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Packaging as a Last-Mile Logistics Decision: Consumer Expectations Across E-Commerce Fulfillment Channels

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Abstract

Background: Last-mile delivery is the most operationally complex and consumer-visible segment of E-commerce fulfillment, and direct-from-store (DFS) operations account for a growing share of online orders; yet packaging has been studied largely as a materials or sustainability problem rather than as a consumer-facing logistics decision. This study characterizes consumer packaging expectations across fulfillment channels and compares them with observed DFS practice. *Methods:* We integrate two empirical efforts: an online survey of general E-commerce packaging perceptions (n = 1947 U.S. consumers) and a DFS investigation comprising an exploratory international field audit of 51 orders across four countries and an online DFS consumer survey (314 participants). Analyses include professional–consumer comparisons, internal-consistency and exploratory factor analyses, and a mixed-effects model of the repeated scenario ratings. *Results:* Consumers consistently prioritize functional protection, content concealment, and practical sustainability over experiential and branding attributes; packaging professionals rate experiential attributes more highly than consumers do (medium-to-large effects); and observed DFS practices frequently misalign with consumer-prioritized functions. *Conclusions:* The findings support treating packaging as a managed, consumer-centric logistics variable and identify packaging choice at checkout as a feasible lever for DFS providers.

Keywords: last-mile delivery; packaging; direct-from-store; ship-from-store; consumer expectations; E-commerce; omnichannel fulfillment; expectation-confirmation; perceived sustainability

1. Introduction

The exponential growth of E-commerce has transformed retail supply chains and placed unprecedented pressure on last-mile delivery. U.S. retail E-commerce sales reached an annualized level of approximately $1.2 trillion in 2025, with quarterly E-commerce shares of total retail sales around 16% [1]. Last-mile delivery, the final segment of distribution from a transit point to the consumer's doorstep, accounts for a disproportionately large share of total transportation costs and remains the most operationally complex and expensive component of the E-commerce supply chain [2,3]. As consumer expectations for faster and more convenient delivery have intensified, retailers have diversified their fulfillment strategies beyond the traditional centralized warehouse model.

In response, retailers have adopted omnichannel approaches that use existing retail store networks as distribution nodes. Direct-from-store (DFS) delivery, also referred to as ship-from-store, is a fulfillment model in which online orders are picked, packed, and dispatched directly from brick-and-mortar retail locations rather than from dedicated

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distribution centers [4,5]. Major U.S. retailers now report that over half of their online orders are fulfilled from store locations, citing reductions in delivery times and fulfillment costs [6]. However, this transition introduces operational challenges distinct from those of warehouse-based fulfillment. Retail stores are designed for in-person shopping, not order picking and packing: the tools and processes used in warehouses (such as pick-to-light systems, standardized packaging stations, and wave picking) are not available in a retail store environment [7,8].

One operational dimension that has received limited attention is packaging. In warehouse-based E-commerce, packaging decisions follow relatively standardized protocols: products are placed in corrugated shippers with appropriate void fill and protective materials, often including branded inserts [9]. In DFS operations, by contrast, packaging defaults to whatever is available at the retail store, such as plastic grocery bags, paper bags, or no additional packaging at all. This lack of standardization creates variability in the consumer experience and raises questions about product protection, privacy, theft prevention, and environmental impact. Despite the central role packaging plays in both protecting products during transit and shaping the consumer's post-purchase experience, packaging decisions in last-mile logistics have been studied almost exclusively from a materials engineering or sustainability perspective [9,10]. The logistics and supply chain management literature has largely overlooked packaging as a consumer-facing decision variable in last-mile delivery.

Consumers form distinct expectations about how their deliveries should be packaged, and these expectations plausibly relate to satisfaction, repurchase intention, and service-provider selection. We draw on expectation-confirmation theory [11,12] as an interpretive lens (rather than as a tested causal model; see Section 2.4) to organize this argument. Packaging is a tangible and immediately visible component of the delivery experience and can therefore function as a salient signal of service quality. If consumers expect their orders to arrive with contents concealed for privacy, protected from theft, and packaged in environmentally responsible materials, then packaging that falls short of these expectations may be associated with reduced post-purchase evaluations even when the product itself arrives undamaged. Recent research on package theft underscores this concern: Hicks et al. [13] found that nearly one in four U.S. online retail consumers had experienced package theft, with fear of theft producing risk-avoidance behaviors such as forgoing higher-value online purchases. In this context, packaging that conceals the contents and value of a delivery is plausibly a logistics decision with implications for the consumer relationship, although direct measurement of repurchase or retention behavior is beyond the scope of the present study.

Consumer demand for sustainable packaging has also grown substantially. Consumers increasingly expect packaging to be recyclable, reusable, or made from renewable materials, and these preferences can shape their choice of delivery service providers [14]. Within the framework of customer-centric supply chain design [15], packaging decisions in the last mile should be informed by downstream consumer requirements rather than determined solely by upstream operational convenience. Given that DFS operations inherently afford less control over packaging standardization than warehouse-based fulfillment, understanding what consumers expect from delivery packaging across these channels is essential for designing strategies that balance operational efficiency with consumer-perceived service quality.

Despite the growing importance of DFS delivery and the recognized role of packaging in consumer satisfaction, there is limited empirical research connecting consumer packaging expectations to fulfillment channel type. Existing studies on last-mile optimization have focused predominantly on routing efficiency, delivery speed, cost reduction, and alternative

delivery technologies such as drones and parcel lockers [3,16,17]. While these contributions are valuable, they do not address how packaging as a tangible element of the delivery service is perceived by consumers, or how those perceptions differ depending on whether the order was fulfilled from a warehouse or directly from a store. To address this gap, the present study investigates the following research questions:

- RQ1. What packaging functions do consumers prioritize in general E-commerce delivery, and how do these priorities differ between packaging-industry professionals and non-professional consumers?
- RQ2. What packaging functions do consumers prioritize specifically in DFS delivery scenarios?
- RQ3. How do observed DFS packaging practices in selected international markets align or misalign with consumer-prioritized packaging functions (as measured in a North American sample)?
- RQ4. What packaging decision principles can guide consumer-centered last-mile packaging strategy across fulfillment channels?

To address these questions, a multi-method empirical approach was adopted. Study 1 surveyed 1947 U.S. consumers regarding their perceptions of general E-commerce packaging elements, covering fundamental packaging functions, marketing attributes, and environmental characteristics. Study 2 combined an exploratory international field audit of DFS packaging practices across four countries (United States, Canada, Hungary, South Korea) with an online survey of 314 consumers focused specifically on DFS delivery packaging preferences. By integrating findings from both studies, this research provides—to our knowledge—the first joint characterization of consumer packaging expectations alongside observed DFS packaging practices across multiple international markets. The results contribute to the logistics and supply chain management literature by positioning packaging as a consumer-facing logistics decision variable and offering evidence-based recommendations for retailers and logistics managers seeking to optimize last-mile packaging in an omnichannel environment.

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature on last-mile logistics, packaging as a logistics function, consumer expectations in delivery, and the theoretical framing employed. Section 3 describes the research design and methods. Section 4 presents the results, including a cross-channel thematic comparison. Section 5 discusses the findings and their implications. Section 6 concludes with a summary of contributions, limitations, and directions for future research.

2. Literature Review

This section reviews four streams of literature that inform the present study: the evolution of last-mile logistics and fulfillment channel diversification, the role of packaging as a logistics function, emerging research on consumer expectations in last-mile delivery, and the theoretical framing employed.

2.1. Last-Mile Logistics and Fulfillment Channel Diversification

Last-mile delivery has emerged as one of the most studied areas in logistics and supply chain management over the past decade. Defined as the final leg of the delivery process from a distribution point to the end consumer, last-mile operations are characterized by high cost, low efficiency, and substantial environmental impact [2,3]. The cost intensity of last-mile delivery stems from serving dispersed residential locations with small, individual shipments under tight delivery windows. Mangiaracina et al. [3], in a review of 75 papers on last-mile delivery efficiency, identified the probability of failed deliveries, customer density in delivery areas, and the degree of process automation as the primary cost drivers.

These factors are amplified by the same-day and next-day delivery promises that have become common across major E-commerce platforms.

The traditional model for E-commerce fulfillment relies on centralized distribution centers (DCs) where inventory is stored, orders are picked and packed by trained warehouse staff, and shipments are dispatched via carrier networks. This model benefits from economies of scale in storage, standardized picking and packing, and optimized outbound logistics [5]. However, centralized fulfillment presents limitations in speed and flexibility, particularly when consumers demand same-day or sub-day delivery. In response, retailers have turned to omnichannel fulfillment strategies that leverage their store networks. Melacini et al. [5] mapped the key logistics challenges across three dimensions: distribution network design, inventory and capacity management, and delivery planning and execution. Their review highlighted that the logistics and supply chain dimensions of omnichannel retailing remain under-researched relative to its sales and marketing dimensions.

Ship-from-store (SFS), or direct-from-store (DFS), represents a specific form of omnichannel fulfillment in which retail stores serve as micro-distribution centers for online orders. Bayram and Cesaret [4] modeled order fulfillment policies for SFS implementation and showed that stores can reduce delivery lead times and improve inventory utilization when fulfillment is appropriately managed. Baron et al. [18] further examined operational uncertainties inherent in SFS, including inventory censoring (products misplaced or displayed in-store), variable employee workload, and the risk of pick-up failures. These challenges are compounded because store employees must balance in-person customer service with online order fulfillment, often without dedicated picking or packing infrastructure [6]. Wollenburg et al. [19] investigated how grocery retailers restructure their logistics networks for omnichannel operations, finding that many initially leverage existing store infrastructure rather than investing in purpose-built micro-fulfillment centers.

What is notably absent from this growing body of literature is any systematic examination of how packaging decisions are made, standardized, or experienced by consumers in the DFS context. This omission appears structural rather than incidental: Risberg's [20] systematic review of 373 E-commerce logistics articles consolidates the field into an omnichannel decision framework spanning network design, fulfillment, last-mile delivery, and returns, yet packaging enters that framework only at the margins. The pattern extends across adjacent research streams: recent systematic reviews of last-mile E-commerce delivery in urban areas [21], of sustainable digital omnichannel retailing [22], and of omnichannel customer buying behaviour [23] likewise engage packaging only through the lenses of waste, returns, and delivery externalities, never as a consumer-facing service attribute in its own right. The operational challenges of DFS have likewise been studied primarily through the lenses of routing optimization, inventory management, and labor allocation. Packaging, as the element of the fulfillment process that directly interfaces with the consumer, has been treated as a secondary concern or omitted entirely. This gap is particularly significant because DFS delivery often results in products arriving in ad-hoc packaging (grocery bags, paper bags, or no additional packaging), in contrast to the standardized corrugated shippers used in warehouse-based E-commerce.

