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From sensor data to supply chain decisions: a mechanism framework for IIoT and sensor networks in automotive supply chains

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Abstract: Automotive logistics and supply chain networks coordinate complex multi-tier material flows under strict sequencing, transport synchronization, and quality constraints. These systems are highly sensitive to information-flow latency, exception-handling delays, and disruptions affecting inbound, production, and distribution logistics processes. Although Industrial Internet of Things (IIoT) and sensor-network technologies enable real-time visibility across material and transport flows, prior literature frequently emphasizes technological capability rather than clearly operationalized logistics decision mechanisms. This study develops a decision-centric mechanism framework explaining how IIoT-enabled sensing is translated into governed logistics decisions influencing reliability, responsiveness, inventory–production synchronization, and disruption mitigation in automotive supply chains. Based on a structured 2025 literature review (Scopus, Web of Science, IEEE Xplore; $n = 13$ included studies), four recurring sensor-to-decision mechanisms are identified: (M1) real-time visibility and traceability control, (M2) predictive asset and quality logistics, (M3) inventory–production flow synchronization, and (M4) event-driven logistics decision support. The contribution lies in formalizing reproducible sensor-to-decision pathways that connect sensing capability, analytics, decision triggers, and execution routines to measurable logistics performance outcomes.

1 Introduction

Automotive logistics networks coordinate thousands of components across multi-tier supply chains while ensuring synchronized material flows, production sequencing, and transport reliability. Late information, inaccurate inventory records, and poorly governed exception handling destabilize inbound logistics, production logistics, and outbound distribution processes.

Despite extensive deployment of Industrial Internet of Things (IIoT) and sensor technologies (e.g., RFID, telematics, condition sensors), value realization in logistics remains uneven (Figure 1). Many initiatives increase visibility of material and information flows but do not explicitly define how sensor signals are operationalized into governed logistics decisions such as call-off adjustments, rerouting, quality containment, or dynamic allocation.

Research gap: Existing literature frequently treats visibility as a performance outcome rather than specifying the operational mechanism linking sensing capability to logistics decision routines. The “sensor-to-decision” chain is often under-specified.

Aim of the study: The aim of this paper is to develop a structured mechanism framework that links IIoT sensing capabilities to reproducible logistics decision mechanisms in automotive supply chains.

Research question: How are IIoT-enabled sensor signals translated into governed logistics decision routines that measurably influence material-flow reliability, responsiveness, and resilience?

Contribution: The study advances a decision-centric lens by distinguishing sensing capability, operational mechanism, decision trigger, and logistics performance impact. The proposed framework structures four recurring mechanisms (M1–M4) and identifies enabling conditions required for scalable implementation.

From sensor data to supply chain decisions: a mechanism framework for IIoT and sensor networks in automotive supply chains

Monika Zatrochová, Tarek Khatib, Samet Sezgin

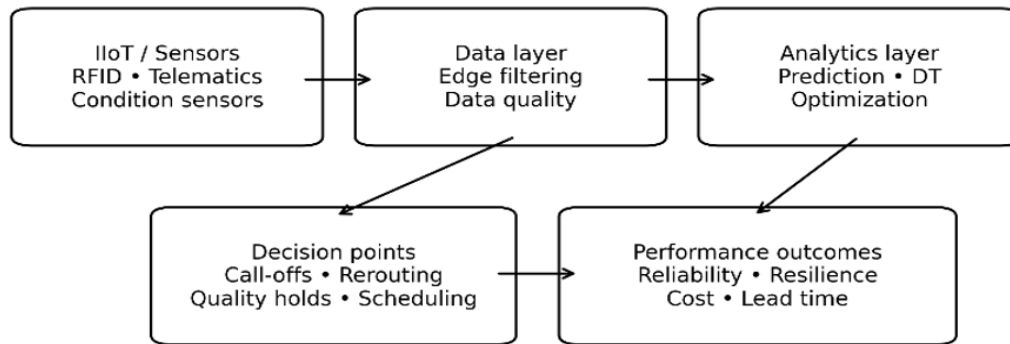


Figure 1 Conceptual positioning of IIoT-enabled sensor-to-decision pathways in automotive supply chains

2 Literature review

2.1 IIoT, Sensor networks, and digital twins in SCM

IIoT extends industrial connectivity to physical assets through sensing, networking, and computation. Sensor networks provide identity, location, and condition signals; digital twins increasingly serve as a decision layer by combining real-time data with analytical models. Recent 2025 work emphasizes supply chain digital twin design and analytics frameworks for connecting data to decision contexts [1,2], and reviews the role of digital twins in operational efficiency and risk management [3], including resilience improvement [4].

