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Research on the Digital Intelligence Innovation Model for Emergency Management in Urban and Rural Agricultural Supply Chains

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Abstract: *This study focuses on protecting agricultural supply chains between urban and rural areas during social emergencies. It aims to examine the effective application of digital intelligence and related technologies within the emergency management systems of these agricultural supply chains. The goal is to explore a new management model that meets daily consumption needs while also enabling a rapid response to emergency demands. From the perspectives of technology, organization, and social interaction, the study systematically presents a three-dimensional analytical framework encompassing digital intelligence risk perception, organizational operation, and social market value co-creation. It elucidates the significant impact and mechanisms through which digital intelligence influences the prevention and preparation for urban and rural emergencies, early warning and monitoring, emergency response, and recovery processes. Furthermore, it outlines the future direction for developing urban and rural agricultural supply chain emergency management in the digital intelligence era, highlighting the path forward in the context of digitalization.*

Keywords: *Agricultural Supply Chains; Digital Intelligence Innovation; Emergency Management*

1. Introduction

With the deepening of globalization and rapid socio-economic development, agriculture, as a fundamental industry of the national economy, plays a crucial role in the overall development of the country. In recent years, the government has placed significant emphasis on modernizing agriculture and highlighted the importance of coordinating epidemic prevention and control with the market supply of agricultural products as part of its comprehensive promotion of key initiatives for rural revitalization in 2023. This coordination is essential to ensure a smooth and unobstructed agricultural product logistics supply chain. Additionally, accelerating the application of agricultural and rural big data and promoting the development of smart agriculture are vital for enhancing high-quality agricultural productivity. The government further proposes optimizing the construction of the cold chain logistics system for agricultural products and promoting the establishment of county e-commerce live bases. It also emphasizes the need to improve the monitoring and early warning mechanisms for the entire agricultural product supply chain, as well as to implement reserve regulation and emergency protection measures. Strengthening the monitoring and analysis of food consumption and important agricultural products is crucial.

The outbreak of the new crown epidemic significantly impacted agricultural production and marketing in China. Many regions experienced labor shortages, disruptions in production and harvesting, poor logistics, limited sales channels, and stagnation of agricultural products, which highlighted the shortcomings of the traditional agricultural supply model. Issues such as information asymmetry, which resulted in an imbalance between supply and demand, and a high rate of loss during transportation were exposed. Consequently, leveraging modern information technology to enhance the efficiency of agricultural production has become a key focus for the transformation and upgrading of China's agriculture, both now and in the foreseeable future. However, numerous challenges remain in the practical implementation of these strategies, including how to balance economic and social benefits and how to navigate the boundaries between government guidance and the independent operation of enterprises. These issues must be addressed to ensure successful reform in the agricultural sector.

Therefore, it is imperative to explore a new agricultural supply chain management model that can meet daily consumption demands while also swiftly responding to emergency situations. Ensuring a

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stable supply of agricultural products and developing an innovative value chain model for an urban and rural areas to address sudden social emergencies presents a novel research opportunity. This topic holds significant theoretical value as well as practical and strategic importance.

2. Literature Review

2.1 Study on the Current Status of Agricultural Supply Chain Development and Models

The issue of supply chain governance is a traditional yet relatively new topic. Li （2016） systematically proposed a normative analytical framework for research in supply chain governance[1]. The supply chain can also be viewed as an ecosystem, and future research on supply chain ecosystems will focus on participant behavior, product creation strategies, and competition patterns[2-4]. Scholars both domestically and internationally have introduced various forms of supply chain management models[3,5]. Additionally, Feng (2024) proposed a more advanced and scientifically grounded modern supply chain model by analyzing the shortcomings of traditional supply chain models[6].