2.2. Packaging as a Logistics Function

Packaging serves multiple functions within the supply chain, extending well beyond the containment and protection of products. Regattieri and Santarelli [24] proposed a framework in which the functions of packaging within E-commerce supply chains can be organized into three categories: marketing, environment, and flow. The marketing function refers to the role of packaging in creating value, communicating brand iden-

tity, and enhancing the consumer experience; the visual design elements of packaging are known to shape consumers' emotions and their perceptions of product quality and price [25]. The environment function addresses the minimization of negative environmental impacts of packaging decisions. The flow function encompasses logistics-related objectives such as efficient handling, transport, storage, and waste management. This tripartite framework is useful because it situates packaging at the intersection of consumer experience and logistics operations, a position especially relevant for last-mile delivery. That intersection is the premise of the packaging logistics perspective, in which García-Arca et al. [26] argue that packaging should be designed jointly with the supply chain, balancing protection, handling efficiency, and sustainability, rather than treated as a downstream marketing afterthought. Extending that perspective to the consumer-facing last mile is precisely the contribution this study pursues. As discussed in Section 3 and revisited in the Results, we partially reorganize Regattieri and Santarelli's marketing category in the present analysis, because one of its constituent elements (doorstep discretion) is conceptually closer to privacy/security/risk mitigation than to branding or experiential marketing.

Within the E-commerce context, packaging has been studied primarily from a sustainability perspective. Escursell et al. [9] conducted a comprehensive review of sustainability in E-commerce packaging, identifying key themes including material selection, packaging reduction, recyclability, and the environmental cost of over-packaging. They noted that E-commerce generates substantially more packaging waste per unit than traditional retail, owing to the need for individual shipment protection and the addition of void fill materials. Scharpenberg et al. [10] examined packaging strategies in packaging-free supermarkets, highlighting the tension between waste reduction and consumer expectations regarding product protection and convenience, and Silva and Pålsson's [27] systematic review traces how design choices, including material selection, dimensioning, and void fill, govern both waste and circularity outcomes. This supply-side emphasis, however, sits in tension with how consumers themselves weigh packaging: Lindh et al. [28] found that consumers tend to underestimate the protective and product-preserving value of packaging relative to its environmental impact. The implication is consequential for the last mile—sustainability-driven material reductions risk degrading functions that consumers do not consciously rank highly but still penalize when they fail. These studies establish that packaging optimization in E-commerce requires balancing environmental objectives with functional performance, yet they approach the problem almost exclusively from the supply side, without systematic consideration of what consumers actually expect or prefer.

That functional performance is far from a solved problem is underscored by transit-hazard and outcome evidence. Instrumented-parcel measurements show that small and medium E-commerce parcels routinely experience drops and shocks of consequential magnitude as they move through the delivery network [29], so the protective adequacy of ad-hoc DFS packaging cannot be taken for granted. Downstream, Wallenburg et al. [30] show that shipping-package characteristics shape online product-return behavior, with packaging acting simultaneously as physical protection and as a signal that conditions the consumer's response on receipt. Read together, these results reframe protection not as a settled engineering detail but as a consumer-facing variable with measurable behavioral consequences, one that the DFS shift toward grocery bags and no-additional-packaging places directly at risk.

The International Safe Transit Association (ISTA) has developed standardized testing protocols for E-commerce packaging, most notably the ISTA 3L standard for generalized E-commerce retailer fulfillment testing. However, this standard is designed to evaluate packaging performance under simulated distribution conditions and does not

replicate the last-mile conditions of DFS delivery, where handling is less standardized and transit distances are shorter. Given the lack of DFS-specific packaging standards, retailers operating DFS models must make packaging decisions on an ad-hoc basis, often defaulting to the bags and materials used for in-store customer transactions. This represents a missed opportunity to leverage packaging as a strategic element of the last-mile service offering.

2.3. Consumer Expectations in Last-Mile Delivery

Consumer expectations in last-mile delivery have received increasing attention in the logistics literature, though the focus has been predominantly on delivery attributes such as speed, cost, time-window flexibility, and delivery mode. Merkert et al. [16] used stated choice experiments to examine consumer preferences for innovative and traditional last-mile delivery methods, including postal delivery, parcel lockers, and delivery drones. Their findings indicated that delivery speed and cost were the primary drivers of consumer choice, with security concerns moderating preferences for autonomous delivery methods. Peppel et al. [17] evaluated the integration of mobile parcel lockers into last-mile delivery networks, modeling consumer preferences using a multinomial logit approach. Nguyen et al. [31] similarly found that consumers weigh delivery attributes such as speed, time slot, and fee heterogeneously, segmenting into distinct preference clusters, and Gawor and Hoberg [32] quantified these trade-offs monetarily, showing through choice-based conjoint analysis that consumers attach measurable willingness to pay to the fulfillment options presented at online checkout, while Klein and Popp [33] showed that perceived sustainability and convenience significantly affect the acceptance of last-mile delivery methods. Importantly, the last-mile experience is not peripheral to satisfaction: Vakulenko et al. [34] found that last-mile delivery mediates the relationship between the online retail experience and customer satisfaction, and Aljohani [35] provides recent empirical support that last-mile delivery quality drives the overall online retail experience. Olsson et al. [36] push this further, decomposing the last-mile delivery experience into cognitive, emotional, sensorial, and physical dimensions, several of which are realized precisely at the moment of receipt, where the packaging is the first and most tangible thing the consumer handles. These studies are valuable for understanding how consumers evaluate delivery service attributes, yet they stop short of the packaging itself, which is arguably the most concrete artifact of that experience, leaving open what consumers expect packaging to do.

One dimension of consumer expectations with direct relevance to packaging is concern over package theft (porch piracy). Hicks et al. [13] conducted the first peer-reviewed academic study on the fear of package theft. Their findings revealed that 23.8% of respondents had personally experienced package theft, and that fear of theft was significantly higher among women, urban and suburban residents, and those with prior victimization. Critically, this fear led to behavioral changes: consumers reported avoiding expensive online purchases, rerouting deliveries to alternative addresses, and staying home during expected delivery times. Stickle et al. [37], using crime script analysis of security camera recordings, found that package thefts typically occurred on properties close to roadways in suburban and urban areas, suggesting that the visibility of packages on doorsteps is a key factor. These findings have direct implications for packaging design in last-mile delivery: packaging that conceals the contents, value, and source of a delivery can function as a theft deterrent, an aspect particularly relevant for DFS orders, where products may arrive in transparent grocery bags or without additional packaging.

Sustainability is another domain in which consumer expectations intersect with packaging decisions. Heikkinen [14] explored how retail and logistics service provider managers cognitively frame sustainability in last-mile delivery, finding that managers primarily associate sustainability with emission reduction rather than packaging optimization. From the consumer perspective, however, packaging is one of the most tangible and immediately evaluable sustainability signals in the delivery experience. Buldeo Rai et al. [38], in an assessment of the environmental impact of online shopping, argued that most E-commerce research fails to consider consumer behavior and the consumption landscape, both of which can substantially affect sustainability outcomes. Green packaging has since been studied from both consumer and business perspectives [39], and recent evidence indicates that consumers with higher environmental awareness express greater willingness to pay for green E-commerce packaging, although price sensitivity tempers this effect [40]. A systematic review of consumer responses to environmentally friendly packaging corroborates a consistent, if attribute-dependent, willingness to pay a modest premium [41], and choice-based evidence specific to E-commerce shows that consumers actively disfavor overpackaging and prefer right-sized, reduced-material options when recycling infrastructure and environmental awareness support them [42]. These results temper, but do not resolve, a persistent attitude–behavior gap: consumers voice pro-environmental attitudes toward last-mile delivery yet act on sustainable options less consistently than those attitudes would imply [43]. The present study addresses this gap by empirically measuring how consumers evaluate the perceived sustainability attributes of last-mile packaging, including recyclability, compostability, reusability, and material renewability, while remaining careful to distinguish perception from actual environmental performance.

Baldi et al. [15], in a comprehensive review of consumer-centric supply chain management, identified four recurring themes in the literature: closed-loop supply chains, information disclosure and communication, sustainable supply chain management, and logistics service quality. Their analysis revealed that the post-purchase phase of the consumer journey, which includes delivery, packaging interaction, and product evaluation upon receipt, remains significantly under-researched relative to the pre-purchase and purchase phases. The present study contributes to filling this gap by focusing specifically on the post-purchase packaging experience across fulfillment channels.

2.4. Theoretical Framing

This study draws on two complementary theoretical perspectives, expectation-confirmation theory and customer-centric supply chain design, to interpret the empirical findings.

Expectation-confirmation theory, originally proposed by Oliver [11] and subsequently adapted to information-systems continuance by Bhattacherjee [12] as the expectation-confirmation model (ECM). We use the abbreviation ECM throughout this paper, following Bhattacherjee [12]. ECT is avoided to prevent confusion with Edge Crush Test (TAPPI T 811), a standard packaging performance metric. ECM provides a framework for understanding how consumer satisfaction is formed through the comparison of prior expectations with perceived performance. Under ECM, consumers form expectations about a product or service before experiencing it; after the experience, they evaluate whether the perceived performance confirms or disconfirms those expectations, with disconfirmation predicting satisfaction. This consumer-level account dovetails with the electronic-service-quality literature, which locates delivery squarely within service evaluation: in the validated E-S-QUAL framework, fulfillment (the accuracy and condition in which orders arrive) is one of the core dimensions of online service quality [44]. Because packaging is the tangible determinant of that arrival condition, it provides a concrete bridge between our ECM-based framing and an established service-quality construct. We make a deliberate scope

restriction here: we use ECM as an interpretive lens for organizing and discussing our findings, not as a tested causal model. Our instruments measure stated importance ratings and stated preferences rather than the four ECM constructs themselves (prior expectations, perceived performance, confirmation/disconfirmation, and post-experience satisfaction). Accordingly, throughout this paper we avoid causal claims about how packaging outcomes "erode satisfaction" or have "direct implications for retention," and instead use ECM to motivate why packaging warrants attention as a consumer-facing signal and to organize the discussion of where consumer-prioritized attributes appear to be misaligned with current DFS practice. Empirical tests of the full ECM pathway (importance → perceived performance → confirmation → satisfaction → behavior) in the packaging context are identified in Section 5.6 as a priority for future research.

The second perspective, customer-centric supply chain design, shifts the focus from operational efficiency to the alignment of supply chain decisions with downstream consumer requirements. Baldi et al. [15] define consumer-centric supply chain management as the incorporation of consumer needs, preferences, and behaviors into supply chain decision-making. Applied to packaging, this perspective argues that packaging decisions should not be determined solely by cost minimization or operational convenience at the fulfillment point, but should also consider how the end consumer will interact with, evaluate, and respond to the packaging they receive. This is particularly relevant in DFS, where packaging decisions are made by store employees who may prioritize speed and simplicity over consumer-facing quality. By combining ECM (as an interpretive lens at the consumer level) with a customer-centric perspective (at the supply chain decision level), this study provides both a diagnostic framing (why consumers care about packaging) and a prescriptive framing (how logistics managers should incorporate these preferences into packaging strategy).

Building on these two perspectives, Figure 1 presents the conceptual framework that organizes the present study. Recent work reinforces both lenses: in online post-purchase settings, (dis)confirmation of expectations shapes satisfaction [45], and the last-mile delivery experience, of which packaging is the most tangible artifact, mediates the relationship between the online retail experience and customer satisfaction [34]. Packaging itself is an expectation-shaping touchpoint, as the unboxing experience influences consumers' product expectations [46]. The customer-centric perspective, in turn, reflects a broader reorientation of supply chains around the consumer experience rather than internal efficiency alone [47]. We translate this framing into four propositions that the study explores. We deliberately label these propositions rather than causal hypotheses: our instruments measure stated importance and preferences, not the ECM constructs or behavioral outcomes, so the propositions are organizing expectations examined descriptively rather than formally tested causal paths.

