

Review

Factors Influencing Consumer Adoption of Smart Parcel Lockers: A Scoping Review

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Abstract

Background: Smart Parcel Lockers (SPLs) have emerged as an important solution for improving last-mile delivery (LMD) efficiency in response to the rapid growth in e-commerce and increasing consumer demand for flexible delivery options. Despite growing research interest, the factors influencing consumer adoption of SPLs remain fragmented across different theoretical and geographical contexts. This scoping review aims to synthesize the existing literature and identify the key factors influencing consumer adoption of SPLs. **Methods:** A structured literature search using PRISMA Extension for Scoping Reviews (PRISMA-ScR) guidelines was conducted to identify peer-reviewed studies published between 2014 and 2024. Following the screening and selection process, 38 studies were included in the scoping synthesis. **Results:** The findings show that convenience, security, service reliability, and perceived value are the most frequently reported factors shaping SPL adoption. The review also shows that the TAM, DOI, and UTAUT are the most commonly applied theoretical frameworks. The studies were also methodologically dominated by quantitative survey-based studies and geographically concentrated mainly in Asian markets. **Conclusions:** Overall, the review identifies the main drivers and barriers of SPL adoption and provides guidance for future research and practical implementation.

Keywords: smart parcel lockers; consumer intention; last-mile delivery; review

1. Introduction

The growing field of e-commerce has significantly challenged the logistics industry; global retail e-commerce sales exceeded USD 6 trillion in 2024 and are projected to continue growing in the coming years [1]. Despite representing the final stage of the logistics process, last-mile delivery accounts for approximately 41–53% of total supply chain delivery costs, making it the most expensive component of parcel distribution [2]. Last-Mile Delivery (LMD), which is the final step of the delivery process from a distribution center to the consumer. Traditional delivery faces rising inefficiencies, failed delivery attempts, high delivery costs, and environmental concerns such as carbon emissions [3].

These challenges became more pronounced during the COVID-19 pandemic, as movement restrictions and social distancing measures accelerated the adoption of online shopping and generated unprecedented growth in parcel volumes. At the same time, the pandemic increased demand for contactless delivery solutions that could reduce physical interactions while maintaining delivery efficiency [4]. Consequently, logistics providers



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have increasingly turned to innovative LMD solutions, such as smart parcel lockers, to address these operational and consumer-related challenges [5].

In response to these challenges, Smart Parcel Lockers (SPLs) have emerged as a promising solution to improve the efficiency, security, and convenience of LMD [6–9].

SPLs offer consumers the convenience of picking up their parcels from secure, automated lockers using digital pick-up codes, thus reducing failed delivery attempts and minimizing the environmental impact of multiple delivery trips [10,11]. Moreover, consumer preferences for more flexible delivery options and the demand for same-day delivery suggest that SPLs could become a key component of the future of e-commerce logistics [12]. Table 1 presents the major differences between traditional and SPL delivery mechanisms.

Table 1. The differences between traditional and SPL delivery.

Aspect	Traditional Delivery	SPL Delivery
Recipient presence	Must be present in person to receive the parcel	Not required; parcel can be left even in recipient's absence
Handover method	Direct handover from courier to customer	Courier leaves the package in a specified location
Security	Very secure, often with a signature for proof	Depending on the location's security (risk of theft if unsecured)
Convenience	Requires scheduling or waiting for arrival	More flexible timing; no need to wait for courier
Proof of delivery	Signature or photo at the door	Photo of drop-off or locker scan (depending on the system)

Despite its many advantages, the adoption of SPLs varies across regions and consumer segments and is influenced by several factors, including psychological factors, sustainability concerns, and technological acceptance [13,14].

To date, only two studies have systematically examined SPLs. Tsai et al. [14] conducted a review focused on Vietnam, offering insights into a four-year period around the COVID-19 pandemic, while Ma et al. [13] explored self-collection services by analyzing how consumers navigate last-mile delivery constraints and interact with operator strategies. However, both studies remain limited in scope and context.

Building upon these foundations, the present study advances the field by providing an extensive scoping literature review that examines the factors influencing consumer adoption of SPLs between 2014 and 2024, a transformative decade characterized by the rapid expansion of e-commerce, digital innovation, and shifting consumer behaviors shaped by global disruptions such as the COVID-19 pandemic. This period was deliberately chosen to capture critical transitions in technology use, delivery infrastructure, and sustainability practices, as well as the accelerated deployment of SPL systems worldwide. By integrating diverse theoretical and methodological perspectives, this review offers a broader and more comprehensive understanding of SPL adoption, addressing existing research gaps and guiding future advancements in last-mile delivery optimization.

