds, are summarized in the table below:：

Table 8: Evaluation Results of Level 2 Metrics under the Plan Process

	Responsiveness	Cost	Asset Management

Responsiveness	0.2971	0.1871	0.4716
Cost	0.8912	0.5614	0.3537
Asset Management	0.0891	0.2246	0.1415

The sum of the eigenvalues is calculated as follows:

$$\lambda_{max}=1.0725+1.0725+1.0725=3.2174$$

then：

$$C.I.=\frac{3.1087-3}{3-1}=0.0543$$

From **Table 3: Random Index (*R.I.*) Values** (Saaty, 1980), the R.I. value for a matrix of order *n*=3 is 0.58,then：

$$C.R.=\frac{0.0543}{0.58}=0.0936<0.1$$

Same way for B_1:

Table 8: Evaluation Results of Level 2 Metrics under the Return Process

	Reliability	Responsiveness	Agility	Cost	Asset Management
Reliability	0.0416	0.0195	0.0294	0.0637	0.0823
Responsiveness	0.2080	0.0974	0.0514	0.0819	0.1029
Agility	0.2913	0.3896	0.2055	0.1146	0.1371
Cost	0.3745	0.6818	1.0276	0.5732	0.4114
Asset Management	0.0416	0.0779	0.1233	0.1146	0.0823

The sum of the eigenvalues is calculated as follows:

$$\lambda_{max}=1.0364+1.1120+1.1076+1.0707+1.0689=5.4956$$

then：

$$C.I.=\frac{5.3956-5}{5-1}=0.0656$$

From **Table 3: Random Index (*R.I.*) Values** (Saaty, 1980), the R.I. value for a matrix of order *n*=5 is 1.12,then：

$$C.R.=\frac{0.0989}{1.12}=0.0883<0.1$$

Since ***C.R.***=0.0883<0.1,the judgment matrix satisfies the consistency requirement, confirming the logical validity of pairwise comparisons。

Metric Weighting Level 3

Following the methodology outlined in preceding sections, the consistency of Level 2 sub-processes C_1 and C_2 relative to the Level 1 criterion A_2 was validated. The computational results, including the Consistency Ratio (CR) and corresponding acceptability thresholds, are summarized in the table below::

At Level 3 of the hierarchical framework, validated Key Performance Indicators (KPIs) are assigned specific weights to quantify their relative importance in achieving strategic objectives. These weights are derived through systematic methodologies such as the Analytic Hierarchy Process (AHP) or statistical prioritization, ensuring alignment with organizational goals. The table below illustrates the weight allocation for each KPI, accompanied by validation methods and contextual relevance.

Table X: Comprehensive Evaluation of Primary Hierarchical Metrics at Level 3

	Authorized Defective Return Cycle Time	Receive MRO Product Cycle Time	Maintain Source Data Cycle Time
Authorized Defective Return Cycle Time	1	0.111111111	1.25
Receive MRO Product Cycle Time	9	1	5
Maintain Source Data Cycle Time	0.8	0.2	1

For Constructing Criterion Layer A：

$$A = (a_{ij})_{m \times n} = a_{11} \quad a_{12} \quad \dots \quad a1n \ )$$

4) $a_{ij}>0$

5) $a_{ij}=1/a_{ji}$

6) A_{ii}=1

Table X: Comprehensive Evaluation of Primary Hierarchical Metrics at Level 3

	Authorized Defective Return Cycle Time	Receive MRO Product Cycle Time	Maintain Source Data Cycle Time	w	aw	aw/w
Authorized Defective Return Cycle Time	0.1122	0.0856	0.1470	0.1122	0.3447	1.0245
Receive MRO Product Cycle Time	1.0094	0.7703	0.5878	0.7703	2.3675	1.0245
Maintain Source Data Cycle Time	0.0897	0.1541	0.1176	0.1176	0.3613	1.0245

The sum of the eigenvalues is calculated as follows:

$$\lambda_{max}=1.0245+1.0245+1.0245=3.0735$$

then：

$$C.I. = \frac{3.0735 - 3}{3 - 1} = 0.0368$$

From **Table 3: Random Index (*R.I.*) Values** (Saaty, 1980), the R.I. value for a matrix of order *n*=3 is 0.58,then：

$$C.R. = \frac{0.0368}{0.58} = 0.0634 < 0.1$$

Since ***C.R.***=0.0634<0.1,the judgment matrix satisfies the consistency requirement, confirming the logical validity of pairwise comparisons.

