

Enhancing Supply Chain Resilience Through Internet of Things Integration: A Systematic Literature Review

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Abstract. This systematic review is based on a search of five bibliographic databases covering the period from 2019 to 2025, from which an explicit inclusion process selected 34 articles. The Internet of Things (IoT) enhances supply chain resilience by providing real-time operational visibility and, through its integration with artificial intelligence (AI), blockchain technology, and cloud computing, by reducing operational uncertainty. Several obstacles persist, such as limited interoperability, ineffective governance, and a skills gap, particularly in cybersecurity. Interest in supply chain research has grown in the literature over the past decade, but studies of resilience in emerging economies remain insufficient.

Keywords. Digital transformation; Industry 4.0; Internet of Things; supply chain resilience; systematic literature review

I. INTRODUCTION

Supply chains have become increasingly vulnerable to crises such as the COVID-19 pandemic, geopolitical tensions, and logistical disruptions [24], [31], [37]. These events have revealed several weaknesses in the ability of supply chains to anticipate, respond to, and recover from disruptions. In this context, the Internet of Things (IoT) is no longer considered a secondary technology. It has become an important component of Industry 4.0, particularly because it supports data governance and enables real-time analysis across the supply chain [25], [33].

The literature has shown growing interest in the role of the IoT in supply chain resilience. Several studies present the IoT as a strategic lever that improves visibility, eases information sharing, and strengthens the ability of firms to respond to unexpected events [38]. This contribution also depends on the integration of the IoT with other digital technologies. The ABCD framework, for example, combines artificial intelligence, blockchain, cloud computing, and data analytics [30]. These technologies may complement the IoT and improve the collection, processing, and use of operational data. Similar developments have been observed in sectors such as agri-food [3] and logistics [10]. Bibliometric analyses also confirm that academic interest in this field has continued to increase [27].

The findings of previous studies remain limited in geographical coverage, however. Most research has been conducted in China, Europe, and the United States. This concentration may limit the generalization of the findings to countries with different institutional, technological, and infrastructural conditions [14], [27], [28]. The adoption and

use of the IoT may differ according to the availability of digital infrastructure, financial resources, technical expertise, and institutional support. The issue is particularly relevant to Morocco, the Middle East and North Africa (MENA) region, and Africa, where empirical evidence remains limited. The present study addresses this research gap through a systematic review covering 2019 to 2025. It examines how the IoT contributes to supply chain resilience and identifies the factors that support or constrain this contribution. Section II presents the methodology. Sections III and IV present and discuss the main findings and propose directions for future research, and Section V concludes the study.

II. RESEARCH METHODOLOGY

In accordance with the guidelines of Kitchenham and Charters [35], the research questions were defined before data collection, as the systematic literature review (SLR) protocol requires. The approach goes beyond a simple descriptive synthesis by incorporating technological, organizational, and contextual dimensions, and so examines the contribution of the IoT to supply chain resilience from a broader perspective than the current literature.

A. Research Questions

In light of these observations, this study addresses these gaps through a rigorous SLR conducted in accordance with the guidelines of Kitchenham and Charters [35], [39]. The review is structured around four research questions (RQs):

RQ1: How has the literature addressed the relationship between the IoT and supply chain resilience?

RQ2: What factors and challenges influence the adoption of the IoT to strengthen this resilience?

RQ3: What lessons can be drawn for emerging economies, particularly Morocco?

RQ4: What limitations and future directions emerge from the literature?

B. Research and Selection Process

The search was conducted in Scopus, Web of Science, Google Scholar, ScienceDirect, and Springer. The search

string combined the terms “Internet of Things,” “IoT,” “supply chain resilience,” “supply chain,” “resilience,” “adoption,” “integration,” “implementation,” “digital transformation,” and “Industry 4.0.” After identification, removal of duplicates, screening by title and abstract, and full-text reading, 34 studies were included in the final analytical corpus. The stages of this process are shown in Fig. 1.



Fig. 1. Data extraction and synthesis process.

The article selection followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol [36], which ensures transparency and reproducibility. The steps are shown in Fig. 2.