Adopting a scoping approach, this review categorizes influencing factors into key thematic areas, also reporting on the theoretical frameworks and methodological approaches applied in existing studies, and it identifies persistent research gaps and future opportunities.

In practical terms, it offers actionable insights for logistics operators, policymakers, and academics, establishing a comprehensive foundation for future research and strategic planning aimed at optimizing SPL adoption across diverse socio-economic and geographic contexts, outlining the study's innovative contribution.

1.1. Research Questions

- What factors influence consumers to adopt SPLs for their parcel deliveries?
- What analytical frameworks have been applied in existing research on this topic?
- What qualitative and quantitative methods are commonly used to investigate SPL adoption?
- What opportunities exist for future research to enhance the adoption and effectiveness of SPLs?

1.2. Objectives

- To conduct a scoping review of existing literature to identify and synthesize factors influencing SPL adoption.
- To propose directions for future research and practical implications to support the effective adoption and integration of SPLs in last-mile delivery systems.

The remainder of this paper is structured as follows. Section 2 outlines the research methodology, Section 3 presents the main findings and thematic analysis of SPL adoption factors, and Section 4 discusses the study's limitations and directions for future research.

2. Methods

2.1. Design

This review adopted the PRISMA extension for scoping reviews (PRISMA-ScR) to examine specifically consumer adoption and acceptance of SPLs as LMD solution. Studies examining store pickup, click-and-collect services within omnichannel retailing, and other retail channel integration mechanisms were excluded when their primary focus was retail operations rather than SPL usage or consumer adoption behavior. Similarly, studies focusing exclusively on logistics optimization, routing, facility location, and operational performance without a behavioral component were excluded because they did not address the factors influencing consumer adoption of SPL services. The methodological process was informed by structured review guidance, particularly the principles of transparent searching, screening, data charting, and evidence mapping outlined in the Joanna Briggs Institute guidance for scoping reviews, as illustrated in Figure 1 [15].

Following this structured approach, the review proceeded through six stages: defining the purpose and research questions; identifying and collecting relevant studies; selecting studies based on predefined inclusion and exclusion criteria; charting key data from the included studies; organizing and summarizing the findings; and reporting thematic patterns and knowledge gaps. This process allowed the review to synthesize studies with different theoretical perspectives, methods, countries, and research designs transparently and consistently.

The design of the study draws conceptually on earlier systematic reviews of LMD [7,13,14,16,17], which primarily examined operational and structural dimensions of delivery systems. Building upon their foundations, the present study adopts a scoping approach that expands the analytical scope to include behavioral, technological, and contextual factors influencing SPL adoption.

