New Possibilities, New Responsibilities: Ethical Challenges and Guidance for Location Tracking Device-based Research in Supply Chains

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Abstract

This study explores the use of location tracking devices (LTDs) as a method for generating independent, geospatially grounded data to enhance transparency in global supply chains. While LTDs offer promising alternatives to self-reported data, their application introduces complex ethical challenges. Through a developmental literature review, this work synthesizes how LTDs have been empirically employed and how ethical concerns – such as consent, fairness, and data protection – have been addressed. Drawing on these insights, it proposes a practical ethics framework tailored to LTD-based studies in supply chain contexts. The findings contribute to geographic information systems (GIS) research by promoting the integration of geospatial data into opaque domains and support the Green IS agenda by advancing responsible, sustainability-oriented research design.

Keywords: Tracking research, geospatial data, supply chain, transparency, ethical concerns.

1. Introduction and motivation

In the era of globalization, supply chains have become increasingly international and complex, driven by the advantages of labor arbitrage and specialization (Loonam & O'Regan, 2022). While transparency is widely promoted as a means to optimize and govern these networks, the strategic advantages of external intransparency are often overlooked (Budler et al., 2024; Stohl et al., 2016). Obscured visibility can serve to protect cost structures, protect trade secrets, externalize environmental or social costs, and shift legal or ethical accountability (Harness et al., 2024). This deliberate opacity may align with business interests but stands in direct opposition to sustainability goals and societal expectations (Egels-Zandén & Hansson, 2016).

In response to these tensions, legislative measures such as the California Transparency in Supply Chains Act (2010), the German Supply Chain Due Diligence Act (2023), and the EU Corporate Sustainability Due Diligence Directive (2024) have emerged to enforce responsible practices. However, the effectiveness of these frameworks remains questionable due to their narrow scope and weak enforcement and sanctions (Schilling-Vacaflor & Gustafsson, 2024). Moreover, driven by economic and ideological concerns that are framed in terms of competitiveness, fairness, and pragmatism, there is a growing tendency to roll back environmental and transparency legislation (Athayde et al., 2022; Fiorino, 2025).

As political momentum stalls, the role of science becomes increasingly vital in advancing transparency. Academic research is essential for identifying the invisible, uncovering structural causes, demystifying industry narratives, and informing effective policy design. Fulfilling the dual role of a watchdog and guide requires robust evidence – something not easy to achieve. Traditional empirical methods, such as interviews and surveys, are prone to methodological weaknesses that affect the validity, reliability, and generalizability of findings (Kakhki et al., 2021; Myers & Newman, 2007). The lack of incentives for external transparency, combined with asymmetries in access and power, makes investigations vulnerable to three key biases: (1) non-response bias, (2) selection bias, and (3) social desirability bias.

In a supply chain context, non-response bias arises when institutions, particularly those engaged in controversial practices, choose not to participate in interviews, surveys, or data-sharing initiatives (Sivo et al., 2006). Related is sample selection bias, which stems from the tendency to study those supply chain parts that are visible and accessible (Peng et al., 2023). Social desirability bias refers to participants who (un)consciously present their practices in a favorable light to better align with normative expectations (Kwak et al., 2021). These biases can distort representations of supply chain practices and lead to flawed theoretical insights or policy recommendations. In the worst case, they may unintentionally legitimize harmful practices, such as greenwashing (Montgomery et al., 2024).

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To address these challenges, this work proposes the use of location tracking devices (LTDs) to facilitate data collection that is independent of supply chain actors and subjective influences, bypassing the biases and access constraints that affect traditional data collection methods. As LTD-based research is still emerging, this study takes a broader perspective by reviewing applications across domains. The rationale is that insights from other fields can inform the design and implementation of future studies in a supply chain context. Accordingly, the first research question (RQ) is:

RQ1. How and in which empirical context have LTDs been used in the literature?

While innovative means of collecting data provide new research opportunities, they also raise new responsibilities. Therefore, this study examines the normative dimensions of LTD-based investigations leading to the following two complementary RQs:

RQ2. Which ethical concerns have been considered and addressed in past LTD-based research?

RQ3. How can scholars ensure compliance with existing ethical standards in the design of LTD-based studies in a supply chain context?

