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e-mail: support@smart-scm.org
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Hryhorak M.Yu. Doctor of Economics, Associate Professor, Professor of the Department of International Business and Logistics, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute." (Ukraine)

ORCID – 0000-0002-5023-8602
Researcher ID AAK-2963-2021
Scopus author id: – 57208222758
E-Mail: hryhorak.mariia@edu.kpi.ua

Karpun O.V. PhD (Economics), Associate Professor, Associate Professor of Department of International Business and Logistics, National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute» (Ukraine)

ORCID – 0000-0003-2058-9070
Researcher ID – S-6428-2018
Scopus author id: – 60001156100
E-Mail: karpun.olha@edu.kpi.ua

INTELLECTUALIZATION OF LOGISTICS AND SUPPLY CHAIN MANAGEMENT: CONCEPTUAL FRAMEWORK, RESEARCH AGENDA, AND THE ROLE OF A SCIENTIFIC JOURNAL

Mariia Hryhorak, Olga Karpun. «Intellectualization of logistics and supply chain management: conceptual framework, research agenda, and the role of a scientific journal». *The rapid growth of research in digital logistics, artificial intelligence, autonomous systems, resilience, and circular supply chains exacerbates the fragmentation of logistics knowledge and complicates the explanation of modern logistics systems as holistic socio-technical ecosystems. The purpose of this article is to substantiate the intellectualization of logistics and supply chain management as an integrative conceptual framework and an open research agenda. The methodological foundation includes a targeted conceptual literature review, comparative analysis of related concepts, theoretical synthesis, and logical modeling. The article systematizes contemporary directions in logistics research, identifies their integrative gap, and differentiates intellectualization as a process, an intelligent logistics system as an analytical system type, a conceptual framework as an analytical tool, and a research agenda as a domain for further inquiry. The unit of analysis and the boundaries of the proposed framework are specifically clarified. A mechanistic-process model of intellectualization is proposed, in which human intelligence, organizational memory and learning capacity, inter-organizational collective intelligence, and artificial intelligence – through knowledge sharing, coordination, organizational learning, and human oversight of algorithmic decisions – are transformed into adaptive capabilities of the logistics system. Boundary conditions and risks of intellectualization are identified, including algorithmic opacity, poor data quality, platform dependency, cyber risks, and the loss of human expertise. Four theoretical propositions regarding*

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causal relationships within the logistics system are formulated, along with a separate methodological proposition on changing the unit of analysis and an institutional proposition on the journal's role. The scientific contribution lies in distinguishing intellectualization from digitalization and AI, constructing a testable system of propositions, and shaping the Research Agenda. A limitation of the study is its theoretical and conceptual nature, which requires further operationalization and empirical testing.

***Keywords**:* Intellectualization, Logistics, Supply Chain Management, Research Agenda, Conceptual Research, Conceptual Framework, Integrative Research Program, Digital Transformation, Open Science

Марія Григорак, Ольга Карпунь. «Інтелектуалізація логістики та управління ланцюгами постачання: концептуальна рамка, дослідницький порядок денний і роль наукового журналу». *Стрімке зростання досліджень цифрової логістики, штучного інтелекту, автономних систем, резильєнтності та циркулярних ланцюгів постачання посилює фрагментацію логістичного знання й ускладнює пояснення сучасних логістичних систем як цілісних соціотехнічних екосистем. Метою статті є обґрунтування інтелектуалізації логістики та управління ланцюгами постачання як інтегративної концептуальної рамки й відкритої дослідницької програми. Методологічною основою є цільовий концептуальний огляд літератури, порівняльний аналіз суміжних понять, теоретичний синтез і логічне моделювання. У статті систематизовано сучасні напрями логістичних досліджень, визначено їхню інтегративну прогалину, розмежовано інтелектуалізацію як процес, інтелектуальну логістичну систему як аналітичний тип системи, концептуальну рамку як інструмент аналізу та дослідницьку програму як простір подальших питань. Окремо уточнено одиницю аналізу й межі застосування запропонованої рамки. Запропоновано механістично-процесну модель інтелектуалізації, у якій людський інтелект, організаційна пам'ять і здатність до навчання, міжорганізаційний колективний інтелект і штучний інтелект через обмін знаннями, координацію, організаційне навчання та людський контроль алгоритмічних рішень перетворюються на адаптивні здатності логістичної системи. Визначено обмежувальні умови та ризики інтелектуалізації, зокрема непрозорість алгоритмів, низьку якість даних, платформну залежність, кіберризики та втрату людської експертизи. Сформульовано чотири теоретичні положення про причинні зв'язки в логістичній системі, окреме методологічне положення про зміну одиниці аналізу та інституційне положення про роль журналу. Науковий внесок полягає у відмежуванні інтелектуалізації від цифровізації та AI, побудові перевірюваної системи положень і формуванні Research Agenda. Обмеженням є теоретико-концептуальний характер дослідження, що потребує подальшої операціоналізації та емпіричної перевірки.*

Ключові слова: Інтелектуалізація, логістика, управління ланцюгами поставок, дослідницький порядок денний, концептуальні дослідження, концептуальна основа, інтегративна дослідницька програма, цифрова трансформація, відкрита наука

1. Introduction. The beginning of the 21st century has become a period of profound transformation in logistics and supply chain management. Globalization, digitalization, the rapid development of artificial intelligence, platform business models, autonomous transport systems, the Internet of Things, and digital twin technologies are fundamentally changing the principles of designing, operating, and developing logistics systems [2-6; 11-18]. Concurrently, the world faces unprecedented challenges – geopolitical instability, military conflicts, pandemics, climate change, and energy and food security crises. Under these conditions, logistics increasingly exhibits the characteristics of a complex adaptive socio-technical system, in which a decisive role is played not only by material flows, but also by

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data, knowledge, interaction, trust, and the capacity for rapid collective decision-making.

These changes naturally impact the evolution of logistics science. In recent years, there has been a significant surge in research devoted to digital transformation, artificial intelligence applications, big data analytics, the circular economy, sustainable supply chains, humanitarian logistics, digital trade corridors, and other prominent fields [5-10; 19-35]. However, the vast majority of publications focus on addressing narrow applied problems or examining specific technological solutions. Considerably less attention is paid to comprehending fundamental shifts within logistics science itself, as well as developing new theoretical constructs, conceptual frameworks, and integrative research agendas.

Signs of methodological fragmentation are gradually accumulating within the academic community. Individual research streams evolve with extreme intensity, yet frequently remain isolated from one another, utilizing disparate conceptual approaches, terminologies, and research traditions. Consequently, a paradoxical situation arises: while the volume of scientific knowledge grows exponentially, the need for its integration and conceptual re-evaluation becomes increasingly acute. Therefore, alongside empirical studies, conceptual articles capable of shaping new research avenues, explaining systemic shifts, and proposing new scientific frameworks for their interpretation acquire paramount importance.

Against this backdrop, the concept of intellectualization of logistics and supply chain management becomes increasingly relevant. In this article, it is viewed not as a synonym for digitalization or the implementation of isolated artificial intelligence technologies, but as a qualitatively new stage of logistics development. This stage is characterized by the integration of human intelligence, organizational memory and learning capacity, inter-organizational collective intelligence, and artificial intelligence, as well as the widespread utilization of data and knowledge, the development of adaptive management mechanisms, interdisciplinary research, and the formation of new theoretical models for operating complex logistics systems.

In this context, the role of scientific journals is evolving as well. While traditionally serving primarily to disseminate findings of completed studies, modern academic periodicals are increasingly becoming active participants in shaping the scientific agenda, fostering international research networks, and initiating new scholarly debates. It is precisely through editorial policy, special issues, conceptual publications, methodological papers, and open academic discussions that they can significantly influence the development trajectory of specific scientific fields.

The re-confirmation of the status of the journal "Intellectualization of Logistics and Supply Chain Management" as a Category "B" professional scientific publication represents an important milestone in its development. At the same time, the editorial board considers this event not as the conclusion of a certain stage, but as a rationale for re-conceptualizing the journal's mission in both national and international academic spaces. The natural next step must be to strengthen the journal's role as an international platform for advancing conceptual research, establishing new scientific domains, and integrating interdisciplinary knowledge in logistics and supply chain management.

By genre, this article is a programmatic conceptual publication formatted as an editorial perspective. It does not claim the status of a finalized theory or a proven scientific paradigm. Its purpose is different: to propose an integrative conceptual framework and an open research agenda within which various avenues of contemporary logistics science can be understood as interconnected manifestations of a broader

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intellectualization process. This genre selection also determines the nature of the argumentation: the article combines conceptual synthesis, problem statement, the formulation of an authorial framework, and the outlining of an open research agenda [27; 36-38].

The objective of this article is to substantiate the intellectualization of logistics and supply chain management as a process of developing logistics system capabilities, build an integrative conceptual framework for its analysis, identify key methodological challenges of modern logistics science, and outline the journal's role as an academic platform for the development, critical discussion, and subsequent operationalization of the corresponding research agenda.