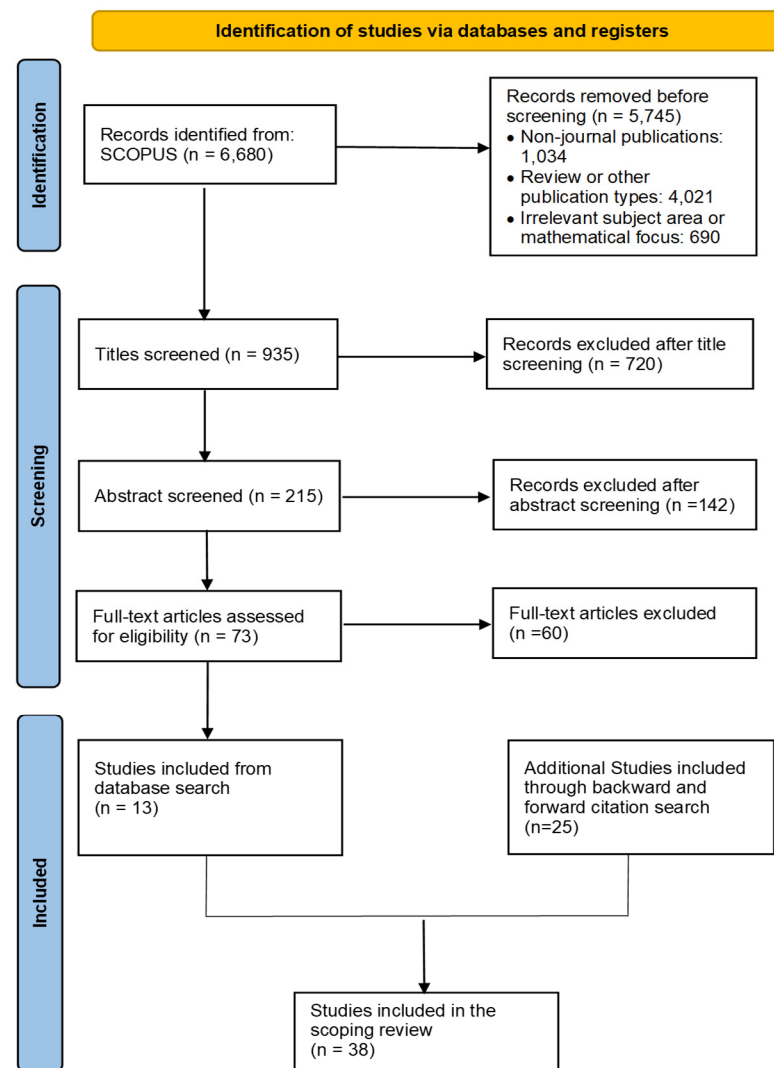


Figure 1. PRISMA-ScR flow diagram.

2.2. Data Selection Process and Search Strategy

Scopus was selected as the database for this review because it provides broad multi-disciplinary coverage of peer-reviewed literature across logistics, transportation, supply chain management, business, information systems, and technology adoption research. Its indexing breadth and advanced search functionality make it suitable for identifying literature in an interdisciplinary field such as SPL adoption [18]. Moreover, the study selection process was documented using the PRISMA-ScR flow diagram [19], and the completed PRISMA-SCR checklist is provided in Supplementary Materials.

The search covered peer-reviewed journal articles published between 2014 and 2024. This period was selected because it captures the rapid expansion of e-commerce, LMD innovation, and the increasing deployment of SPLs. Searches were conducted within relevant subject areas, including Social Sciences, Business and Management, Computer Science, Economics and Finance, Decision Sciences, and Environmental Science.

The search strategy combined SPL-related terms with consumer adoption and last-mile delivery terms using Boolean operators: (“smart parcel lockers” OR “automated parcel lockers” OR “self-collection service” OR “delivery lockers” OR “collection and delivery points”) AND (“consumer adoption” OR “last-mile delivery” OR “e-commerce logistics”)

Only English-language, peer-reviewed journals addressing SPL adoption, use, or consumer behavior and articles exploring psychological, technological, or contextual fac-

tors were included. Non-journal materials, including conference papers, reports, theses, dissertations, book chapters, and editorials, were excluded to maintain consistency in the reviewed evidence.

To improve coverage beyond the database search, backward and forward citation tracking was conducted. Backward citation tracking involved examining reference lists of relevant studies, while forward citation tracking was used to identify later studies citing key publications [20].

The screening process was conducted in stages. First, records were assessed against the basic inclusion criteria relating to language, document type, and relevance to SPLs or LMD. Titles and abstracts were then reviewed to exclude studies unrelated to consumer adoption, intention, satisfaction, or experience with SPLs. Full texts of the remaining articles were assessed to confirm their relevance to the review objectives. Studies focusing primarily on mathematical optimization, routing, facility-location modelling, technical system design, or B2B logistics were excluded when they did not address consumer adoption or behavioral factors. The screening and eligibility assessment were conducted by the author and co-author. Uncertainties regarding study inclusion or classification were discussed and resolved through consensus.

2.2.1. Inclusion Criteria

- Empirical or conceptual studies addressing SPL adoption, use, or consumer behavior were included to ensure comprehensive coverage of both theoretical and empirical contributions to the field.
- Research exploring psychological, technological, or contextual factors.

2.2.2. Exclusion Criteria

- Papers focused primarily on mathematical optimization, routing, or cost-minimization models without behavioral emphasis, as the review aimed to examine consumer adoption factors rather than operational or logistics optimization issues.
- Non-peer-reviewed studies to ensure the inclusion of high-quality and rigorously evaluated evidence.
- Studies unrelated to parcel-locker or self-collection services

2.3. Data Extraction and Synthesis

For each included study, data were extracted on authorship, publication year, country or region, theoretical framework, methodology, sample characteristics, key adoption factors, principal findings, and literature gaps. The extracted information was reviewed by the authors (L.H.M., M.A.S.) to ensure consistency, accuracy, and alignment with the review scope.

A formal quality appraisal was not conducted because the objective of this review was to provide a scoping synthesis of the SPL adoption literature rather than to assess methodological quality or compare effect sizes across studies. The review focused on identifying dominant themes, theoretical patterns, methodological approaches, geographical coverage, and research gaps across a heterogeneous body of literature. Nevertheless, restricting the review to peer-reviewed journal articles and applying explicit inclusion and exclusion criteria helped support the credibility and consistency of the selected evidence.

