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Capturing Data Through Tracking Devices: Enhancing Visibility and Transparency in E-Commerce Reverse Logistics

Research-in-progress

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Abstract

E-commerce returns, particularly in the fashion sector, have become a growing sustainability concern. Existing studies of reverse logistics often rely on assumptions or proprietary datasets, resulting in limited transparency and potentially distorted theorisation. This research-in-progress explores the use of tracking devices to generate data on the reverse logistics of consumer returns. Trackers were placed in twenty returns across European fashion e-tailers, producing 563 geolocation data points. Data analysis reveals substantial inconsistencies between declared and actual logistics flows, with large e-tailers' returns travelling significantly longer distances than previously reported. Benchmarking further suggests that the Google Maps API provides reliable distance measures. The study contributes to Green IS research by positioning independent data generation as a means to reduce information asymmetries and by advancing a performative view of data as an enabler of sustainability outcomes. Expected contributions include more accurate emissions estimation, comparative analyses, and new directions for governance and accountability research.

Keywords E-Commerce, Reverse Logistics, Consumer Returns, Tracking Device, Green IS.

1 Motivation

Achieving internationally agreed climate targets requires a substantial reduction in greenhouse gas emissions. While progress has been made in some sectors, transport remains a persistent challenge. Globally, transportation and logistics account for approximately 15% of total GHG emissions (Crippa et al. 2024). The European Commission reported that transport showed "[…] the largest increase, both in relative (+3.7%) and absolute terms (301 Mt CO_{2eq})" (Crippa et al. 2024). "To get on track with the Net Zero Emissions (NZE) by 2050 Scenario, CO_2 emissions from the transport sector must fall by more than 3% per year to 2030" (International Energy Agency 2023). Addressing this challenge requires not only technological and systemic innovations that improve efficiency and reduce resource consumption, but also research that documents current realities, thus providing a foundation for informed decision- and policy-making and incentives for change.

In this context, information systems (IS) and information and communication technologies (ICT) research play an increasingly vital role. Building on recent advances in theorising the relationship between data and sustainability, relevant data should not be viewed merely as an informational input but as a transformational resource (Püchel et al. 2024). Its transformative potential lies in the ability to reshape organisational and societal practices in alignment with sustainability objectives (George et al. 2021; Kotlarsky et al. 2023). Yet, translating this potential into practice has proven difficult (Krasikov and Legner 2023). A performative view of data (Parmiggiani et al. 2022) directs attention to how data are produced, interpreted, and mobilised to enact sustainability in practice. Following this logic, enhancing transparency, optimising processes, and supporting more sustainable systems can make an important contribution to achieving the Sustainable Development Goals (SDGs) (Püchel et al. 2024).

This study focuses on e-commerce. While reliable statistics on the emissions from e-commerce logistics remain scarce, it is evident that these emissions have increased and will continue to rise alongside the strong growth of e-commerce. Within e-commerce logistics, consumer returns are particularly critical. Returns are substantially more frequent in online retail than in brick-and-mortar contexts and can generate a disproportionate share of emissions (Bozzi et al. 2022; Tian and Sarkis 2022). Yet, the overall environmental burden of returns remains uncertain (e.g., Edwards et al. 2009; Wiese et al. 2012). Recent empirical research has begun to address this gap, but transparency remains limited because crucial logistical data are often withheld as proprietary knowledge (Roichman et al. 2024).

This lack of transparency may stem from corporate practices that could be perceived as environmentally questionable, posing a risk of reputational damage. Recent investigative reports support this notion. For instance, journalists investigating Nike's reverse logistics fitted sneakers with trackers to trace their post-return journey. Their findings indicated that Nike destroyed and recycled returned shoes in mint condition (Gorsler 2022). A similar investigation tracked returns within Zalando, one of Europe's leading fashion e-tailers, revealing that a single return shipment travelled up to 7,000 km (Mathews 2023). Motivated by the research gap and inspired by these insights, the authors of this paper initiated an explorative research project to determine whether tracking devices can serve as a reliable and independent data collection method for reverse supply chains. Specifically, the research questions are:

1. *What level of transparency can tracking devices provide in a reverse supply chain?*
2. *Is the Google Maps API suitable for determining the distances travelled?*

Answering these questions contributes to SDG 12 ("Responsible Consumption and Production") and SDG 13 ("Climate Action"). This study showcases the potential of tracking technology to enhance the data landscape and generate otherwise unavailable empirical insights, which provide the basis for policy interventions or corporate sustainability initiatives.