2.2 Decision relevance and operationalization

A recurring limitation is that technology capabilities are frequently treated as outcomes. For example, visibility is assumed to increase performance without specifying the decision point (what decision is taken, by whom, under what threshold). Frameworks for IIoT adoption and supply chain information management stress governance, information quality, and adoption conditions [5,6]. A mechanism perspective separates (i) capability (what is sensed), (ii) mechanism (repeatable operational pattern connecting signals to decisions), and (iii) performance impact.

2.3 Resilience, risk, and security as boundary conditions

Automotive supply chain research in 2025 continues to foreground resilience and risk. Risk prioritization approaches highlight the need for actionable decision support in automotive contexts [7]. At the same time, cybersecurity becomes a prerequisite for scaling IIoT-enabled SCM systems; analytics-driven security frameworks target this gap [8]. Sustainable SCM frameworks and ISO-based guidance.

3 Methodology

This study applies a structured literature review (SLR) combined with qualitative synthesis. The scope is restricted to English-language publications from 01.01.2025 to 31.12.2025, to enable a focused snapshot of recent mechanism and framework contributions.

Data sources and search strategy. Searches were conducted in Scopus (15.08.2025), Web of Science (16.08.2025), and IEEE Xplore (17.08.2025). The database-specific search strings combined IIoT/industrial IoT terms, sensor technologies (sensor networks, RFID, telematics), supply chain/logistics decision-support terms, automotive context terms, and mechanism/framework terms.

Screening and eligibility. The search yielded 53 records (Scopus: 13; WoS: 17; IEEE Xplore: 23). Records were exported to EndNote and de-duplicated (Find Duplicates); 14 duplicates were removed, leaving 39 unique records. Title/abstract screening excluded 22 records primarily due to lack of automotive specificity, absence of supply-chain decision relevance, peripheral use of IIoT/sensors, or missing operationalized mechanisms/frameworks. Seventeen full texts were assessed and four excluded due to missing sensor-to-decision chains, superficial automotive mentions, overlap without added value, or insufficient methodological transparency. The final sample includes 13 studies (7 journal articles, 6 conference papers).

Data extraction and synthesis. Included studies were coded using decision-relevant SCM performance dimensions (visibility/traceability, reliability, responsiveness, inventory/cost, asset utilization) and operational translation elements (sensor data type, processing/analytics, decision trigger, responsible role/function, and response routine). Evidence was synthesized into mechanisms defined as repeatable operational patterns that link IIoT capabilities to decisions and expected performance impacts.

Mechanism identification and framework derivation.

To ensure methodological transparency, the identification of the four mechanisms (M1–M4) followed a structured qualitative coding procedure.

From sensor data to supply chain decisions: a mechanism framework for IIoT and sensor networks in automotive supply chains

Monika Zatrochová, Tarek Khatib, Samet Sezgin

First, all included studies ($n = 13$) were systematically reviewed to extract decision-relevant elements describing how IIoT and sensor data were used in automotive supply chain contexts. Particular attention was given to passages describing operational decision points, decision triggers, analytics usage, and resulting logistics actions.

Second, an open coding process was conducted to identify recurring “sensor-to-decision” patterns. Codes were assigned to textual segments that described how sensing capability was translated into operational supply chain decisions. Examples of initial codes included real-time tracking, predictive maintenance alerts, dynamic replenishment adjustment, and disruption-response alerting.

Third, the initial codes were iteratively grouped into higher-level analytical categories representing similar operational decision logics. During this phase, overlapping codes were consolidated and compared across studies to identify recurring operational structures.

Finally, four mechanisms were derived based on three consolidation criteria:

- (1) the presence of a clear sensor-to-decision pathway,
- (2) recurrence across multiple studies, and
- (3) a distinct operational decision logic separating it from other mechanisms.

This process resulted in four recurring mechanisms:

- M1 – real-time visibility and traceability control,
- M2 – predictive asset and quality logistics,
- M3 – inventory–production synchronization, and
- M4 – event-driven logistics decision support.