Accordingly, the article answers the following research questions: how can the intellectualization of logistics be conceptualized as a process of developing logistics system capabilities without equating it with digitalization, automation, or AI; through what core mechanism are sources of intelligence transformed into adaptive capabilities and systemic outcomes; how does the proposed framework differ from the related concepts of digital, smart, autonomous, cognitive, knowledge-based, and resilient logistics; how can a scientific journal support the formation and validation of conceptual frameworks; and what research clusters, questions, units of analysis, theoretical lenses, and methods should constitute an open Research Agenda for the intellectualization of logistics.

The scientific contribution of the article consists of four interconnected outcomes. First, the intellectualization of logistics is substantiated as an integrative conceptual framework that is not reducible to digitalization, automation, or the application of artificial intelligence. Second, four key categories are differentiated: intellectualization as a capability development process, an intelligent logistics system as an analytical system type, a conceptual framework as an analytical tool, and a research agenda as a domain for further inquiry. Third, a mechanistic-process model of intellectualization is proposed, and propositions are grouped by level: theoretical propositions on causal relationships in the logistics system, a methodological proposition regarding the unit of analysis, and an institutional proposition regarding the journal's role. Fourth, a structured Research Agenda is established, translating the journal's thematic priorities into a system of research problems, questions, units of analysis, theoretical lenses, and methods.

2. Conceptual Research Methodology. This article is executed as a theoretical and conceptual study aimed not at empirical hypothesis testing, but at constructing an integrative framework for comprehending the current stage of logistics and supply chain management development. The methodological foundation of the study comprises a targeted conceptual literature review, a comparative analysis of key concepts, theoretical synthesis, and logical modeling. This approach aligns with the genre of a programmatic conceptual paper: it enables not only the synthesis of existing research streams, but also the proposal of an open research agenda for further scientific debate.

The subject of analysis includes contemporary concepts of digital, intelligent, cognitive, autonomous, adaptive, and resilient logistics, as well as studies that view supply chains as complex socio-technical, network, and ecosystem structures [1-25; 39; 40]. Particular attention is given to works analyzing artificial intelligence, big data, digital twins, the Internet of Things, autonomous logistics systems, circular logistics, humanitarian logistics, knowledge management, resilience, and digital trade and logistics corridors [5-18; 26-35; 39; 40]. These research streams are viewed not as isolated thematic domains, but as sources of concepts

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and mechanisms necessary to construct an integrative concept of intellectualization.

The literature selection logic was grounded in the principles of a targeted conceptual review rather than a systematic meta-analysis. The source base was formed by selecting peer-reviewed articles, conceptual reviews, programmatic publications, and highly methodologically relevant works indexed in international scientometric databases and academic search engines. The primary time horizon encompassed publications from 2019–2026, as this period witnessed the intensive evolution of research on digital logistics transformation, Industry 4.0, artificial intelligence, and supply chain resilience. Classical works in logistics and supply chain management were utilized as a theoretical baseline for comparing previous and contemporary stages of the discipline's development.

The search, thematic selection, and verification of sources were conducted on July 24, 2026. The source base was drawn from the academic search engines Scopus, Web of Science, and Google Scholar, as well as from publisher portals including Elsevier, Emerald, Taylor & Francis, Springer, Wiley, IEEE, MDPI, and relevant institutional repositories. Bibliographic metadata for the final corpus – specifically DOIs, author names, article titles, journals, publication years, volumes, issue numbers, and page ranges – were additionally verified via Crossref. The search horizon primarily covered 2019–2026 publications; classical works were included only when necessary to explain the theoretical origins of specific concepts or conceptual research methodology. The initial working pool was built as a targeted rather than exhaustive bibliometric sample, incorporating publications directly addressing digitalization, artificial intelligence, resilience, circularity, humanitarian logistics, complex adaptive systems, knowledge management, and theory-building in supply chain management. Following thematic filtering, duplicate removal, and DOI verification, 40 sources were included in the conceptual analysis [1-40].

The search was conducted using the following English search strings and their combinations: digital logistics; intelligent logistics; smart logistics; cognitive logistics; autonomous logistics; artificial intelligence in logistics; artificial intelligence supply chain resilience; digital twin logistics supply chain systems; digital supply chain management industry 4.0 logistics review; supply chain resilience digitalization systematic literature review; adaptive supply chains; circular supply chain digital technologies; humanitarian logistics digital technology resilience; logistics ecosystems; knowledge management supply chain digital transformation; conceptual research supply chain management; research agenda supply chain management; theory building in supply chain management. Sources were included if they met at least one of the following criteria: proposed a new concept or conceptual model; synthesized the evolution of a distinct research stream; explained mechanisms of logistics system transformation; exhibited an interdisciplinary character; or contained methodological propositions relevant to formulating a research agenda. Excluded from the analysis were sources lacking DOIs or complete metadata, duplicates, preprints, non-peer-reviewed materials, publications with retraction notices, purely technical papers disconnected from logistics or SCM, and articles that duplicated already represented approaches without offering new concepts, mechanisms, or explanatory logic.

Because the study was conducted as a targeted conceptual review rather than a systematic bibliometric analysis or meta-analysis, the total volume of initial search hits per database was not treated as evidentiary statistics for the article. The study's working log documented the final corpus of 40 sources included in the conceptual analysis, along with the procedure for their thematic and bibliographic verification. The initial

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record counts in Scopus, Web of Science, and Google Scholar, the number of duplicates, and the count of sources post-screening were not presented as established facts, as an exhaustive bibliometric search log per database was not retained. This limitation reduces the search phase's replicability, yet it does not preclude utilizing the assembled corpus for programmatic conceptual synthesis.

Source coding was performed manually using a thematic-conceptual scheme. For each source, the following were recorded: research stream, central concept, main object of analysis, unit of analysis, dominant explanatory logic, role of technology, role of humans, role of knowledge, adaptation or coordination mechanisms, and conceptual boundaries of the approach. Following initial coding, concepts and mechanisms were cross-compared across streams, enabling the identification of recurrent semantic clusters: knowledge creation and utilization, analytical decision support, organizational learning, human-algorithm interaction, trust, inter-organizational coordination, self-organization, adaptation, and evolutionary system change. These clusters formed the foundation for the subsequent articulation of the five dimensions of intellectualization and the mechanistic-process model.

Material synthesis proceeded through several sequential stages. First, the main streams of contemporary logistics transformation were identified: digitalization, artificial intelligence, autonomy, resilience, circularity, humanitarian logistics, ecosystems, and knowledge management. Next, the conceptual boundaries of each stream and the recurrent mechanisms through which distinct forms of intelligence are converted into systemic capability were determined: knowledge sharing, coordination, organizational learning, and human oversight of algorithmic decisions. On this basis, four categories were differentiated: intellectualization as a capability development process, an intelligent logistics system as an analytical system type, a conceptual framework as an analytical tool, and a research agenda as a set of questions for further testing. Subsequently, the mechanistic-process model was constructed, and an open research agenda was formulated.

The sequence of building the conceptual framework is summarized in Figure 1. It encompasses the search and thematic selection of sources, grouping of research streams, analysis of their conceptual boundaries, identification of recurrent mechanisms, differentiation of key categories, model construction, formulation of propositions, and specification of the research agenda.

As shown in Figure 1, the proposed conceptual framework was formed not through an arbitrary combination of current concepts, but as a result of a sequential conceptual synthesis. The transition from building the source base and structuring research streams to constructing the model and formulating theoretical propositions ensures the internal consistency of the framework and creates a foundation for its further operationalization and empirical testing.

The quality of the proposed concept was evaluated against six criteria. The first criterion is distinctiveness from existing concepts: the analysis verified whether intellectualization duplicates digitalization, automation, artificial intelligence implementation, or knowledge management, and whether it explains their relationship within a broader systemic logic. For this purpose, its conceptual boundaries were compared with digital logistics, smart logistics, Logistics 4.0/5.0, AI logistics, as well as cognitive, autonomous, knowledge-based, resilient, and complex adaptive logistics. The second criterion is logical consistency: elements of the concept were cross-examined to identify potential internal contradictions. The third criterion is explanatory power: the framework's ability to interpret various

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avenues of contemporary logistics research as manifestations of a common process was assessed. The fourth criterion is operationalizability: the suitability of the proposed dimensions for subsequent conversion into variables, indicators, research questions, or hypotheses was analyzed. The fifth criterion is boundary conditions definition: it was clarified that the concept applies primarily to complex socio-technical logistics systems in which knowledge, data, technology, interaction, and adaptability become key drivers of development. The sixth criterion is generativity: the concept's capacity to establish a basis for new research programs, testable questions, and interdisciplinary discussions was evaluated.