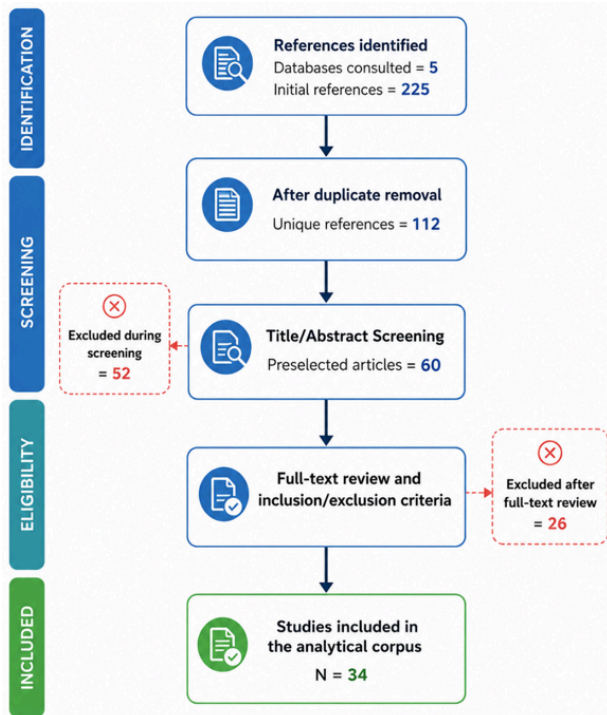


Fig. 2. Study search and selection process, adapted from the PRISMA framework.

C. Quality Assessment

Each article was evaluated against three questions: QA1, clarity of the inclusion and exclusion criteria; QA2, transparency and reproducibility of the method; and QA3,

relevance of the results to the IoT, to supply chain resilience, or to both. Each question was scored 1, 0.5, or 0. The scores obtained range from 2.0 to 3.0, which confirms the overall quality of the corpus.

D. Data Collection

Data were extracted manually into a structured grid covering the study identifier, title and abstract, authors, publication, geographic context, year, methodological type, and database. A second level of coding classified the articles by analytical family, resilience mechanism, and contribution to the research questions.

III. RESULTS

A. Research Results

The final corpus comprises 34 articles published between 2019 and 2025. It covers a variety of sectors, including agri-food, pharmaceuticals, manufacturing, the cold chain, inter-modal logistics, and global digital transformation. Quantitative studies, systematic reviews, bibliometric analyses, and conceptual works complement one another and form a field now mature enough to be interpreted as a structured discipline. Table 1 summarizes the main characteristics of the included studies and shows the thematic and methodological diversity of the literature analyzed.

B. Article Quality Assessment

Each criterion was scored on the following scale: yes, 1 point; partially, 0.5 points; no, 0 points. The maximum total score is 4 points. Only articles with a total score of 2 or higher were included in the final corpus, which ensures a minimum level of quality while keeping sufficient coverage of the literature. Table 2 presents the quality assessment scores of the 34 selected studies on the four criteria (QA1 to QA4).

TABLE 1. STUDIES INCLUDED IN THE SYSTEMATIC REVIEW

ID	Study	Year	Focus	Country	Database	Type
[1]	Haque	2025	IoT and shelf life, cold chain	Saudi Arabia	Scopus	Res. Art.
[2]	Bakioğlu	2025	Digital intermodal transport	Turkey	ScienceDirect	Res. Art.
[3]	Sharma	2025	Agri-food and resilience	UAE, MENA	ScienceDirect	Res. Art.
[4]	Guo	2024	Vulnerability and emerging technologies	USA	ScienceDirect	Res. Art.
[5]	Qader	2022	Industry 4.0 and resilience	Pakistan	ScienceDirect	Res. Art.
[6]	Verma	2025	Innovative logistics	India	Scopus	Res. Art.
[7]	Han	2025	OIPT and resilience	Global	Scopus	Res. Art.
[8]	Roman	2025	Digital twins	Romania	Scopus	SLR
[9]	Wang and Chen	2025	Rail logistics	China	Scopus	Res. Art.
[10]	Briatore	2025	Industry 4.0	Italy	Scopus	Res. Art.
[11]	Ganesh Kumar	2025	SC performance and technology	India	Scopus	Res. Art.
[12]	Min and Sheriff	2025	Automotive resilience	Global	Scopus	SLR
[13]	Yang	2025	OIPT bibliometrics	Global	WoS	Biblio.
[14]	Selepe	2025	4IR sourcing	South Africa	Scopus	SLR
[15]	Fatorachian and Pawar	2025	Forecasting and waste in the cold chain	United Kingdom	Scopus	Res. Art.
[16]	Bhaskar	2025	Bibliometrics of digital twins	India	Scopus	Biblio.
[17]	Tian	2024	Datafication and resilience	China	Scopus	Res. Art.
[18]	Wu	2025	Digital intelligence	China	Scopus	Concept.
[19]	Li	2025	Digital transformation	China	ScienceDirect	Res. Art.
[20]	Mishra	2022	Resilient IoT-blockchain	Global	Scopus	Res. Art.
[21]	Chen	2023	Pharma IoT-blockchain	Global	Scopus	Res. Art.
[22]	Al-Ayed and Al-Tit	2023	Risk management and IoT	Jordan	Scopus	Res. Art.
[23]	Auhl	2022	Blockchain consensus in IoT	Global	Scopus	Res. Art.
[24]	Njomane and Telukdarie	2022	Food SC in South Africa	South Africa	ScienceDirect	Res. Art.
[25]	Spieske and Birkel	2021	Resilience through Industry 4.0	Germany, global	Scopus	SLR
[26]	Zhao	2023	Digitalization and performance	China	Scopus	Res. Art.
[27]	Rejeb	2020	Bibliometrics of IoT in SCM	Global	Scopus	Biblio.
[28]	Zrelli and Rejeb	2024	Logistics IoT bibliometrics	Global	Scopus	Biblio.
[29]	Zaman	2025	IoT and AI	Global	Scopus	Res. Art.
[30]	Akter	2022	ABCD framework	Australia	Springer	Lit. Rev.
[31]	Belhadi	2021	COVID-19 resilience	Global, Morocco	ScienceDirect	Mixed
[32]	Pournader	2020	Blockchain supply chains	Global	Scopus	SLR
[33]	Ben-Daya	2019	IoT and SCM	Global	Scopus	Lit. Rev.
[34]	Hosseini	2019	Quantitative methods of resilience	Global	ScienceDirect	SLR