The traditional agricultural supply chain model encompasses various frameworks, including the wholesale market-centered model, the and supermarket docking model, the third-party logistics enterprise-centered model, the agricultural product processor-centered model, the retailer-centered model, and the direct sales model for agricultural products [7-8]. Li (2019) categorized the management models into four fundamental agricultural supply chain management frameworks, focusing on production and processing enterprises, professional wholesale markets, supermarket chains, and third-party logistics enterprises, based on the differing roles of core enterprises within the agricultural supply chain[9]. Niu(2010) examined the procurement, distribution, and sales modules of agricultural products by analyzing the supply chain system of fresh agricultural products centered around large supermarket chains[10]. Some scholars have specifically investigated the pathways to enhance the resilience of domestic agricultural supply chains[11], as well as the bottlenecks in the modernization of agricultural industry supply chains and their corresponding breakthrough strategies[12]. Zhang (2010) initiated a preliminary discussion on the new agricultural product circulation system based on the agricultural super docking model[13], while He (2014) explored the internal mechanisms and institutional logic behind the market-oriented transformation of the agricultural product circulation system from the theoretical perspective of transaction deregulation[14].

Under the backdrop of the development of the fresh agricultural products supply chain has introduced various supply chain models, including the online and offline fusion supply chain model, intelligent logistics supply chain model, strategic alliance agricultural products supply chain model, and consumer demand-driven agricultural products supply chain model[15-16]. Additionally, there are e-commerce supply chain models led by e-commerce sales platforms, wholesale market supply chain models that utilize wholesale markets for agricultural products as the primary distribution channel, and supermarket supply chain models that leverage numerous supermarkets within urban areas as platforms. Other models include leisure tourism-driven supply chains centered around rural tourism attractions, direct sales of agricultural products from impoverished regions facilitated by institutions or public welfare organizations, and supply chain models driven by live broadcasting platforms through self-media. Furthermore, there are supply chain models for agricultural product sales supported by third-party logistics[17-19]. Research on agricultural product supply chain models, both domestically and internationally, indicates that there remains a significant gap compared to foreign counterparts, as illustrated in Table 1 below:

Table 1: Comparison of Chinese and Foreign Agricultural Supply Chains

Comparison	Our country	External Affairs
Management Philosophy	The management is outdated and lacks specialization.	Adoption of Competitive Strategies for Supply Chain Management
Cooperation Mechanisms	Smallholder production results in unequal market power and complicates the establishment of cooperative mechanisms.	Vertically Integrated and Horizontally Integrated Cooperative Mechanisms
logistics system	Duplication, low responsiveness, and inadequate cold chain technology.	Professional logistics, advanced technical equipment, and a high level of cold chain management.
Information System	Insufficient application, low engagement, and minimal sharing.	Openness, node applicability, and scalability

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2.2 Digital Intelligence and Emergency Management Capacity in Urban and Rural Agricultural Supply Chains

In the field of crisis and emergency management research in the West, , three distinct research traditions like “engineering-technology”[20], “organization-institution”[21] and “politics-society” [22]have developed over time, and have yielded significant findings in various areas, including emergency management phases, risk perception and assessment, emergency response, and collaborative governance[23-25]. In China, scholars have increasingly focused on risk management in the context of global changes, particularly following the SARS epidemic in 2003 and the COVID-19 pandemic in 2020[26]. As a result, emergency management has garnered considerable attention from the academic community.

Existing studies have elaborated on the definitions, types, and characteristics of public emergencies, as well as their grading and staging, occurrence and spreading mechanisms[27-29], and associated risk characteristics and trends. Additionally, these studies have analyzed the main actors involved in emergencies from both institutional and process perspectives [30], and have developed a disaster analysis framework based on the Chinese context[31]. Some scholars have also examined significant social emergency events, such as the SARS outbreak in 2003, the COVID-19 pandemic in 2020, the Wenchuan earthquake in 2008, the Shanghai Bund stampede on December 31, and the Maoming PX project, all of which have been studied in great detail[32].