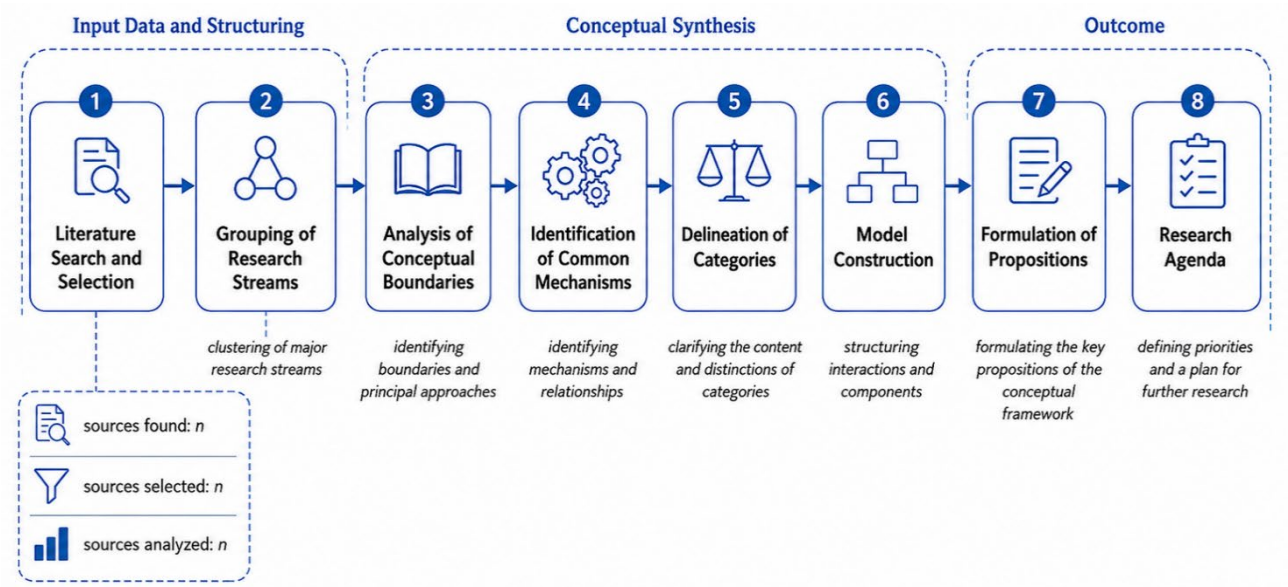

Figure 1 – Methodological Logic for Constructing the Conceptual Framework
Source: developed by the author.

Thus, the methodology of the article combines conceptual analysis, theoretical synthesis, and programmatic research agenda setting. This clearly distinguishes the presented material from an essayistic exposition: the conclusions of the article are grounded not on a free interpretation of isolated trends, but on a rigorous procedure of identifying scientific streams, analyzing their boundaries, determining common mechanisms, building an integrative framework, and outlining criteria for its further validation.

3. From Digital Logistics to Intelligent Socio-Technical Systems

Over the past three decades, logistics and supply chain management have matured as an independent, interdisciplinary scientific domain combining advances in economics, management, engineering, information technology, systems analysis, and operations research. Throughout this period, academic research has significantly expanded its subject field: from optimizing transport and warehousing processes to managing global value chains, digital platforms, risks, resilience, and supply chain sustainability.

Since the second decade of the 21st century, scientific discourse has increasingly shifted toward digital transformation [2-4]. Scholars have focused on Industry 4.0 technologies, the Internet of Things, artificial intelligence, big data, blockchain, digital twins, autonomous transport systems, warehouse robotics, and digital trade platforms [3-6; 11-18]. Concurrently, avenues in humanitarian logistics, the circular economy, green logistics, cybersecurity of logistics systems, risk management, resilience

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building, and post-crisis recovery have actively evolved [19-35].

While these streams have broadened the scope of logistics science, they have simultaneously amplified its fragmentation. A significant portion of research remains technologically or empirically focused: attention is concentrated on isolated digital solutions, algorithms, optimization models, disruption response scenarios, or specific flow types. Considerably less developed is the question of how these avenues interact within a complex adaptive socio-technical logistics system.

To systematize these trends, Table 1 summarizes the primary streams of contemporary logistics research. While the table is not the output of an exhaustive bibliometric analysis of the entire field, it captures the key conceptual boundaries of the streams most frequently highlighted in recent review, conceptual, and empirical works [1-35; 39; 40].

Table 1. Main streams of contemporary logistics research and their integrative gap

Stream	Research Focus	Dominant Logic	Integrative Gap	What Intellectualization Adds
Digital Logistics and Supply Chain 4.0	Data, platforms, digital capabilities	Process automation and visibility	Human, social, and evolutionary dimensions	Connects technology with knowledge, learning, and interaction [2–4; 39; 40]
AI in Logistics and SCM	Algorithmic solutions, forecasting, optimization	Decision support or automation	Accountability, trust, human expertise	Views AI as part of hybrid intelligence [1; 5–10]
Digital Twins	Virtual models of processes and supply chains	Monitoring, simulation, stress-testing	Organizational learning and social coordination	Integrates digital models into the knowledge and feedback cycle [11–18]
Resilience and Viability	Disruption response and recovery	Adaptation, reserves, scenario-based management	Crisis experience accumulation and learning	Explains resilience as an emergent outcome of capabilities [19–25]
Circular and Sustainable Logistics	Closed-loop flows, sustainability, resource cycles	Ecological efficiency	Collective decision-making and digital coordination	Combines sustainability with inter-organizational intelligence [26–31]
Humanitarian Logistics	Crisis and humanitarian supply chains	Rapid response, transparency, trust	Long-term crisis memory and AI ethics	Links response mechanisms with social and cognitive dimensions [32–35]
Business Ecosystems	Platforms, partnerships, co-creation of value	Orchestration of autonomous actors	Cognitive and technological network architecture	Uncovers inter-organizational collective intelligence [35; 39; 40]

Sourse: compiled by the authors based on [2-40].

The presented synthesis demonstrates that each of the examined streams possesses its own research focus, dominant logic, and typical unit of analysis. While this ensures the depth of specialized research, it simultaneously creates a risk of conceptual isolation. The integrative gap lies in the insufficient explanation of how digital technologies, knowledge, organizational learning, trust, adaptation, and collective interaction together form a new quality of the logistics system.

4. Conceptual Boundaries of Logistics Intellectualization

The current stage of logistics development is characterized by changes not

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only in technologies, but in the very nature of logistics systems themselves. While previous stages of evolution were primarily associated with improving the management efficiency of material, financial, and information flows, today the capacity of systems to create, integrate, utilize, and reproduce knowledge is increasingly becoming the defining driver of development. Within this article, it is precisely this qualitative transformation that is examined as the intellectualization of logistics and supply chain management.

In contemporary scientific literature, the concept of intellectualization is most frequently linked to the digital transformation of logistics, the implementation of artificial intelligence, big data technologies, the Internet of Things, digital platforms, robotics, and other information and communication technologies [2-10; 14; 40]. Undeniably, these processes are crucial components of modern logistics system evolution. However, in our view, equating intellectualization exclusively with technological innovations substantially narrows the scope of this concept.

Technologies in and of themselves do not create an intelligent logistics system. They merely expand the capacities of humans, organizations, and networks regarding information processing, decision-making, and operational coordination. The decisive factor is not the presence of isolated digital tools, but the system's ability to learn, adapt to changes, accumulate knowledge, form new behavioral patterns, and ensure the effective interaction of a large number of autonomous participants. For this reason, intelligence should be viewed not as a property of an individual human or software algorithm, but as an emergent property of a logistics system that arises from the interaction of its elements.

This understanding reflects the natural evolution of logistics as a scientific discipline. While classical logistics focused on material flow management, and the supply chain management concept integrated material, information, and financial flows within a unified network, the current stage of development is characterized by a transition to managing knowledge, adaptability, interaction, and the collective capacity of logistics systems to learn and make decisions. Thus, intellectualization does not contradict previous concepts, but logically extends their evolution, elevating the subject of study to a new level of complexity.

Concurrently, the nature of logistics systems themselves is changing. They are increasingly exhibiting the characteristics of complex adaptive socio-technical ecosystems, in which humans, organizations, digital platforms, artificial intelligence algorithms, autonomous hardware assets, regulatory institutions, and global networks of knowledge creation and exchange interact. The behavior of such systems is determined not only by the optimization of individual processes, but also by mechanisms of self-organization, co-evolution, trust, inter-organizational coordination, and continuous adaptation to external shifts.

Under these conditions, the essence of management undergoes a fundamental change. Its subject becomes not merely material or information flows, but primarily the processes of knowledge creation, integration, sharing, capability development, trust building, decision-making support, and ensuring the capacity of logistics systems for self-learning and self-development. It is these characteristics that determine the competitiveness, resilience, and long-term efficiency of modern business ecosystems.

In this context, it is appropriate to differentiate four interconnected, yet distinct categories:

– Intellectualization of logistics and supply chain management is the process of developing the capabilities of logistics systems to create, integrate, utilize, and reproduce knowledge, make informed decisions, adapt, self-organize, and engage in collective interaction. This refers not merely to the adoption of digital technologies or artificial intelligence algorithms, but to the

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formation of a new operational quality of the system, in which knowledge, data, competencies, trust, and coordination become key drivers of development.

– An intelligent logistics system is an analytical system type of logistics system in which the capabilities for knowledge creation, learning, coordination, and adaptation have acquired a stable organizational, technological, and social form. Such a system functions as a complex adaptive socio-technical ecosystem whose development is sustained by the synergy of human intelligence, organizational memory and learning capacity, inter-organizational collective intelligence, and artificial intelligence.

– The conceptual framework of intellectualization is a scientific analytical tool that allows describing, comparing, and explaining the technological, cognitive, organizational, social, and evolutionary dimensions of logistics systems development. Its purpose is not to replace existing concepts of digitalization, automation, resilience, or knowledge management, but to explain their interrelationship within a broader systemic logic.