By deriving a set of guiding principles intended to support both scholars and reviewers in designing and evaluating ethically sound studies, this work lays the foundation for the broader use of LTDs as a method for collecting geospatial data in academic research. Such data is essential for the modeling and decision-support capabilities of geographic information systems (GIS) (Pick, 2004). Moreover, the ability to generate spatially explicit insights into previously opaque processes enhances visibility and transparency across supply chains. In doing so, this research not only contributes to the GIS literature but also advances the growing intersection with Green IS scholarship (Gholami et al., 2016). Finally, it adds to the ongoing discourse on responsible information and communication technology (ICT) and data-driven research in supply chain contexts (Myers & Klein, 2011; Stahl et al., 2014).

2. Background: New possibilities

The ongoing technological progress offers new opportunities to collect geospatial data. The following sections introduce the underlying technology and concretize the research potential.

2.1. Location tracking devices

In general, LTDs are systems designed to collect geospatial coordinates and temporal information. They can be categorized by their tracking approach. The first involves Global Navigation Satellite Systems (GNSS), which allow for precise and continuous geolocation via satellite signals (Balakrishnan et al., 2009). The most commonly known example of such a system is the Global Positioning System (GPS). The approach is commonly used for outdoor, long-range tracking. Alternatively, short-range proximity-based systems use technologies like Radio Frequency Identification (RFID), Near Field Communication (NFC), or Ultra-Wideband (UWB) technology to infer an object's location based on signal exchanges with nearby fixed devices or readers (Zhang et al., 2022).

In both cases, the recorded data is transmitted to a central system via cellular of low-power networks for subsequent analysis. Satellite-based trackers offer the advantage of precise and continuous global tracking in real time (Balakrishnan et al., 2009). In contrast, proximity-based trackers are characterized by their suitability for indoor applications, low energy consumption, which enables longer observation periods, and their cost-efficiency (Zhang et al., 2022). Since neither approach is universally superior, the choice of LTD should be guided by the specific objectives, constraints, and operational context of the investigation.

2.2. Potential and value of LTD-based research in supply chains

Supply chains are commonly understood as interorganizational systems for value creation in which goods, information, and financial flows are coordinated across entities to deliver products or services to end customers (Mentzer et al., 2001). This not only includes the forward processes, such as raw material extraction to manufacturing, and distribution, but also reverse processes like returns, repair, recycling, and disposal (Srivastava, 2007).

LTDs in supply chains are attached to logistical units (e.g., containers, pallets) or products (Lo et al., 2004). The geospatial and temporal data they generate enable detailed insights into the flow of goods across the entire product lifecycle. This visibility opens up a variety of application areas that represent a growing business opportunity. In recent years, commercial tracking solutions, such as those offered by Digital Matter or Trusted, have gained traction. Their devices and services not only facilitate supply chain mapping and real-time shipment tracking, but also enable the analysis of transportation patterns, travel distances,

Table 1. Possible implications of LTD-based research in supply chains

Purpose	Theoretical implications	Managerial implications	Societal implications
Descriptive	Allows for geospatial modeling of material flows; generates insights on underexplored or invisible supply chain structures and dynamics.	Enhances operational visibility through geolocation and movement data and provides the basis for change.	Supports public awareness and policy discourse by visualizing real-world flows and uncovering hidden practices.
Comparative	Facilitates spatial-temporal comparison between expected and observed behaviors; helps test assumptions about performance or compliance.	Identifies geographic or process-level discrepancies; highlights reputational and legal risks tied to regional practices.	Reveals greenwashing or ethical gaps; supports stakeholder scrutiny, accountability, and compliance.
Predictive	Geospatial data enables predictive modeling that supports theory building related to risk management and resilience along the supply chain.	Supports anticipation of process disruptions; informs sensitivity analyses; enhances contingency planning.	Enables scenario planning to minimize negative societal impacts of disruptions or observed developments.
Prescriptive	Advances theory through normative recommendations derived from geospatial data-driven insights, such as theory on responsibility or compliance.	Provides transparency as an incentive to change questionable practices; offers location-based recommendations for risk reduction or partner selection.	Enables spatially grounded policy recommendations; supports targeted interventions for environmental and social improvement.

delivery times, product utilization, and final disposition outcomes, such as reuse, resale, recycling, or disposal (Digital Matter, 2025; Trusted, 2025).

While LTDs are increasingly used in industry, their potential remains underexploited in academic research. Yet, the data they provide could serve a range of purposes, from descriptive to comparative, predictive, and prescriptive studies. Although such LTD-based research may not always align with managerial interests and may even produce uncomfortable truths, it is valuable and necessary from a scientific and societal perspective (Searcy et al., 2022; Sodhi & Tang, 2019). Table 1 outlines the possible implications of LTD-based research across different analytical purposes.