The mechanisms therefore represent synthesized operational decision patterns observed across the reviewed studies rather than isolated technological applications.

Study selection summary (Table 1, Figure 2).

Table 1 Study selection summary (2025 SLR)

Step	Count (2025)
Records identified (Scopus + WoS + IEEE Xplore)	53
Duplicates removed (EndNote)	14
Records after de-duplication	39
Title/abstract screened	39
Excluded at title/abstract	22
Full-text assessed	17
Full-text excluded	4
Studies included in synthesis (Journal / Conference)	13 (7 / 6)

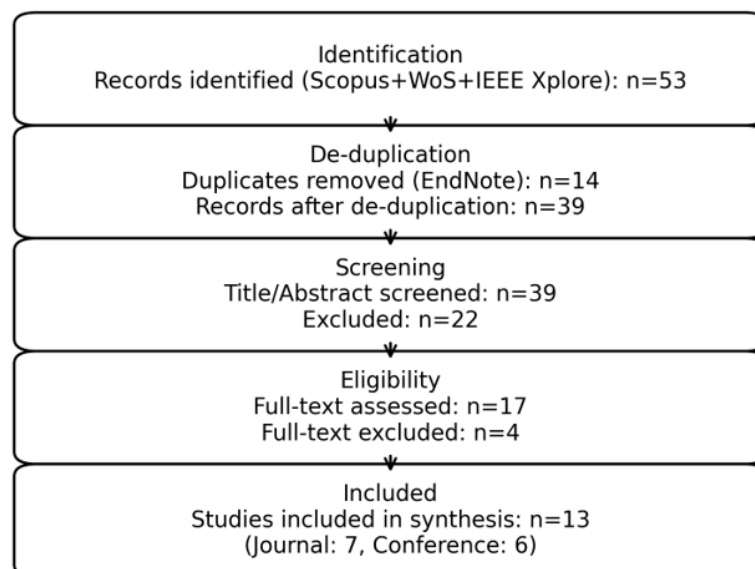


Figure 2 illustrates the PRISMA-based screening and selection process for the 2025 SLR

From sensor data to supply chain decisions: a mechanism framework for IIoT and sensor networks in automotive supply chains

Monika Zatrochová, Tarek Khatib, Samet Sezgin

3.1 Data extraction and coding procedure

We used a structured data extraction form to ensure consistent capture of “sensor-to-decision” elements across all included studies ($n = 13$). For each article, we extracted: (i) automotive context and supply chain scope (tier, node, or process), (ii) IIoT/sensor modalities and data characteristics (e.g., RFID, telematics, condition sensors; update frequency if reported), (iii) integration layer and systems interface (e.g., edge/cloud, middleware, ERP/WMS/TMS/MES touchpoints), (iv) analytics approach (e.g., prediction, optimization, digital twin, anomaly detection), (v) decision point(s) and triggering logic (what initiates a decision and who acts), and (vi) the intended or reported performance outcomes (e.g., lead time, service level, inventory accuracy, disruption impact, quality/reliability).

3.2 Synthesis approach

We synthesized evidence using a narrative synthesis combined with cross-case mapping. Narrative synthesis was used to describe how each study operationalizes sensor data for decision support in automotive supply chains, while cross-case mapping was applied to assign each study to one or more mechanisms (M1–M4) and to identify enabling conditions that recur across mechanisms. We report results at two levels: (i) mechanism-level insights (what the mechanism does and which decision points it targets), and (ii) cross-cutting enablers and boundary conditions (e.g., interoperability, governance, cybersecurity, organizational capability) that shape whether mechanisms can be implemented and scaled. This synthesis deliberately avoids inferring causal effects beyond what the reviewed studies explicitly report; instead, we focus on transparent mechanism descriptions that can guide implementation and future empirical testing.