- P1. Consumers prioritize functional protection and content concealment over experiential and branding attributes, and this priority hierarchy is relatively stable across fulfillment channels (RQ1–RQ2).
- P2. Packaging professionals place greater importance on experiential and branding attributes than non-professional consumers do—a perception gap concentrated in marketing-oriented elements (RQ1).
- P3. Observed DFS packaging practices frequently misalign with the concealment and protection functions consumers prioritize (RQ3).
- P4. Customer-centric mechanisms, such as offering packaging choice at the point of checkout, can narrow the expectation–practice gap (RQ4).

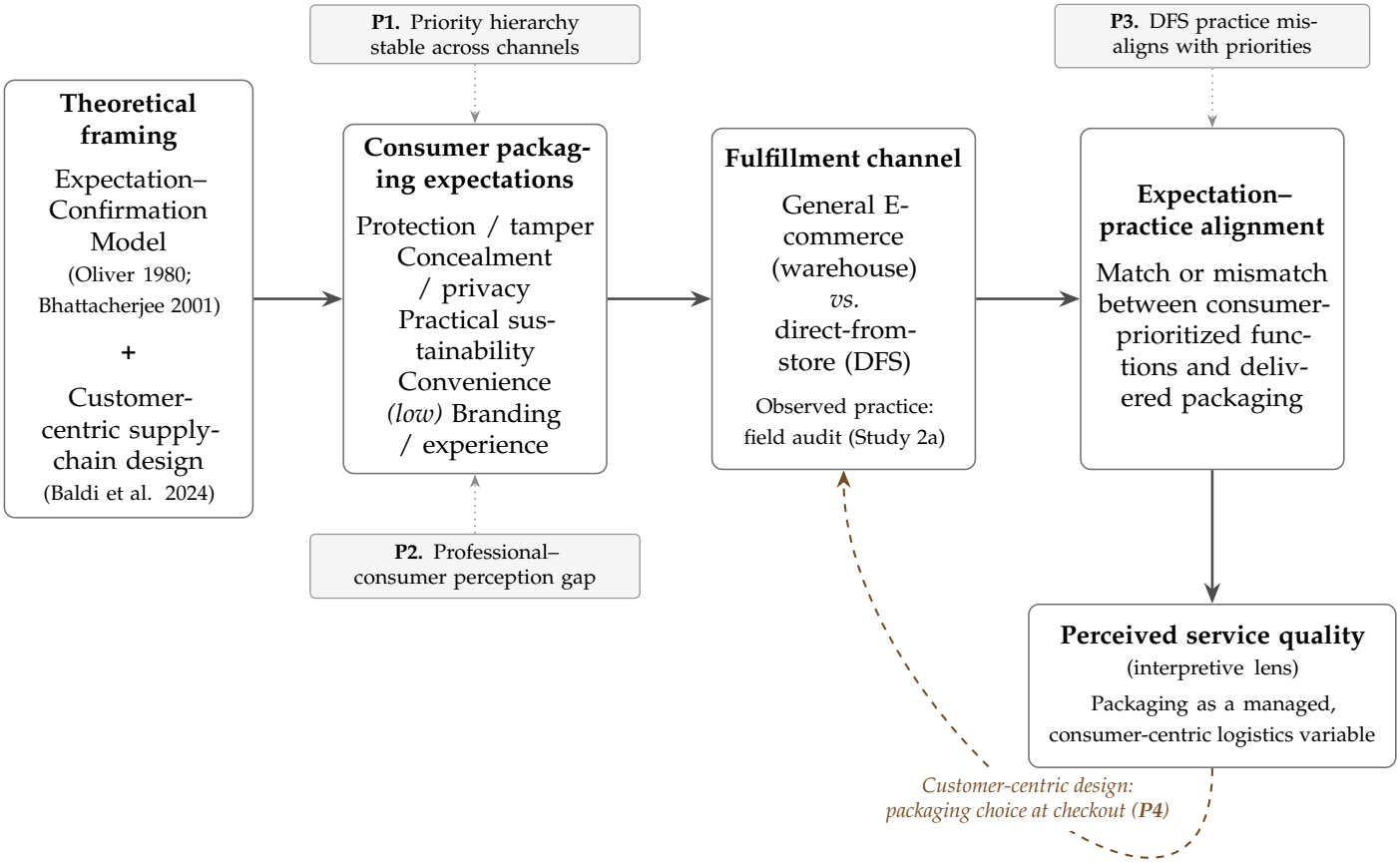

Figure 1. Conceptual framework linking the theoretical lenses (expectation-confirmation model [11,12] and customer-centric supply chain design [15]) to consumer packaging expectations, the fulfillment channel, and the resulting expectation–practice alignment. Propositions P1–P4 are explored descriptively across the three empirical components; the framework is interpretive, not a tested causal model.

3. Materials and Methods

3.1. Overview of the Multi-Method Approach

This study used a multi-method empirical approach combining two independently conducted research efforts. Study 1 investigated consumer perceptions of packaging in the context of general E-commerce delivery (the survey instrument referred to "online orders" without distinguishing fulfillment channel, so we frame the resulting evidence as general E-commerce expectations rather than warehouse-specific). Study 2 focused specifically on DFS operations and comprises (a) an exploratory international field audit of DFS packaging practices (Study 2a) and (b) an online consumer survey on DFS packaging preferences (Study 2b). An additional in-person survey with a smaller sample provided supplementary validation. Conducting two studies at different time points (2021 and 2023) across different fulfillment contexts enables a thematic comparative analysis. Table 1 summarizes the research design.

Studies 1 and 2 were originally designed and conducted as independent research efforts. The present paper integrates findings from both within a unified framework. The temporal separation between the studies (April–June 2021 for Study 1; August–December 2023 for Study 2) is acknowledged as a limitation and is discussed in Section 5.6.

Two design choices warrant justification. First, both surveys used social-media convenience sampling. This is appropriate for the exploratory and comparative aims of the study: characterizing the relative importance consumers assign to packaging attributes and contrasting subgroups, rather than estimating population prevalence; the large Study 1 sample ($n = 1947$) and the deliberate, near-even split of packaging professionals and non-professionals are analytical features that enable the professional–consumer comparison, not attempts at a

representative panel. We report results for the non-professional subsample and a professionals-excluded robustness check so that the "consumer" interpretation does not depend on the professional respondents. Second, the instruments have content validity by construction: the Study 1 items operationalize the established Regattieri and Santarelli [24] packaging-function framework, each as a concrete situational question, and both surveys embedded attention checks and applied the data-quality exclusions described below. Internal-consistency reliability (Cronbach's α) is reported with the results in Section 4.

Table 1. Summary of the multi-method research design.

Component	Focus	Method	Sample	Period	Platform/Location
Study 1	General E-commerce packaging perceptions	Online survey	$n = 1947$	April–June 2021	Qualtrics; USA
Study 2a	DFS packaging practices (exploratory international field audit)	Field observation	51 orders	August–December 2023	USA, Canada, Hungary, S. Korea
Study 2b	DFS packaging consumer perceptions	Online survey	$n = 314$	August–December 2023	QuestionPro; USA, Canada
Supplementary	In-person packaging preference validation	In-person survey	$n = 43$	Spring 2024	University campus, USA

3.2. Study 1: General E-Commerce Packaging Perceptions Survey

3.2.1. Survey Instrument

An online survey was designed to assess how consumers perceive the value of different packaging elements in the context of E-commerce. The survey instrument was adapted from the framework proposed by Regattieri and Santarelli [24], which categorizes packaging functions in E-commerce supply chains into three areas: marketing, environment, and flow. For the purposes of this study, the flow category was relabeled as "packaging functions" to communicate its content to respondents. A total of 22 packaging elements were identified as critical in the E-commerce packaging design process and organized into three sections: Packaging Functions (10 elements), Marketing (6 elements), and Environment (6 elements). These elements are listed in Table 2. All questions were prefaced with the phrase "you receive an online order" (with no further specification of fulfillment channel), so the resulting evidence reflects general E-commerce packaging expectations.

Table 2. Packaging design and engineering elements evaluated in the consumer perceptions survey (Study 1), grouped by the original Regattieri and Santarelli [24] category structure. As discussed below and in Section 4, in our analysis we reassign doorstep discretion from the marketing category to a concealment/privacy/security domain.

Packaging Functions	Marketing	Environment
Appearance protection	Unboxing experience	Reusability
Handleability	Brand recognizability	Validating certification
Weight efficiency	Attractiveness	Renewability
Unboxing function	Brick-and-mortar similarity	Renewability of materials
Volume efficiency	Novelty	Material post-use
Containment	Doorstep discretion [a]	Recyclability
Function protection		
Apportionment		
Resistance to climatic influences		
Tamper protection		

[a] Originally classified under Marketing per Regattieri and Santarelli [24]; in the present study we treat it as a concealment/privacy/security attribute (see Section 4).

Each packaging element was evaluated through a situational question describing a specific scenario related to E-commerce delivery. For example, to assess the importance of tamper protection respondents were asked: "How important is it to you that when you receive an online order you can distinctly tell if the package has been opened or tampered with (example: noting broken seals, tape, etc.)?" Responses were collected on a 5-point Likert scale ranging from "Not at all important" (1) to "Extremely important" (5). Demographic information collected included age, gender, ethnicity, education level, and E-commerce purchasing frequency. Respondents were also asked whether they worked in a packaging-related field and, if so, their number of years of experience.

3.2.2. Distribution and Data Quality

The survey was developed and distributed using the Qualtrics XM platform (Qualtrics XM version April–June 2021; Qualtrics, Provo, UT, USA) between April and June 2021. Respondents were recruited through social media channels (Facebook, Reddit, Instagram, LinkedIn). Undergraduate research assistants promoted the survey on personal social media and within groups affiliated with the packaging industry, the university, and general survey sampling communities. As an incentive, three respondents selected at random received a small gift card. This convenience sampling approach, while providing access to a large respondent pool, introduced potential biases related to age distribution, education level, and familiarity with the packaging industry. These biases are acknowledged in Section 5.6.

A total of 2139 responses were recorded. To ensure data quality, several exclusion criteria were applied: responses from duplicate email addresses or device identifiers were removed, and responses completed in less than 126 seconds (estimated as the minimum feasible completion time at approximately three seconds per question for the 42-item survey) were excluded as unreliable. After these exclusions, 1947 valid responses remained for analysis. Of these respondents, 50.5% self-identified as working in a packaging-related field and 49.5% did not. This near-equal split, while not representative of the general population, enables a systematic comparison of packaging perceptions between industry professionals and general consumers. To protect the "general consumer" interpretation of the main results, in Section 4 we present sample means separately for the non-professional subsample and report the full-sample results as a robustness reference.

3.3. Study 2: DFS Packaging Practices and Consumer Perceptions

3.3.1. Study 2a: Exploratory International Field Audit of DFS Packaging Practices

To characterize current packaging practices in DFS operations across different international markets, an exploratory field audit was conducted in which participants purchased products from grocery and retail delivery services in multiple countries. We use the terminology "exploratory field audit" rather than "benchmarking" because the sample is convenience-based, modest in size, and not representative of country-level practices. Data were collected in the United States (Blacksburg, VA, and Richmond, VA), Canada (Toronto), Hungary (Budapest), and South Korea (Seoul); see Figure 2. In each market, participants were instructed to place orders with three to five grocery/retail delivery services, with approximately four orders per service. Products ordered were ambient consumer-packaged goods selected from commonly available categories: beverages, household items, food, small appliances, and toys/games. The priority was to place orders exclusively with services offering direct-from-store fulfillment.