– The research agenda of intellectualization is a set of open questions, avenues, and hypotheses for further conceptual, empirical, and applied studies. It defines which aspects of the proposed framework require operationalization, empirical testing, critical refinement, and interdisciplinary discussion.

Thus, in this article, intellectualization is not equated with an analytical system type, a methodological framework, or a list of future topics. It is a process; an intelligent logistics system is an analytical type used to describe the stable form of this process; the conceptual framework is a method for its scientific analysis; and the research agenda is the direction for the further development of this analysis.

To substantiate scientific novelty, it is essential to show not only a positive definition of intellectualization, but also its distinction from related concepts already utilized in contemporary logistics literature. Digital logistics, smart logistics, Logistics 4.0/5.0, AI logistics, cognitive logistics, autonomous logistics, knowledge-based supply chain management, digital supply chain, resilience, and the concept of complex adaptive systems explain important, yet partial aspects of logistics transformation [1-25; 36-40]. The proposed framework (Table 2) does not deny these approaches, but clarifies their boundaries and integrates them into a broader logic of developing logistics system capabilities.

Table 2 – Conceptual boundaries of logistics intellectualization

Concept	What It Explains Best	Typical Boundary of Explanation	Unit of Analysis	How Intellectualization Differs
Digital Logistics / Digital Supply Chain	Data, platforms, flow integration	Weaker at explaining learning, trust, and self-organization	Process, enterprise, supply chain	Demonstrates how digital integration becomes a system's capability to learn
Smart Logistics / Logistics 4.0	Automation, sensors, cyber-physical systems	Tends toward technological determinism	Technical system, operation, supply chain	Treats technology as infrastructure rather than the essence of intellectualization
Logistics 5.0	Human-centricity, sustainability, responsibility	Does not always explain the mechanism of human, organizational, and AI interaction	Organization, supply chain, community	Specifies the logic of hybrid intelligence and human oversight
AI and Autonomous Logistics	Algorithmic decision-making,	May ignore accountability, context,	Task, function, autonomous asset	Treats AI as one of the sources of distributed intelligence

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	forecasting, autonomous action	and inter-organizational coordination		
Knowledge-Based SCM	Knowledge, competencies, organizational learning	Less fully incorporates digital infrastructure and algorithmic models	Organization, supply chain, partner network	Combines knowledge with technology, trust, and evolutionary adaptation
Supply Chain Resilience	Disruption response, recovery, viability	Frequently focuses on crises rather than continuous system learning	Supply chain, network, crisis event	Explains resilience as an emergent outcome of interacting capabilities
Complex Adaptive Supply Systems	Emergence, self-organization, co-evolution	Remains a overly broad systemic lens	Network, ecosystem	Operationalizes complexity through sources of intelligence, mechanisms, and dimensions

Source: developed by the author.

The presented comparison demonstrates that the scientific novelty of the proposed framework lies not in introducing yet another term for digital transformation, but in integrating the partial explanations that already exist across related concepts. Digital logistics and the digital supply chain effectively explain the role of data and platforms, yet reveal weaker explanations regarding the mechanisms of learning, trust, and social interaction. AI logistics concentrates on algorithmic decision support, but does not always account for organizational accountability and the hybrid nature of intelligence. Resilience explains responses to disruptions, yet requires a broader link to knowledge accumulation and the evolutionary development of the system. The concept of complex adaptive systems provides an overarching logic of self-organization, whereas intellectualization specifies it for logistics through sources of intelligence, transformation dimensions, and systemic outcomes.

5. Mechanistic-Process Model of Logistics Intellectualization

To prevent the proposed model from turning into a broad listing of sources, dimensions, and outcomes, it must be subordinated to a single central theoretical core. In this article, this core is formulated as follows: human intelligence, organizational memory and learning capacity, inter-organizational collective intelligence, and artificial intelligence – through mechanisms of knowledge sharing, coordination, organizational learning, and human oversight of algorithmic decisions – are transformed into adaptive capabilities of the logistics system. Consequently, intellectualization is explained not as the mere presence of numerous modern technologies or competencies, but as a process of converting distributed sources of intelligence into a system's capacity to learn, align actions, respond to disruptions, and update its own decision-making models.

The logic of the model is processual in nature: sources of intelligence transition into integration mechanisms; integration mechanisms shape adaptive capabilities across five dimensions; mature capabilities manifest in systemic outcomes; operational experience, feedback, and the consequences of implemented decisions update knowledge, coordination rules, and algorithmic models. As a result, the model demonstrates not only the components of intellectualization, but also the sequence of transformations, mediation, and cyclical learning within the system.

The generalized logic of transforming distributed sources of intelligence into adaptive capabilities and systemic outcomes of a logistics system is presented in Figure 2. The model reflects not only the components of intellectualization, but also the causal

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sequence of their interaction: sources of intelligence are integrated through knowledge sharing, analytical support, coordination, organizational learning, trust building, and human oversight of algorithmic decisions; these mechanisms shape system capabilities across cognitive, technological, organizational, social, and evolutionary dimensions, which under appropriate conditions leads to enhanced decision quality, adaptability, resilience, flexibility, sustainability, and value co-creation.

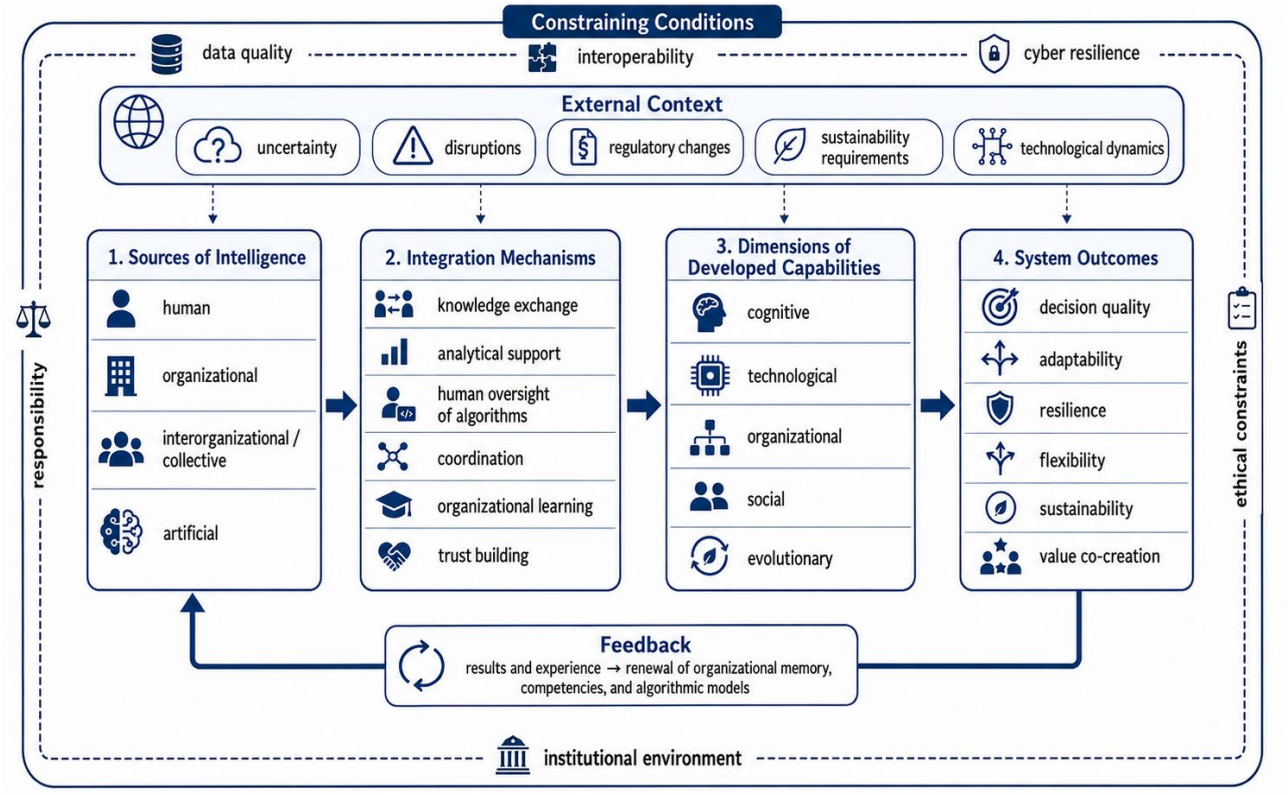

Figure 2 – Mechanistic model of logistics system intellectualization
Source: developed by the author.

As shown in Figure 2, the mere presence of human expertise, organizational memory, inter-organizational collective intelligence, or artificial intelligence technologies does not ensure the intellectualization of a logistics system. The decisive factor is the functioning of integration mechanisms that convert distributed knowledge, experience, data, and algorithmic recommendations into coordinated decisions and adaptive system behavior. Therefore, integration mechanisms constitute the central explanatory link of the proposed conceptual framework.

The model also demonstrates that systemic outcomes are not a guaranteed consequence of digitalization. Their formation depends on boundary conditions, including data quality, system interoperability, cyber resilience, accountability definition, ethical constraints, and the institutional environment. If these conditions are not met, digital technologies may fail to enhance system adaptability, instead scaling errors, increasing dependency on technological infrastructure, and creating new organizational and cybernetic risks.

