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Research on Digital-Intelligent Transformation Scheme of State-owned Enterprises' Logistics and Warehousing Resources for Dual Routine-Emergency Use in Response to Major Emergencies in the Capital — A Case Study of a Logistics Enterprise in Beijing

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Abstract

Against the strategic backdrop of building resilient cities and modernizing emergency management, the digital and intelligent transformation of logistics and warehousing resources of state-owned enterprises for dual-use in routine and emergency scenarios has become a key approach to enhancing the safety resilience and emergency material support capacity of megacities. Taking a logistics company in Beijing, a state-owned enterprise affiliated with Beijing Municipality, as a typical case, this paper systematically explores the digital and intelligent transformation scheme for logistics and warehousing resources of state-owned enterprises targeting major emergencies in the capital, following the logical thread of policy response - current situation assessment - demand mapping - digital and intelligent integration - supporting adaptation.Through field investigations and in-depth interviews, this study comprehensively identifies the current status of the enterprise's warehousing resources and the deficiencies in its routine-emergency conversion capacity. It establishes a scenario spectrum of major emergencies in the capital to accurately map the conversion demands for logistics and warehousing resources under emergency conditions. On this basis, a three-in-one digital and intelligent transformation scheme covering hardware transformation, software upgrading and intelligent support is formulated, and a three-phase implementation path of near-term breakthrough, medium-term development and long-term collaboration is planned.Furthermore, this research builds a support system from four dimensions: organization, capital, technology and institution. It aims to form a replicable and promotable model for the digital transformation of state-owned logistics enterprises featuring dual-use in routine and emergency scenarios, and deliver policy-compliant and practical solutions to improve the resilience of emergency logistics in megacities.

Keywords: Dual-use for Routine and Emergency; Major Emergencies; Logistics and Warehousing Resources

1. Introduction

Against the backdrop of further advancing the strategies for building resilient cities and modernizing emergency management, the capability of logistics and warehousing resources to serve both routine and emergency scenarios has become a key issue for enhancing the safety resilience of megacities and scaling up the support capacity for emergency supplies. In 2025, the Opinions on Promoting High-Quality Urban Development issued by the Central Committee of the Communist Party of China and the State Council explicitly called for establishing a resilience framework featuring dual-use for routine and emergency purposes. It required transforming urban logistics and warehousing resources and conducting comprehensive upgrading via digital and intelligent technologies. The Implementation Plan for the Construction of Suburban Large Warehouse Bases released by the National Development and Reform Commission further emphasized that leveraging digital and intelligent technologies to enable warehousing resources to flexibly shift from distributing daily urban supplies in peacetime to operating as transit and dispatching stations for emergency supplies in emergencies is an inevitable path for the high-quality development of the emergency logistics system.

As the main force for guaranteeing emergency supplies, state-owned logistics enterprises face prominent structural dilemmas in the routine-emergency conversion of their warehousing resources. The layout of warehouses fails to meet emergency coverage requirements. There is no institutional interface between customer-oriented workflows for daily operations and directive execution mechanisms for emergency responses. Designed primarily for commercial operations, existing information systems cannot keep pace with the demand for real-time collaborative scheduling of multi-source data in emergency scenarios. Cross-departmental coordination relies on ad-hoc organizations, resulting in slow conversion responses and poor information connectivity. How to break down information barriers with digital and intelligent technologies, restructure warehousing spaces and operational workflows, and realize flexible switching between routine and emergency modes has become an urgent practical challenge for state-owned logistics enterprises to address.

Digital and intelligent technologies, including IoT perception, big data analysis and artificial intelligence-based decision-making, create new possibilities for the routine-emergency conversion of logistics and warehousing resources. Existing studies have yielded valuable outcomes on resilient cities, emergency material reserves and digital warehouse management. Nevertheless, most of these studies focus on general public facilities or individual warehousing nodes. There is a lack of systematic research on the routine-emergency conversion of state-owned logistics enterprises across the entire network, full workflows and diverse business formats. In particular, insufficient attention has been paid to the collaborative design of conversion trigger mechanisms, digital and intelligent integration schemes and institutional guarantee systems. Against this background, this study takes a logistics company in Beijing, a state-owned enterprise under the jurisdiction of Beijing Municipality, as a typical case to explore the digital and intelligent conversion scheme for the

dual-use of logistics and warehousing resources of state-owned enterprises in response to major emergencies in the capital.