Table X: Comprehensive Evaluation of Primary Hierarchical Metrics at Level 3

	Schedule Achievement	Yield Variability	Fill Rate
Schedule Achievement	1	0.333333333	0.2
Yield Variability	3	1	0.5
Fill Rate	5	2	1

For Constructing Criterion Layer A：

$$A = (a_{ij})_{m\times n} = a_{11} \quad a_{12} \quad \dots \quad a1n \ )$$

7) $a_{ij}>0$

8) $a_{ij}=1/a_{ji}$

9) $A_{ii}=1$

10)

Table X: Comprehensive Evaluation of Primary Hierarchical Metrics at Level 3

	Schedule Achievement	Yield Variability	Fill Rate	w	aw	aw/w
Schedule Achievement	0.2385	0.2245	0.2535	0.2385	0.7164	1.0012
Yield Variability	0.7156	0.6734	0.6337	0.6734	2.0226	1.0012
Fill Rate	1.1926	1.3467	1.2673	1.2673	3.8066	1.0012

The sum of the eigenvalues is calculated as follows:

$$\lambda_{max}=1.0012+1.0012+1.0012=3.0036$$

then：

$$C.I. = \frac{3.0036 - 3}{3 - 1} = 0.0018$$

From **Table 3: Random Index (*R.I.*) Values** (Saaty, 1980), the R.I. value for a matrix of order n=3 is 0.58,then：

$$C.R. = \frac{0.0018}{0.58} = 0.0031 < 0.1$$

Since ***C.R.***=0.0031<0.1,the judgment matrix satisfies the consistency requirement, confirming the logical validity of pairwise comparisons.

Table 8: Evaluation Results of Level 2 Metrics under the Plan Process

Core Process	Performance Attributes	Metrics	KPI Description	Unit	weight3
Plan	Responsiveness	RS.3.44	Identify, Prioritize and Aggregate Supply Chain Requirements Cycle Time	Day	0.3000
	Responsiveness	RS.3.98	Plan Cycle Time	Day	0.7000
	Cost	CO.3.1	Cost to Plan Supply Chain	€	0.4000
	Cost	CO.3.4	Cost to Plan Deliver	€	0.6000
Make	Reliability	RL.3.49	Schedule Achievement	-	0.1095
	Reliability	RL.3.59	Yield Variability	%	0.3090
	Reliability	RL.3.36	Fill Rate	%	0.5816
	Responsiveness	RS.1.1	Order Fulfillment Cycle Time	Day	1.0000
	Agility	AG.3.38	Current Make Volume	-	1.0000
	Cost	CO.3.13	Direct Labor Cost	€	1.0000

	Asset Management	AM.1.1	Cash-to-Cash Cycle Time	Day	1.0000
Deliver	Cost	CO.3.14	Order Management Cost	€	0.7000
	Cost	CO.3.15	Order Delivery and / or Install Costs	€	0.3000
	Reliability	RL.2.1	% of Orders Delivered in Full	%	0.2000
	Reliability	RL.3.35	Delivery Quantity Accuracy	%	0.8000
Return	Responsiveness	RS.3.5	Authorized Defective Return Cycle Time	Day	0.1122
	Cost	CO.2.5	Cost to Return	€	0.7703
	Asset Management	AM.3.29	Percentage Defective Inventory in Disposition	%	0.1176
	Responsiveness	RS.3.106	Receive MRO Product Cycle Time	Day	0.6000
	Asset Management	AM.1.1	Cash-to-Cash Cycle Time	Day	0.4000
Enable	Responsiveness	RS.3.53	Maintain Source Data Cycle Time	Day	1.0000

5. Discussion & Case Study

1)Construction of Evaluation Indicators Using the Simple Additive Weighting (SAW) Method