To examine how this potential has been explored to date and how it could be further leveraged, we conducted a systematic literature review. The methodology is presented in the following section.

3. Methodology

This literature review aims to identify empirical applications and ethical considerations related to LTD-based research, thereby offering guidance for scholars interested in applying such methods in supply chain contexts. Following the classification of Templier and Paré (2015), this study constitutes a developmental review, which organizes prior work to form conceptual frameworks, theoretical models, or methodological guidelines. To ensure rigor and relevance, we adopt the well-established review process proposed by Webster and Watson (2002). They suggest a comprehensive, systematic search process and a concept-centric analysis of the extant research, particularly suited for reviews in the information systems (IS) field.

Search process. In alignment with the study's research questions, the review casts a broad net, not limited to supply chain research alone. The rationale is that LTD-based studies from adjacent domains may yield transferable insights. Accordingly, the scope of interest is defined by four key pillars: (1) tracking devices, (2) used technologies, (3) location-based data, and (4) empirical research. For each of these pillars, relevant keywords were identified and combined using Boolean operators, resulting in the following search string: *("tracker" OR "beacon" OR "transmitter" OR "location tag") AND ("GPS" OR "NFC" OR "UWB" OR "Wi-Fi" OR "IoT") AND ("geographic data" OR "geospatial data" OR "location data") AND ("data collection" OR "empirical").*

Following Webster and Watson (2002)'s guidance to include publications in both, academic journals and conference proceedings, and to "[…] look not only within the IS discipline […] but also outside the field", the search was conducted in three databases, namely (1) AIS eLibrary, (2) Scopus, and (3) Web of Science. AIS eLibrary was selected as it is arguably the leading IS-specific repository. This was complemented by Scopus and Web of Science as two of the leading comprehensive interdisciplinary databases with rigorous quality-control measures (Gusenbauer & Haddaway, 2020).

The initial search was performed in May 2025. Results were exported to a spreadsheet, where duplicates, non-English publications, and papers not published in journals or conference proceedings were excluded. We then applied content-specific criteria. Accordingly, a study was excluded if it:

- was a literature review or conceptual paper;
- did not use LTDs for data collection;
- relied on crowdsourced, social media-based, or mobile network location data;
- presented algorithms or data mining techniques without actual data collection.

First, titles and abstracts were reviewed for relevance; then, full texts of the remaining available articles were assessed. The export from the databases and the screening process are documented in the digital appendix. In total, 28 studies were retained (see Figure 1).

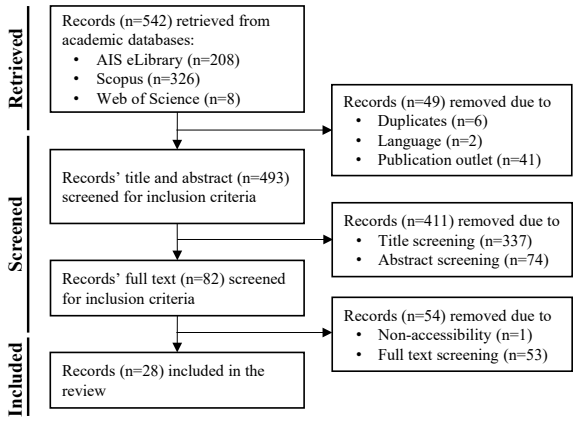

Figure 1. The search and screening process

Concept-centric analysis. To address RQ1, the analysis examined both the technologies employed and the empirical context of each study. This included identifying the type of LTD used, the tracked object or subject, and the intended research objectives. The goal was to determine whether certain technologies have emerged as more prevalent or advantageous and to understand the range of empirical applications and insights enabled by LTD-based research.

To address RQ2, we analyzed the extent to which authors engaged with ethical considerations. This included assessing whether studies obtained approval from institutional review boards or equivalent bodies or reflected on broader normative implications related to data collection, analysis, and use. The insights gathered from RQ1 and RQ2 form the basis for addressing RQ3, which concerns how scholars can ensure ethical compliance when designing LTD-based studies in a supply chain context.