This research boasts important theoretical and practical significance. Theoretically, based on field investigations of a logistics company in Beijing, this study systematically identifies the weaknesses in routine-emergency conversion capabilities from four dimensions: the spatial distribution of the enterprise's warehousing resources, business workflows, information systems and organizational coordination. It constructs a scenario spectrum of major emergencies in the capital to accurately map the conversion demands of logistics and warehousing resources under emergency conditions. A three-in-one digital and intelligent conversion framework consisting of hardware transformation, software upgrading and intelligent support is proposed, which enriches the theoretical understanding of the application of resilience theories and the dual-use concept in logistics operations. In view of the enterprise's characteristics of sound infrastructure yet inadequate conversion standards, and partial advantages in informatization alongside widespread data silos, this paper formulates a three-phase implementation path: near-term breakthrough, medium-term development and long-term collaboration. It provides a systematic theoretical solution to the problems of insufficient motivation and unclear paths for the routine-emergency conversion of state-owned logistics enterprises. Practically, by sorting out the technical requirements for routine-emergency conversion and exploring approaches to facilitate information sharing of warehousing resources and cross-departmental coordination, this research directly helps a logistics company in Beijing improve its emergency response efficiency and resource scheduling capacity. The implementation of digital and intelligent renovation schemes strengthens the emergency material support resilience of the capital in response to major emergencies. Moreover, it forms a replicable and promotable model for the digital and intelligent transformation of state-owned logistics and warehousing resources with dual-use functions, offering a systematic implementation roadmap and demonstration experience for similar enterprises in megacities to achieve green, resilient and intelligent transformation covering status assessment and scheme integration.

This study aims to identify the deficiencies in the routine-emergency conversion capabilities of a logistics company in Beijing' warehousing resources. It integrates the three-in-one technical solution driven by digital and intelligent technologies, namely hardware transformation, software upgrading and intelligent support, and builds a dual-use conversion system covering elastic facility reconstruction, standard workflow development, data middle platform integration and coordinated institutional guarantees. A three-phase implementation path of foundation consolidation, key breakthroughs and system integration is also planned. Following the logical thread of policy response, current situation assessment, demand mapping, digital and intelligent integration and supporting adaptation, this paper strives to deliver a set of replicable and promotable systematic digital and intelligent conversion solutions for routine-emergency dual-use to a logistics company in Beijing and similar state-owned logistics enterprises across China.

1.1. Research Status of Dual-Use Infrastructure for Daily and Emergency Scenarios amid Major Emergencies

Regarding the research on the dual-use of infrastructure for both peacetime and emergency situations in major emergencies, with the continuous promotion of national policies, it has developed rapidly in recent years and has become an important direction in the field of resilient city research. Li et al. (2025) proposed the integration of the concept of dual-use for peacetime and emergency functions into territorial spatial planning based on the resilient city theoretical framework.They explored how to leverage existing public infrastructure in enhancing urban resilience, providing planning strategies to support the construction of resilient territorial space. Zhai et al. (2024) systematically analyzed the "dual-use" public infrastructure system and its mechanism construction, pointing out that building this system is an important way to improve urban and rural capabilities in pre-disaster prevention, disaster relief, and post-disaster recovery, and is a key aspect of improving the construction of urban and rural emergency management systems. Zhai (2025) focused on construction standards, reviewed the conceptual connotation and policy evolution of the "dual-use" public infrastructure, analyzed significant differences in construction goals, functional positioning, and management models across regions, and proposed policy suggestions such as constructing a hierarchical and classified standard system and improving collaborative governance mechanisms. In terms of rapid switching of facility functions, relevant scholars haveprovided practical references for the dual-use transformation of public facilities by analyzing cases of large-scale public facility renovation, proposing specific paths for rapid switching of emergency functions and intelligent system-based rapid function conversion schemes.

1.2. Research Status of Routine-Emergency Dual-Use Conversion of Logistics and Warehousing Resources

The dual-use conversion of logistics warehousing resources is an important application direction of the dual-use concept in the logistics field. According to the "Implementation Plan for the Construction of Suburban Large Warehouse Bases" issued by the National Development and Reform Commission (2024), suburban large warehouse bases are large-scale "dual-use" public logistics infrastructure located outside urban areas, integrating functions such as warehousing, sorting, processing, packaging, and distribution. They serve as transit and distribution centers for urban living supplies during "normal times" and can be quickly converted into emergency and living supplies transit and distribution stations, connection points, or sorting venues during "emergencies". They are important organizational platforms for enhancing the "dual-use conversion" capability of urban logistics systems. Li (2025) proposed that the "dual-use" model of suburban large warehouses is a key link connecting normal management and emergency response, and has important value in enhancing national emergency response capabilities, safeguarding strategic material reserves, and promoting military-civilian integration. Fang et al. (2025) analyzed the joint reserve issues between government and enterprises under the dual-use conversion model based on evolutionary game theory, providing a theoretical basis for designing a reasonable collaborative mechanism between government and enterprises. In terms of digital warehouse management, some scholars have designed an integrated mechanism for digital reserve

management of emergency supplies using the Analytic Hierarchy Process (AHP), proposing the application of technologies such as RFID, WMS, and EPC in the integrated warehouse management for both normal and emergency situations. In terms of standard system construction, relevant research has proposed the establishment of a unified "dual-use conversion" technical standard system, the development of dual-mode switching performance indicators for intelligent equipment, and the development of interconnection and interoperability standards for key equipment, providing technical support for the standardized development of dual-use warehousing and logistics.