To develop the mechanism framework, we applied an iterative coding strategy. First, we conducted open coding to identify recurring “data → analytics → decision” chains and operational decision triggers. Second, we grouped codes into higher-level categories that reflected the role of IIoT/sensor data in supply chain decision-making. Third, we consolidated categories into four mechanisms (M1–M4) by checking whether each mechanism represented (a) a distinct decision-relevant pathway, (b) a reproducible sequence from sensing to decision action, and (c) a defensible boundary to other mechanisms. Disagreements in coding were resolved through discussion and re-reading of the full texts until consensus was achieved. To illustrate the operational logic of the proposed mechanisms, consider a temperature-sensitive automotive component monitored via IIoT-enabled condition sensors. If a temperature threshold (e.g., $>8^{\circ}\text{C}$ for a defined duration) is breached during transport, the event is automatically transmitted to the integration layer and evaluated via predefined decision rules. If the threshold violation exceeds tolerance limits, a quality containment decision is triggered. The responsible quality manager receives an automated alert, and a hold status is posted in the ERP/QMS system. The shipment is flagged for inspection before further processing. This closed-loop structure (sensor signal → threshold logic → decision trigger → role assignment → system update → controlled response) operationalizes the sensor-to-decision pathway and clarifies how sensing capability translates into governed logistics action.

4 Results

Qualitative synthesis yields four recurring value-creation mechanisms. Each mechanism combines technology (sensing, connectivity, analytics) with process design (integration, governance, decision rights, and response playbooks). Where available, the 2025 literature provides decision-layer concepts such as digital twins and early-warning systems that exemplify ‘sensor-to-decision’ chains [1,2,9,10].

Across the included literature ($n = 13$), evidence clusters around four recurring sensor-to-decision pathways. While individual studies emphasize different technologies (e.g., RFID, telematics, digital twins), the reviewed contributions converge on a common structure: sensor data is integrated into enterprise decision contexts, transformed via analytics, and translated into concrete operational decisions (e.g., reallocation, replanning, quality containment, disruption response). We therefore present results as four mechanisms (M1–M4) and then synthesize cross-cutting enabling conditions that recur across mechanisms. From a logistics perspective, the four mechanisms can be interpreted as structured interventions into material flow control (M1, M3), transport coordination (M4), and production and quality logistics (M2). The framework therefore shifts the analytical focus from technological deployment to governed flow management across material, information, and financial coordination processes.

4.1 Mechanism 1: Real-time visibility and traceability

Identification technologies (e.g., RFID) and telematics improve the timeliness and granularity of state information (location, identity, status). Value is realized when visibility is embedded in closed-loop workflows: automated capture, exception detection, thresholds, and standardized escalation. Digital twin designs at scale illustrate how data models can support traceability and operational decision contexts [1], while adoption frameworks highlight the governance prerequisites for converting visibility into action [6].

From sensor data to supply chain decisions: a mechanism framework for IIoT and sensor networks in automotive supply chains

Monika Zatrochová, Tarek Khatib, Samet Sezgin

4.2 Mechanism 2: Predictive asset and quality operations

Condition and process sensors combined with analytics enable prediction of failures and deviations. Performance gains occur when predictive insights are integrated into maintenance planning and quality gates, shifting from reactive interventions to condition-based scheduling and targeted inspection/holds. Digital twin-based predictive quality assurance and resilience frameworks exemplify this integration layer in automotive contexts [9].

4.3 Mechanism 3: Inventory-production synchronization

Continuous inventory and consumption signals reduce latency between physical stock and planning records. When integrated into replenishment rules and allocation logic, these signals enable dynamic safety-stock adjustments and earlier detection of shortages. Knowledge-enhanced information management frameworks reinforce the role of high-quality information flows as a prerequisite for planning synchronization [5].

4.4 Mechanism 4: Event-driven decision support

IIoT platforms translate sensor events into actionable alerts through rule engines, workflow automation, and control-tower practices. Value is realized when thresholds, decision rights, and response playbooks are defined and governed. Early-warning systems for supplier delays illustrate decision-triggered alerting and probabilistic risk signals [10], while resilience-oriented literature motivates event-driven mitigation to reduce disruption impact [3,4,7].

4.5 Cross-cutting enabling conditions

Across mechanisms, three enabling conditions determine whether outcomes are realized: (i) interoperability and data governance (identifiers, master data, integration architecture, ownership), (ii) cybersecurity and data protection (secure onboarding, segmentation, monitoring), and (iii) organizational capability and decision rights (skills, training, authority to act). Security-focused frameworks explicitly address the governance gap for IIoT-enabled SCM systems [8]. ISO-based guidance and sustainability framing further shape how IIoT is designed and governed in practice [11-14].