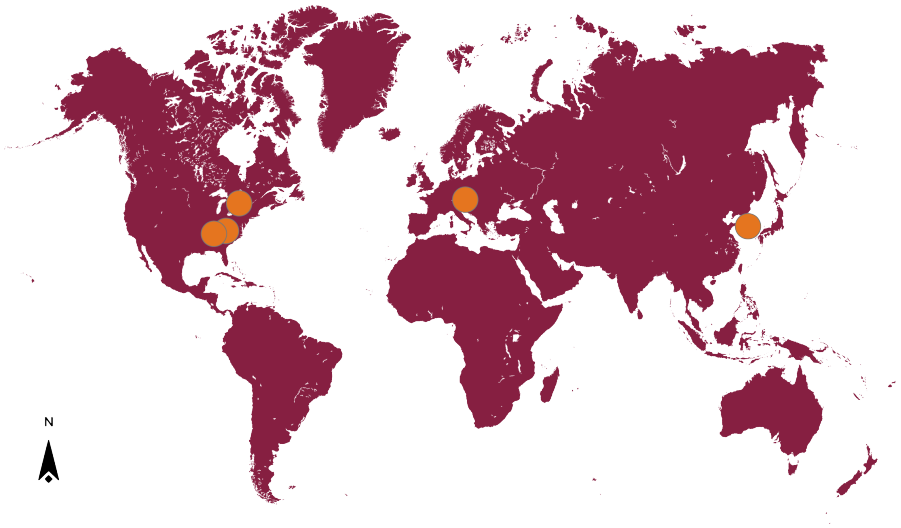

Figure 2. Geographical scope of the exploratory international field audit (Study 2a). Orders were placed from grocery and retail DFS services in five metropolitan areas across four countries: Blacksburg and Richmond (Virginia, USA), Toronto (Canada), Budapest (Hungary), and Seoul (Republic of Korea).

Data collection occurred between August and December 2023. A total of 51 orders were placed across the four countries. For each order, the following data were recorded: product category, packaging material used for delivery (categorized as no additional packaging, normal grocery bag, paper bag, reusable bag, or kraft corrugated box), and the condition of the products upon arrival (good condition, minor damage, or visibly damaged). Analysis focused on identifying patterns in packaging material usage across product categories and regions, and on descriptively summarizing the relationship between packaging material and product condition. Because packaging material was not randomly assigned to products (less fragile and bulkier categories were disproportionately likely to ship with no additional packaging) we treat the relationship between packaging type and product condition as descriptive only and do not interpret it causally.

This audit is limited by its sample size (51 orders), uneven country-level n (ranging from approximately 9 to 25 orders), single-season coverage, convenience-based retailer selection, and absence of randomization across cities, delivery modes, or seasons. The packaging observed for any given order may also be shaped by confounds we did not control, including product characteristics, order size, delivery distance, weather, platform-specific rules, and local packaging regulations. We therefore avoid country-level inferential comparisons and treat the results as an illustrative international snapshot.

3.3.2. Study 2b: DFS Consumer Perceptions Survey

A second online survey was designed to investigate consumer perceptions of packaging specifically within the context of DFS delivery. The survey consisted of 33 questions organized into four sections: demographics, delivery-from-store usage patterns, packaging function preferences, and sustainability attitudes. The demographics section collected information on respondent location, age, gender, race/ethnicity, education, household size, and income. The usage patterns section examined frequency of DFS service use, factors influencing service selection, and the time elapsed between order delivery and product retrieval.

The core section of the survey assessed the importance of specific packaging functions across four purchasing scenarios: a small appliance (e.g., a hand blender or coffee maker), a toy for a child, small loose packaged items (e.g., canned food or cereal), and a large item (e.g., diapers or toilet paper). For each scenario, respondents rated the importance of

packaging functions such as hiding the product to prevent theft, concealing the contents for privacy, hiding the store of purchase, grouping items for transport, and (in the case of toys) avoiding spoiling a surprise. All importance ratings used a 5-point Likert scale (1 = Not at all important; 5 = Extremely important). The sustainability section assessed the importance of receiving orders in low-environmental-footprint packaging, perceived sustainability rankings of different packaging options (plastic bags, paper bags, paper mailers, reusable totes, and no additional packaging), and the importance of specific sustainability attributes (curbside recyclability, home compostability, industrial compostability, renewable materials, store-return reusability, and consumer reusability). Attention checks were embedded throughout the survey to identify and exclude inattentive respondents.

The survey was distributed online using the QuestionPro platform (version August–December 2023; QuestionPro Inc., Austin, TX, USA) between August and December 2023. Recruitment followed the same social-media-based convenience sampling approach used in Study 1, with distribution through Facebook, Reddit, Instagram, and LinkedIn via personal networks and packaging-related online communities. As an incentive, respondents were offered the opportunity to participate in a giveaway of a $10 store gift card upon completion. The survey platform enforced single-device submission to prevent duplicate responses.

A total of 314 respondents participated in the survey, with 89.5% residing in the United States and 10.5% in Canada. The majority of respondents (69.9%) were between the ages of 25 and 44; the sample was skewed toward males (68.0%) and White/Caucasian respondents (79.2%); 69.8% held a college degree or higher; the median household income range was $50,000–$99,999; the most common household size was three people (39.9%). Approximately 38.4% of respondents reported current or prior employment in a packaging-related role. Because the survey allowed partial completion, the number of respondents answering each packaging-importance item varies; we report the per-item analyzed sample size in the relevant table notes (247–249 for the scenario items and 209–211 for the sustainability items, after excluding "not applicable" responses). As with Study 1, results presented below distinguish between the packaging-professional and non-professional subsamples to protect the "consumer expectations" interpretation. Table 3 summarizes the demographic profile of both survey samples.

Table 3. Demographic profile of the two survey samples. Percentages are of valid responses and may not sum to 100% due to rounding and "prefer not to answer" responses.

Characteristic	Study 1 ($n = 1947$)	Study 2b ($n = 314$)
Age	18–30: 43%; 30–45: 39%; 45–65: 14%	25–44: 70% (modal band)
Gender	Female 53%; Male 46%	Male 68%; Female 32%
Race/ethnicity	Caucasian 40%; Hispanic 17%; Native American 16%; Black 11%; Asian 7%	White/Caucasian 79%
Education (college or higher)	75%	70%
E-commerce/DFS use (≥weekly)	38%	56%
Packaging-industry experience	51%	38%
Location	United States	US 90%; Canada 10%

3.3.3. Supplementary In-Person Survey

To complement the online survey findings and provide a dimension of physical interaction with packaging materials, a supplementary in-person survey was conducted at a university campus in the United States in Spring 2024. A total of 43 respondents participated. Respondents were presented with six physical packaging options (plastic bag, paper bag, paper mailer, reusable tote bag, original product packaging, and plastic mailer) alongside representative products commonly delivered through DFS services. Respondents first ranked their packaging preferences based on visual impression alone,

then re-ranked their preferences after physically handling the packaging and products. Additional questions assessed perceptions of which packaging type was easiest to transport, priciest, most private, most protective, and most sustainable.

The in-person survey was limited by its small sample size ($n = 43$), which precludes inferential statistical analysis. The data are reported as supplementary findings and are not treated as a primary data source in the cross-channel analysis.

3.4. Cross-Study Comparison Methodology

Because Studies 1 and 2 were designed independently with different survey instruments, direct statistical comparison of individual items is not appropriate. Instead, the cross-channel analysis follows a thematic comparison approach, supplemented by a construct-mapping table (Table 4) that explicitly documents which Study 1 and Study 2 items map to which thematic domain, the degree of comparability, and the treatment applied. Both studies measured consumer priorities across overlapping domains: product protection, concealment/privacy/security, sustainability, convenience, and the relative importance of branding/experiential packaging attributes. Within each domain, the findings from the general-E-commerce context (Study 1) and the DFS context (Study 2b) are compared qualitatively and, where the comparison is supportable, quantitatively using the mean importance ratings on the shared 5-point Likert scale.

Table 4. Construct crosswalk between Study 1 and Study 2 items, used as the integration protocol for cross-channel comparison.

Domain	Study 1 Item(s)	Study 2b Item(s)	Comparability	Treatment
Protection/tamper evidence	Tamper protection; function protection; containment; climatic resistance; appearance protection	(not measured directly)	Partial	Within-Study 1 only
Concealment/privacy/security	Doorstep discretion	Hide product/value; hide for privacy; hide store name	Partial	Thematic + rank-order
Sustainability	Recyclability; reusability; renewability; certification; material post-use	Curbside recyclable; reusable; renewable; compostable; store-return reusable	Partial	Rank-order comparison
Branding/experience	Unboxing experience; brand recognizability; attractiveness; novelty; brick-and-mortar similarity	(not directly measured; "hide store name" is a distinct privacy item, not a branding measure)	Not comparable	Reported within Study 1 only
Convenience/handling	Handleability; weight efficiency; volume efficiency; apportionment; unboxing function	Group into single package (Study 2b scenarios)	Partial	Thematic

Specifically, the cross-channel comparison addresses three areas. First, the hierarchy of packaging function priorities is compared to determine whether consumers assign similar relative importance to protection, concealment, and sustainability regardless of fulfillment channel. Second, the professional-versus-consumer perception gap identified in Study 1 is examined for evidence of parallel patterns in the DFS context, using the subset of Study 2b respondents who reported packaging-related professional experience. Third, the sustainability preferences expressed by consumers in both studies are compared to

assess consistency of environmental priorities across channels. The field audit data from Study 2a are juxtaposed with the consumer expectation data from Studies 1 and 2b to identify areas of alignment and misalignment between observed DFS packaging practices and consumer preferences as measured in a North American sample; we do not extrapolate the consumer-side findings to Hungarian or South Korean consumers.

3.5. Statistical Analysis

For Study 1, we report mean importance ratings, standard deviations, and 95% confidence intervals (CIs) computed as $\bar{x} \pm 1.96\,\mathrm{SD}/\sqrt{n}$. For the professional-versus-consumer comparison (Section 4.1.2), we computed, for each element, the subgroup means and standard deviations, a Welch (unequal-variance) t statistic, and Cohen's d using the pooled subgroup standard deviation; p-values were adjusted for the family of 22 simultaneous element comparisons using the Holm–Bonferroni procedure. We assessed the internal consistency of the three thematic domains with Cronbach's α, and examined the empirical dimensionality of the 22-item battery with an exploratory factor analysis (principal-axis extraction with oblimin rotation; Kaiser–Meyer–Olkin sampling adequacy and Bartlett's test of sphericity reported). As a robustness check, the element and category rankings were recomputed with packaging professionals excluded.

For Study 2b, we report means, SDs, and 95% CIs on the importance ratings, with the per-item analyzed sample size given in the table notes (items answered "not applicable" were excluded from the corresponding means). Because each respondent rated the same packaging functions across the four scenarios, the scenario ratings are not independent within respondents; we therefore fit a linear mixed-effects model (restricted maximum likelihood) to the three concealment functions (theft prevention, privacy, store-name concealment) across the four scenarios, with a random intercept by respondent and fixed effects for function and scenario, and tested the function×scenario interaction by likelihood-ratio test. Internal consistency of the concealment and sustainability item sets was assessed with Cronbach's α.