Feedback completes the processual loop of intellectualization. Data on decision outcomes, experience in disruption response, identified errors, and emerging practices must flow back into the system in the form of updated organizational memory, competencies, coordination procedures, and algorithmic models. In this manner,

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intellectualization emerges not as a one-off technological transformation, but as a cyclical process of learning and development within the logistics system.

The first link of the model is sources of intelligence. They answer the question of whose or what intelligence is leveraged in the development of the logistics system. These include:

– Human intelligence, associated with professional knowledge, experience, expertise, and managerial accountability.

– Organizational memory and learning capacity, manifested in accumulated procedures, culture, knowledge, response rules, and the organization's ability to convert experience into new managerial practices.

– Inter-organizational collective intelligence, i.e., the ability of autonomous network participants to co-create knowledge, align decisions, and adapt behavior.

– Artificial intelligence, implemented through algorithms, analytical systems, digital agents, digital twins, and autonomous technologies.

The second link is integration mechanisms. They perform the core explanatory function of the model by demonstrating under what conditions distinct sources of intelligence cease to be isolated resources and begin to form systemic capability. Knowledge sharing ensures the transfer of experience, data, and practical interpretations among humans, organizations, and digital systems. Coordination aligns the decisions of autonomous or semi-autonomous supply chain participants. Organizational learning transforms isolated disruption responses into stable rules, procedures, competencies, and updated behavioral models. Human oversight of algorithmic decisions guarantees accountability, explainability, and the adjustment of automated recommendations in situations of high uncertainty. Trust in this model is viewed as a prerequisite for effective knowledge sharing and a mechanism for inter-organizational coordination, rather than an independent systemic outcome.

The third link is mature capabilities across the five dimensions of intellectualization:

– The cognitive dimension reflects the capacity to create, accumulate, integrate, and utilize knowledge.

– The technological dimension captures the ability to employ digital platforms, AI, digital twins, the Internet of Things, robotic systems, and big data analytics as the infrastructure for intelligent management.

– The organizational dimension characterizes not a source of intelligence, but the transformation of structures, roles, decision rights, coordination procedures, and interaction models among autonomous actors.

– The social dimension reflects the capacity to sustain trust, collaboration, leadership, human capital development, and collective decision-making.

– The evolutionary dimension characterizes the capacity for self-organization, innovative development, co-evolution, and continuous adaptation under conditions of high uncertainty.

Thus, organizational memory and learning capacity act as a source of intelligence, whereas the organizational dimension describes the domain of structural and managerial system transformation.

The fourth link is systemic outcomes. The immediate integral outcome of intellectualization is the adaptive capability of the logistics system – that is, the capacity to modify decisions, routes, roles, procedures, partnerships, and resource deployment models in response to shifting conditions. Through this capability, broader systemic outcomes can take shape: decision quality, resilience, sustainability, flexibility, and value co-creation. At the same time, these outcomes are not guaranteed by products of digitalization or AI implementation. They emerge only when sources of intelligence are integrated through the specified mechanisms and anchored within the corresponding

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cognitive, technological, organizational, social, and evolutionary capabilities.

This structuring aligns the distinct elements of the authorial concept within a single unified model and mitigates the risk of excessive combinatorics. Sources of intelligence do not substitute for the dimensions of intellectualization, but explain the origin of knowledge, experience, decisions, and algorithmic recommendations. Integration mechanisms are not an additive list of factors, but represent a causal bridge between distributed intelligence and the adaptive capability of the system. Dimensions are not types of intelligence, but delineate the domains in which this capability is anchored. Systemic outcomes are not an automatic consequence of digitalization, but arise provided that integration mechanisms genuinely convert individual resources into coordinated logistics system behavior.

Figure 2 establishes the sequence: "sources of intelligence → integration mechanisms → capabilities across five dimensions → systemic outcomes → experience and feedback → knowledge and model updates". This mode of presentation is essential for a conceptual article: it demonstrates causality, mediation, boundary conditions, and cyclical system learning, rather than offering a static list of components.

From a methodological standpoint, the mechanistic-process model enables the integration of a wide spectrum of contemporary research streams into a single conceptual framework [1-40]. Digital twins, artificial intelligence, big data, the Internet of Things, blockchain, autonomous transport, digital trade and logistics corridors, circular and humanitarian logistics, resilience management, business ecosystems, and other avenues cease to be treated as isolated objects of study. They emerge as diverse sources, infrastructures, or contexts for intelligence integration, the impact of which depends on whether knowledge sharing, coordination, organizational learning, human oversight of algorithmic decisions, and feedback loops are effectively secured.

In this lies the strategic value of the proposed concept. It is not intellectualization itself, but the conceptual framework of its analysis that unites the findings of different scientific schools, refines the conceptual apparatus, and creates a methodological foundation for subsequent conceptual and empirical studies in logistics and supply chain management. Within this article, the authors deliberately refrain from proclaiming intellectualization a new scientific paradigm; such status can only be recognized through broader adoption of this problem-formulation approach, explanatory logic, and method selection within the scientific community. Therefore, the research agenda of intellectualization is presented as an open set of propositions and questions requiring further operationalization, critical discussion, and empirical validation.

5.1. Propositions for Further Testing

To prevent the proposed model from remaining merely a descriptive framework, it must be translated into propositions suitable for subsequent operationalization (Table 3). These propositions operate across different levels: theoretical propositions describe causal and mediated relationships within the logistics system; the methodological proposition clarifies the unit of analysis; and the institutional proposition addresses the journal's role in shaping the research field (and is presented separately in Section 7). This division prevents the conflation of systemic theory, research methodology, and editorial policy.

The presented theoretical propositions serve two key functions. First, they render the conceptual framework open to academic debate: each proposition can be supported, refined, or contested in subsequent research. Second, they transform the general model of intellectualization into a set of testable relationships between sources of intelligence,

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integration mechanisms, transformation dimensions, and systemic outcomes.

Table 3 – Theoretical propositions of the conceptual framework of logistics intellectualization

Proposition	Content	Direction of Testing
1. Complementarity of Dimensions	Intellectualization is determined not by the maximum development of a single dimension, but by the alignment of cognitive, technological, organizational, social, and evolutionary dimensions.	Comparison of balanced versus technology-dominant profiles of logistics systems.
2. Mediated Impact of AI	Artificial intelligence enhances adaptability only through data quality, organizational learning, and human oversight of algorithmic decisions.	Testing the mediating effect of data, learning, and human-in-the-loop mechanisms.
3. Emergent Nature of Resilience	Resilience is an emergent outcome of interacting technological, social, and organizational capabilities, rather than a direct consequence of digitalization.	Comparison of digital sophistication with actual recovery speed and adaptability.
4. Integration of Distributed Intelligence	Human, organizational, inter-organizational, and artificial intelligence are converted into adaptive capabilities through knowledge sharing, coordination, learning, and oversight.	Analysis of the role of integration mechanisms between sources of intelligence and systemic outcomes.

Source: developed by the author.

The methodological proposition of this article asserts that intellectualization alters the primary unit of analysis in logistics science: shifting from an individual process or enterprise to a supply chain, network, and socio-technical ecosystem. This proposition does not describe an internal causal mechanism within the logistics system, but specifies the level at which such a system should be investigated. It can be tested by comparing the explanatory power of models operating at different scales: functional, organizational, network, and ecosystemic.

5.2. Boundary Conditions and Risks of Intellectualization

The mechanistic-process model of intellectualization does not assume an automatic transition from digitalization or AI implementation to adaptability, resilience, sustainability, and value creation. On the contrary, its explanatory strength also lies in revealing when the expected positive effect may fail to materialize. If sources of intelligence are not integrated through effective knowledge sharing, coordination, organizational learning, and human oversight of algorithmic decisions, intellectualization can introduce new vulnerabilities or scale existing errors.

Consequently, intellectualization must be viewed not as a linearly positive process, but as an ambivalent transformation of a complex socio-technical system. It can enhance adaptability only in the presence of sufficient data quality, transparent algorithmic procedures, distributed accountability, cyber resilience, system interoperability, preservation of human expertise, and balanced data access rules. In the absence of these conditions, the very same technologies and organizational mechanisms can amplify algorithmic opacity, platform lock-in, data power concentration, cyber risks, automated erroneous decisions, local optimization at the expense of the system, and the environmental costs of digital infrastructure.

The most critical boundary conditions include data quality and availability, algorithmic transparency, meaningful human oversight, digital system interoperability, cyber resilience, equitable data access rules, and the organizational capacity to retain critical expertise. Lacking these,

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intellectualization may weaken rather than strengthen the system: scaling faulty decisions, diluting accountability, deepening platform lock-in, generating cascading digital vulnerabilities, reinforcing localized optimization to the detriment of the network, or increasing the environmental footprint of digital infrastructure.

Thus, the intellectualization model must not only explain the desired developmental trajectory of logistics systems, but also define its boundaries. This distinction is vital for subsequent operationalization: future empirical studies must test not only the direct or mediated positive impacts of intellectualization, but also the conditions under which these effects diminish, reverse direction, or yield unintended consequences. For this reason, risks, constraints, and negative scenarios are not external add-ons to the concept, but an integral part of its theoretical architecture.