4.6 Mechanism framework summary

The Architecture summarizes the proposed mechanism framework as a layered sensor-to-decision chain (Figure 3). The top row describes the technical pathway from sensing (IIoT/sensor data) to integration and analytics, while the bottom row groups the reviewed contributions into four decision-relevant mechanisms (M1–M4) (Figure 4). The framework is intentionally implementation-oriented: it highlights where data quality and interoperability constraints typically emerge (integration layer), where analytical capability is required (analytics layer), and where decisions must be operationalized via routines, roles, and playbooks (decision points) (Table 2). The cross-cutting enablers emphasize that technical readiness alone is insufficient; governance, cybersecurity, and organizational capability determine whether mechanisms can be scaled across automotive networks.

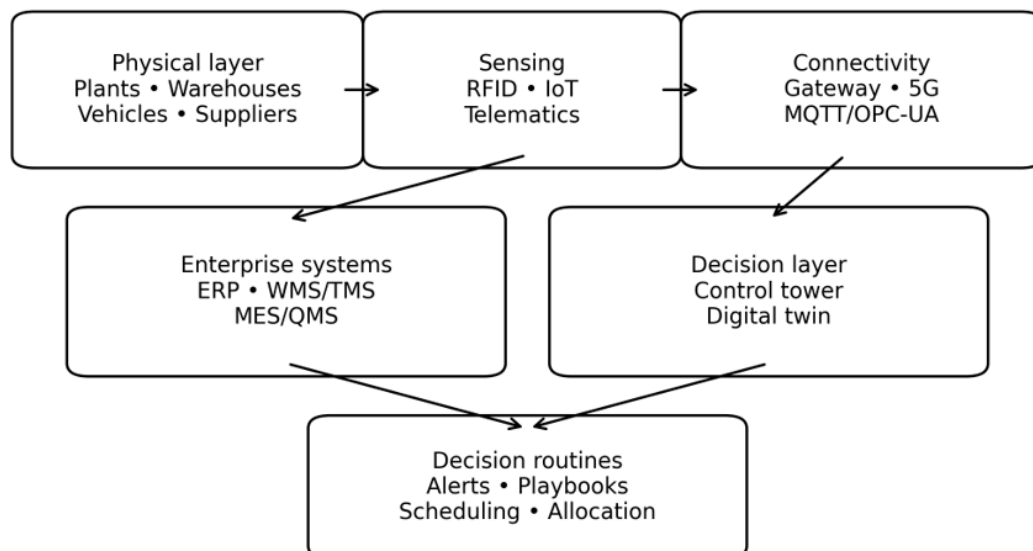


Figure 3 Reference architecture for sensor-to-decision integration in automotive supply chains

From sensor data to supply chain decisions: a mechanism framework for IIoT and sensor networks in automotive supply chains

Monika Zatrochová, Tarek Khatib, Samet Sezgin

Table 2 Mechanism framework linking sensor signals to automotive SCM decisions and impacts

IIoT/Sensor capability	Mechanism	Decision point	Expected impact	Key enablers
RFID, telematics, identification sensing	Visibility & traceability	Exception escalation (late/mismatch/loss)	↑ reliability, ↓ expediting	IDs/master data; integration; decision ownership
Condition/process sensors + analytics	Predictive asset & quality operations	Maintenance scheduling; quality hold/release	↓ downtime, ↓ defect propagation	Calibration; cybersecurity; authority
Consumption + inventory signals	Inventory–production synchronization	Replenishment parameters; allocation under constraint	↑ inventory accuracy, ↓ line-stops	Latency control; governance; ERP/WMS integration
Event processing + workflow automation	Event-driven decision support	Reroute/expedite/reschedule via playbooks	↑ responsiveness, ↓ disruption impact	Playbooks; decision rights; partner data-sharing