1.3. Research status of digital and intelligent transformation of emergency logistics system

In terms of the digital and intelligent transformation of emergency logistics, Wei and Wang (2025) explored how artificial intelligence (AI) drives the paradigm shift of emergency logistics from "passive response" to "active resilience". They constructed a theoretical framework centered around digital twins and proposed a strategic path to strengthen the digital foundation, enhance core capabilities, and improve the governance environment. The Publicity and Education Center of the National Food and Material Reserve Administration (2025) analyzed how AI empowers facility location, material allocation, route planning, and real-time monitoring, driving the transition of emergency logistics from empirical decision-making to a fully controllable intelligent model. This provides a technical direction for addressing disaster relief challenges. The "dual-purpose for both emergency and regular use" warehousing and logistics model, driven by technological innovation, utilizes intelligent management platforms, Internet of Things (IoT) technology, and big data analysis to achieve dynamic allocation and efficient utilization of logistics resources, establishing amodern logistics network with extensive coverage and multifunctional capabilities. With the deep application of AI and IoT technology, the modern emergency logistics system is accelerating its transformation from being driven by human experience to being driven by data intelligence.

2. Policy Response

2.1. Routine-Emergency Dual-Use

This paper defines the "routine-emergency dual-use" concept as follows: targeted at major emergencies, digital and intelligent technologies are leveraged to realize flexible reconstruction of warehouse space, operational procedures and decision-making systems, so as to achieve efficient and reliable transformation from daily routine mode to emergency response mode. This definition breaks through the limitations of static facility renovation and highlights the adaptability and resilience of the system amid uncertain environments. Its core lies in the integrated coordination of physical resources, soft procedures and intelligent decision-making, laying a theoretical foundation for constructing a digital-intelligent transformation scheme for state-owned enterprise logistics in subsequent chapters.

2.2. Major Emergencies

"Major emergencies" refer to natural disasters, industrial accidents, public health incidents and other events that pose severe threats to the safe operation of the capital city, featuring sudden onset and high destructiveness. The core challenge lies in the extreme demands on resource response speed and systemic resilience brought by the high uncertainty of such incidents. As a megacity, the capital is confronted with complex characteristics in major emergencies, including overlapping disaster types, high-density population exposure and cross-regional chain reactions. Accordingly, logistics and warehousing resources must possess the capacity to rapidly switch between routine and emergency states. Clarifying the connotation and evolution rules of major emergencies serves as a prerequisite for designing routine-emergency transformation schemes.

2.3. Digital-Intelligent Transformation

This paper defines "digital-intelligent transformation" as an intelligent decision-making and collaborative execution mechanism that enables warehouse resources to rapidly shift from routine to emergency states for major emergency scenarios, relying on the Internet of Things, big data, artificial intelligence and other technologies. It emphasizes real-time data collection, flexible resource allocation and automated transformation processes. The mechanism aims to address the problem of information lag in emergency response within traditional logistics systems, and provide technical logic support for the integrated framework of physical resources, soft procedures and intelligent decision-making.

3. Current Situation Analysis

Based on the systematic diagnosis of the current status of warehousing resources and the shortcomings in the ability to switch between normal and emergency operations, the SWOT analysis framework is applied to comprehensively assess the internal and external conditions for the digital and intelligent transformation of a logistics company in Beijing' normal and emergency operations. The SWOT analysis is illustrated in Figure 1.

Dimension	Strengths (S)	Weaknesses (W)	Opportunities (O)	Challenges (T)
Physical Space	Rich land; SE-concentrated warehouses rail and intermodal potential Jingnan reserve upgraded	No emergency zones in old parks; northwest mountain coverage gaps	Add west and north forward depots; policy support	Slow response in edges; freight and environment rules limit new depots; mountain storms expose long haul; no standard switch interface
Business Processes	Proven in Beijing flood control; supports Central Military Commission	Long emergency chain; switch relies on ad-hoc teams	Use national "dual-use" policy; build institutional switch	Rising speed demand; current processes fail
Information Systems	Digital dispatch platform; smart dock and warehouse at Jingchangda	Uneven digitalization; info congestion in surges; weak WMS and TMS link	Build collaboration middle platform; unify data standards; optimize algorithms; add WMS visualization	High upgrade cost; data security pressure; poor digital base; no government enterprise data link; low stability
Organizational Collaboration	Skilled in outsized cargo; ad-hoc command; works with municipal departments	No permanent structure; lack cross-trained managers; personal ties over systems; low institutionalization	Set standing emergency department; run drills on WMS and TMS; co-build data platform	Few peacetime-emergency drills; no digital government enterprise link; drill-reality gap

Four-Dimensional SWOT Analysis of a logistics company in Beijing Normal-to-Emergency Conversion Capability

Figure1. A logistics company in Beijing SWOT Analysis Diagram for Normal-Emergency Conversion Capability

3.1 A logistics company in Beijing Warehousing Facility Resource Inventory

A logistics company in Beijing Group is a wholly-owned subsidiary of a logistics company in Beijing Assets. As of the end of 2025, it has 31 operational land parcels covering approximately 2.43 million square meters, with a warehouse area of over 300,000 square meters and more than 300 transportation vehicles. The core parks in Beijing include Tongzhou Majuqiao Park, Daxing Jingnan Changda Logistics Park, Chaoyang Santai Mountain Park, Fangshan Sanchang, and the "A logistics company in Beijing Baicanghui" at East 4th Ring Road. All are self-owned properties. According to the plan, the Jingnan Reserve Warehouse will assume the municipal disaster relief material reserve function from 2026. Currently, the renovation has been initiated to further strengthen the strategic positioning of the warehousing facilities in the emergency response field.