4. Results of the literature review

A total of 13 studies (46%) used satellite-based LTDs, while 10 papers (36%) employed short-range proximity-based systems (see Table 2). A smaller subset (5; 18%) combined both approaches to enhance spatial and temporal coverage, particularly in cases that span both indoor and outdoor environments. Satellite-based trackers were typically applied when continuous tracking and high spatial resolution are required. In contrast, proximity-based systems were more prevalent in indoor settings, where lower power consumption, cost-efficiency, and reliance on fixed infrastructure offer key advantages.

4.1. Study contexts

With respect to tracking focus, the studies were grouped into seven distinct categories, reflecting both the domain of application and the primary tracking objective. These are complemented by an "Others/ Unspecified" category, including studies whose focus was either too specific or too broad to be clearly assigned. The seven categories are presented below in descending order based on the number of studies assigned to each, followed by the "Others/ Unspecified" category.

Animals/Wildlife (n=7). LTDs in wildlife research are mainly used to study animal movement, habitat use, and behavioral adaptation. Most studies applied GPS or Argos-based trackers via collars or tags to capture high-resolution geospatial data (Lane et al., 2024; Ross et al., 2024). The primary aim was to examine how animals respond to environmental changes, such as wildfires, relocation, or habitat shifts (Acácio et al., 2022; Dujon et al., 2014; Forshee et al., 2022). Researchers compared movement patterns across species or conditions to assess site fidelity, resilience, or displacement (Dick et al., 2013). Some studies also used LTD data to infer behavioral states, like resting or foraging (Brushett et al., 2023; Ross et al., 2024).

Healthcare (n=5). In healthcare, LTDs are used to enhance both patient-level monitoring and system-wide decision-making. As patients are typically indoors, proximity-based systems are well-suited to this context. Studies have shown how LTDs can effectively track patient mobility and movement to support personalized care, medication, and safety (Kriara et al., 2021; Ronan et al., 2024) as well as inform user-centered facility design (Donaire-Gonzalez et al., 2016). Beyond movement, GPS-enabled LTDs have been used to quantify individual exposure to air pollution across activities and locations, capturing variability that fixed monitoring stations cannot detect (Kouis et al., 2023; Sloan et al., 2016).

Workforce (n=4). Another documented context of LTD use is workforce tracking to improve planning and operational oversight. Existing studies show that such devices can effectively detect worker presence, measure task durations, and assess workflow reliability (Gong et al., 2025; Guillemette et al., 2009; Pollard et al., 2022; Zhao et al., 2021). These insights support analysis of delays, movement patterns, and conformance to schedules. When tracking spans both

Table 2. Concept matrix

	Technology		Context								Ethics		
Paper	Satellite-based	Proximity-based	Animals/ Wildlife	Healthcare	Workforce	Vehicles/ Traffic	Agriculture	Retail	Supply chain	Others/ Unspecified	Ethical review	Informed consent	Ethical concerns
Acácio et al. (2022)	●		●								●		
Bento et al. (2019)	●	●					●						
Brushett et al. (2023)	●		●								●		
Casano et al. (2022)		●								●	●	●	
Dick et al. (2013)	●		●										
Donaire-Gonzalez et al. (2016)	●			●							●	●	
Dujon et al. (2014)	●		●										
Forshee et al. (2022)	●		●								●		
Gong et al. (2025)		●			●								
Guillemette et al. (2009)	●	●			●								●
Handscombe and Yu (2019)	●	●				●							
Holland and John (2023)	●					●							●
Kawaguchi et al. (2016)		●						●					
Koch and Baars (2009)	●	●							●				
Kouis et al. (2023)	●			●							●	●	
Kriara et al. (2021)		●		●							●	●	
Lane et al. (2024)	●		●								●		
Lo et al. (2004)	●	●							●				
Mandeville and Crossley (2016)		●								●			
Narang et al. (2024)	●						●						
Pollard et al. (2022)		●			●						●	●	
Ronan et al. (2024)		●		●									
Ross et al. (2024)	●		●								●		
Sloan et al. (2016)	●			●								●	
Sung et al. (2018)		●								●			
Wagner et al. (2014)	●					●							
Yan and Zeng (2008)		●						●					
Zhao et al. (2021)		●			●							●	
Σ	**18**	**15**	**7**	**5**	**4**	**3**	**2**	**2**	**2**	**3**	**10**	**7**	**2**

indoor and outdoor settings, combined GPS-RFID systems are recommended (Guillemette et al., 2009).