Note: Study gives the first author, or both authors of a two-author paper. OIPT = organizational information processing theory; SC = supply chain; SCM = supply chain management; 4IR = Fourth Industrial Revolution; ABCD = AI, blockchain, cloud, and data analytics; WoS = Web of Science; Res. Art. = research article; SLR = systematic literature review; Biblio. = bibliometric analysis; Concept. = conceptual paper; Lit. Rev. = literature review.

As Table 2 shows, all 34 studies received a total score between 2.5 and 4.0 out of 4, and most of them (30 of 34) scored at least 3.5, which confirms the methodological

soundness of the selected sample. Table 3 gives the number and percentage of studies in each score class.

TABLE 2. ASSESSMENT OF STUDY QUALITY

ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
QA1	1	0.5	1	1	1	1	0.5	1	0.5	1	1	1	1	1	0.5	1
QA2	1	1	1	1	1	0.5	1	1	1	1	1	1	1	1	1	1
QA3	0.5	0.5	1	1	1	1	1	0.5	0.5	1	0.5	1	0.5	0.5	0.5	0.5
QA4	1	0.5	1	1	1	1	1	1	0.5	1	1	1	1	0.5	0.5	1
Total	2.5	2.0	4.0	4.0	4.0	3.5	3.5	3.5	2.5	4.0	3.5	4.0	3.5	3.0	2.5	3.5

ID	17	18	19	20	21	22	24	25	26	27	28	30	31	32	33	34
QA1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
QA2	1	1	1	1	1	1	1	0.5	1	1	1	1	1	1	1	1
QA3	1	1	1	0.5	1	1	0.5	1	1	1	0.5	0.5	1	0.5	0.5	1
QA4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total	4.0	4.0	4.0	3.5	4.0	4.0	3.5	4.5	4.0	4.5	3.5	4.0	4.0	3.5	3.5	4.0

TABLE 3. DISTRIBUTION OF QUALITY SCORES

Category	Number	Percentage	Reading
Score 4.0	15	44.1%	High quality
Score 3.5	15	44.1%	Good quality
Score 3.0	1	2.9%	Satisfactory quality
Score 2.5	3	8.8%	Acceptable quality
Total	34	100%	Selected corpus

The distribution confirms that most of the papers (88.2%) fall in the high or good quality classes. No article falls below the quality threshold of 2 out of 4.

C. Thematic Map and Structured Reading of the Corpus

The thematic map linking the proposed categories to the included studies is shown in Fig. 3. Thematic analysis links the studies more closely to the research questions. Five analytical categories emerge: conceptual foundations, empirical validation, risk and continuity management, hybrid digital architectures, and sector-specific applications.

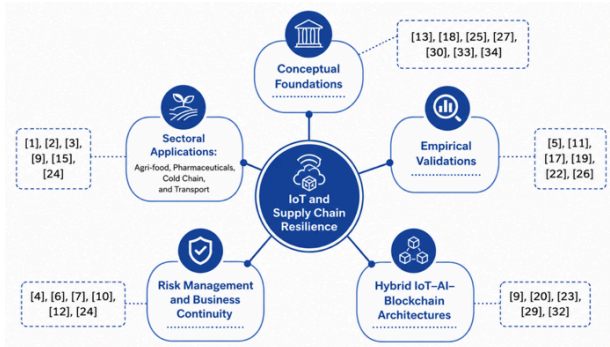


Fig. 3. Thematic map of the final corpus. The numbers in brackets are the study IDs of Table 1.