4. Results

This section presents the results of the three empirical components. Results from Study 1 (general E-commerce packaging perceptions) are presented first, followed by the DFS field audit (Study 2a) and the DFS consumer survey (Study 2b). The section concludes with a cross-channel thematic comparison.

4.1. General E-Commerce Packaging Perceptions (Study 1)

4.1.1. Packaging Function Hierarchy

The 1947 respondents in Study 1 evaluated the importance of 22 packaging elements on a 5-point Likert scale. Results for the ten fundamental packaging functions are shown in Figure 3; marketing-related elements in Figure 4; and environmental elements in Figure 5. Among the ten fundamental packaging functions, tamper protection received the highest mean importance rating ($M = 4.19$, 95% CI [4.17, 4.21]), followed by resistance to climatic influences ($M = 3.96$, 95% CI [3.94, 3.98]), apportionment ($M = 3.75$, [3.73, 3.77]), function protection ($M = 3.68$, [3.66, 3.70]), and containment ($M = 3.61$, [3.58, 3.64]). At the lower end, appearance protection ($M = 3.53$, [3.51, 3.55]) and handleability ($M = 3.53$, [3.50, 3.56]) received the lowest importance ratings among packaging functions. This pattern indicates that consumers prioritize the functional utility of packaging (its ability to deliver products safely, intact, and verifiably untampered) over its visual presentation on arrival.

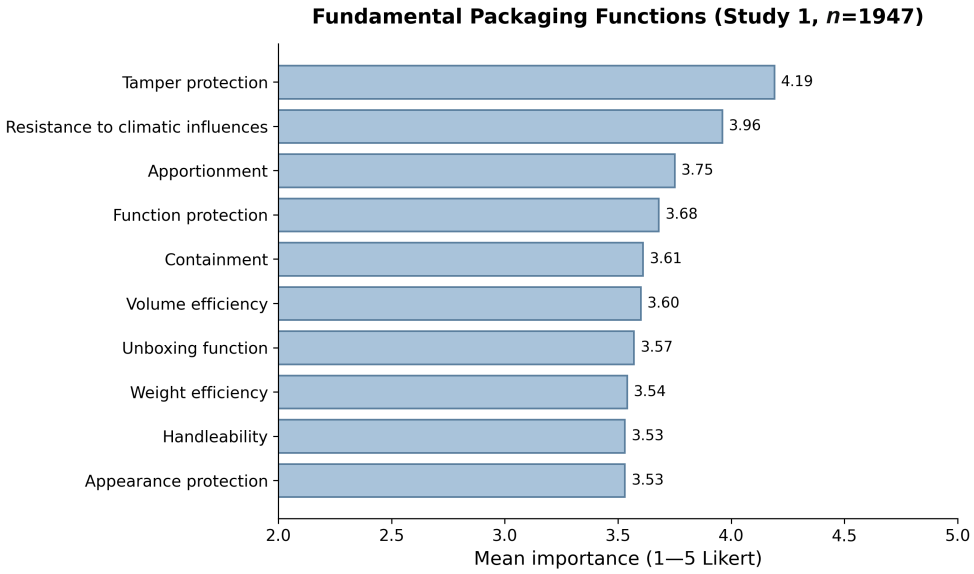

Figure 3. Mean importance ratings for fundamental packaging functions (Study 1, $n = 1947$) on a 5-point Likert scale (1 = Not at all important; 5 = Extremely important). Standard deviations are reported in the text and tables.

Among the six marketing-related packaging elements, doorstep discretion received the highest importance rating ($M = 3.79$, 95% CI [3.77, 3.81]). This element evaluated the importance of concealing the delivery contents from view while on the doorstep, encompassing both privacy and security motivations. As discussed in Section 3, doorstep discretion is conceptually a concealment/privacy/security attribute and is treated as such in our cross-channel analysis (Section 4.4), even though the Regattieri and Santarelli [24] framework historically placed it in the marketing category. The other five marketing elements: novelty ($M = 3.41$), brick-and-mortar similarity ($M = 3.34$), attractiveness ($M = 3.30$), brand recognizability ($M = 3.26$), and unboxing experience ($M = 3.24$), received markedly lower ratings, suggesting that once a purchasing decision has been made, consumers are not concerned with the experiential or branding aspects of the delivery packaging. The environmental elements (Figure 5) were rated consistently in the moderate-to-high importance range, with recyclability ($M = 3.79$) receiving the highest score and reusability ($M = 3.51$) the lowest among environmental attributes.

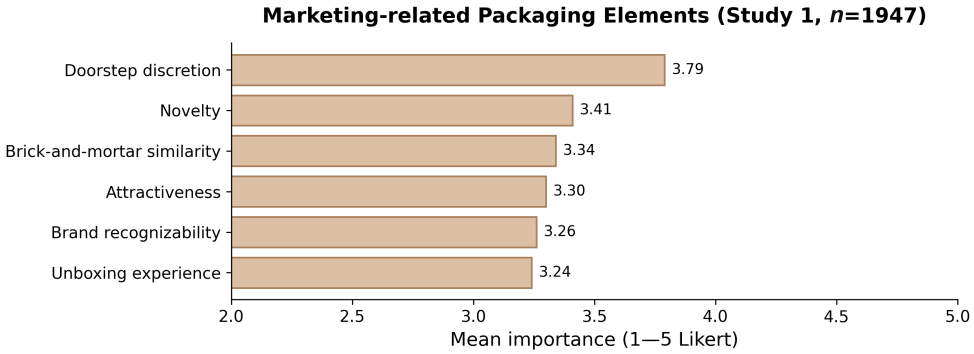

Figure 4. Mean importance ratings for marketing-related packaging elements (Study 1, $n = 1947$). Note that doorstep discretion is conceptually a concealment/privacy/security attribute rather than a branding or experiential one, and is reclassified accordingly in the cross-channel analysis (see Section 4.4).

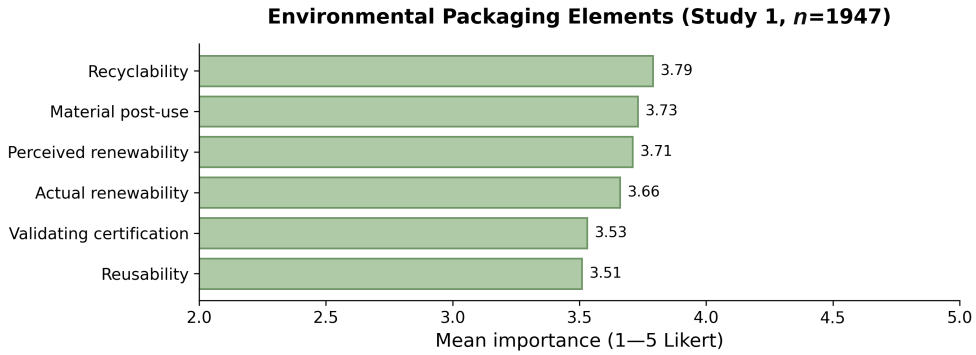

Figure 5. Mean importance ratings for environmental packaging elements (Study 1, $n = 1947$). Standard deviations are reported in the text and tables.

When the overall category importance was assessed, respondents ranked fundamental packaging functions as the most important category, followed by environmental attributes, and last by marketing functions. This hierarchy was consistent across age groups and education levels.

4.1.2. Professional vs. Consumer Perceptions

A comparison of responses between packaging professionals ($n = 983$, 50.5%) and non-professional consumers ($n = 964$, 49.5%) revealed substantial differences in the evaluation of marketing-related elements. Table 5 presents the nine packaging elements with the largest differences between the two groups, with Welch's t computed from the subgroup standard deviations and Holm–Bonferroni-adjusted p-values. The three elements with the greatest divergence were attractiveness ($d = 0.84$), brand recognizability ($d = 0.79$), and unboxing experience ($d = 0.74$). For the unboxing experience specifically, professionals rated it at 3.68 while non-professional consumers rated it at 2.78, a difference of nearly one full point on the 5-point scale. All nine differences in Table 5 are medium-to-large in magnitude (Cohen's d from 0.48 to 0.84) and remain highly significant ($p < 0.001$) after Holm–Bonferroni correction. This finding indicates that packaging professionals rate experiential and aesthetic packaging attributes as substantially more important than non-professional consumers do. Because our data capture stated importance rather than firm packaging budgets, willingness to pay, or post-purchase satisfaction, we describe this strictly as a perception gap between the two respondent groups and do not infer a specific pattern of corporate over- or under-investment. Fundamental packaging functions and most environmental elements showed smaller differences between the two groups, indicating greater alignment on the importance of core protective and sustainability attributes.

The three thematic domains showed good-to-excellent internal consistency (Cronbach's $\alpha = 0.82$ for packaging functions, 0.88 for marketing, and 0.88 for environment; $\alpha = 0.92$ for the full 22-item battery). An exploratory factor analysis (KMO = 0.94; Bartlett's test $p < 0.001$) returned four factors rather than a clean three-domain structure: the environmental items formed a single coherent factor, the marketing items loaded together (joined by appearance protection), and the original "packaging functions" domain separated into a protection/security factor (tamper protection, climatic resistance, and, notably, doorstep discretion) and a convenience/efficiency factor (volume, weight, handling, apportionment). The emergence of doorstep discretion on the same factor as the core protection items provides empirical support for our decision to treat it as a concealment/security attribute rather than a marketing one (Section 3). We therefore retain the thematic domains as an organizing scheme that is reliable internally but acknowledge that the finer empirical structure distinguishes security from efficiency within the functional domain.

Table 5. Mean importance ratings (standard deviation in parentheses) comparing packaging professionals ($n = 983$) and non-professional consumers ($n = 964$) for the marketing- and appearance-related elements with the largest group differences (Study 1). Welch's t computed with unequal variances using the subgroup standard deviations; Cohen's d uses the pooled subgroup SD; p-values are Holm–Bonferroni-adjusted across the family of 22 element comparisons. All nine differences are medium-to-large and significant at $p < 0.001$.

Packaging Element	Professionals *M* (SD)	Non-Prof. Consumers *M* (SD)	Welch *t*	Cohen's *d*	*p* (Holm)
Attractiveness	3.77 (0.97)	2.81 (1.30)	18.3	0.84	<0.001
Brand recognizability	3.73 (1.05)	2.78 (1.35)	17.2	0.79	<0.001
Unboxing experience	3.68 (1.05)	2.78 (1.37)	16.2	0.74	<0.001
Novelty	3.78 (0.98)	3.03 (1.22)	14.7	0.67	<0.001
Brick-and-mortar similarity	3.70 (1.08)	2.97 (1.34)	13.1	0.60	<0.001
Appearance protection	3.86 (1.01)	3.20 (1.25)	12.6	0.58	<0.001
Handleability	3.79 (0.97)	3.27 (1.09)	11.2	0.51	<0.001
Reusability	3.77 (0.94)	3.24 (1.18)	10.8	0.50	<0.001
Validating certification	3.79 (0.95)	3.26 (1.23)	10.5	0.48	<0.001

4.2. DFS Packaging Practices: Exploratory International Field Audit (Study 2a)

The exploratory international field audit of DFS packaging across 51 orders in four countries revealed substantial variation in packaging material usage by both product category and region. Figure 6 shows representative examples of the five packaging material categories observed across the audit. Table 6 summarizes the packaging materials used by product category.