In the context of the recent COVID-19 pandemic, Ban(2022) developed a new supply model for agricultural products by examining the current supply situation in Heilongjiang Province[33]. He (2024) emphasized that the integration of digital intelligence logistics into the optimization strategies for the supply chains of agricultural products, particularly those with mountainous characteristics, should enhance the overall level of digital intelligence within these supply chains[34]. Li (2023) analyzed the characteristics, requirements, and shortcomings of performance management in the current digital-intelligent agricultural supply chain in China. She explored the key components necessary for developing performance management in this context and proposed relevant countermeasures and recommendations for its advancement [35]. The field of digital intelligence is rapidly expanding, contributing to urban government emergency management, supply chain management, logistics services, industry chain development, intelligent supply chains, e-commerce supply chain logistics, and the construction and optimization of urban security resilience[36-38]. In China, research primarily focuses on assessing the current state and providing policy recommendations for the application of digital intelligence in emergency management from both strategic and technical perspectives[39]. Furthermore, digital twin technologies, including big data, the Internet of Things, cloud computing, and blockchain, can facilitate information sharing, traceability, and the establishment of trust within the supply chain[40]. These technologies are expected to be widely implemented in logistics management, particularly in reverse supply chains and emergency agricultural supply chains.

To summarize, there are several deficiencies in the existing research: first, there are shortcomings in research perspectives. Current studies primarily focus on the application potential of big data through the lens of the value co-creation facilitated by the use of digital intelligence in emergency management scenarios. Second, the research content is inadequate. Although some scholars have begun to investigate the application potential of big data-based digital intelligence technology in agriculture, they have not thoroughly addressed the challenges encountered in the practical implementation of this technology. Third, there is a lack of robust research methods. Most current research on value chain model innovation in agricultural supply chains remains at a theoretical level or is limited to case analyses, rarely employing standardized empirical research methods such as numerical intelligence analysis, experimental methods, or project practice methods for validation. As a result, the findings often lack sufficient persuasive power and generalizability. The purpose of this paper is to explore the innovation of value chain models in urban and rural agricultural supply chains within the context of social emergencies, examining both the supply side (production of agricultural products) and the demand side (consumption of agricultural products) while utilizing advanced information technologies such as digital twins in numerical intelligence.

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3. Monitoring and Early Warning Systems

3.1 Monitoring and Early Warning

3.1.1 Big Data and Fundamentals of Intelligent Cloud Technology

Big data effectively captures the characteristics, substance, and causes of public affairs problems due to its features, including multi-channel data sources, diverse data types, and massive data volumes[41]. The application of big data analytics in risk identification facilitates the construction of dynamic risk assessment models by comprehensively analyzing historical transaction data, climate change data, and market volatility data. These models can identify potential supply chain risks by leveraging a combination of statistical methods and machine learning techniques. In the context of emergency management, potential risk factors can be proactively identified through in-depth analysis of historical data, weather information, market fluctuations, and social sentiment. The diversity and volume of this data provide a robust foundation for monitoring and forecasting emergencies. Furthermore, a cloud computing-based intelligent warning platform is developed to enable real-time data sharing and cross-platform analysis by utilizing cloud storage and computing resources. This platform should integrate multiple data sources to enhance the comprehensiveness and timeliness of information acquisition. As Yuan(2022) noted, big data technology plays a crucial role in the allocation of emergency resources, and an efficient information communication mechanism can be achieved by integrating a network-wide coverage of perception networks, such as the Internet of Things and social media. This architecture not only improves the accuracy of information but also enhances the responsiveness of emergency management[42].