The remainder of the paper situates the study within Green IS and sustainability research in e-commerce reverse logistics (section 2), before outlining the research design and data collection approach (section 3). Thereafter, the preliminary findings are presented (section 4) and the expected contributions are discussed (section 5). The paper concludes with a brief reflection on the study's limitations (section 6).

2 Related Literature

This study is positioned at the intersection of two research streams: (1) Green IS and (2) environmental sustainability in e-commerce reverse logistics.

2.1 Green IS

A growing body of IS research addresses sustainability challenges, often categorised under the umbrella of Green IS. Scholars typically distinguish between the "Greening of ICT", which focuses on reducing the environmental impact of technology itself, and the "Greening by ICT" that emphasises how digital technologies can enable sustainability across organisational processes and interorganisational supply chains (AIS SIG Green 2024; Esfahbodi et al. 2023; Leidner et al. 2022). Within this second stream, an emerging consensus holds that sustainability data should be regarded not merely as informational input but as a transformational resource that can catalyse change across and beyond organisations (Hovorka and Mueller 2025; Püchel et al. 2024). However, sustainability data are often fragmented, inaccessible, or of limited quality (Krasikov and Legner 2023), which reduces their transformative potential.

Green IS research further conceptualises ICT-enabled sustainability impacts at different magnitudes. Direct impacts relate to the ecological footprint of technologies themselves; enabling impacts capture how digital systems reshape processes and decision-making; and systemic impacts involve broader cultural and institutional shifts that redefine how sustainability is pursued (Owsiany and Brohman 2024). Recognising these layered impacts clarifies how data-centric technologies can move from supporting operational efficiency to enabling long-term sustainability transformation. Despite this potential, scholars have identified persistent barriers to data sourcing and governance in sustainability transformations (Benfeldt and Schroder 2025). Issues of trust, alignment, formalisation, harmonisation, and flexibility often reinforce information asymmetries between companies, regulators, and consumers. Such asymmetries hinder transparency and constrain sustainability-oriented decision-making (Gholami et al. 2016).

Building on the growing recognition of data's transformative role, Green IS research has embraced a performative view of data, which emphasises that data do not merely describe sustainability but help enact it in practice (Lycett 2013; Parmiggiani et al. 2022). In that regard, tracking technologies that produce independent data could be promising tools. These technologies generally fall into two categories: (1) satellite-based systems that provide accurate, real-time tracking (Balakrishnan et al. 2009) and (2) proximity-based localisation, which require local infrastructure but offer advantages in cost and energy efficiency (Zhang et al. 2022). When combined with geographic information systems (GIS), location-based data can support the design of more sustainable logistics networks (Göswein et al. 2018; Senán-Salinas et al. 2021) and cirular supply chains (Tsui et al. 2024).

2.2 Environmental Sustainability in E-Commerce Reverse Logistics

In e-commerce, consumer returns are not only substantially more frequent than in brick-and-mortar retail, but may also contribute disproportionately to overall emissions. Tian and Sarkis (2022) estimated that returns could account for more than 30% of the carbon emissions associated with initial deliveries but that the full environmental burden remains uncertain due to a lack of comprehensive data. Several studies have sought to assess the environmental impact of returns, often by comparing e-commerce with physical retail (Buldeo Rai et al. 2019; Edwards et al. 2009; Hischier 2018; Mangiaracina et al. 2016; van Loon et al. 2015; Wiese et al. 2012). However, their results diverge substantially because of varying assumptions about reverse logistics flows. For instance, estimated return distances range from 13 miles (Edwards et al. 2009) to 602 km (Wiese et al. 2012), highlighting the lack of consensus.

More recently, Roichman et al. (2024) attempted to overcome these limitations by analysing empirical return data from 630,000 parcels managed by "ReBound Returns", a service provider for fashion e-tailers. Their lifecycle assessment revealed that transport accounts for 79–89% of post-return emissions, processing and packaging contribute 2–3%, while incineration is responsible for the remainder. However, the study did not disclose crucial logistical details, such as actual return distances or final destinations. In the paper's digital appendix, this omission is justified as "proprietary knowledge", suggesting that ReBound Returns or its clients did not permit the release of this information. This illustrates both the potential and the limitations of current approaches: while empirical evidence is emerging, transparency remains restricted by corporate data control.