3.2. Current Status of Key Facilities and Equipment

The company possesses over 300 transportation vehicles, equipped with forklifts, cranes, and other loading and unloading equipment, capable of meeting large-scale emergency transportation needs. The Jingnan Changda Park has established smart security systems, smart platforms, and a 2500-square-meter intelligent automated three-dimensional warehouse, with plans to advance the unmanned warehouse project by 2025. In terms of information systems, the "A logistics company in Beijing Zhiyun" online freight platform has achieved digital transportation scheduling and introduced the Yituo Cloud Warehouse WMS system to realize visual warehouse management. Research has found that the informatization levels of various parks vary, with traditional parks lagging in digital coverage and insufficient data linkage between WMS and TMS systems, which may become a constraint on the e ffi ciency of transitioning from peacetime to emergency operations.

3.3. Analysis of GIS Location Radiation and Service Coverage Scope

The warehousing network exhibits a characteristic of "concentration in the southeast and scattered distribution across multiple points." The Majuqiao Park is adjacent to the Beijing-Tianjin-Tanggu Expressway, radiating to the eastern part of the Beijing-Tianjin-Hebei region. The Jingnan- Changda Park is located 19 kilometers away from the new airport and possesses a dedicated railway line, enabling combined transportation via road, rail, and air. The Santai Mountain Park serves the southern urban area.The "A logistics company in Beijing Baicanghui" responds to the central urban area. The Fangshan Three Fields radiate towards the southwest. However, the warehousing nodes in the west- ern mountainous areas and the northern ecological conservation zones are weak. During the severe rainstorm in Fangshan in 2023, materials had to be transported long distances from the southeastern park, revealing the issue of long emergency response times in the edge areas under a single-center radial road network.

3.4. Comprehensive Process Analysis and Efficiency Node Identification for "Regular" Business

"Regular" business encompasses trunk transportation, warehouse management, urban distribution, and integrated logistics, with clients including China Post, Canon, Beijing International Resort, etc. The WMS system supports warehousing, storage, picking, delivery, and processing, while the TMS system, integrated with the "A logistics company in Beijing Zhiyun" platform,

facilitates digitalized transportation scheduling. Smart parks such as Jingnan Changda exhibit high efficiency, yet traditional parks like Santai Mountain have low levels of informatization; there is insufficient data linkage between WMS and TMS, resulting in different business needs of the same client being managed by different sys- tems. These efficiency bottlenecks will be magnified in "emergency" response scenarios, becoming a key constraint in the transition from regular to emergency operations.

3.5. Analysis of Process Breakpoints and Delay Mechanisms in Emergency Response

The company undertakes functions such as the 5th Strategic Delivery Brigade of the Central Military Commission and the Beijing Flood Control and Emergency Support Brigade. It has efficiently completed tasks including the expansion of Xiaotangshan Hospital, the removal of the Winter Olympic "Ice Waterfall" installation, and flood control work in Fangshan District. However, process breakpoints exist in practical operations. Emergency orders require multi-level approval, reducing the efficiency of information confirmation and decision linkage. There is a lack of data connection between daily warehousing and emergency material systems. Cross-departmental collaboration relies on temporary organizations, which led to separated transportation and warehousing space during the ventilator delivery mission in 2023. The information system lacks sufficient concurrent processing capacity under emergency scenarios, easily causing congestion of information flow.

4. Demand Mapping

To effectively resolve conflicts and realize rapid response, a trigger mechanism for the transition from routine to emergency modes should be designed based on conflict analysis. The mechanism covers three parts: trigger conditions formulated according to officially released emergency response levels and material scheduling orders; an authorization system that clarifies decision-making authority and procedures within the enterprise as well as in government-enterprise coordination; activation signals released in the form of preset alarms via the routine-emergency dual-use data middle platform to guarantee fast response. This trigger mechanism is the key to realizing rapid and orderly conversion of warehousing resources and advancing the routine-emergency dual-use transformation of urban warehousing resources in the capital city (see Figure 2).

4.1. Construction of Scenario Spectrum for Major Emergencies in the Capital

This study categorizes major emergencies in the capital that demand large-scale logistics support into four main types: major event support, public health incidents, natural disasters, and industrial accidents. The construction of this scenario spectrum aims to provide typical scenarios for demand analysis on the routine-emergency conversion of warehousing resources. On this basis, typical scenarios are selected for in-depth deconstruction. For instance, the scenario of "transshipment of relief supplies for regional flood disasters" features sudden outbreak, wide impact coverage, and urgent demand for emergency materials, which can reflect core challenges faced by logistics and warehousing systems under emergency conditions, including resource scheduling and supply speed. The in-depth deconstruction of this scenario helps identify special requirements for logistics and

warehousing nodes throughout the whole process from government order issuance to task completion.