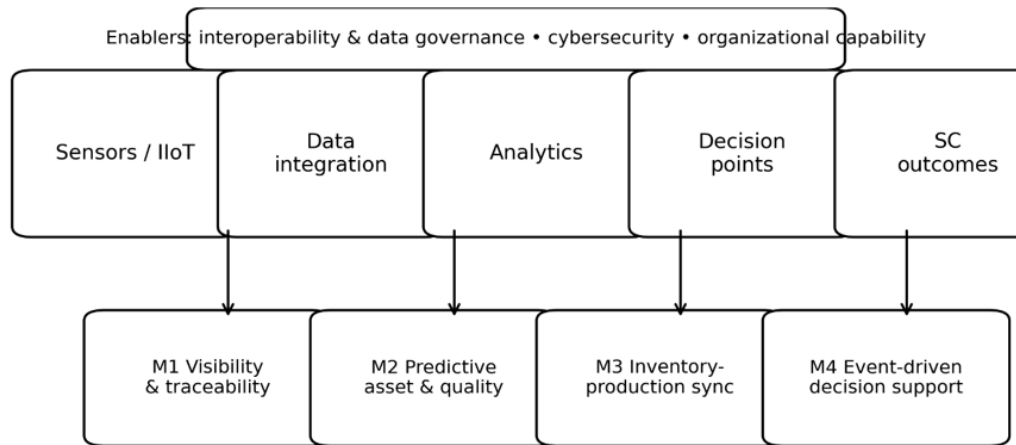


Figure 4 Sensor-to-decision mechanism framework synthesizing four recurring IIoT-enabled decision pathways (M1–M4) in automotive supply chains

5 Discussion

The mechanism framework clarifies why IIoT initiatives often under-deliver: sensing improves information, but performance improves only when signals are embedded into governed decision routines. Digital twin research strengthens the decision-layer perspective by formalizing data models and analytics contexts for operational decisions [1,2], and reviews consolidate evidence that digital twins can support risk management and resilience when appropriately governed [3,4]. At the same time, adoption and information management frameworks emphasize organizational and governance conditions, not only technology [5,6]. Unlike traditional visibility-oriented supply chain frameworks that primarily emphasize information transparency as an end state, the proposed model explicitly defines governed decision routines, operational triggers, and execution-layer integration. The novelty therefore does not lie in sensor deployment itself, but in formalizing reproducible decision pathways that connect sensing, analytics, and organizational authority. By separating capability, mechanism, trigger, and performance impact, the framework addresses a structural gap between technological readiness and executable supply chain control.

5.1 Managerial implications

This review suggests three actionable implications for managers aiming to implement IIoT- and sensor-driven decision support in automotive supply chains.

First, managers should start from a concrete decision point rather than from technology availability. Successful initiatives specify who decides (role), when a decision is triggered (threshold/event), which systems must be updated (ERP/WMS/TMS/MES), and how the response is executed (playbook). This reduces the common failure mode where sensor data is collected but does not translate into operational action.

Second, interoperability and master-data governance should be treated as core design requirements. Many sensor-to-decision chains depend on consistent identifiers (items, containers, locations, vehicles) and reliable event timestamps.

From sensor data to supply chain decisions: a mechanism framework for IIoT and sensor networks in automotive supply chains

Monika Zatrochová, Tarek Khatib, Samet Sezgin

Without a disciplined data governance model, analytics outputs cannot be trusted or operationalized across partners and tiers. Managers should therefore invest early in standardization (data dictionary, event schema, mapping rules) and in monitoring of data quality.

Third, organizations should align analytics capability with the maturity of decision routines. Where decision routines are immature, lightweight analytics and alerting (e.g., exception detection) can deliver value quickly by improving visibility (M1) and event response (M4). As routines mature, more advanced analytics (prediction, optimization, digital twin) becomes feasible and can support higher-impact decisions such as dynamic allocation, inventory–production synchronization, and disruption mitigation. Across all mechanisms, cybersecurity and access control are essential, because sensor-driven decision support expands the attack surface along the supply chain network. Overall, the mechanism framework can be used as a practical roadmap: firms can assess which mechanism they can realistically operationalize given their integration maturity, governance capability, and decision process readiness, and then scale stepwise toward more advanced decision automation.