Vehicles/Traffic (n=3). In the traffic and vehicle domain, LTDs are used to support optimization in both private-sector services and public traffic planning. In carsharing, GPS data have been applied to determine demand, enabling operators to identify high-potential areas for fleet expansion (Wagner et al., 2014). In vehicle insurance, LTDs enable individual risk profiling by capturing spatial and contextual driving behavior, such as road type, which informs usage-based pricing models (Holland & John, 2023). For urban traffic management, LTDs have been used to generate anonymized flow data that inform the design of adaptive traffic systems (Handscombe & Yu, 2019).

Agriculture (n=2). In agriculture, LTDs support precision farming by enabling real-time monitoring. Existing research highlights the use of GPS-equipped machinery to optimize field operations and reduce inefficiencies (Narang et al., 2024). In addition, GPS and RFID technologies have been applied to digitalize farm management by geotagging crops and linking production data to specific cultivation zones (Bento et al., 2019).

Retail (n=2). LTDs in retail have been used to enhance behavioral insights and inform location-aware marketing and store design. Studies have shown how tracking customer movements enables the identification of common in-store routes, which can be used to optimize product placement and improve spatial layout (Kawaguchi et al., 2016; Yan & Zeng, 2008).

Supply chain (n=2). In the supply chain domain, LTDs are used to increase transparency and control over interorganizational material flows, particularly in logistics and packaging processes. GPS- and RFID-enabled tracking systems have shown to improve inventory accuracy and enhance operational coordination (Lo et al., 2004). Additionally, tracking the location of packaging materials enables the establishment of reusable packaging cycles (Koch & Baars, 2009).

Others/Unspecified (n=3). Some studies applied LTDs in experimental or non-specific contexts to test methodological innovations. One work focused on

indoor pedestrian tracking using advanced signal processing and sensor fusion techniques to improve accuracy in challenging environments (Sung et al., 2018). Other studies explored the use of Bluetooth beacons in alternate reality games or art museums to illustrate the potential in dynamic, user-centric applications (Casano et al., 2022; Mandeville & Crossley, 2016).

Having outlined the technological approaches and empirical contexts for which LTDs have been used (RQ1), this section turns to the second dimension of the review: the ethical considerations associated with their application (RQ2).

4.2. Research ethics

A total of 10 out of 28 studies (36%) explicitly reported that their research was reviewed by an ethics committee. Most of these fall into the "Animals/Wildlife" or "Healthcare" domains. Nine of the ten studies were formally approved, while one was "[…] exempt from ethical review […] as it involved the use of anonymous, non-identifiable data and was deemed negligible risk research" (Pollard et al., 2022, p. 3). Some studies also referenced specific ethical frameworks. These include domain-specific protocols, such as animal welfare regulations and institutional animal care protocols (Lane et al., 2024; Ross et al., 2024) or broader guidelines in human subject research, such as the Declaration of Helsinki (Kriara et al., 2021). Among the studies that involved tracking of human participants, most reported that written *informed consent* was obtained, which is a central concern in studies where individuals may be affected by the data collection.

Only two studies explicitly reflected on broader ethical concerns beyond formal compliance (Guillemette et al., 2009; Holland & John, 2023). Across their papers, they refer to the following areas of ethical concern. *Fairness* was discussed in terms of preventing harm or disadvantage resulting from LTD use (Guillemette et al., 2009; Holland & John, 2023). *Transparency* was emphasized in two ways: clarifying the scope as well as the purpose of data collection (Guillemette et al., 2009) and ensuring that individuals have access to their data so that the system "[…] is open to interrogation […]" (Holland & John, 2023, p. 5088). The studies also addressed the risk of *data misuse and data protection*, stressing that only data necessary for the study should be collected, handled with care, and used exclusively for its stated purpose (Guillemette et al., 2009; Holland & John, 2023). If individuals are involved, measures must also be in place to protect their *privacy* (Guillemette et al., 2009). Finally, both studies argued that data collection should not become an end in itself, but must produce demonstrable, justifiable *value contribution* (Guillemette et al., 2009; Holland & John, 2023).

The preceding analysis addressed the empirical contexts in which LTDs have been used and examined how ethical concerns have been acknowledged in prior research. The following section uses those findings to derive ethical guidelines (RQ3).