Table 4 sets out the six mechanisms through which the articles show the contribution of the IoT to supply chain resilience, with the specific ways in which the IoT acts in each.

TABLE 4. SUMMARY OF THE EVIDENCE

Evidence	Description	Study IDs
Real-time visibility	Reduction of blind spots, continuous monitoring of traffic flows, and improved anticipation of disruptions	3, 4, 5, 10, 11, 17, 19, 22, 26, 31, 33
Traceability	Batch tracking, data integrity, compliance, and quality control	1, 3, 20, 21, 23, 24, 29, 32, 33
Coordination and information processing	Improved information flow, data sharing, and faster process reconfiguration	7, 11, 18, 19, 25, 30, 33
Technological hybridization	Combination of IoT, AI, blockchain, cloud, and digital twins to enhance resilience	8, 14, 16, 20, 21, 23, 29, 30, 32
Sector-specific applications	Agri-food, pharma, cold chain, transportation, manufacturing, and logistics	1, 2, 3, 6, 9, 12, 14, 15, 21, 24
Foundations and cross-cutting framework	Conceptual, bibliometric, and review studies used to structure the interpretation of the evidence	13, 16, 27, 28, 30, 33, 34

Sector-specific applications (12 references) and real-time visibility (11 references) are the most frequently documented mechanisms in Table 4, while conceptual,

bibliometric, and literature-based analyses remain relatively underdeveloped (7 references). This echoes the answer to RQ4: the literature still lacks an integrated and empirically validated framework for IoT-based resilience.

IV. DISCUSSION

A. RQ1: The IoT and Resilience in the Literature

This question is not new, but recent crises have brought it back to the forefront of research. The literature has addressed the relationship between the IoT and resilience from the perspective of data visibility and traceability. Authors have stressed the use of connected sensors to monitor data flows, detect anomalies, and coordinate geographically dispersed stakeholders [33], [40]. Quantitative studies have highlighted the correlation between access to data and the ability to use it during disruptions, and they treat responsiveness as an essential component of resilience [18], [26]. After the pandemic, reviews of the literature recorded a sharp increase in the number of supply chain publications [41], which shows that the crisis brought logistical vulnerabilities to light and accelerated research [21].

B. RQ2: Factors and Challenges in IoT Adoption

The literature indicates that digital infrastructure and reliable connectivity, together with an organization's ability to analyze the data produced and orchestrate timely responses, support the adoption of the IoT in supply chains [19], [29]. The studies of Qader and colleagues [5] and of Zhao and colleagues [26] show that management support is a decisive organizational factor. The IoT requires cross-organizational integration, which allows data sharing among suppliers, logistics providers, and distributors. The literature identifies several obstacles. Some are technical, such as interoperability between heterogeneous systems, which remains a structural problem [4], [25]. Others are economic, such as high investment costs. The third category of barriers to deployment is cybersecurity, which is often underestimated [20], [21].

C. RQ3: Lessons for Emerging Economies and Morocco

Theories on the relationship between digital supply chains and resilience have been documented in studies conducted in various contexts [6], [7], [26]. The problem with these studies is the lack of empirical validation. Morocco illustrates this gap: recent bibliometric analyses of the IoT and its relationship to supply chain resilience confirm that the MENA region and sub-Saharan Africa remain almost absent from the corpus studied [14], [27], [28].

D. RQ4: Limitations, Gaps, and Future Directions

Current research on the IoT and supply chain resilience still lacks longitudinal studies. Most previous studies have assessed effects at a single point in time rather than over an extended period [17], [25]. Another limitation is the difficulty of measuring the return on investment of IoT implementation, which may affect managerial decision making, particularly where resources are limited [4]. The relationship among resilience, environmental sustainability, and overall performance also remains insufficiently theorized, although these dimensions are rarely separable in practice [3], [10].

V. CONCLUSION

The main finding of this literature review is that the IoT should not be considered a standalone solution. It strengthens supply chain resilience when it is treated as an information infrastructure that combines visibility, monitoring, and coordination. The distinction matters because it shapes how organizations design their technology investments and management architectures.

Three avenues for future research follow. The first is the measurement of the return on investment of IoT deployments. The second is the environmental externalities generated by these digital infrastructures. The third is the testing of existing models in emerging contexts, such as Morocco and other African countries, where technology adoption is shaped by institutional and infrastructural conditions that the dominant literature has not sufficiently addressed.

AUTHOR CONTRIBUTIONS

All authors contributed to the conception and preparation of this work and approved the final version of the manuscript.

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DECLARATION OF GENERATIVE AI USE

The authors declare that no generative artificial intelligence tools were used in the preparation of this manuscript. The authors take full responsibility for the content of the publication.

DATA AVAILABILITY

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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