3.1.2 Building an Early Warning Monitoring System to Establish a Risk Perception Mechanism

The emergency management of crises is a dynamic process that encompasses preparation, response, recovery, and other stages. It also involves the specific implementation of the emergency intelligence workflow, which optimizes the integration of emergency intelligence data to support decision-making. This workflow follows a sequence of steps: intelligence acquisition and processing, intelligence organization, intelligence analysis and application, and intelligence feedback and evaluation[43]. Constructing a multi-level risk perception mechanism is crucial for enhancing the efficiency of emergency management. This mechanism should integrate both quantitative and qualitative indicators to achieve a comprehensive risk assessment. Quantitative indicators may include price volatility and supply gap rates, which provide an objective basis for understanding market dynamics and supply chain conditions through historical data analysis and real-time monitoring. For instance, price volatility can help identify trends in market supply and demand, thereby predicting potential price risks[44]. Conversely, qualitative indicators encompass factors such as market sentiment and policy changes, which can reveal the psychological state of market participants and their expectations for the future. By analyzing these indicators, decision-makers can capture risk signals that are difficult to quantify and enhance their sensitivity to changes in the external environment[45]. Combined with advanced cloud technology, a cloud computing-based intelligent early warning platform is developed, enabling real-time data sharing and cross-platform analysis. This platform integrates multiple data sources, providing a more comprehensive information base for the risk perception mechanism. With cloud storage and robust computing capabilities, enterprises can swiftly process and analyze vast amounts of data to assess risks more accurately[46]. For instance, through real-time monitoring and data mining, the intelligent early warning system can deliver dynamic risk analysis results based on a thorough assessment of both quantitative and qualitative indicators.

In the current complex and ever-evolving agricultural supply chain environment, establishing an efficient early warning system is crucial. The development of a multi-channel early warning information dissemination system based on mobile internet technology can significantly enhance the timeliness and accuracy of information delivery, thereby improving the resilience of the supply chain. This system should integrate various information channels, including mobile applications, SMS, email, and social media platforms, to ensure that relevant stakeholders receive early warning information immediately when an emergency arises. The accuracy and timeliness of early warning information are key factors in bolstering supply chain resilience[47]. Furthermore, the design of the early warning system must leverage data analytics to monitor market dynamics, meteorological changes, and the status of each link in the supply chain in real time, enabling the timely identification of potential risks. By establishing a dynamic early warning indicator system, predictions can be generated from various links in the supply chain, thereby shortening the warning cycle and enhancing the effectiveness and relevance of the alerts. Additionally, when combined with modern information technology, the

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implementation of this system should prioritize user experience to ensure that information is communicated clearly and concisely to multiple stakeholders, including farmers, logistics companies, wholesalers, and government agencies[48]. By creating an efficient feedback mechanism, stakeholders can respond to early warning information promptly and take necessary emergency measures, effectively mitigating the impact of emergencies on the supply chain.

3.2 Emergency Management

Studies on agricultural supply chain models, both domestically and internationally, indicate that there remains a significant gap between China and countries that have more effectively implemented agricultural supply chains. Therefore, in light of the unique socio-economic conditions, we propose an innovative urban-rural integrated supply chain model for agricultural products. This model introduces a comprehensive one-stop service system for the urban-rural supply of agricultural products, facilitating the journey from farmers' fields to citizens' dining tables. We call this the "Integrated Urban-Rural Supply Chain System for the Production and Marketing of Agricultural Products" (5Ps). This initiative aims to address the extraordinary pressures that emergencies place on traditional urban agricultural supply chains while ensuring that farmers can continue their production without disruption. It seeks to prevent epidemics from halting production, stabilize farmers' incomes, and contribute to the revitalization of rural areas.

Part 1. The mu base + farmers the challenges of agricultural product supply at the source while supporting farmers' prosperity. The cornerstone of this model is the establishment of a stable and efficient agricultural production and supply system that ensures both the quality of agricultural products and the stability of their supply.

Part 2. Enhancing the standardization system for agricultural products and reinforcing the quality orientation of these products are essential measures for deepening the structural reform of the agricultural supply side and promoting the revitalization of the rural industry. Additionally, optimizing the sorting process and establishing a robust quality control system are crucial. Beyond addressing the transition from non-standard to standardized agricultural products, the factory or sorting center must also develop a stable and efficient warehousing and logistics system.