5.2 Limitation and future research

This review has several limitations. First, the study deliberately focuses on literature published in 2025 to provide a high-resolution snapshot of current developments. While this supports timeliness, it limits longitudinal comparison and may underrepresent foundational work published earlier. Second, although the search strategy covered three major databases and applied explicit screening criteria, publication bias and database coverage bias cannot be fully ruled out. Third, the synthesis emphasizes mechanism transparency rather than meta-analytic effect estimation; the included studies vary in method, reporting depth, and evaluation setting, which constrains the ability to compare outcomes quantitatively. Future research can build on this review in three directions. (1) **Mechanism validation:** The proposed M1–M4 mechanisms should be empirically tested in real automotive networks (OEM–tier systems) using measurable decision outcomes (e.g., service level, lead time, disruption impact). Comparative designs could examine which enablers (governance, cybersecurity, organizational capability) moderate mechanism effectiveness. (2) **Decision-centric metrics and playbooks:** More work is needed on standardizing decision triggers, escalation paths, and playbooks that translate analytics into action. This includes defining KPI dictionaries and linking decision routines to system updates (ERP/WMS/TMS/MES), enabling replicable implementations. (3) **Cross-organizational integration and trust:** As sensor-to-decision chains increasingly span partners, research should address interoperability standards, data-sharing agreements, and security architectures that allow scalable collaboration without sacrificing confidentiality or resilience. Extending the review window beyond 2025 and incorporating multiple years would further support robustness and enable trend analysis across the evolving IIoT and digital-twin landscape. Future studies should operationalize the proposed mechanisms using measurable decision-level indicators, such as trigger frequency, decision latency, override rates, and post-decision performance impact. Linking sensor-to-decision execution logs with KPI outcomes would allow quantitative validation of mechanism effectiveness and comparison across automotive supply chain tiers.

5.3 Practical implementation checklist (decision-centric, sensor to decision)

This subsection translates the proposed sensor-to-decision mechanism framework into an implementation-oriented checklist. The checklist is decision-centric: it starts from concrete decision points and links them to sensing requirements, integration design, analytics capability, and operational response routines (playbooks). It is intended to support stepwise adoption across the four mechanisms (M1–M4) and to increase implementation transparency and reproducibility. The items can also be used as an assessment instrument to identify capability gaps before scaling across sites or partners.

Scope and decision design:

- ☐ Decision scope defined: which specific supply chain decisions will be improved (e.g., call-off adjustments, rerouting, quality containment, scheduling, inventory rebalancing).
- ☐ Decision owners assigned: RACI defined (owner, back-up, escalation path, approval authority).
- ☐ Decision timing specified: reaction time targets (minutes/hours/days) and operational cadence defined.
- ☐ Success criteria agreed: primary KPIs selected (service level, lead time, disruption impact, inventory accuracy, quality yield).

Sensing and data requirements:

- ☐ Sensor modalities selected and justified: RFID / telematics / condition sensors / scanning events (fit to the decision).
- ☐ Event schema defined: which events exist (e.g., arrival/departure, temperature breach, shock, machine state, quality flag).
- ☐ Refresh rate and latency targets defined for each event stream.
- ☐ Identifier consistency ensured: item/container/location/vehicle IDs standardized across partners and systems.

From sensor data to supply chain decisions: a mechanism framework for IIoT and sensor networks in automotive supply chains

Monika Zatrochová, Tarek Khatib, Samet Sezgin

- Data quality rules documented: completeness, timeliness, plausibility checks, deduplication, missing-event handling.

Integration and interoperability:

- System touchpoints identified: ERP / WMS / TMS / MES / QMS / control tower / digital twin.
- Mapping rules documented: sensor IDs ↔ master data ↔ transactional objects (orders, shipments, lots/batches).
- Interface design defined: protocols and pipelines (API, MQTT/OPC-UA, ETL/ELT, message bus).
- Data governance established: ownership of master data, change management, versioning, and auditability.
- Cross-organizational agreements clarified: data sharing boundaries, retention, access rights, and confidentiality.

Analytics and mechanism selection (M1–M4):

- Target mechanism selected: M1 visibility/traceability; M2 predictive quality/asset/operations; M3 inventory–production synchronization; M4 event-driven decision support.
- Analytics approach matched to maturity: alerting → prediction → optimization → digital twin (stepwise roadmap).
- Decision triggers defined: thresholds, anomaly rules, prediction confidence levels, scenario triggers (for digital twins).
- False positive/negative handling defined: suppression rules, confirmation steps, human override, and retraining cadence.

Decision operationalization (the sensor-to-decision link):

- Response playbooks written for each trigger: action steps, responsible role, communication steps, and required system updates.
- Execution-system updates specified: what must be posted/changed in ERP/WMS/TMS/MES/QMS for the decision to take effect.
- SLA and escalation set: time limits, fallback procedures, and escalation hierarchy defined.
- Human-in-the-loop policy defined: where manual approval is required and where automation is permitted.

Security and resilience (boundary conditions):

- Threat model documented: risks for sensor streams, gateways, APIs, and partner interfaces.
- Access control implemented: roles, least privilege, secret management, and logging.
- Integrity and auditability ensured: provenance, tamper detection (where feasible), and audit trails.
- Resilience plan defined: outage mode, buffering, replay strategy, and recovery procedures.