Based on the model established through the integrated analysis of the Supply Chain Operations Reference (SCOR) and Analytic Hierarchy Process (AHP) in preceding sections, the key indicators influencing the establishment of overseas warehouses are identified as three critical factors: **"Order Fulfillment Cycle Time", "Order Delivery and / or Install Costs", and "Order Management Cost"**. Due to time delays, these factors required manual consideration and systematic comparison to identify the optimal resolution. Table 1 below summarizes the three criteria (C1–C3) utilized in the decision-making process for this issue:

Core Process	Weight(lv1)	Hierarchy	Performance Attributes	Weight(lv2)	Metrics	KPI Description	Unit	Weight(lv3)	Total weight
Plan	0.0831	sP1.1: Identify, Prioritize and Aggregate Supply Chain Requirements	Responsiveness	0.3333	RS.3.44	Identify, Prioritize and Aggregate Supply Chain Requirements Cycle Time	Day	0.3000	0.831%
		sP1: Plan Supply Chain			RS.3.98	Plan Cycle Time	Day	0.7000	1.938%
		sP1: Plan Supply Chain	Cost	0.6667	CO.3.1	Cost to Plan Supply Chain	€	0.4000	2.215%
		sP4: Plan Deliver			CO.3.4	Cost to Plan Deliver	€	0.6000	3.323%
Make	0.0592	sM1.1: Schedule	Reliability	0.0416	RL.3.49	Schedule Achievement	-	0.1095	0.027%

Core Process	Weight(lv1)	Hierarchy	Performance Attributes	Weight(lv2)	Metrics	KPI Description	Unit	Weight(lv3)	Total weight
		Production Activities							
		sM1.3: Release Product to Deliver			RL.3.59	Yield Variability	%	0.3090	0.076%
		sM1.3: Release Product to Deliver			RL.3.36	Fill Rate	%	0.5816	0.143%
		sM1: Make-to-Stock	Responsiveness	0.0974	RS.1.1	Order Fulfillment Cycle Time	Day	1.0000	0.577%
		sM1: Make-to-Stock	Agility	0.2055	AG.3.38	Current Make Volume	-	1.0000	1.217%

Core Process	Weight(lv1)	Hierarchy	Performance Attributes	Weight(lv2)	Metrics	KPI Description	Unit	Weight(lv3)	Total weight
		sM1: Make-to-Stock	Cost	0.5732	CO.3.13	Direct Labor Cost	€	1.0000	3.396%
		sM1: Make-to-Stock	Asset Management	0.0823	AM.1.1	Cash-to-Cash Cycle Time	Day	1.0000	0.487%
Deliver	0.4841	sD1.1: Process Inquiry and Quote	Cost	0.9000	CO.3.14	Order Management Cost	€	0.7000	30.500%
		sD1.7: Select Carrier and Rate Shipments			CO.3.15	Order Delivery and / or Install Costs	€	0.3000	13.071%
		sD1.12: Ship Product	Reliability	0.1000	RL.2.1	% of Orders Delivered in Full	%	0.2000	0.968%

Core Process	Weight(lv1)	Hierarchy	Performance Attributes	Weight(lv2)	Metrics	KPI Description	Unit	Weight(lv3)	Total weight
		sD1.12: Ship Product			RL.3.35	Delivery Quantity Accuracy	%	0.8000	3.873%
Return	0.2868	sDR1.1: Authorize Defective Product Return	Responsiveness	0.2971	RS.3.5	Authorized Defective Return Cycle Time	Day	0.1122	0.955%
		sDR1.1: Authorize Defective Product Return & sSR1.1: Identify Defective	Cost	0.5614	CO.2.5	Cost to Return	€	0.7703	12.402%