Part 3. Outlines the model of + Cooperatives + Enterprises + E-commerce, which effectively integrates traditional agriculture with modern information technology and innovative business models. The goal is to achieve the standardization, branding, and marketization of agricultural products by optimizing resources, streamlining processes, and enhancing efficiency. This approach aims to promote the advancement of the agricultural industry and increase farmers' incomes. Rural e-commerce is empowered through the Internet of Things, with cooperatives serving as a vital link between farmers and enterprises. Cooperatives are tasked with integrating farmers' agricultural resources, while enterprises focus on brand development and market promotion. Finally, e-commerce platforms facilitate online trading and data analysis. All parties collaborate closely, integrating resources to create an efficient and synergistic agricultural supply chain system.

Part 4. The objective is to establish a part-time sales team in the residential district, primarily targeting square dancers and other community members who are available for part-time sales. This initiative aims to engage residents who possess social networks and influence within the community, enabling them to effectively communicate with their neighbors. Additionally, participants should have some experience in purchasing agricultural products.

Part 5. The plan involves developing both online and offline agricultural product supermarkets that focus on netroots attributes. These supermarkets will offer specialty fruits, organic vegetables, and high-quality grains and oils, utilizing a combination of online e-commerce platforms and physical retail locations. By collaborating with the community and organizing activities such as group purchases, we aim to enhance interaction with consumers, thereby improving customer satisfaction and loyalty.

3.3 Reset Recovery

3.3.1 Technological Foundation

Unforeseen events significantly impact the agricultural supply chain; therefore, the ability to reset and restore this supply chain is critical. This paper explores the use of metaverse and blockchain technologies to facilitate value co-creation, effectively promoting resilience and flexibility within the agricultural supply chain. The metaverse serves as an immersive virtual environment that enables

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participants to interact and collaborate in real time on a shared platform. In this environment, farmers, cooperatives, businesses, and consumers can instantly share information and make dynamic adjustments and decisions. This real-time capability not only enhances information transparency but also establishes a rapid response mechanism, allowing the supply chain to quickly adapt to changes in market demand in the face of unforeseen events.

The integration of blockchain technology will enhance the comprehensiveness, accuracy, and timeliness of the national emergency management information system. It will further strengthen the institutional effectiveness of the prevention and early warning mechanisms and support the development of an open and adaptive emergency decision-making system tailored to complex scenarios and open-source information. This integration will facilitate the dynamic iteration of the decision-making process and ultimately improve the coordination of actions among various stakeholders during emergencies[49]. Additionally, blockchain technology, with its characteristics of decentralization, immutability, and high transparency, offers robust support for all aspects of the supply chain. Through blockchain technology, the production, circulation, and sales processes of agricultural products can be accurately recorded and tracked, thereby enhancing the credibility of information. The application of this technology establishes a trust mechanism that enables all parties to share data and allocate resources more efficiently, promoting cooperation and collaborative innovation. Wang (2020) utilizing the food emergency case construction model of data block generation and data traceability extraction, demonstrated that through the joint participation and real-time maintenance of blockchain nodes, the data in the construction of the food emergency case database is both authentic and reliable, with implementation that is timely and efficient. This approach facilitates the accurate formulation of food emergency decision-making, ultimately improving the efficiency of food emergency rescue operations and advancing the digital governance of the food emergency system[50].

3.3.2 Value Co-Creation in Resetting Recovery for Emergency Management in the Supply Chain

Supply chain reset and recovery can be optimized in three core areas. First, establishing a refined management and monitoring early warning system helps identify potential risks in a timely manner and formulate corresponding response strategies. This mechanism not only enhances the effectiveness of risk management but also improves the emergency response capabilities of the supply chain. Secondly, data integration and analysis enhance the understanding and control of each link in the supply chain. Utilizing big data technology allows for in-depth analysis of market dynamics, thereby optimizing the efficient allocation of resources and ensuring the continuity and stability of the supply chain during crises. Finally, strengthening the synergy mechanism encourages interaction and cooperation within the metaverse platform, fostering collaboration to address the challenges posed by emergencies. By integrating the resources and expertise of all parties and building a multi-party ecosystem, we can better achieve benefit sharing and value creation.