5. Deriving guidance: New responsibilities

On the one hand, the review shows that LTD-based research in supply chains is still in its infancy. On the other hand, only a limited number of studies engage systematically with the ethical aspects of such research. For researchers, engaging with ethical questions is not merely a matter of formal compliance. Ethical reflection can strengthen research design by clarifying the study's purpose, sharpening research questions, and anticipating unintended consequences (Myers & Klein, 2011). It is also essential for ensuring the credibility of the work, which directly affects its reception and the likelihood of publication (Stahl et al., 2014).

To support scholars in navigating these challenges, the following section proposes ethical guidelines tailored to the specific demands of LTD-based research in a supply chain context. The guidelines are grounded in the concerns identified through the literature review and translated into actionable considerations for designing and evaluating ethically responsible LTD studies.

The review identified six core areas of concern: (1) informed consent, (2) fairness, (3) transparency, (4) data misuse and data protection, (5) privacy, and (6) value contribution. In addition, drawing on precedents set in the reviewed studies (Kriara et al., 2021; Lane et al., 2024; Ross et al., 2024), established ethical guidelines, such as the Declaration of Helsinki (WMA, 2024), the Ethical Principles of Psychologists and Code of Conduct (APA, 2017), the Responsible Research and Innovation guideline (RRI, 2014), and the European General Data Protection Regulation (GDPR, 2016) were consulted.

Although most of these guidelines were originally developed for research involving human participants, certain principles, particularly those related to consent, transparency, and data handling, may offer useful reference points for LTD-based studies in supply chains. Moreover, even if such research focuses on object tracking (Koch & Baars, 2009; Lo et al., 2004), individuals can be indirectly affected depending on the study design. This particularly applies to studies with a focus on the use phase of a product, when the tracked object is utilized by an individual.

Table 3. Areas of ethical concern, challenges, and suggested measures

Concern	Supporting sources	Challenge	Exemplary mitigation or justification measures
Informed consent	APA (2017); WMA (2024); Pollard et al. (2022); Kriara et al. (2021)	*Lack of consent:* Monitored supply chain actors may not know that they are part of a study.	• If obtaining consent is impossible or impractical, the study should be reviewed and approved by an ethics committee. • A waiver of consent may be justified if: o no feasible alternative method exists, o the validity of the study would be compromised by disclosure, o the research serves a legitimate scientific and public interest.
Fairness	GDPR (2016); Guillemette et al. (2009); Holland and John (2023)	*Exposure of sensitive business information:* Tracking data reveal supply chain structures, locations, or processes that may be considered confidential; publication could violate commercial secrecy.	• Apply full (e.g., pseudonyms) or partial (dissociating specific findings from identifiable entities) anonymization. • Use of close-range tracking devices (e.g., RFID, UWB) to prevent precise individual localization. • Present the findings to a group of external experts to assess whether the anonymization is sufficient and effective. • No publication of exact coordinates.
		Misinterpretation of context: Tracking data is objective but lacks context. This may lead to a risk of drawing false conclusions.	• Triangulation with other data sources (e.g., qualitative interviews, secondary sources). • Transparent communication of uncertainties and limitations in reporting.
Trans-parency	APA (2017); Guillemette et al. (2009); Holland and John (2023)	*Lack of disclosure:* Supply chain institutions may be unaware of the study's scope, purpose, or intended use.	• Establishment of a homepage on which affected stakeholders can inform themselves about the background of the research activities. • Proactively share publications with the investigated institutions.
		Limited credibility: Supply chain institutions may contest the findings and reject the validity of the conclusions.	• Provide access to data summaries or audit trails upon institutional request, if this does not compromise the interests of other stakeholders. • Offer pre-publication review of the conducted study to provide the opportunity to check for factual accuracy.
Data misuse and data protection	APA (2017); GDPR (2016); Holland and John (2023)	*Dual-use and instrumentalization:* Collected tracking data may be used later beyond the original research purpose.	• Strict limitation of data access and sharing. • Definition of clear data use boundaries. • Deletion or secure archiving of the data thereafter, with restricted access if retention is necessary.
		Involuntary disclosure: Tracking data may be accessed by unauthorized parties or leaked unintentionally.	• Avoidance of cloud solutions and local data storage. • Encryption of all saved tracking data. • Define a data retention policy that balances scientific transparency with ethical risk mitigation (e.g., 6–12 months post-publication).
Privacy	APA (2017); GDPR (2016); Guillemette et al. (2009); Holland and John (2023)	*Perceived surveillance:* If tracking can be linked to identifiable individuals, this may enable surveillance or profiling.	• Usage of close-range tracking devices (e.g., RFID, BT, UWB) to prevent precise individual localization. • Application of data minimization principles; delete data if unintended personal movement tracking is detected. • Provide access to study findings and clarify (e.g., during debriefing) which and how data were collected.
		Psychological distress: Individuals discovering a tracking device may experience strong emotional reactions due to feelings of surveillance or overcontrol.	• Post-study debriefing (e.g., via QR code on the device) that links to information about the study's purpose, data use, and ethical safeguards.
Value contri-bution	RRI (2014); Guillemette et al. (2009)	*Unclear beneficiaries and operational difficulties:* Supply chains are complex systems with interdependencies. It may, therefore, be hard to determine the impact of a study.	• Stakeholder mapping to assess who may be affected. • Justification of the study by highlighting the necessity and usefulness of the collected data with regard to environmental, compliance, or governance goals. • Contact the investigated institutions and request the data to be collected with the LTDs to show that alternative access is not possible. • Highlight the relevance of the study by referring to secondary data (e.g., market size, growth rates).
		Research footprint: The tracking devices used in the study have an environmental footprint of their own. In addition, studies may trigger real-world processes that would not have occurred otherwise, resulting in financial and environmental consequences.	• Limit sample size to what is necessary to achieve data saturation. • Minimize device loss by offering return mechanisms (e.g., return envelopes). • Report the financial and environmental side-effects of the study. • Compensation of unavoidable emissions where possible (e.g., via offsetting schemes).