Table 6. Packaging materials used by product category in DFS delivery (Study 2a, $n = 51$ orders, exploratory international field audit).

Product Category	No add. pkg.	Normal Grocery Bag	Paper Bag	Reusable Bag	Kraft corr. Box
Beverages	71.4%	7.1%	21.4%	0%	0%
Household items	83.3%	16.7%	0%	0%	0%
Food	22.2%	44.4%	33.3%	0%	0%
Small appliances	62.5%	0%	25.0%	0%	12.5%
Toys and games	12.5%	37.5%	50.0%	0%	0%

Beverages, which represented 27.5% of all orders, were delivered without any additional packaging in 71.4% of cases. Household items showed an even higher rate of no additional packaging (83.3%). Food items were primarily delivered in normal grocery bags (44.4%) or paper bags (33.3%); toys and games were most frequently packaged in paper bags (50%) or normal grocery bags (37.5%). Small appliances showed a mixed pattern, with 62.5% arriving without additional packaging but 12.5% delivered in kraft corrugated boxes (the only product category for which corrugated packaging was observed in this audit).

Regional differences were pronounced (Table 7). In the United States, 60% of orders arrived without additional packaging, and the remaining orders used normal grocery bags (28%) or paper bags (12%). Toronto, Canada exhibited the most diverse packaging material usage, with reusable bags (20%) and kraft corrugated boxes (13.3%) observed alongside paper bags and no additional packaging. Budapest, Hungary showed the most polarized pattern: 77.8% of orders had no additional packaging, while the remaining 22.2% used kraft corrugated boxes. Seoul, South Korea was the only market in which paper bags were the dominant packaging material (60%), followed by normal grocery bags (26.7%). Given the small country-level samples (approximately 9–25 orders per country) and convenience-based retailer selection, these regional patterns should be read as illustrative rather than

representative. They may reflect differences in local regulations, cultural norms, or the operational models of the specific delivery services sampled.

(**a**) No additional packaging (USA).

(**b**) Transparent normal grocery bag, contents visible (USA).

(**c**) Branded retailer plastic bag at the doorstep (USA).

(**d**) Paper bag with retailer sustainability branding (South Korea).

(**e**) Kraft corrugated box (Canada).

Figure 6. Representative examples of the five DFS packaging material categories observed in the exploratory international field audit (Study 2a). Photographs taken by the authors during the audit. Brands were subsequently blurred. Across the 51 audited orders, packaging defaulted to whatever was available at the originating store. (**a**) No additional packaging exposes the product and any retailer branding on its primary package; (**b**) transparent grocery bags fail both concealment and theft-deterrence functions; (**c**) even opaque retailer-branded bags signal the source store and item type; (**d**) paper bags (dominant in Seoul) offer opacity but limited tamper evidence; (**e**) kraft corrugated shippers were observed in only one product category in our audit.

Table 7. Packaging materials used by region in DFS delivery (Study 2a, exploratory field audit).

Region	No add. pkg.	Normal Grocery Bag	Paper Bag	Reusable Bag	Kraft corr. Box
United States	60.0%	28.0%	12.0%	0%	0%
Toronto, Canada	46.7%	0%	20.0%	20.0%	13.3%
Budapest, Hungary	77.8%	0%	0%	0%	22.2%
Seoul, S. Korea	13.3%	26.7%	60.0%	0%	0%

Overall, 92.2% of products arrived in good condition regardless of the packaging material used, with 5.9% showing minor damage and 2.0% visibly damaged. Products delivered without any additional packaging had a 95.8% good-condition rate. We caution against a causal reading of this finding: packaging material was not randomly assigned to products. Less fragile, bulkier, or already-protected product categories (e.g., beverages, household items) were disproportionately likely to be delivered with no additional packaging, and these categories may themselves be less prone to visible damage. The most appropriate descriptive reading is that for the categories typically shipped without additional packaging in our sample, the primary product packaging appeared adequate for last-mile DFS transit on most occasions; we do not infer that no additional packaging is generally protective.

4.3. DFS Consumer Expectations (Study 2b)

4.3.1. Usage Patterns and Service Selection

The 314 respondents in Study 2b reported varying frequencies of DFS service usage: 28.7% used these services once a week, 27.2% used them two to three times per week, and 25.7% used them two to three times per month. When selecting a DFS service, respondents identified overall price ($M = 3.98$), speed of delivery ($M = 3.96$), and customer service ($M = 3.89$) as the most important decision factors. After receiving an order, 51.7% of respondents reported picking up the delivery within 10 minutes; 11.1% waited one to four hours; less than 1% reported leaving the package outside overnight. Regarding porch piracy awareness, 52.2% reported having seen it on the news but not having experienced it personally, 20.1% reported that a neighbor had experienced it within the year, and 3.6% reported having personally had a package stolen.

4.3.2. Packaging Function Preferences

Table 8 presents the mean importance ratings (with SDs and 95% CIs) for packaging functions across the four DFS purchasing scenarios. Across all scenarios, hiding the product and its value to prevent theft was consistently rated as the most important or second-most important function. For small appliance purchases, theft prevention received the highest rating ($M = 3.70$, SD = 0.97, 95% CI [3.58, 3.82]). For toy purchases, both theft prevention ($M = 3.67$, [3.54, 3.80]) and hiding contents to avoid spoiling a surprise ($M = 3.61$, [3.49, 3.73]) were highly rated. For small loose items and large items, grouping products into a single package for easy transport received importance ratings comparable to theft prevention ($M = 3.48$ and $M = 3.46$, respectively). Across all scenarios, hiding the store name from which products were purchased was consistently rated lowest ($M = 3.04$–3.17), indicating that consumers are not especially concerned with concealing the retailer's identity but do value concealment of product contents and their monetary value.

Because each respondent rated these functions across all four scenarios, we tested the function ordering with a linear mixed-effects model (random intercept by respondent), which accounts for the within-subject dependence of the ratings. The respondent random intercept was substantial (intraclass correlation = 0.49), confirming the need for a repeated-measures treatment. After modeling this dependence, theft prevention remained significantly more important than privacy, and privacy more important than store-name concealment (theft $+0.48$ and privacy $+0.26$ relative to store-name concealment, both $p < 0.001$), and the function×scenario interaction was non-significant (likelihood-ratio $\chi^2 = 10.8$, df = 6, $p = 0.10$), indicating that this ordering is stable across the four scenarios. The 12-item concealment battery (theft, privacy, and store-name across the four scenarios) was highly reliable (Cronbach's $\alpha = 0.92$). We note that the strength of the theft-prevention argument is likely heterogeneous across consumer subgroups (e.g., higher among respondents with personal or neighbor theft experience, longer retrieval delays, urban/suburban

residence, or higher-value items); a moderator analysis on these dimensions is a promising next step beyond the present results.

Table 8. Mean importance ratings (with SD and 95% CI) for packaging functions across DFS purchasing scenarios (Study 2b). CIs computed as $\bar{x} \pm 1.96\,\mathrm{SD}/\sqrt{n}$; each scenario item was answered by 247–249 respondents (responses of "not applicable" excluded).

Scenario	Packaging Function	*M*	SD	95% CI
Small appliance	Hide product/value to prevent theft	3.70	0.97	[3.58, 3.82]
	Hide products for privacy	3.40	1.18	[3.25, 3.54]
	Hide the store of purchase	3.05	1.21	[2.90, 3.20]
Toy for a child	Hide product/value to prevent theft	3.67	1.05	[3.54, 3.80]
	Hide products for privacy	3.40	1.10	[3.27, 3.54]
	Hide the store of purchase	3.17	1.21	[3.01, 3.32]
	Hide contents to avoid spoiling surprise	3.61	0.95	[3.49, 3.73]
Small, loose items	Hide product/value to prevent theft	3.48	1.10	[3.34, 3.62]
	Hide products for privacy	3.24	1.13	[3.10, 3.38]
	Hide the store of purchase	3.04	1.20	[2.89, 3.19]
	Group into single package for transport	3.48	1.00	[3.36, 3.61]
Large item	Hide product/value to prevent theft	3.40	1.15	[3.26, 3.55]
	Hide products for privacy	3.31	1.12	[3.17, 3.45]
	Hide the store of purchase	3.05	1.20	[2.90, 3.20]
	Group into single package for transport	3.46	1.10	[3.32, 3.60]

4.3.3. Sustainability Preferences

Regarding sustainability, 82.9% of respondents rated receiving orders in low-environmental-footprint packaging as "Important," "Very important," or "Extremely important." When ranking the perceived sustainability of different packaging options, respondents identified reusable totes as the most sustainable (49.3% ranked them first), followed by paper bags (35.1% ranked second) and paper mailers (34.1% ranked third). We emphasize the word "perceived" here: respondents were evaluating their beliefs about the sustainability of these options, not actual environmental performance, which depends on reuse rates, reverse logistics, cleaning, materials, transport, and loss rates over a full life cycle. Table 9 presents the importance ratings for specific sustainability attributes. Curbside recyclability was rated highest ($M = 3.74$), followed by consumer reusability ($M = 3.68$) and materials from renewable sources ($M = 3.57$). Home compostability received the lowest rating ($M = 3.37$), possibly reflecting limited access to home composting infrastructure among the survey population.

Table 9. Importance ratings for sustainability attributes of DFS packaging (Study 2b), ranked by mean score. CIs computed as $\bar{x} \pm 1.96\,\mathrm{SD}/\sqrt{n}$; each attribute was answered by 209–211 respondents. The six-item set had high internal consistency (Cronbach's $\alpha = 0.89$).

Sustainability Attribute	*M*	SD	95% CI
Package is curbside recyclable	3.74	0.96	[3.61, 3.87]
You can reuse the package	3.68	1.03	[3.54, 3.82]
Package is made of materials from renewable sources	3.57	1.11	[3.42, 3.72]
Package is compostable in an industrial composter	3.47	1.04	[3.33, 3.62]
Package can be returned to a store for reuse	3.47	1.09	[3.32, 3.61]
Package is compostable in a home composter	3.37	1.09	[3.22, 3.52]

4.3.4. Packaging Customization Demand

A majority of respondents (82.9%) indicated they would select a packaging type matching their preferences if given the option at checkout, and 76.6% reported that the ability to select packaging type would influence their choice of delivery service. These findings suggest that packaging customization represents an opportunity for service differentiation in the DFS market.

4.3.5. Supplementary In-Person Findings

The supplementary in-person survey ($n = 43$) at a university campus in the United States provided corroborating evidence for the online findings. The survey station (Figure 7) presented respondents with the six packaging options alongside representative products commonly delivered through DFS services, allowing tactile evaluation of materials in addition to visual ranking. When ranking packaging preferences based on first impression alone, respondents preferred original product packaging (average rank = 2.62) and reusable tote bags (2.34) over paper bags (2.95), paper mailers (3.43), plastic bags (4.44), and plastic mailers (4.26).

Figure 7. Supplementary in-person survey setup. Respondents were presented with six packaging options (plastic bag, paper bag, paper mailer, reusable tote bag, original product packaging, and plastic mailer) alongside representative products spanning the four DFS scenarios used in Study 2b (small appliance, toy, small loose items, large item). Photograph taken by the authors during data collection. Brands were subsequently blurred.