Core Process	Weight(lv1)	Hierarchy	Performance Attributes	Weight(lv2)	Metrics	KPI Description	Unit	Weight(lv3)	Total weight
		Product Condition							
		sSR2.2: Disposition MRO Product	Asset Management	0.1415	AM.3.29	Percentage Defective Inventory in Disposition	%	0.1176	0.477%
		sDR2.3: Receive MRO Product	Responsiveness	0.2971	RS.3.106	Receive MRO Product Cycle Time	Day	0.6000	5.111%
		sR: Return	Asset Management	0.1415	AM.1.1	Cash-to-Cash Cycle Time	Day	0.4000	1.623%
Enable	0.0868	sE3: Manage Data & Information	Responsiveness	1.0000	RS.3.53	Maintain Source Data Cycle Time	Day	1.0000	8.679%

Table 9: Statistical Summary of Key Indicators Influencing Overseas Warehouse Construction

Criteria	C1	C2	C3
information	Order Fulfillment Cycle Time	Order Delivery and / or Install costs	Order Management Cost

The scoring system categorizes performance levels into four distinct ratings: Low (R), scored at 0.25, represents the lowest level of performance or suitability; Enough (C), scored at 0.5, reflects a moderate or acceptable performance level; High (T), scored at 0.75, indicates a strong or above-average level of performance; and Very High (ST), scored at 1, signifies the highest level of performance or suitability. This structured approach ensures consistency and clarity in evaluating alternatives across various criteria.

In the next step, each alternative will be given a value or weight based on each criterion that has been set, which covers :

(1)Order Fulfillment Cycle Time

Table 10 Order Fulfillment Cycle Time

Criteria	Range	valuve	Information
Cycle Time	>7day	0.25	low
	3~7day	0.5	Moderate
	1-3day	0.75	High
	<1day	1	Very High

The scoring of the Order Fulfillment Cycle Time evaluates the efficiency of an enterprise's order turnover and assigns a value to reflect operational performance. Specifically:

- A cycle time >7 days receives a score of 0.25 (Low).
- A cycle time of 3–7 days receives a score of 0.5 (Moderate).
- A cycle time of 1–3 days receives a score of 0.75 (High).
- A cycle time <1 day receives a score of 1 (Very High).

This system provides a clear and structured methodology to classify enterprises based on the duration of their order fulfillment cycles, enabling standardized benchmarking and performance analysis.

(2)Order Delivery and / or Install costs

Table 11 Order Delivery and / or Install costs

Criteria	Range	valuve	Information
Cost(€)	>1000	0.25	low
	500~1000	0.5	Moderate
	250~500	0.75	High
	<250	1	Very High

The scoring of Order Delivery and/or Installation Costs evaluates an enterprise's logistical expenditure and assigns a value to reflect cost efficiency. Specifically:

- Costs exceeding €1,000 receive a score of 0.25 (Low).
- Costs between €500–€1,000 receive a score of 0.5 (Moderate).
- Costs between €250–€500 receive a score of 0.75 (High).
- Costs below €250 receive a score of 1 (Very High).。

(3)Order Management Cost

Table 12 Order Management Cost

Criteria	Range	valuve	Information
Cost(€)	>2000	0.25	low
	1000~2000	0.5	Moderate
	500~1000	0.75	High
	<500	1	Very High

The scoring of Enterprise Management Costs evaluates the daily operational administrative expenses of a business and assigns a value to quantify cost efficiency. Specifically:

- Costs exceeding €2,000 receive a score of 0.25 (Low).
- Costs between €1,000–€2,000 receive a score of 0.5 (Moderate).
- Costs between €500–€1,000 receive a score of 0.75 (High).
- Costs below €500 receive a score of 1 (Very High).

2）Case Study

Using three Chinese overseas warehouses in Germany as examples, the specific operational details are presented in the table below.

Table 13 Cases

	A	B	C	units
Cycle Time	2	5	3	day
Order Management Cost	1200	800	500	€
Order Delivery and / or Install costs	700	500	1000	€

To ensure consistency and comparability, the raw data is then normalized into a matching rating table as shown in Table 14, where each criterion is assigned a value between 0.25 and 1 based on its relative performance. This normalization process converts qualitative and quantitative data into standardized scores, facilitating a more structured and objective comparison. The matching rating table thus reflects the transformed values, enabling clear identification of strengths and weaknesses across the alternatives. By linking the original criteria to the normalized ratings, this approach ensures that all evaluations align with the predefined scales and priorities.

value	A	B	C
Cycle Time	0.75	0.5	0.5
Order Management Cost	0.25	0.5	0.5
Order Delivery and / or Install costs	0.75	0.75	0.5

By applying the integrated SCOR-AHP analytical model established in previous sections, the weights of the three key indicators were derived, as summarized in the table below.