The resulting framework was developed by mapping established normative principles to the practical conditions and challenges of LTD-based research in supply chains. Drawing on the reviewed literature and incorporating feedback from their university's ethics committee, the authors identified eleven specific challenges and derived corresponding mitigation and justification strategies (see Table 3).

While the guidelines provide a systematic reflection on the ethical aspects of LTD-based research in supply chains, it is not without limitations. First, the choice of search string, the databases considered, and the study's inclusion and exclusion criteria may have excluded relevant literature. Second, the analysis concentrated on studies that explicitly reported their use of LTD, potentially overlooking research that applied similar technologies without foregrounding them in the method section. Third, ethical concerns were coded based on explicit mentions in the literature; implicit considerations or undocumented practices may therefore have been missed.

Against this background, the guidelines should not be understood as a mandatory checklist, but as a practical guide to support ethical reflection. It is intended to be further developed, adapted, or supplemented in light of evolving research contexts and should be tailored to the specific goals and design of each study.

6. Conclusion

This study proposes the use of LTDs as a method for independently and objectively generating geospatial data in supply chain contexts. Although supply chains significantly shape the environmental and social footprint of products, they often remain an opaque "black box" for external stakeholders. LTDs offer a promising means of increasing transparency, enabling previously unattainable insights with descriptive, comparative, predictive, and prescriptive value. To explore the current state of the literature, this paper conducted a developmental review.

The results show that LTD-based research in supply chains is still rare. Ethical concerns surrounding this form of data collection likely represent a major barrier to broader adoption, especially given the sensitivity of observing commercial practices. To address these concerns and foster further uptake, this paper introduces a literature-grounded ethical framework, including exemplary mitigation and justification strategies.

Theoretically and methodologically, the proposed framework can help enable a broader collection of geographic data in supply chains, opening new possibilities for location analytics and GIS-based research (Pick, 2004). In addition, LTD-based studies contribute to the growing but still underrepresented field of Green IS. Gholami et al. (2016) emphasized that "[…] the IS scholarly community needs to help create a sustainable society. […] Too few people are working on green IS given its importance, and fewer still are publishing papers about IS solutions that could contribute to dealing with climate change". By promoting transparency in supply chains, LTD-based research responds directly to this call. Finally, the framework advances the discourse on responsible data-driven research (Myers and Klein 2011; Stahl et al. 2014) by supporting both scholars and reviewers in designing and evaluating ethically sound research.

Beyond academic relevance, this study also offers practical value for managers and supply chain professionals who could be interested in using LTDs to monitor supply chain processes by providing a synthesized overview of the extant literature. By embedding ethical considerations into the design and communication of tracking initiatives, companies can build trust with affected employees, suppliers, and/or customers.

7. Digital appendix

The digital appendix documents the systematic literature analysis. It includes the export of the databases as well as the screening process of the articles retrieved:

→ https://doi.org/10.6084/m9.figshare.29949839.v1

8. References

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