6. Research Agenda

The rapid transformation of the global economy, business process digitalization, geopolitical instability, climate challenges, and accelerated technological progress impose fundamentally new demands on logistics science. Under these conditions, establishing a long-term academic research agenda – which consolidates the efforts of the scholarly community around the most promising and socially significant issues – becomes just as critical as analyzing current operational processes.

The editorial board of the journal operates on the premise that modern logistics is undergoing a transition from predominantly functional flow management to the governance of complex adaptive socio-technical systems. Therefore, a Research Agenda cannot be limited to a mere list of thematic priorities. It must capture unresolved scientific problems, formulate research questions, define units of analysis, propose theoretical lenses, guide authors on appropriate methodologies, and outline the type of scientific contribution expected from future submissions.

To this end, the journal's research avenues are presented as a system of research clusters (Table 4). Each cluster directly connects to the mechanistic-process model of intellectualization proposed in this article: sources of intelligence specify which actors or systems generate knowledge, decisions, and algorithmic recommendations; integration mechanisms explain the bridge from isolated resources to adaptive capabilities; intellectualization dimensions delineate the domains where these capabilities become embedded; and systemic outcomes define the expected effects to be conceptually explained or empirically tested.

The established research agenda is not a simple inventory of thematic topics, but a system of interconnected research clusters. To reflect its internal logic, the clusters are structured across three levels: sources and mechanisms of intelligence; systemic properties and domains of application; and methodological research support. The architecture of the research agenda is presented in Figure 3.

As shown in Figure 3, the first level unites clusters that investigate the sources and mechanisms for building the intellectual capabilities of a logistics system: hybrid intelligence, autonomous systems, digital trust, knowledge, and human capital. These avenues explain which actors, technologies, and mechanisms create knowledge, shape decisions, enable human-algorithm interaction, and support inter-organizational coordination.

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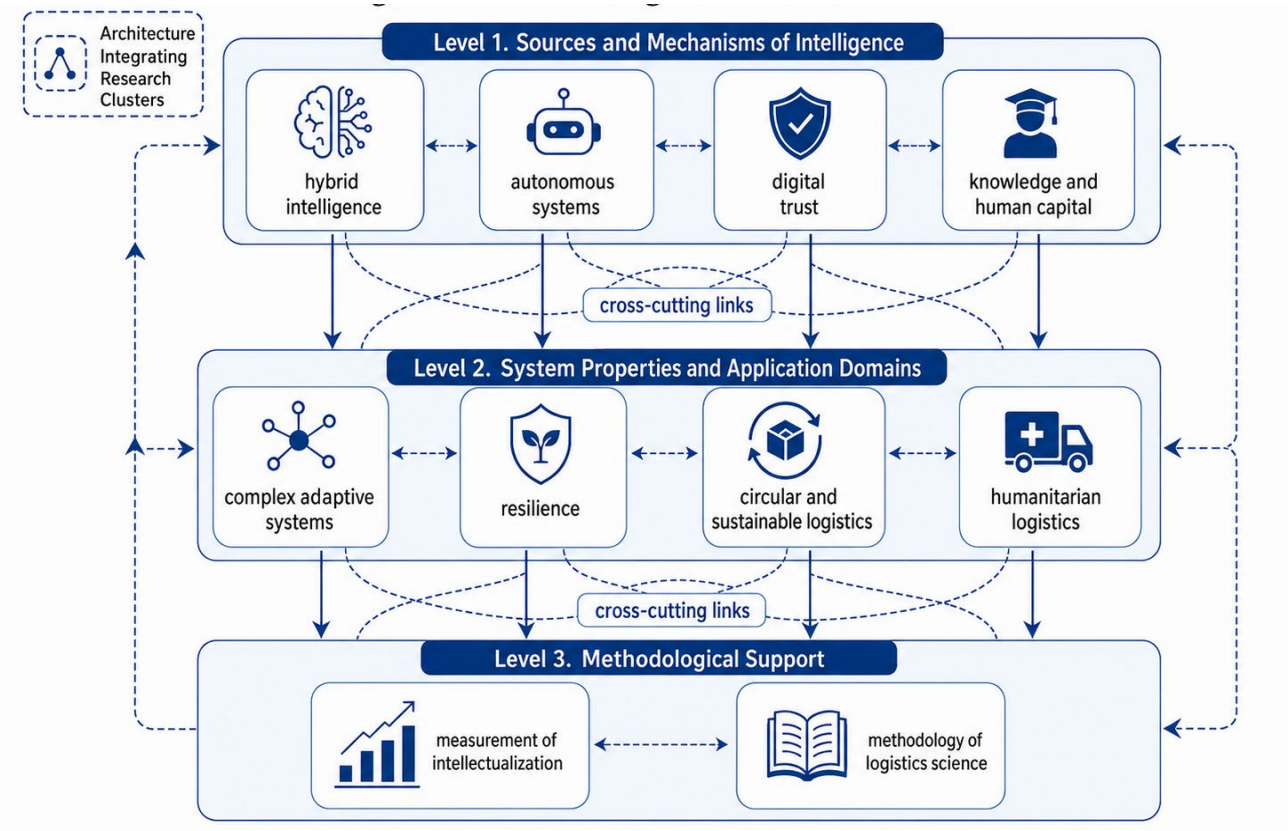

Figure 3 – Research agenda architecture
Source: developed by the author.

The second level encompasses systemic properties and practical application domains of intellectualization: complex adaptive systems, resilience, circular and sustainable logistics, and humanitarian logistics. Within these clusters, research focuses on how the combination of human, organizational, inter-organizational, and technological capabilities influences logistics system adaptation, performance under disruption, resource flow sustainability, and societal resilience.

The third level provides the methodological support for the research program, covering the measurement of intellectualization and the methodological development of logistics science. It ensures concept operationalization, indicator development, unit-of-analysis selection, theoretical proposition testing, and cross-comparison of findings across studies. At the same time, the boundaries between levels remain flexible: cross-cutting linkages demonstrate that each thematic cluster requires an appropriate methodological toolkit, while empirical insights should continuously feed back into refining concepts, models, and research methods.

Figure 3 illustrates the overarching architecture and interdependence of the research clusters. Their substantive breakdown – unresolved problems, core research questions, units of analysis, plausible theoretical lenses, recommended methodologies, and expected types of scientific contribution – is detailed in Table 4.

The presented Research Agenda transforms the journal's thematic profile into an instrument of scientific orientation. Its core logic lies not in establishing an exhaustive list of topics, but in helping authors navigate from a general subject to a research problem, from a problem to a question, and from a question to an appropriate unit of analysis, theoretical lens, and testing methodology. It is precisely this transition that renders the editorial policy not only thematic, but also methodological.

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Table 4 – The journal's Research Agenda as a system of research clusters

Cluster	Unresolved Problem	Core Question	Unit of Analysis & Methods	Expected Contribution
Hybrid Intelligence	Allocation of decisions among human, organization, network, and AI	When does a hybrid decision outperform a purely human or algorithmic one?	Team, process, network; experiments, case studies, agent-based modelling	Accountability distribution models; empirical evidence
Autonomous Systems	Boundaries of control and accountability of autonomous agents	How does autonomization transform the management of logistics operations?	Operation, warehouse, route; design science, simulations, digital twins	Governance architectures; autonomy metrics
Complex Adaptive Systems	Transition from local decisions to systemic properties	How do local rules shape network adaptability or vulnerability?	Chain, ecosystem; network analysis, system dynamics	Explanatory models; testable hypotheses
Resilience	Transforming crisis experience into long-term capability	Which mechanisms build resilience following disruptions?	Chain, critical infrastructure; longitudinal studies, case studies	Adaptation models; assessment methodologies
Digital Trust	Data sharing among autonomous actors	Which rules ensure trust without excessive centralization?	Platform, corridor; comparative case studies, design science	Trust architectures; interoperability criteria
Circular and Sustainable Logistics	Aligning sustainability, closed-loop flows, and digital coordination	How does collective intelligence impact circular flows?	Flow network, ecosystem; LCA, modelling, case studies	Integrative models; sustainability metrics
Humanitarian Logistics	Balancing speed, fairness, transparency, and trust	How to coordinate humanitarian supply chains under extreme uncertainty?	Community, humanitarian chain; action research, scenario planning, network analysis	Applied coordination models; policy recommendations
Knowledge and Human Capital	Transition from individual expertise to systemic capability	How do learning and competencies drive supply chain adaptation?	Specialist, team, organization; surveys, interviews, SEM	Measurement scales; competency models
Methodology of Intellectualization	Risk of substituting intellectualization with digitalization metrics	Which indicators reflect the capacity to learn and adapt?	System, chain, ecosystem; Delphi method, scale validation, bibliometrics	Concept operationalization; research agendas

Source: developed by the author.

The identified clusters are not isolated. For instance, studies on hybrid intelligence are directly linked to digital trust, autonomous systems, knowledge management, and the methodology of measuring intellectualization. Research on resilience intersects with humanitarian logistics, complex adaptive systems, and the circular recovery of material flows. Therefore, the journal's mission extends beyond accepting manuscripts on individual topics to supporting works that build inter-cluster bridges and generate a cumulative scientific contribution.