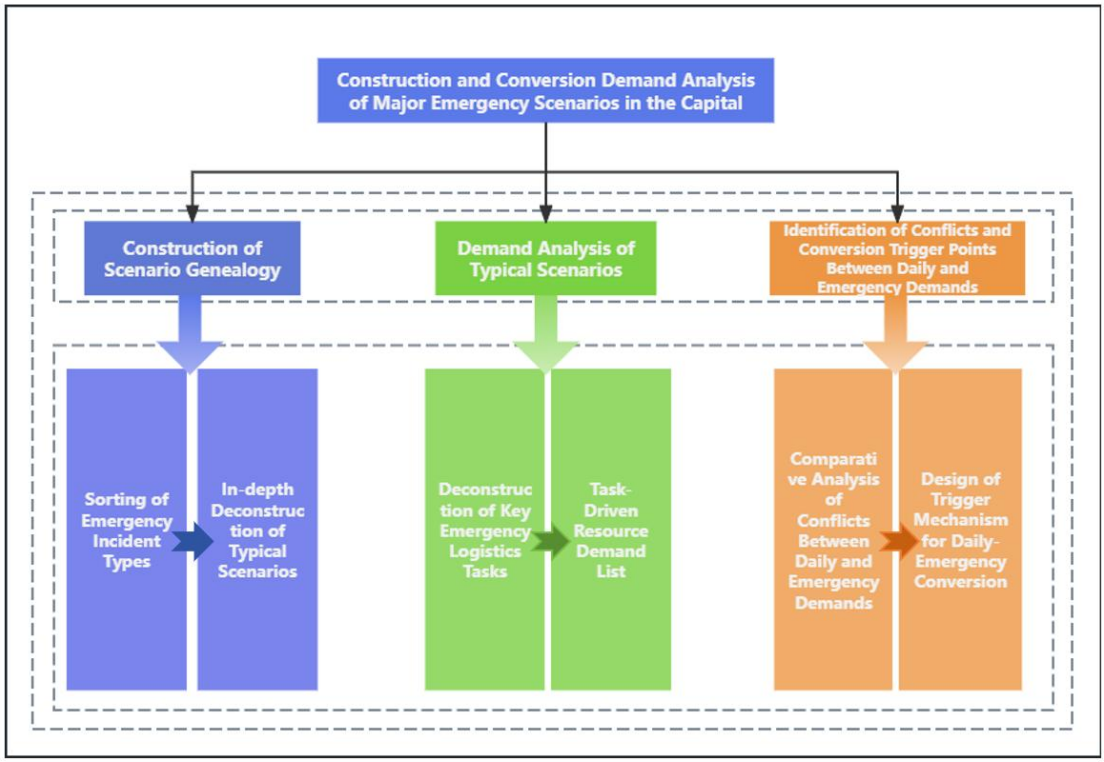

Figure 2. Demand Analysis Diagram for Scenario Construction and Transition of Major Emergencies in the Capital

4.2. Demand Analysis of Logistics and Warehousing Resources Under Typical Scenarios

For typical scenarios such as regional flood disasters, key emergency logistics tasks are first deconstructed, including receiving and inspection of emergency supplies, classified temporary warehousing, sorting in accordance with rescue orders, and distribution to disaster-stricken areas. This process highlights differences in operational procedures and reliability between emergency operations and daily routine operations. Based on task deconstruction, resource demands fall into four dimensions. In terms of space, temporary unloading zones, classified storage zones, sorting zones and pending delivery zones need to be planned. For equipment, high-efficiency loading and unloading machines, rapid information collection tools such as barcode scanners, and automatic or semi-automatic sorting systems should be equipped. In terms of human resources, command staff familiar with emergency procedures, skilled operators and 24-hour shift teams are required. The information system needs real-time linkage with the municipal emergency command platform, material suppliers and transport fleets.

4.3. Identification of Routine-Emergency Demand Conflicts and Transition Trigger Points

Comparative analysis of resource demands under daily routine operations and emergency scenarios is conducted to identify specific routine-emergency demand conflicts. The main conflicts lie in three aspects. First, physical constraints: fixed rack layouts designed for regular logistics may block mass storage and circulation channels of emergency supplies. Second, time cost: the time consumed to restructure warehouse functional areas and adjust operational procedures after

receiving emergency orders may delay rescue work. Third, business interruption: emergency tasks occupying warehousing space and manpower may lead to breach of existing contracts and subsequent economic losses.

5. Digital-Intelligent Integration

Based on the diagnosis of the current routine-emergency conversion capacity of a logistics company in Beijing and analysis of digital-intelligent enabling technical schemes, combined with in-depth interviews with officials from the Municipal Emergency Management Bureau, management staff of a logistics company in Beijing and logistics industry experts, this study proposes a three-in-one digital-intelligent dual-use conversion model for warehousing resources of state-owned logistics enterprises, namely "physical transformation - process upgrading - intelligent support". The technical roadmap is shown in Figure 3.