Taken together, both research streams underscore a persistent lack of data. The scarcity and control of data reflect underlying information asymmetries that determine who can observe, measure, and be held accountable for environmental impacts. Consequently, questions of data availability are not purely technical but are shaped by the power relations and governance mechanisms that influence how sustainability is enacted and assessed. Addressing this gap requires approaches capable of generating trustworthy, independent data that reveal hidden processes. Responding to this need, the present study explores the use of tracking devices as a novel means of observing and analysing return flows. This approach aligns with Green IS theorising that links data visibility to enhanced transparency, accountability, and transformation (Gholami et al. 2016; Melville 2010). The relevance is amplified by the continued growth of e-commerce (Appriss Retail Inc. and Deloitte 2024), which drives an ever-increasing volume of consumer returns and magnifies their environmental footprint, making transparency in reverse logistics both an academic and societal imperative.

3 Methodology

The study targeted online fashion merchants, commonly referred to as fashion e-tailers. Fashion was selected as a focal category because it is the most purchased segment in European online retail and exhibits the highest return rates by far (Lone et al. 2023). It is estimated that fashion items account for around 88% of all consumer returns (Bozzi et al. 2022).

Purposeful Sampling Approach. The primary sample (sample 1) consisted of the ten leading fashion e-tailers with the highest online sales in Germany when the study was conceptualized: (1) About You, (2) Amazon, (3) ASOS, (4) Bonprix, (5) C&A, (6) EMP, (7) Esprit, (8) H&M, (9) Zalando, and (10) Zara (EHI Retail Institute 2024). Six of these companies are headquartered in Germany, while the others are based in Luxembourg, Spain, Sweden, and the United Kingdom. This geographic diversity helps to mitigate potential location bias. All selected fashion e-tailers operate across Europe. For comparison, a control group (sample 2) was formed from ten smaller merchants: (1) Adidas, (2) Fjällräven, (3) Helly Hansen, (4) Mammut, (5) Nike, (6) Puma, (7) Reebok, (8) Schöffel, (9) The North Face, and (10) Vaude. Similar to the primary sample, the investigated companies are geographically diversified with headquarters in Germany (4), the United States (3), Norway (1), Sweden (1), and Switzerland (1). Although Adidas and Nike are widely recognised as blue-chip companies, their direct-to-consumer (D2C) e-commerce sales volumes in Germany (Nike.de: €345.6 million; Adidas.de: €235.7 million) remain marginal relative to leading fashion e-tailers such as Amazon (€14.6 billion) or Zalando (€2.5 billion) (EHI Retail Institute 2024).

Used Tracking Devices. After a trial-and-error phase with different systems, we eventually referred to Bluetooth (BT)-based devices. Interested researchers can contact the authors for additional information. The devices periodically transmit a signal that can be detected by nearby infrastructure, thereby enabling approximate geolocation of the tagged object. The reported locations can then be scraped and exported to a spreadsheet. The device offers three main advantages: (1) the BT-based network is widely available, (2) the tracker is unobtrusive in size, and (3) the device is cost-efficient, allowing for a future scalable deployment across a larger number of parcels.

Research Ethics. While innovative, this approach raises ethical considerations. Most notably, no consent was obtained from the fashion e-tailers being studied. Prior notification, however, would likely have influenced their behaviour, compromising the study's objectivity. Given the urgent sustainability challenges posed by returns (Appriss Retail Inc. and Deloitte 2024; PostNord 2021), the societal and scientific benefits were deemed to outweigh these concerns. Nevertheless, the university's ethics committee reviewed and approved the project, recommending that sensitive business information be anonymised. Accordingly, findings are dissociated from individual e-tailers and precise location data are not disclosed. Importantly, the study tracks parcels, not individuals; no personal data were collected, ensuring compliance with the EU General Data Protection Regulation (GDPR).

Implementation & Data Collection. Purchases consisted of single items of outerwear ordered directly from each e-tailer's own store (excluding third-party sellers). Upon receipt, each parcel was opened, a tracking device discreetly placed inside along with the return slip, then resealed, and returned via the nearest drop-off point of the respective logistics service provider (LSP). The devices subsequently generated geolocation data with two components: (1) the coordinates of each detection and (2) the corresponding timestamp. These data were collected daily into a spreadsheet and served as the basis for distance calculations. Additionally, shipment IDs were used to retrieve LSP tracking information, which enabled cross-validation of the tracking device data for reliability and accuracy.

4 Preliminary Findings

This research-in-progress study aims to assess both the methodological feasibility of using tracking devices at the intersection of Green IS and reverse logistics research and the insights they can provide. The findings reported below therefore fall into two categories that refer to the paper's two research questions: (1) deriving empirical insights into the reverse logistics structures of European fashion e-tailers and (2) reassuring the suitability of tools for distance measurement.