Principles of Building the Editorial Portfolio

The established priorities do not imply restricting the journal's thematic scope. On the contrary, they form an open framework

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for advancing scientific inquiry. The editorial team seeks to support works that:

1. Formulate a clear unresolved problem, rather than merely describing a trendy topic.
2. Offer research questions, hypotheses, or conceptual propositions open to debate or empirical testing.
3. Define the unit of analysis and the boundary conditions for the applicability of conclusions.
4. Combine a theoretical lens with methodologies suited for conceptual or empirical validation.
5. Generate a scientific contribution across one or several levels: empirical evidence, methods, models, concepts, theories, or research agendas.
6. Adhere to the principles of open science, reproducibility of results, and international academic collaboration.

Thus, the journal's Research Agenda serves not as a closed list of subjects, but as an open research platform. Its purpose is to cultivate an intellectual domain where current logistics trends are transformed into scientific problems, testable questions, methodologically sound research designs, and cumulative contributions to the field of logistics science.

7. The Academic Journal as an Institutional Mechanism for Field Development

Scientific progress is driven not only by the emergence of new research findings, but also by the presence of institutions capable of facilitating their critical reflection, integration, and continuous development. Traditionally, the academic journal has served as one such core institution. However, amid the rapid growth of scientific information, deepening interdisciplinarity, and the globalization of scholarly communication, its role is shifting significantly.

In the context of establishing the field of logistics intellectualization, a journal can fulfill five interconnected functions:

– Representative function. Ensures the quality of academic communication, rigorous double-blind peer review, and the international visibility of research findings.

– Integrative function. Unites diverse disciplines, methodologies, and research traditions.

– Concept-forming function. Supports publications that construct new concepts, models, typologies, and theoretical propositions.

– Foresight function. Identifies emerging research problems, organizes special issues, and shapes the Research Agenda.

– Platform function. Builds an open intellectual ecosystem that connects authors, reviewers, editors, early-career researchers, practitioners, and international partners.

The influence of an academic journal on the development of a research field extends beyond selecting and disseminating individual papers. Through editorial policy, peer review standards, special thematic issues, support for conceptual papers, research agenda setting, and the expansion of academic networks, the journal shapes which types of scientific contribution gain recognition, which questions become subjects of future research, and how a shared scientific language is formulated. The generalized mechanism of this impact is illustrated in Figure 4.

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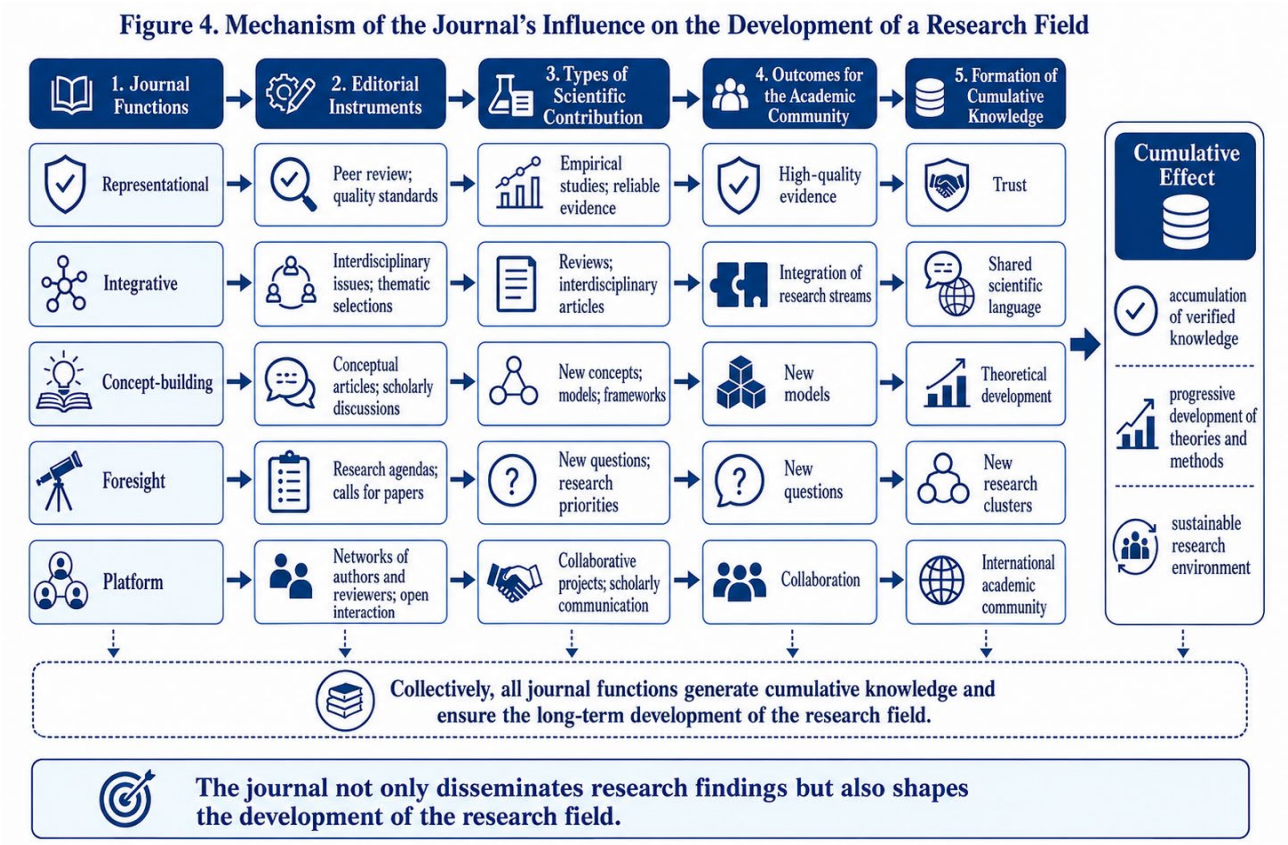

Figure 4 – Mechanism of the Journal`s influence on the development of a research field
Source: developed by the author.

As shown in Figure 4, each function of the journal is operationalized through a specific set of editorial instruments and fosters corresponding types of scientific contribution. The representative function, enforced via peer review and quality standards, supports the generation of reliable empirical evidence and reinforces trust in published findings. The integrative function, executed through interdisciplinary issues, thematic collections, and review papers, facilitates the convergence of research streams and the formulation of a shared scientific language. The concept-forming function creates space for novel concepts, models, and theoretical frameworks, whereas the foresight function translates emerging problems into new research questions, priorities, and thematic clusters. The platform function enables interaction among authors, reviewers, and institutions, sustaining collaborative projects, professional communication, and the growth of the international academic community.

The interplay of these functions yields not a mere sum of discrete publications, but the gradual accumulation of knowledge. Cumulative knowledge arises when new studies build upon prior findings, refine concepts, test models, compare methodologies, and uncover new research questions. Within this logic, the journal operates not merely as a channel of academic communication, but as an institutional mechanism supporting the consistent advancement of theory, methodology, and the research community.

At the same time, the presented diagram is conceptual rather than empirically proven. It depicts a hypothesized mechanism of journal impact that warrants further validation through the analysis of publication thematic structures, citation patterns, interdisciplinary linkages, co-authorship networks, and the emergence of new

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research clusters. This provides grounds to treat the institutional role of the journal as a distinct avenue for future inquiry, rather than an established fact.

Thus, the journal's functions, editorial instruments, and supported types of scientific contribution constitute an interconnected institutional loop. Its performance is measured not by the volume of published material, but by the publication's capacity to ensure evidence quality, knowledge integration, concept development, question generation, and the sustainability of academic engagement.

The institutional proposition of this article asserts that an academic journal influences the development of a research field not only through manuscript selection, but also by defining the admissible types of scientific contribution, interdisciplinary linkages, and open research questions. This proposition belongs not to the operational theory of logistics systems, but to the domain of academic field institutionalization. It can be tested through the analysis of publication thematic structures, the proportion of conceptual and methodological papers, citation interdisciplinarity, co-authorship networks, special thematic issues, and the volume of articles building upon the published Research Agenda.

Editorial instruments for implementing these functions may include special issues, invited conceptual papers, perspective papers, methodological debates, literature reviews with explicitly defined research gaps, methodological transparency requirements, open data support where feasible, the publication of research agendas, and the encouragement of interdisciplinary peer review. Such instruments enable the journal to shape not only publication topics, but also the types of scientific contribution recognized as meaningful for field advancement.

The role of the journal is appropriately framed not around a "quality pyramid," but across distinct levels of abstraction in scientific contribution. Empirical evidence provides the factual foundation; methods and tools enhance research reproducibility; models explain underlying mechanisms; concepts and frameworks refine scientific terminology; and theories alongside research programs shape the long-term agenda. None of these levels is inherently "superior" in quality: theoretical generalizations require validation, while empirical findings derive scientific weight through validity, transparency, and cumulative integration into broader scholarly discourse.

The anticipated outcomes of this institutional role encompass not simply an increase in publication output, but an enhancement in evidence quality, the development of a shared research language, the emergence of novel conceptual frameworks, the strengthening of international research networks, and the accumulation of knowledge in the field of logistics intellectualization. In this process, open science acts not as a decorative principle, but as a prerequisite for trust – safeguarding methodological transparency, responsible data usage, ethical peer review, and the verifiability of research results.