Socialized market value co-creation is a crucial element in the management of urban and rural agricultural supply chains, aimed at fostering collaboration and information sharing among participants through an open data system. The emergency management mechanism for agricultural supply chain disruptions should be an institutional arrangement that establishes a supply chain-based coordination framework under the unified leadership of a governmental oversight group. In this framework, relevant departments and units must cooperate, coordinate their actions, and develop a work pattern characterized by information sharing, division of labor, emergency linkage, and rapid response[51]. Specifically, farmers, enterprises, consumers, and other stakeholders can exchange information and resources in real time on a shared platform. This process not only enhances the transparency of the supply chain and mitigates risks associated with information asymmetry but also strengthens the trust among participants. The establishment of trust fosters a positive cooperative atmosphere, promotes the efficient allocation and rational use of resources, and ultimately maximizes value. Furthermore, through social interaction mechanisms, all parties can collaboratively address market fluctuations and emergencies, thereby enhancing the risk resilience and overall robustness of the supply chain.

3.4 Discussion

In summary, this paper presents a digital and intelligent innovation model for the emergency management of urban and rural agricultural supply chains,as shown in Figure 1. It illustrates an interconnected relationship structure between the center and the periphery, emphasizing the dynamic interactions and synergies among various elements. The core of the model is the innovation of agricultural products in urban and rural areas, which not only reflects the responsiveness of the agricultural supply chain in emergency situations but also underscores its significance in promoting the

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modernization and sustainable development of agriculture. Within this framework, the central theme of innovation of agricultural products in urban and rural areas supply chain management. Achieving this innovation goal requires each participant to flexibly adjust their strategies in response to complex and changing environments, thereby ensuring the efficient allocation and optimal utilization of resources. The surrounding key elements are interconnected by various arrows, forming a systematic thinking framework. These elements—information sharing, risk assessment, resource integration, and collaborative innovation—intertwine to create a dynamic and interactive network. Information sharing serves as the foundation, enabling all parties to quickly access and transfer critical information during emergencies, thus enhancing the timeliness and accuracy of decision-making. Risk assessment assists participants in identifying potential risks through systematic analysis and prediction, allowing them to formulate appropriate response strategies that bolster the resilience of the supply chain. Resource integration emphasizes collaboration and co-construction among multiple participants in emergency management, fostering trust and cooperation among stakeholders. Finally, collaborative innovation, a vital component of the model, not only promotes the application and diffusion of new technologies but also facilitates knowledge sharing and experience exchange, thereby creating a synergy that enhances the efficiency and effectiveness of overall emergency management.

In the model of digital and intellectual innovation for emergency management of urban and rural agricultural supply chains, two key elements underscore the importance of interaction and cooperation among participants. Effective synergy is essential for achieving optimal resource allocation and enhancing overall efficiency. The construction of a synergistic mechanism requires all participants to collaborate based on information sharing, enabling them to collectively respond to market changes and emergencies. This synergy encompasses not only information sharing but also the exchange of resources and complementary advantages. By establishing an effective synergy platform, farmers, enterprises, and consumers can cultivate a strong interactive relationship between supply and demand, allowing for timely responses to market needs and improving the adaptability and flexibility of the supply chain. The sharing mechanism emphasizes the mutual benefits derived from resources, information, and knowledge. Through an open data system, participants can share information in real time within a dynamic environment, thereby reducing the risk of information asymmetry. This mechanism not only fosters trust-building but also enhances participants' willingness to cooperate, ultimately creating a favorable ecosystem.