4.1 Data-driven Insights on E-Commerce Reverse Logistics

Despite potential challenges of data transmission in a logistics context, such as signal interference from Faraday cages in containers, the 20 tracking devices generated a comprehensive dataset of 563 data points (sample 1: 360; sample 2: 203) from the returns' drop-off points to the e-tailers' processing centres. This enabled a systematic modelling of the reverse supply chain structure (e.g., drop-off points, LSP parcel depots, e-tailers' return facilities) and the transportation routes.

A comparison of the tracking data with the addresses provided on the shipping label revealed that only eleven returns (sample 1: 3; sample 2: 8) were actually processed at the specified address. Three e-tailers (sample 1: 2; sample 2: 1) used German addresses that either belong to the e-tailer or the LSP, serving as transit points for the parcels. Six e-tailers (sample 1: 5; sample 2: 1) indicated addresses on the shipping labels that were neither a transit nor a processing location for the parcels.

In total, the LSPs provided 107 data points (sample 1: 42; sample 2: 65) for the observed shipments. The data contained timestamps and activity descriptions; however, destination information was mainly missing (sample 1: 10; sample 2: 9). Moreover, the data shows that the transport leg from the last parcel centre to the e-tailers' return facilities is usually omitted in the LSPs' data, which accounts for 40.1% (sample 1: 57.1%; sample 2: 11.3%) of the total distance. Consequently, even if location data were provided, the LSP data alone would be insufficient for fully modelling logistics structures or accurately calculating transport distances. Importantly, neither the shipping label nor the LSPs' data would reveal that eight parcels (sample 1: 6; sample 2: 2) were transported to other countries for processing. Table 1 summarises further results.

	Sample 1: Leading fashion e-tailers (n=10)	**Sample 2: Smaller fashion e-tailers (n=10)**
Distance Travelled	8,950.6 km total (Ø 895.1 km, SD 228.9 km, range: 480.9–1,172.6 km)	5,290.7 km total (Ø 529.1 km, SD 167.9 km; range: 242.6–795.5 km)
Destination	Czech Republic (1), Germany (2), Poland (6), The Netherlands (1)	Belgium (1), Czech Republic (1), Germany (7), The Netherlands (1)
Transport Mode	Road transport	Road transport
Transport Speed	Ø 7.9 days, SD 2.9 days	Ø 6.1 days, SD 2.2 days

Table 1. Results for Returned Parcels (Sample 1 & 2)

Comparing these results to prior studies, the distances for leading e-tailers (sample 1) are significantly longer than the maximum of 602 km (t(9)=4.049, p=.001) as previously reported by Wiese et al. (2012). Smaller e-tailers (sample 2) show lower average distances, though not significantly different from prior estimates (t(9)= −1.374, p=.101). An independent-samples t-test confirms that returns from leading e-tailers travel significantly farther than those from smaller ones (t(18)=4.077, p<.001).

4.2 Reassuring the Suitability of the Distance Measuring Tool

To calculate the travelled distances as presented in the previous section, the study used the Google Maps API, given its ease of use and scalability. However, Google Maps has two limitations: (1) lack of transparency, as the underlying routing algorithms are undisclosed, and (2) limited reproducibility, since real-time traffic data can lead to varying distance results. These factors raise concerns about its suitability for scientific research requiring replicable results. To assess reliability, the Google Maps results for the primary sample (leading fashion e-tailers) were benchmarked against BRouter, an open-source routing tool that does not incorporate real-time data.

BRouter measured a total distance of 8,924.3 km, compared to 8,950.6 km with Google Maps. Deviations occurred in 157 of the 350 route segments (44.9%). In 104 of these cases, Google Maps calculated a shorter route than BRouter. The total deviation across all segments amounted to 176.1 km, with 74.9 km attributed to Google Maps and 101.2 km to BRouter. Because deviations occurred in both directions, they partially offset each other, resulting in a net deviation of only 26.3 km. Only 22 segments deviated by more than one kilometre. The main causes were (1) differences in route calculation (14 cases), (2) situational factors preventing exact route reproduction on Google Maps (7 times), and (3) company gates, where BRouter, unlike Google Maps, ceases route calculation (1 time). Two paired-sample t-tests confirmed that the deviations were not statistically significant, both at the parcel level (t(9) = .396, p = .702) and at the route segment level (t(349) = .427, p = .670). This suggests that despite its limitations, the Google Maps API is sufficiently reliable for distance calculation in academic research.