8. Discussion

The proposed framework holds merit only if it explains more than existing concepts of digital transformation in logistics. Compared to Logistics 4.0, its explanatory advantage lies not in an expanded roster of technologies, but in a distinct research query. Logistics 4.0 primarily addresses how digital, cyber-physical, platform, and analytical solutions reconfigure operations, processes, and supply chain integration [1-6; 11-18]. Intellectualization, by contrast, asks under what conditions these solutions are converted into a system's capacity to learn, coordinate, adapt, and make responsible decisions. Therefore, a digital twin, a predictive algorithm, or a data-sharing platform does not in itself constitute evidence of intellectualization. These tools become elements of intellectualization only when

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embedded within mechanisms of knowledge creation, organizational learning, human oversight, inter-organizational trust, and feedback loops.

Compared to Logistics 5.0, the proposed framework clarifies the precise interaction among human-centricity, sustainability, technological advancement, and adaptability. Logistics 5.0 importantly shifts focus from purely technocratic automation toward human agency, social responsibility, and sustainable development [19-25]. However, human-centricity alone does not fully explain how human expertise interacts with organizational memory, algorithmic models, and the collective knowledge of the network. The intellectualization framework introduces a mechanistic explanation to this relationship: human intelligence does not merely "remain at the center," but fulfills functions of interpretation, critical oversight, contextualization of algorithmic recommendations, and accountable decision-making under uncertainty. In this sense, intellectualization does not compete with Logistics 5.0, but provides a more precise language for describing the hybrid intelligence of logistics systems.

The relationship between intellectualization and knowledge-based supply chain management warrants distinct delineation. Knowledge-based supply chain management has long emphasized the value of knowledge, competencies, learning, and inter-organizational experience sharing [27; 36-38]. The intellectualization framework does not refute this tradition, but extends it along at least three vectors. First, knowledge is viewed not merely as an organizational or network resource, but as an emergent property resulting from the interaction of human, organizational, inter-organizational, and artificial forms of intelligence. Second, the focus expands beyond knowledge accumulation to encompass its algorithmic representation, automated updating, explainability, and governance. Third, knowledge is linked to the evolutionary adaptation of the system: the critical metric becomes not the mere existence of a knowledge base or skill set, but the system's capacity to modify its behavioral rules in response to disruptions, errors, and novel environmental signals.

Regarding complex adaptive systems (CAS) theory, the proposed framework occupies an intermediate position between a general system metaphor and an operationalized model of logistics transformation. CAS theory effectively explains self-organization, non-linearity, emergence, and co-evolution, yet often remains at a high level of abstraction. Intellectualization operationalizes these concepts for logistics through sources of intelligence, integration mechanisms, five transformation dimensions, and systemic outcomes. Its contribution lies not in replacing complexity theory, but in demonstrating which specific socio-technical mechanisms can convert localized actor decisions, digital signals, algorithmic recommendations, and organizational experience into adaptive supply chain or ecosystem capabilities.

The most debatable proposition within the framework is the complementarity of dimensions. It posits that a high level of technological development cannot compensate for deficiencies in organizational learning, trust, or human oversight. This is a strong, non-trivial proposition. In certain contexts, the technological dimension may indeed exert a dominant influence – such as in standardized operations with high data quality and low environmental uncertainty. In other contexts – particularly during crises, wartime disruptions, information scarcity, or interactions among autonomous actors – technological superiority can be neutralized by a lack of coordination and trust. Thus, complementarity should be treated not as an axiom, but as a hypothesis sensitive to the type of logistics system, the level of uncertainty, and the nature of actor interdependence.

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The proposition regarding the mediated impact of artificial intelligence is similarly open to debate. The proposed framework assumes that AI does not directly generate adaptability, but acts through data quality, organizational learning, and human oversight. An alternative explanation holds that in specific operational tasks, algorithmic optimization can improve outcomes independently of deep organizational transformation. For example, more accurate demand forecasting or route optimization can yield immediate, function-level gains. However, such localized gains do not constitute systemic intellectualization unless the organization can explain the underlying decisions, update operational rules, transfer knowledge across actors, or prevent error scaling. This represents the boundary between an effective digital tool and the evolution of an intelligent logistics system as an analytical construct.

Alternative explanations also exist for the phenomena attributed here to intellectualization. Enhanced resilience may stem not from collective intelligence, but from redundant inventory, supplier diversification, regulatory mandates, or financial reserve accumulation. Improved decision quality may result from centralized governance, procedure standardization, or third-party technology adoption rather than intelligence source integration. Increases in sustainability may be driven by normative constraints, market pressures, or customer requirements rather than intellectualization. Acknowledging these alternatives prevents intellectualization from becoming a catch-all explanation for any positive performance outcome. Future empirical studies must explicitly compare these competing mechanisms rather than simply confirming the ideal logic of the proposed model.

For these reasons, the core tenets of the model are formulated to be falsifiable:

– The complementarity of dimensions proposition can be refuted if empirical evidence demonstrates that a single dominant dimension (e.g., technological) consistently explains system adaptability better than a balanced profile across dimensions.

– The mediated impact of AI proposition can be challenged if direct effects of algorithmic solutions on adaptability persist after controlling for data quality, organizational learning, and human oversight.

– The emergent nature of resilience proposition will be weakened if resilience proves to be primarily a function of structural redundancy or contractual mechanisms rather than the interaction of technological, social, and organizational capabilities.

– The distributed intelligence integration proposition will require revision if empirical findings reveal that sources of intelligence impact outcomes independently, without significant mediation by coordination, learning, or feedback loops.

A critical corollary of this discussion is the distinction between digitalization and intellectualization. Digitalization fails to transition into intellectualization when data remains fragmented, inaccurate, or inaccessible to key stakeholders; when algorithms remain opaque and unsubjected to meaningful human oversight; when digital platforms deepen actor dependence instead of fostering reciprocal coordination; when an organization automates outdated or flawed procedures; when technology implementation is uncoupled from personnel learning and decision-rule updating; or when local optimization of a single function compromises overall supply chain performance. In such instances, a system may become more digital, but it does not become more intelligent.

Ultimately, the value of the proposed framework lies not in declaring a new milestone in logistics evolution, but in formulating a testable research problem: which combinations of intelligence sources, integration mechanisms, organizational conditions, and socio-technical constraints

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generate true adaptive capabilities in logistics systems? Its theoretical contribution consists in explaining the transition from technological sophistication to systemic capacity for learning and adaptation. Its methodological contribution lies in shifting the unit of analysis toward the network and socio-technical ecosystem. Its institutional contribution rests on positioning the journal not merely to reflect an established field, but to provide a venue for its critical validation, refinement, and expansion. Critical falsifiability – rather than rhetorical appeal – must determine the enduring scholarly viability of the logistics intellectualization concept.

9. Conclusion and Directions for Future Research.

This article has established the utility of conceptualizing the intellectualization of logistics and supply chain management as an integrative conceptual framework and an open research agenda. The primary outputs include narrowing and refining the problem domain, systematizing core streams in contemporary logistics research, identifying the integrative gap among them, articulating a methodology for conceptual synthesis, delineating key analytical categories, constructing a mechanistic-process model of intellectualization, formulating four theoretical propositions, specifying a distinct methodological proposition on the unit of analysis, identifying boundary conditions and risks, constructing a Research Agenda, and detailing an institutional proposition regarding the role of the academic journal.

The scientific contribution of this paper rests on framing logistics intellectualization not as a technological trend, but as a systemic process through which logistics systems develop capabilities for learning, coordination, adaptation, self-organization, and decision-making. The proposed model explains how human intelligence, organizational memory and learning capacity, inter-organizational collective intelligence, and artificial intelligence – mediated by knowledge sharing, coordination, organizational learning, and human oversight of algorithmic decisions – are converted into adaptive capabilities across cognitive, technological, organizational, social, and evolutionary dimensions. The theoretical propositions translate this conceptual logic into testable relationships, the methodological proposition clarifies the appropriate scale of analysis, and the institutional proposition highlights the role of the journal in driving field development.

Future research should focus on operationalizing the dimensions of intellectualization, developing measurement scales and indicators, empirically testing the impact of AI on adaptability and resilience, investigating hybrid intelligence in logistics decision-making, examining digital trust in decentralized ecosystems, and conducting comparative analyses across units of analysis: process, enterprise, supply chain, network, and socio-technical ecosystem. Negative scenarios of intellectualization require dedicated empirical inquiry: algorithmic opacity, cyber risks, technology vendor lock-in, erosion of human expertise, localized optimization at system expense, and the environmental footprint of digital infrastructure. A final avenue for future investigation concerns academic communication itself: evaluating how editorial policies, open data practices, special thematic issues, and conceptual papers shape the emergence and institutionalization of new research fields.

Accordingly, this article does not claim to conclude the debate. Its objective is to establish a methodologically grounded framework suitable for critical discourse, refinement, operationalization, and empirical testing in future studies. This aligns with the purpose of a foundational conceptual paper and the editorial mission of the journal Intellectualization of Logistics and Supply Chain Management.

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