In addition, three dimensions “volume, velocity, and variety” are emphasized in the Digital Intelligence Innovation Model for Emergency Management of Urban and Rural Agricultural Supply Chains. This framework clearly highlights the significance of data in contemporary supply chain management. The vast amount of information generated at each stage of the agricultural supply chain encompasses data from various phases, including production, transportation, storage, and consumption. This data not only reflects a richness in quantity but also a diversity in content. Effective data management and analysis can provide robust support for decision-making. The ability to analyze real-time data has become a crucial indicator of modern supply chain management. By establishing an efficient data flow and processing mechanism, all stakeholders in the supply chain can promptly understand market dynamics, swiftly adjust their strategies, and enhance overall operational efficiency. Effective data integration and analysis mechanisms can transform this diverse data into actionable insights, thereby supporting supply chain optimization and innovation.

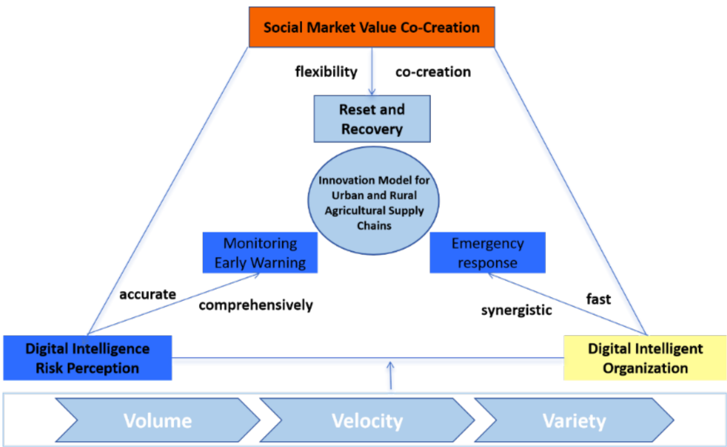

Figure 1: Digital Intelligence Innovation Model for Emergency Management in Urban and Rural Agricultural Supply Chains

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4. Conclusions and perspectives

Against the backdrop of increasing challenges and opportunities in global agriculture, there is an urgent need for transformation and innovation in the emergency management of both urban and rural agricultural supply chains. This paper analyzes the core elements and data dimensions within the digital intelligence innovation model, highlighting key components such as social market value co-creation, reset and recovery, monitoring and early warning, and the critical role of data in supply chain management. This is particularly relevant in the integrated application of vast, high-speed, and diverse data sets. The co-creation of socialized market value not only enhances transparency and trust within the supply chain but also facilitates a more efficient resource allocation mechanism for all participating entities. The reset and recovery capabilities ensure the supply chain's flexible response and rapid recovery following emergencies, while the monitoring and early warning mechanisms provide a scientific foundation for effective risk management. The synergy of these elements forms the foundation of modern agricultural supply chain emergency management, emphasizing the crucial role of digital intelligence in enhancing the resilience and flexibility of the supply chain. Analyzing data dimensions further underscores the complexity and dynamics of contemporary supply chain management. Vast amounts of data create a rich information base for decision-making, while high-speed data necessitates that participants possess real-time response capabilities. Additionally, the integration and analysis of diverse data offer a multi-faceted perspective for informed decision-making. Fully leveraging these data characteristics can significantly enhance the overall efficiency and adaptability of the supply chain.

Looking ahead, the digital and intellectual innovation of urban and rural agricultural supply chains requires further in-depth exploration and practical application. First, with the continuous advancement of information technology, the integration and application of emerging technologies such as blockchain, artificial intelligence, and big data will present new opportunities and challenges for supply chain management. In particular, issues related to data governance and privacy protection necessitate the formulation of appropriate policies and standards to ensure the secure and compliant use of data. Future research should concentrate on establishing more efficient synergistic mechanisms within an ecosystem characterized by multi-party participation. By fostering in-depth collaboration and resource sharing among various stakeholders, a more comprehensive optimization of the supply chain can be achieved, thereby promoting the sustainable development of agriculture. Policymakers and industry leaders should actively advocate for digital transformation and create a policy environment and infrastructure that supports the digitalization of the agricultural supply chain. Only through the collaboration and concerted efforts of all parties can the resilience and sustainable development of urban and rural agricultural supply chains be realized in a turbulent market environment, ultimately providing robust support for the future advancement of global agriculture.

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