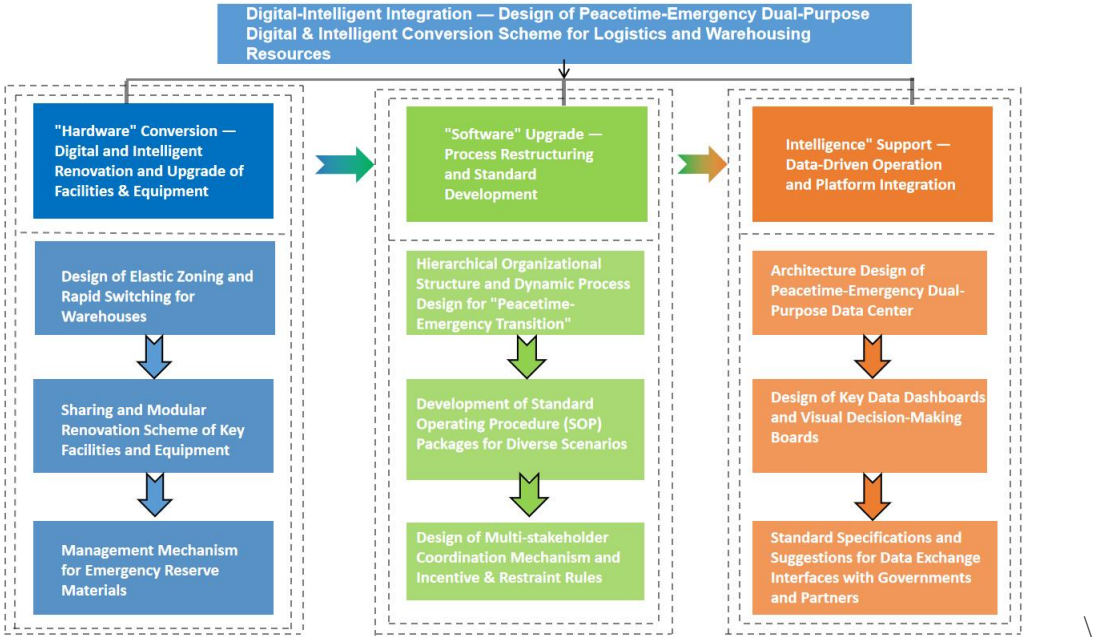

Figure 3. Design Diagram for the Digital and Intelligent Transformation Scheme of Logistics Warehousing Resources for Both Normal and Emergency Situations

5.1. "Hard" Transformation - Digital and Intelligent Upgrading of Facilities and Equipment

The "hard" transformation aims to address the spatial conflicts and functional rigidities of physical resources under both normal and emergency conditions. It focuses on the elastic reconstruction of warehouse space, modularization of key equipment, and dynamic management of emergency sup- plies. Spatially, the warehouse is divided into "core operation area", "flexible expansion area", and "emergency dedicated area". During emergencies, 30%-50% of the net area can be released within 4-6 hours through inventory contraction and stock transfer strategies, allowing for the centralized stacking of emergency supplies. In terms of equipment, a shared pool management system is es- tablished, which facilitates "service during normal times, emergency response during

emergencies". Modularization is implemented for general equipment such as pallets, enabling rapid functional conversion. In terms of material management, the WMS system is used to set expiration alerts, and through the "first-in, first-out" principle and market coordination mechanisms, near-expiration emergency supplies are automatically rotated, reducing holding costs and overdue risks.

5.2. "Soft" Upgrade: Process Restructuring and Standard Formulation

The "soft" upgrade focuses on breaking organizational inertia and addressing insufficient organizational flexibility through process standardization and institutionalization. Structurally, an emergency command center embedded in the existing organization is automatically activated according to emergency levels to enable cross-departmental resource allocation. In terms of workflows, standardized operating procedures are developed for core tasks including material receiving, priority sorting, loading and delivery. These procedures are encapsulated into digital task cards that can be sent to handheld terminals with one click according to scenarios, shifting operations from experience-driven to process-driven modes. For collaboration, the interfacing roles of governments, enterprises and social forces within the emergency logistics system are clarified. A coordination mechanism based on blockchain or rights-obligation-interest contracts is established to facilitate the rapid formation of effective cooperation networks.

5.3. "Intelligent" Support: Data-Driven Operation and Platform Integration

The "intelligent" support module realizes perception, prediction and decision support for routine and emergency states via data fusion and intelligent algorithms. First, a routine-emergency dual-use data middle platform is built to open cross-departmental emergency data channels covering medical care, supplies, transportation and logistics, eliminating information silos. Dynamic resource optimization algorithms and collaborative decision-making engines are deployed on this platform. Second, key data dashboards and visual decision boards are designed to dynamically display the conversion readiness of each warehouse, distribution of emergency materials and transportation trajectories. They provide full situational awareness for managers at strategic, operational and tactical levels, supporting data-driven precise scheduling and resource deployment.

6. Path Planning

To facilitate the implementation and deployment of the digital-intelligent dual-use conversion scheme for a logistics company in Beijing' warehousing resources, this paper sorts out and analyzes relevant implementation arrangements. The strategic construction roadmap for the routine-emergency digital-intelligent transformation of a logistics company in Beijing is divided into three phases: foundation consolidation, key breakthrough, and system integration. It provides a systematic practical guideline for the dual-use digital transformation of warehousing resources of state-owned logistics enterprises (see Figure 4).