After physically handling the packaging with representative products, the top preferences remained stable: original packaging (2.59) and reusable tote bags (2.63). When asked to identify the most sustainable option, 50.0% selected reusable tote bags and 40.5% selected original packaging. Regarding transport ease, 46.5% selected reusable tote bags and 30.2% selected original packaging. When asked which option provides the most product protection, responses were more distributed, with paper mailers (31.0%), reusable totes (28.6%), and original packaging (26.2%) receiving similar support. These results are consistent with the online survey findings, in that reusable totes and original product packaging were consistently preferred over single-use bag options.

4.4. Cross-Channel Comparison

Integrating the results from Studies 1 and 2 through the construct crosswalk in Table 4, five cross-channel patterns emerge. These are summarized in Table 10 and the alignment/misalignment between observed DFS practice and consumer-prioritized functions is summarized in Table 11.

Table 10. Thematic comparison of consumer packaging expectations across the general E-commerce context (Study 1) and the DFS context (Study 2b).

Domain	General e-Commerce (Study 1)	DFS (Study 2b)
Protection/tamper evidence	Tamper protection $M = 4.19$ (highest overall); function protection $M = 3.68$; containment $M = 3.61$	Not measured directly
Concealment/privacy/security	Doorstep discretion $M = 3.79$ (top of its group, reclassified here)	Hide product/value to prevent theft $M = 3.40$–3.70; hide for privacy $M = 3.24$–3.40
Sustainability (perceived)	Recyclability $M = 3.79$ (top env. element); reusability $M = 3.51$ (lowest env. element)	Curbside recyclability $M = 3.74$ (top); consumer reusability $M = 3.68$ (second); 82.9% would choose packaging if given option
Branding/experience	Unboxing experience $M = 3.24$, brand recognizability $M = 3.26$ among non-prof. consumers ≈ 2.78 each	Not directly measured; "hide store name" $M = 3.04$–3.17 shown as a distinct privacy item, not a branding measure
Convenience/handling	Handleability, weight, volume efficiency rated near sample average ($\approx$3.55)	Group into single package $M = 3.46$–3.48 (comparable to theft prevention for loose/large items)

Table 11. Expectation–practice gap matrix. Consumer-importance ratings drawn from the North American Studies 1 and 2b; observed practice drawn from the exploratory international field audit (Study 2a). The gap is coded by an explicit, repeatable rule (see note), and remains an author-coded synthesis intended as a qualitative summary rather than a validated metric.

Domain	Consumer Importance	Observed DFS Alignment	Gap
Product concealment/privacy	High	Low in no-packaging and transparent-bag cases	Large
Theft prevention	High	Low where contents visible	Large
Transport grouping (multi-item)	Moderate–high	Mixed	Medium
Curbside recyclability	High	Mixed (region-dependent)	Medium
Branding/unboxing	Low	Low	Not a problem

Coding rule. *Consumer importance* is coded from the domain's mean importance rating on the 5-point scale: High ($\geq$3.60), Moderate (3.30–3.59), Low ($<$3.30). *Observed DFS alignment* is coded from the share of audited orders (Study 2a) that fulfil the function: High ($\geq$66%), Mixed (33–65%), Low ($<$33%). *Gap* = Large when importance is High and alignment is Low; Medium when importance is High and alignment is Mixed, or importance is Moderate and alignment is Low/Mixed; "Not a problem" when importance is Low. The rule is reported so the classification can be reproduced; it remains a descriptive synthesis across non-identical instruments and is not a tested statistic.

First, theft prevention and privacy emerged as consistently high priorities across both fulfillment channels. In the general E-commerce context (Study 1), doorstep discretion was the highest-rated element among those originally classified as marketing ($M = 3.79$). In the DFS context (Study 2b), hiding the product to prevent theft was the highest- or second-highest-rated function across all four purchasing scenarios ($M = 3.40$ to 3.70). This convergence indicates that, regardless of fulfillment channel, consumers expect delivery packaging to serve a concealment function, one that the field audit data from Study 2a show is frequently unmet in DFS practice.

Second, sustainability expectations were present in both channels with a notable shift in the relative hierarchy of attributes. In Study 1, recyclability was the highest-rated environmental element while reusability was the lowest. In Study 2b, curbside recyclability remained the top-rated sustainability attribute ($M = 3.74$), but consumer reusability was rated nearly as high ($M = 3.68$). This shift plausibly reflects the nature of DFS packaging: because reusable tote bags are a viable packaging format in DFS (unlike in warehouse

E-commerce, where corrugated shippers are standard), consumers may place greater value on reusability when it is a practically available option. The strong demand for packaging customization in the DFS context (82.9% would choose their packaging) supports the idea that consumers view DFS packaging as a decision they would like input into.

Third, branding and experiential attributes ranked low among non-professional consumers in both studies, although the two studies measured different items and we do not treat them as equivalent. In Study 1, the directly experiential elements, unboxing experience and brand recognizability, were the lowest-rated marketing elements among non-professional consumers ($M = 2.78$ each). Study 2b did not include a branding-importance item; the closest available indicator, "hiding the store name," was the lowest-rated concealment function across all scenarios ($M = 3.04$ to 3.17), which suggests that retailer identity was not a salient concern but does not directly measure interest in brand-promoting packaging. Read together, and cautiously, given the non-identical instruments, neither study indicates strong consumer demand for packaging that promotes the retailer's brand or creates an aesthetically enhanced experience. For DFS operations, this tentatively suggests that the lack of branded packaging in store-fulfilled orders may not be a meaningful deficiency from the consumer's perspective.

Fourth, the professional–consumer perception gap identified in Study 1 has implications for DFS packaging strategy. Packaging professionals rated attractiveness, brand recognizability, and unboxing experience approximately 30–34% higher than non-professional consumers, with medium-to-large effect sizes ($d \approx 0.7$–0.8). If packaging decisions for DFS operations are made by professionals who place more weight on experiential attributes than consumers do, the resulting packaging may not align with what the consumers in our samples reported valuing: concealment, protection, sustainability, and convenience.

Fifth, the exploratory international field audit reveals a misalignment between current DFS packaging practices in the sampled markets and consumer expectations measured in the North American surveys. In the United States, 60% of DFS orders arrived without additional packaging, while consumer data from both studies indicate that concealment for theft prevention and privacy is highly valued. The prevalence of transparent grocery bags (28% of U.S. orders) further compounds this misalignment, as such bags provide neither privacy nor theft deterrence. Seoul's reliance on paper bags (60%) and Toronto's use of reusable bags (20%) appear, descriptively, to align more closely with the concealment and sustainability preferences our North American respondents reported, though we cannot infer alignment with Hungarian or South Korean consumer expectations, which were not measured in this study.

5. Discussion

The findings from this multi-method study provide empirical evidence for positioning packaging as a consumer-facing logistics decision variable in last-mile delivery. This section interprets the results through the lenses of expectation-confirmation theory and customer-centric supply chain design, discusses the implications for logistics management across fulfillment channels, and acknowledges the limitations of the research.

5.1. Packaging Expectations Through the Lens of Expectation-Confirmation Theory

We use expectation-confirmation theory [11] as an interpretive framing rather than as a tested model (Section 2.4). With that framing, the findings from both studies suggest that consumers hold clear, measurable, and broadly consistent priorities regarding last-mile packaging, centered on functional utility and concealment rather than on marketing or experiential attributes. In the general E-commerce context (Study 1), tamper protection ($M = 4.19$) and doorstep discretion ($M = 3.79$) were the highest-rated elements, while unboxing experience and brand recognizability ranked lowest. In the DFS context (Study 2b),

theft prevention ($M = 3.40$ to 3.70) and privacy ($M = 3.24$ to 3.40) dominated, while store-name concealment was consistently the lowest priority. Across both fulfillment channels, consumer-stated importance for packaging is anchored in protection, concealment, and convenience rather than in aesthetics or brand reinforcement.

Within an ECM-informed reading, this hierarchy carries diagnostic value: the most consequential mismatches between consumer expectation and observed practice are likely to occur where consumer-prioritized attributes are routinely unmet. The field audit data (Study 2a) suggest such mismatches are common in DFS in our sample: in the United States, 60.0% of audited orders arrived without additional packaging and 28.0% in transparent grocery bags. Neither outcome addresses the privacy and theft-prevention concerns rated as important in Study 2b. While the high good-condition rate (92.2%) suggests basic functional protection is being met in most cases for the product categories sampled, an ECM-informed reading would predict that confirmation across the broader expectation set, not protection alone, drives overall service evaluation. We emphasize again that the present study does not measure satisfaction, repurchase, or provider-switching behavior; empirically testing the full pathway from packaging-related expectation–performance confirmation to consumer behavior is an important direction for future research.

The customer-centric supply chain design perspective [15] complements this lens by shifting the unit of analysis from the individual consumer to the supply chain decision-making process. This framework argues that supply chain decisions, including packaging, should be informed by downstream consumer requirements rather than optimized exclusively for upstream operational efficiency. The present findings suggest a disconnect between how packaging decisions appear to be made in DFS operations (based on what is available at the store) and what consumers in our samples reported expecting (concealment, sustainability, and consolidation). This disconnect is not necessarily an inherent trade-off between efficiency and consumer satisfaction; rather, it reflects the absence of consumer data in the packaging decision-making process at the store level. The customer-centric perspective suggests that integrating consumer preference data into DFS packaging protocols could simultaneously improve perceived service quality and reduce waste by eliminating packaging that consumers neither need nor value.

These results extend and, in places, refine prior work. The primacy of concealment and theft-prevention in our data is consistent with the porch-piracy literature, which documents that fear of theft alters consumer behavior [13,37]; we add that consumers translate this concern into a packaging expectation (opaque, non-revealing packaging) that DFS practice frequently fails to meet. Our finding that consumers evaluate the last-mile packaging experience aligns with evidence that last-mile delivery mediates the relationship between the online retail experience and satisfaction [34,35] and that consumers weigh delivery attributes heterogeneously [31]. On sustainability, the high stated importance of recyclability and reusability echoes documented willingness to pay for green E-commerce packaging [40], but our perceived-versus-actual caution is reinforced by the attitude–behavior gap reported for sustainable last-mile options [33,43]: stated preference need not translate into behavior or environmental benefit. Finally, the professional–consumer gap is consistent with research showing that packaging visual-design and unboxing elements shape perceived quality and expectations [25,46]. These are attributes that packaging professionals are trained to attend to, thus may explain why professionals weight them more heavily than the consumers in our sample do.

5.2. Channel-Specific Packaging Strategies Within a Common Expectation Framework

A central pattern in this study is that consumer packaging priorities appear remarkably consistent across the two fulfillment channels examined, despite the fundamental

operational differences between warehouse-based E-commerce and DFS delivery. In both contexts, consumers prioritized protection and concealment over branding and aesthetics. This consistency suggests that consumers evaluate last-mile packaging through a relatively stable set of functional criteria that are largely independent of how or where the order was fulfilled. From a logistics management perspective, this simplifies the strategy challenge: rather than designing fundamentally different packaging approaches for each fulfillment channel, companies can develop a common set of consumer-facing packaging principles (prioritizing concealment, protection, and practical sustainability) and adapt implementation to the operational constraints of each channel.

However, the operational implications of meeting these shared expectations differ substantially between channels. In warehouse-based E-commerce, concealment is achieved through standardized corrugated shippers that are inherently opaque and can be sized to the order. In DFS operations, where packaging materials are limited to what is available in the retail store, achieving concealment requires deliberate investment in packaging supplies that may not currently be stocked. The field audit data show that most DFS orders in our sample arrived in transparent grocery bags or without additional packaging, neither of which satisfies the concealment expectations consistently reported as important by Study 2b respondents. This operational gap represents a concrete area for intervention by DFS providers.