5 Discussion and Outlook

This study set out to explore how digital tracking technologies can generate independent data that enhance transparency in reverse logistics. Building on Green IS theorising that positions data as a transformational resource (George et al. 2021; Kotlarsky et al. 2023; Püchel et al. 2024), we conceptualise a data-driven mechanism linking digital innovation to sustainability outcomes.

In line with the performative view of data (Lycett 2013; Parmiggiani et al. 2022), we argue that data may not only describe reality but also actively shape organisational and societal practices. Tracking devices autonomously acquire process-embedded data, producing visibility into activities that are otherwise hidden (Melville 2010). This visibility enables information transparency, defined as the extent to which sustainability-relevant processes become accessible and verifiable by internal and external stakeholders (Schnackenberg and Tomlinson 2016; Watson et al. 2010). Greater transparency strengthens accountability, as external actors can evaluate whether corporate practices align with stated commitments and societal expectations (Bovens 2007; Leidner et al. 2022). Through these mechanisms, information asymmetries, which long have been recognised as barriers to sustainability-oriented decision-making (Gholami et al. 2016), are reduced and sustainability transformation is fostered as decision- and policy-making becomes more evidence-based. This performative sequence (Data Acquisition → Visibility → Transparency → Accountability → Sustainability Outcomes) captures how data from tracking devices can enact sustainability (Parmiggiani et al. 2022).

Building on this sequence, this study highlights the potential of tracking device data to complement and challenge existing corporate sustainability information. While not yet demonstrating causal effects, the findings indicate that independent data can expand the informational basis for sustainability evaluation, thereby strengthening transparency and accountability. By capturing data within processes, tracking technologies foster a more dynamic and activity-based understanding of environmental performance, aligning with calls for process-oriented and verifiable measurement practices (Melville 2010; Püchel et al. 2024). Furthermore, enabling independent data generation reframes the role of academia and civil society as active contributors to sustainability assessment. This shift offers a pathway to mitigate alignment and formalisation barriers in sustainability data governance (Benfeldt and Schroder 2025) and may, over time, catalyse broader institutional and cultural change.

As the project expands, this research is also expected to advance theorisation on how to assess and govern environmental sustainability in e-commerce reverse logistics. Prior studies have largely relied on assumptions or proprietary data (Roichman et al. 2024; Wiese et al. 2012), limiting the ability to conceptualise how reverse flows contribute to emissions and sustainability outcomes. The ongoing research aims to generate visibility into these opaque processes, which would enable more accurate estimation of return-related emissions (Tian and Sarkis 2022) and facilitate comparative analyses across company sizes and business models, revealing structural inefficiencies and potential trade-offs between scale and ecological performance. Over time, these insights could inform theoretical perspectives on fairness and governance in e-commerce by examining whether scale advantages are achieved at the expense of the common good, namely ecological sustainability. Furthermore, they offer a foundation for theorising how greater accountability, once achieved, may influence sustainability-oriented behaviour among consumers and organisational decision-making within firms, ultimately contributing to improved sustainability outcomes.

To realise these expected contributions, the next steps involve (1) developing a research framework to assess the environmental impact of e-commerce returns with a high degree of generalisability, and (2) expanding the project through international scientific collaborations beyond Europe.

6 Limitations and Conclusion

As a research-in-progress study, this work faces several limitations. First, the findings are based on a small sample, which constrains the generalizability of the results. Second, given the early stage of the project, the insights into environmental sustainability in e-commerce logistics remain descriptive rather than explanatory. Third, the analysis builds on the assumption that longer transport distances worsen the ecological footprint, which only holds if all else, particularly the load factors, remains equal. To the best of our knowledge, however, there is no empirical evidence that load factors systematically increase with travel distance in e-commerce reverse logistics. On the contrary, our observations of fashion e-tailers suggest that LSPs typically hold shipments at logistics depots until a full truckload is achieved, with no fixed departure schedule.

Despite these constraints, the study demonstrates the potential of tracking devices as independent data sources in IS research. Unlike self-reported or proprietary data, tracking provides an independent and verifiable means of observation in real-world conditions, thereby reducing “data analysis poverty” (Gholami et al. 2016). While data collection is ongoing, the findings indicate that tracking devices can enhance transparency in reverse logistics and suggest that prior assessments may have underestimated the true environmental impact of consumer returns by large fashion e-tailers, who account for the majority of returns and tend to obscure their reverse flows. Moreover, the study shows that the Google Maps API is a suitable tool for calculating transport distances in this context. As the project expands, we will work on these limitations to develop a framework that supports more accurate environmental assessments and strengthens stakeholder accountability in line with the Green IS agenda.

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