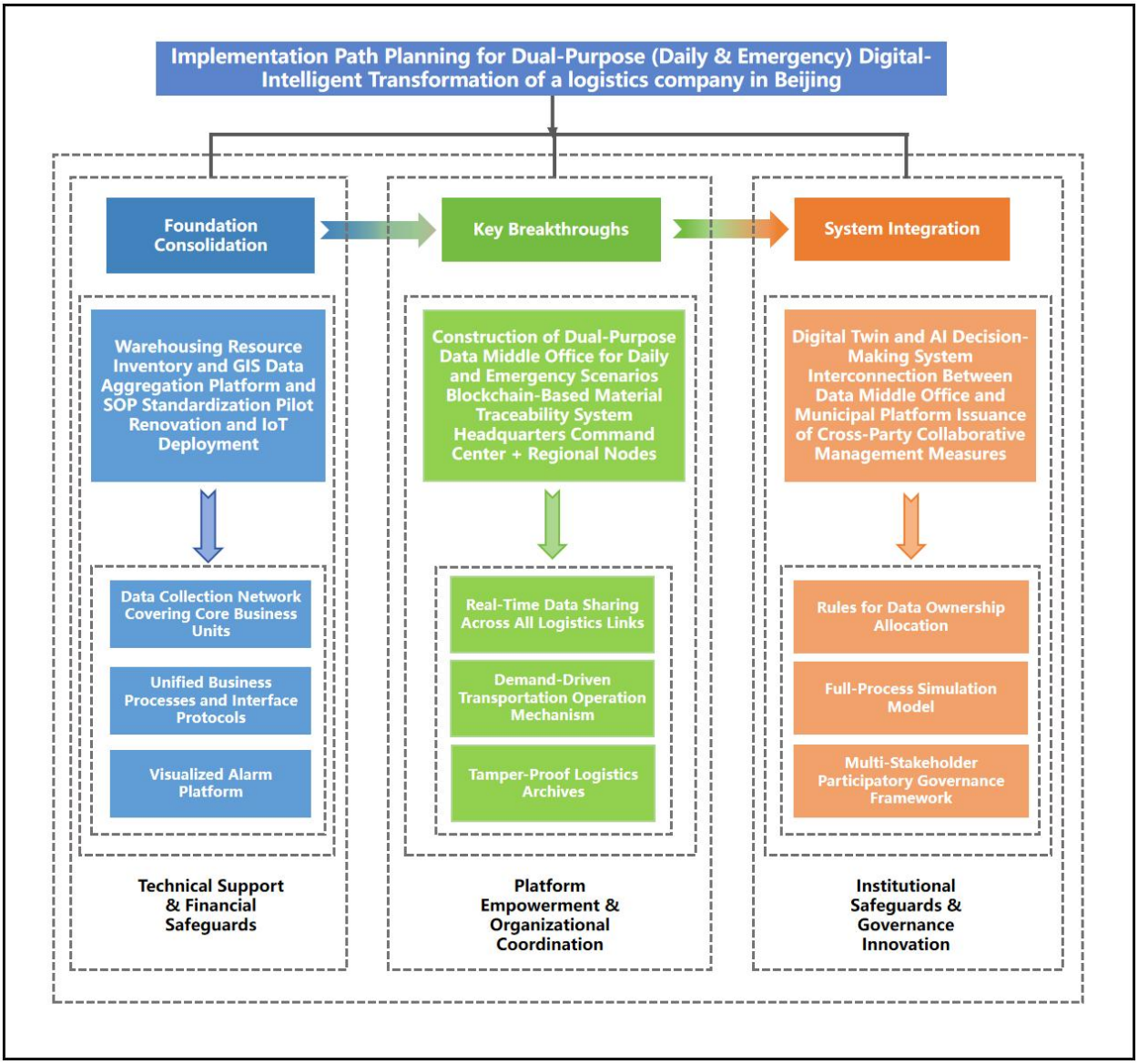

Figure 4 Technical Roadmap for the Implementation Path of Routine-Emergency Dual-Use Digital-Intelligent Transformation of a logistics company in Beijing' Warehousing Resources

6.1. Foundation Consolidation Stage

This stage focuses on completing the organizational preparation, facility assessment, standard setting, and pilot verification for the transition from routine to emergency operations. Addressing the management shortcomings of various storage points within a logistics company in Beijing' warehousing resources, a systematic inventory of the warehousing resources is conducted. A "Warehousing Re-source Inventory Database" encompassing dimensions such as geographical location and facilities is established, and a GIS location analysis is simultaneously completed to form a data collection network covering core warehousing units. Efforts are made to advance the standardization of the transition from routine to emergency operations, unify operational processes and data interface pro- tocols, and initially establish a warehousing resource data aggregation platform to achieve centralized storage and visual display of basic information for each warehouse. For typical scenarios of major emergencies in the capital, a standardized operational process package covering the entire process from "receipt—storage—sorting—dispatch" is developed. 1-2

warehouses with mature conditions are selected as the first batch of pilot projects, implementing flexible functional area renovations and deploying IoT sensing equipment. A special working group for the dual-purpose digital and intelligent transformation is established, formulating transformation management methods to pro-vide reliable data and experience support for subsequent organizational collaboration and intelligent decision-making.