Measurement and continuous improvement:

- Baseline captured: pre-implementation KPI levels recorded.
- Monitoring set up: data quality dashboards and decision adoption metrics (how often playbooks are executed).
- Post-decision evaluation defined: KPI impact window and review cadence agreed.
- Scaling criteria defined: go/no-go thresholds for extending to additional sites/partners and mechanisms.

5.4 Research agenda and testable propositions

While the 2025 literature provides a broad set of technology- and application-driven contributions, it remains comparatively under-specified on how sensor and IIoT data is translated into reproducible decisions at scale across automotive networks. Future research should therefore move from technology-centric descriptions toward decision-centric operationalization and evaluation of the proposed mechanisms (M1–M4). In particular, empirical studies should test (i) which enabling conditions (interoperability, governance, cybersecurity, organizational capability) are necessary and sufficient for each mechanism, (ii) how decision routines and human-in-the-loop designs affect adoption and performance, and (iii) under which operational contexts (product mix, disruption profile, network structure) each mechanism yields the highest benefit. Based on the synthesized framework, we propose the following testable propositions:

P1 (Decision operationalization): IIoT initiatives that explicitly define decision triggers, decision owners, and response playbooks achieve higher decision adoption and sustained use than initiatives focusing primarily on sensor deployment and data collection.

From sensor data to supply chain decisions: a mechanism framework for IIoT and sensor networks in automotive supply chains

Monika Zatrochová, Tarek Khatib, Samet Sezgin

P2 (Data governance as moderator): The positive impact of sensor-based analytics on supply chain performance is strengthened by master-data quality and interoperability, particularly consistent identifiers, timestamps, and standardized event schemas across partners and systems.

P3 (Security as boundary condition): Cybersecurity maturity moderates the scalability of sensor-to-decision mechanisms; low security maturity increases implementation risk and reduces cross-organizational data sharing and adoption.

P4 (Mechanism–context fit): The performance effects of the four mechanisms (M1–M4) depend on the disruption and variability profile of the supply chain (e.g., visibility mechanisms are more valuable in high-variability transport networks, while predictive quality mechanisms yield greater benefits in quality-sensitive component flows).

P5 (Digital twin value conditions): Digital twin-based decision support delivers superior operational outcomes compared to non-twin analytics when closed-loop integration with execution systems (ERP/WMS/TMS/MES/QMS) and clearly defined decision routines are established.

P6 (Human-in-the-loop design): Mechanisms that combine automation with structured human oversight (e.g., exception-based approval and escalation rules) outperform fully manual or fully automated approaches in terms of robustness and organizational acceptance.

P7 (Cross-organizational trust and incentives): The effectiveness of sensor-to-decision mechanisms in multi-tier automotive networks increases when data sharing agreements, incentive alignment, and auditability mechanisms are in place, reducing information asymmetry and opportunistic behaviour.

These propositions provide a concrete basis for future empirical validation of the mechanism framework, including comparative multi-site studies, longitudinal designs, and mixed-method evaluations that link sensor-to-decision operationalization to measurable supply chain outcomes.

6 Conclusion

This study contributes a decision-centric mechanism framework that formalizes how IIoT and sensor networks translate into governed logistics decisions within automotive supply chains. Based on 13 included studies, four recurring sensor-to-decision mechanisms (M1–M4) were identified, clarifying how sensing, analytics, and governed decision routines influence material and information flow performance.

The theoretical contribution lies in formalizing sensor-to-decision pathways as reproducible logistics mechanisms rather than treating IIoT capability as an isolated technological upgrade. The framework emphasizes that logistics performance improvements emerge when sensing is embedded into structured decision triggers and execution routines.

For practitioners, the framework provides a roadmap for stepwise operationalization across visibility control, predictive logistics, synchronization of material flows, and event-driven disruption response.

Future research should empirically validate the mechanisms across multi-tier automotive networks and examine how governance, cybersecurity, and organizational capability moderate logistics performance outcomes.

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From sensor data to supply chain decisions: a mechanism framework for IIoT and sensor networks in automotive supply chains

Monika Zatrochová, Tarek Khatib, Samet Sezgin

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Review process

Single-blind peer review process.