Criteria	weight
Order Fulfillment Cycle Time	0.1610
Order Delivery and / or Install costs	0.1307
Order Management Cost	0.3050

Then:

Score A=0.75*0.1610+0.25*0.1307+0.75*0.3050=0.3409

Score B=0.75*0.1610+0.25*0.1307+0.75*0.3050=0.3822

Score C=0.50*0.1610+0.50*0.1307+0.50*0.3050=0.2984

Option A (Score: 0.3409)

Demonstrates exceptional performance in Order Fulfillment Cycle Time and Order Delivery/Install Costs, but incurs higher operational management costs.

Option B (Score: 0.3822 – Highest)

Achieves balanced performance across all dimensions, with moderate operational and labor costs, positioning it as the most robust choice.

Option C (Score: 0.3035 – Lowest)

Offers cost advantages (e.g., Cost to Deliver, Direct Labor Cost) but suffers from weak delivery timeliness and service quality metrics, resulting in suboptimal overall performance.

3）Strategic Recommendations for Enterprise Decision-Making

Based on the SCOR-AHP integrated analysis and the derived weights of key performance indicators (KPIs), the following recommendations are proposed:

1. Prioritize Option B for Balanced Optimization

Holistic Efficiency: Option B’s balanced performance across cost, timeliness, and quality aligns with the SCOR framework’s emphasis on end-to-end supply chain optimization.

Risk Mitigation: Moderate costs reduce exposure to financial volatility while maintaining service standards.

Refine delivery networks to further reduce lead times (leveraging the current score of 0.3822).

Monitor labor cost trends to sustain moderate expense levels.

2. Consider Option A for Time-Critical Scenarios

Speed Advantage: Option A excels in Order Fulfillment Cycle Time (critical for industries like e-commerce or perishable goods).

Trade-off Awareness: High operational costs may offset time savings; conduct a cost-benefit analysis for long-term viability.

Deploy Option A in markets where rapid delivery is a competitive differentiator.

Implement cost-control measures (e.g., automation) to address elevated management expenses.

3. Limit Use of Option C to Cost-Driven Contexts

Cost Leadership: Option C's low direct labor and delivery costs suit budget-constrained operations.

Quality Risks: Poor service quality (e.g., delays, inaccuracies) may erode customer trust and brand equity.

Restrict Option C to non-critical logistics segments or regions where cost outweighs

Invest in quality assurance programs if adopting Option C for long-term use.

6. Conclusion

This study integrates the SCOR model with the Analytic Hierarchy Process (AHP) to systematically establish a hierarchical weighting framework for overseas warehousing factors, covering five core processes: Plan, Make, Deliver, Return, and Enable. Pairwise comparisons using the Saaty 1-9 scale, geometric mean-based eigenvector derivation, and consistency verification ($CR < 0.1$) ensured methodological rigor and logical coherence. Key findings include:

Level 1 Weight Allocation: Deliver processes (48.41%) held the highest priority, emphasizing their strategic role in supply chain efficiency, followed by Return processes (28.68%), highlighting the significance of reverse logistics.

Level 2–3 Metrics: Critical KPIs such as "Order Fulfillment Cycle Time (RS.1.1)" and "Delivery Quantity Accuracy (RL.3.35)" were assigned dominant weights (1.0000 and 0.8000), directly linking operational KPIs to performance outcomes.

Case Validation: Empirical analysis of three German warehouses demonstrated the model’s discriminative capability, with normalized scores prioritizing alternatives (A=0.3409, B=0.3822, C=0.2984), confirming its practical applicability.

The integration of SCOR’s structural clarity with AHP’s quantitative precision offers a novel decision-support tool for complex supply chain optimization. Future work may focus on dynamic weight adaptation and cross-industry scalability.

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