6.2. Key Breakthrough Stage

This stage focuses on building a collaborative operation mechanism that spans departments and links. Relying on the previously established digita facility network and pilot experience, a "dual-purpose data hub for both routine and emergency use" is established, enabling real-time data sharing and interconnectivity between warehouse management systems (WMS), enterprise resource planning (ERP), and transportation management systems (TMS). Efforts are made to establish an emergency response organization system consisting of a "headquarters command center+regional response nodes", piloting an emergency material reserve and dispatch model based on demand forecasting, achieving collaborative dispatch driven by "demand and data".A blockchain-based emergency material traceability system is established, with key node information such as material procurement, warehousing, storage, ex-warehouse, and transportation being stored on the blockchain as evidence, forming an immutable quality archive. Key data dashboards and visual boards are developed to enable real-time monitoring of core information such as emergency conversion status and emergency material inventory distribution across warehouses. Differentiated standard operating procedure (SOP) packages are developed for four major types of emergency scenarios, and a regular drill mechanism is established at least once every quarter, upgrading from compartmentalization to strategic collaboration, laying the groundwork for subsequent full-chain integration.

6.3. System Integration Stage

This stage focuses on solidifying coordination mechanisms and perfecting the governance system to build a sustainably operated digital ecosystem for routine-emergency conversion. In terms of institutions, the Administrative Measures for the Coordinated Routine-Emergency Conversion of a logistics company in Beijing ' Warehousing Resources will be formulated and issued,clarifying trigger conditions, decision-making authority and assessment requirements for conversion, as well as establishing incentive and restriction mechanisms for cross-departmental data sharing.Technically, cutting-edge technologies such as digital twins and artificial intelligence will be further deployed to construct an intelligent decision support system for routine-emergency conversion. The system can automatically assess emergency material demand, dynamically optimize delivery routes and generate automated process improvement suggestions, realizing the shift from experience-based decision-making to intelligent decision-making.From the governance perspective, full interconnection will be achieved between the data middle platform and Beijing Municipal Emergency Materials Management Platform. A collaborative emergency logistics ecosystem featuring government leadership,state-owned enterprise backbone and public participation will be established.Construction experience will be systematically summarized into standardized deliverables, which will be used to participate in the formulation of relevant national and municipal standards. This marks an upgrade from technological empowerment to institutional

guarantee, forming a replicable and scalable digital-intelligent dual-use transformation paradigm for state-owned logistics enterprises.

7. Conclusions and Recommendations

7.1. Main Conclusions

National and municipal policies regarding resilient city construction and routine-emergency dual-use provide clear guidance and institutional support for the digital-intelligent transformation of warehousing resources of state-owned logistics enterprises. Although a logistics company in Beijing boasts large-scale facilities and rich experience in supporting major events, it suffers from prominent drawbacks: solid foundations paired with slow conversion, abundant experience lacking unified standards, and scattered data without integrated interfaces. Its facilities are poorly adapted to emergency scenarios, no standardized switching workflows are available, and information systems remain isolated.Core conflicts including physical space constraints, time cost loss and business interruption risks are identified under typical scenarios such as major events, public health incidents and natural disasters, and clear decision trigger signals for routine-emergency conversion are defined.This study proposes a three-dimensional framework of "physical transformation – soft process upgrading – intelligent support", forming a complete conversion chain covering flexible space reconstruction, standardized workflow formulation and integrated data middle platform. The supporting three-stage implementation roadmap of "pilot demonstration - standard promotion - city-wide replication", alongside a four-dimensional guarantee system covering organization, capital, technology and institutions, delivers a replicable reference paradigm for other state-owned logistics enterprises pursuing routine-emergency digital transformation.

7.2. Research Recommendations

This research adopts a single-case exploratory design, and the effectiveness of partial schemes is only theoretically estimated, requiring long-term empirical tracking and verification. Institutional issues including data right confirmation, cross-stakeholder trust and benefit compensation are not thoroughly discussed.Future research can apply this framework to various state-owned enterprises and cities to improve external validity through cross-case comparison. In-depth research on technology-institution coordination can be carried out to explore mechanisms for data ownership confirmation, smart contracts and cost sharing during routine-emergency conversion. Further attention should be paid to the impact of digital transformation on the public welfare nature of state-owned enterprises, so as to organically balance operational efficiency improvement and emergency support capacity.

Author Contributions:

Xueqing Wang: Proposed the research idea; designed the overall research framework and survey scheme; led the diagnostic analysis of the current situation and bottleneck identification; constructed the “four-chain integration”green reconstruction model; drafted the initial manuscript; reviewed and edited the manuscript; supervised the research process; responsible for project

management. Jingxuan Zhang: Participated in survey design and implementation; took charge of questionnaire distribution, collection, and data collation; conducted reliability and validity analysis (SPSS) and cross-validation with interview records; contributed to the design of technical integration schemes; created charts and diagrams; participated in model construction. Yupeng Shao: Conducted literature review; participated in technical demand surveys; designed the digital intelligence - driven low-carbon technology integration scheme (including precision feeding, intelligent scheduling, and cold-chain optimization); contributed to path planning; performed data sorting and formal analysis.Yukun Wang: Designed and implemented the in-depth interview protocol; carried out field research and interviews with multiple stakeholders; participated in current situation diagnosis and model construction; contributed to the three-stage implementation path planning; revised the initial manuscript. All authors have read and agreed to publish this manuscript. All authors have read and agreed to publish this manuscript.

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Conflict of Interest:

The authors declare no conflict of interest.

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