The strong consumer demand for packaging customization (82.9% would select a preferred packaging type; 76.6% report this would influence provider choice) offers a potential path forward. Implementing a packaging selection option at the point of online checkout is operationally feasible in DFS environments, where packing occurs at the store level and can be adjusted on a per-order basis. Unlike warehouse operations, where packaging is often automated and optimized for throughput, DFS packing is a manual process performed by store employees; while less efficient, this provides greater flexibility for order-level customization. Offering a choice between, for example, a paper bag, a reusable tote, or no additional packaging would allow consumers to self-select based on their individual priorities (privacy, sustainability, or waste reduction), consistent with evidence that consumers value and differentiate among the fulfillment options presented to them at checkout [31,32].

5.3. The Professional–Consumer Perception Gap and Its Implications for Packaging Investment

The professional–consumer perception gap identified in Study 1 is one of the most practically significant findings of this research. Packaging professionals rated attractiveness, brand recognizability, and unboxing experience 30–34% higher than non-professional consumers, with Cohen's d values in the 0.7–0.8 range (medium-to-large effects), all significant at $p < 0.001$ after Holm–Bonferroni correction. If the professionals who design and specify packaging systems place greater weight on experiential and aesthetic attributes than non-professional consumers do, packaging solutions may be misaligned with consumer-stated priorities. Within an ECM-informed reading, packaging may be optimized to confirm expectations that consumers do not strongly hold, while potentially under-performing on expectations they do. We frame this as a hypothesis for future work rather than a demonstrated outcome: the packaging professionals in our sample are survey respondents, not necessarily the budget-holders or decision-makers in their organizations, and we did not measure packaging cost, firm investment, consumer willingness to pay, or satisfaction. The gap therefore documents a difference in stated attribute importance between groups, not a proven misallocation of corporate resources.

This finding is consistent with broader patterns in the operations management literature, where supply-side decision-makers can project their own values and priorities

onto consumers [15]. It also parallels two well-established results in the marketing and service-quality literatures: the "knowledge gap" between managers' perceptions of customer expectations and the expectations customers actually hold, formalized as Gap 1 in the service-quality model of Parasuraman et al. [48], and large-scale evidence that managers systematically overestimate customer satisfaction and misjudge its drivers [49]. Our results extend this asymmetry to the packaging domain, where it has not previously been documented. For logistics managers, the implication is that packaging investment could be redirected toward attributes consumers prioritize. Specifically, the data suggest that resources currently allocated to enhancing unboxing experiences, branded packaging inserts, or visually distinctive shipper designs may yield greater returns if redirected toward improved tamper evidence, more discreet exterior packaging, or accessible sustainability attributes such as curbside recyclability. The gap was concentrated in marketing-related elements, while functional and most environmental elements showed smaller differences, supporting the conclusion that the disconnect is specifically about the experiential dimension of packaging rather than about packaging performance broadly.

5.4. Sustainability as a Practical Packaging Attribute (Perceived)

Sustainability emerged as a consistently important, though not dominant, packaging attribute across both studies. In both the general E-commerce and DFS contexts, recyclability was the highest-rated sustainability attribute. In Study 2b, curbside recyclability ($M = 3.74$) outranked all other perceived sustainability options, followed by consumer reusability ($M = 3.68$), consistent with review evidence that recyclability is among the environmental attributes consumers value most in packaging [41]. These two attributes share a common characteristic: they are practical and accessible to consumers without requiring specialized infrastructure or extra effort. Industrial compostability ($M = 3.47$) and home compostability ($M = 3.37$) ranked lower, likely reflecting both the limited availability of composting infrastructure in the United States and lower consumer familiarity with these end-of-life pathways.

For DFS providers, this finding suggests that the most impactful sustainability intervention may be ensuring that whatever packaging is used for delivery is curbside recyclable in the consumer's locality. This is a more targeted recommendation than a generic commitment to "sustainable packaging," which often leads to the adoption of materials (such as industrially compostable films) that consumers cannot easily process through their existing waste-management systems. The risk of such misalignment is well documented: consumers judge packaging sustainability through lay beliefs that frequently diverge from life-cycle outcomes [50], and they respond to the visual appearance and verbal claims of sustainable packaging as much as to its material substance [51]. Recommendations anchored in attributes consumers can both recognize and act upon, such as curbside recyclability, are less exposed to this perception–performance gap.

The finding that reusable totes were perceived as the most sustainable option (49.3% ranked first in Study 2b) and were among the most preferred packaging types overall suggests a promising avenue for DFS providers, conditional on operational feasibility and sufficient reuse cycles. We emphasize the conditional framing: actual environmental performance of reusable totes depends on reuse rates, reverse logistics, cleaning, materials, transport, and loss rates over a full life cycle, and is not established by stated-preference data. Life-cycle comparisons of E-commerce and conventional retail channels show that packaging choices, last-mile configuration, basket size, and returns can each reverse an apparent environmental advantage [52,53], underscoring that stated preferences and actual environmental performance must be assessed separately. Reusable tote programs, in which totes are either returned to the delivery driver or deposited at the retail store on a

subsequent visit, have been implemented in several markets (notably Toronto in our field audit, where 20.0% of orders used reusable bags). Such programs align simultaneously with the stated consumer preferences for sustainability, concealment (totes are opaque), and transport convenience (totes have handles and structural integrity). However, implementing reusable tote programs requires logistical coordination for collection and cleaning that adds operational complexity, and a full life-cycle assessment of such programs in the DFS context is needed before strong sustainability claims are made.

5.5. Managerial Implications

The results yield several recommendations for logistics managers and DFS service providers. We frame these as consumer-preference-informed propositions to be tested in practice rather than as demonstrated economic prescriptions: our data establish what consumers say they value, not the fulfillment cost, inventory complexity, reverse-logistics burden, or willingness to pay that would determine whether a given intervention is profitable. Each recommendation below should therefore be read as a hypothesis for managers to pilot and evaluate against their own operational and financial data.

First, packaging decisions in DFS operations should be treated as a managed logistics variable rather than as an incidental byproduct of the store environment. The current ad-hoc approach, in which store employees select whatever bags are available, produces outcomes that, in our sample, are misaligned with consumer expectations for privacy, theft prevention, and sustainability. Establishing a standardized set of packaging options for DFS fulfillment (even a small selection of two to three material types) would reduce variability and improve the consistency of the consumer experience.

Second, DFS providers should consider offering packaging selection at the point of online checkout. Given that 82.9% of consumers indicated they would select a preferred packaging type if the option were available, and 76.6% said this would influence their choice of service provider, packaging customization is a low-cost competitive differentiator; conjoint evidence that consumers attach monetary value to the fulfillment options offered at checkout [32] suggests packaging choice is a natural extension of that option set. The operational feasibility of this approach is enhanced by the manual nature of DFS order packing, which allows for per-order flexibility that would be difficult to achieve in automated warehouse environments.

Third, investment in packaging design should prioritize functional performance (tamper evidence, product protection, content concealment) and practical sustainability attributes (curbside recyclability, consumer reusability) over experiential and marketing-oriented features (attractive graphics, unboxing experience, brand visibility). The professional–consumer gap identified in Study 1 is consistent with the possibility that experiential features receive more emphasis than consumer priorities would warrant, though confirming this would require firm-level cost and investment data we did not collect.

Fourth, the porch piracy data underscore the importance of discreet packaging as a theft deterrent. With 52.2% of DFS consumers in Study 2b reporting awareness of package theft in their community and academic research documenting the behavioral consequences of theft fear [13], packaging that conceals product identity and value is not a luxury but a risk-mitigation tool, particularly in markets with higher theft prevalence.

5.6. Limitations and Future Research

Several limitations should be acknowledged.

First, the two primary studies were originally designed and run independently, at different times (2021 and 2023) and with different instruments; before the integrative cross-channel analysis presented here was conceived; the comparison is therefore post hoc rather

than built into a single design. The temporal separation also allows for the possibility that expectations shifted between waves. A purpose-built single-instrument study in which each respondent rates both a warehouse-fulfilled and a store-fulfilled scenario would provide a more rigorous cross-channel test, and would also allow the integration to avoid the imperfect item comparability documented in Table 4 (notably for branding/experience, which is only weakly observable in Study 2b).

Second, both surveys used social-media convenience sampling, producing samples skewed toward younger and college-educated respondents; and, in Study 2b, toward male and White/Caucasian respondents (Table 3) with a high share of packaging professionals (50.5% in Study 1; 38.4% in Study 2b). Although our robustness check shows the consumer-priority ordering is unchanged when professionals are excluded, the samples are not representative of the general E-commerce population, and stratified or quota-based sampling with demographic weighting is needed before the preference estimates are generalized.

Third, the exploratory international field audit (Study 2a) covered only 51 orders in a single season, with 9–25 orders per country; this precludes country-level inference and supports only an illustrative reading. A larger, multi-season, pre-registered audit would be required for stronger claims about international practice.

Fourth, ECM is used as an interpretive lens, not a tested model: the instruments measure stated importance, not the ECM constructs (prior expectations, perceived performance, confirmation, satisfaction) or downstream behavior, and the study is confined to ambient consumer-packaged goods rather than temperature-sensitive products. A purpose-built ECM-aligned design and an extension to chilled/frozen DFS are priorities for future work, along with a moderator analysis of theft-prevention importance and a confirmatory test of the finer factor structure our exploratory analysis suggested.

6. Conclusions

Using a multi-method approach which included a general E-commerce packaging survey ($n = 1947$), an exploratory international field audit of DFS packaging (51 orders, four countries), and a DFS consumer survey ($n = 314$ participants), this study jointly characterizes consumer packaging expectations and observed DFS packaging practice. Three findings stand out. Consumers in our samples hold a consistent priority hierarchy, favoring functional protection, content concealment, and practical sustainability over experiential and branding attributes, and this ordering is stable across both fulfillment contexts and after accounting for within-subject dependence. Packaging professionals rate experiential attributes substantially higher than non-professional consumers do (medium-to-large effects, $d \approx 0.7$–0.8), a perception gap we document descriptively rather than interpret as a proven misallocation of firm resources. Finally, observed DFS practice—most orders arriving with no additional packaging or in transparent bags—frequently misaligns with the concealment, theft-prevention, and sustainability functions consumers prioritize.

These results position packaging as a consumer-facing logistics decision variable and point to packaging choice at checkout as a feasible, low-cost lever for DFS providers, conditional on the operational and cost factors we did not measure. Promising next steps include experimental tests of packaging-choice effects on behavior, a full ECM-aligned design, and life-cycle assessment of reusable-tote programs. As fulfillment channels continue to converge, incorporating consumer packaging expectations into last-mile decision-making appears valuable for service quality and differentiation.

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Informed Consent Statement: Informed consent for participation was obtained from all subjects involved in the study.

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Abbreviations

The following abbreviations are used in this manuscript:

DFS	Direct-from-store (synonymous with Ship-from-store, SFS)
ECM	Expectation-Confirmation Model [12]
ECT	Edge Crush Test (TAPPI T 811)—packaging metric; used here only for disambiguation
ISTA	International Safe Transit Association
SFS	Ship-from-store

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