For each article included, the following information was recorded:

- Author(s) and year
- Theoretical framework
- Research design and methodology
- Region or country of study

- Key adoption factors
- Research gaps

3. Findings and Discussion

3.1. Overview of the Literature Selection Process and Outcomes

The scoping review process began with an initial search that identified 6680 publications related to Smart Parcel Lockers (SPLs) and last-mile delivery (LMD). 5745 articles were excluded prior to screening due to having non-journal publications, having review or other publication types, or focusing on an irrelevant subject area or mathematical focus. During screening, 720 records were excluded after title review due to clear irrelevance to the topic. The remaining 935 articles underwent abstract screening, where 142 were removed because they focused primarily on technical or optimization models, Business-to-Business (B2B) contexts, or did not address consumer behavior, smart lockers, or parcel lockers, and 215 articles remained for full-text assessment.

After full-text assessment, 60 studies were excluded, only 13 studies passed the inclusion criteria. A subsequent backward and forward citation search identified an additional 25 relevant publications, resulting in a final sample of 38 articles included for scoping synthesis. Articles excluded at this stage lacked sufficient relevance to consumer adoption behaviors or failed to provide insights applicable to SPL use in Business-to-Consumer settings.

3.2. Publication Trends and Research Growth

Analysis of the selected studies indicates a steady increase in research activity on SPLs and LMD over the past decade, reflecting growing academic and industry attention to consumer-centric logistics solutions. The number of publications has risen particularly sharply in recent years, corresponding with the acceleration of e-commerce growth and the digitalization of delivery systems (Figure 2).

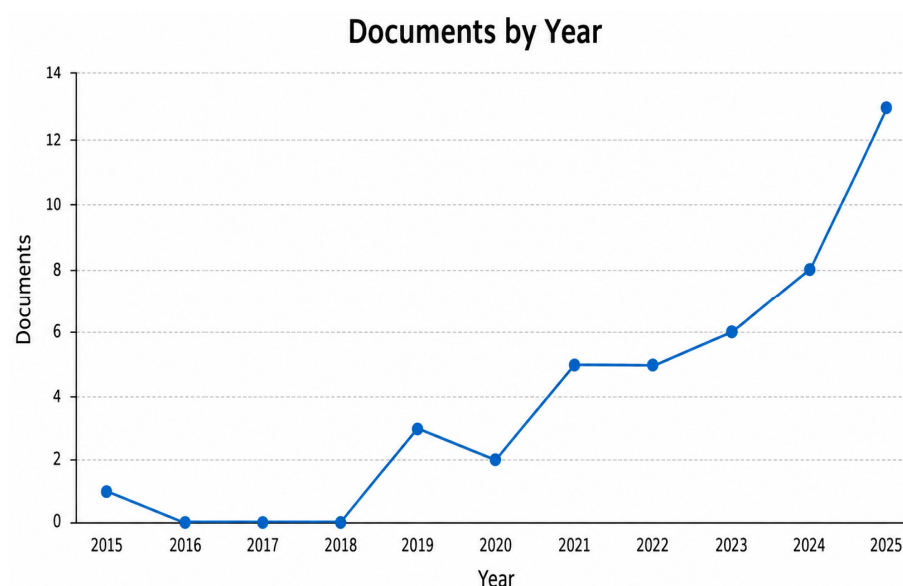


Figure 2. Number of publications per year.

3.3. Emerging Analytical Areas

From the analysis of the 38 included studies, four main analytical areas emerged. These areas reflect the key factors influencing SPL adoption, the theoretical frameworks applied, the methodological approaches used, and the literature gaps identified from the reviewed studies. The main areas are:

1. Key influential factors shaping SPL adoption

2. Methodological approaches used in SPL adoption studies
3. Dominant theoretical frameworks applied in SPL research
4. Geographical context impact on SPL adoption
5. Literature gaps identified from the reviewed studies

Together, these areas provide the structure for the findings section and help clarify how SPL adoption has been studied, which approaches dominate the literature, and which aspects remain underexplored. For more details, refer to Table A1 in Appendix A.

3.3.1. Key Influential Factors Shaping SPL Adoption

Based on the reviewed studies, the most commonly identified factors influencing SPL adoption are convenience, location/accessibility, reliability, security, privacy, trust, perceived value, perceived usefulness, ease of use, and social influence, as illustrated in Table 2. These findings are broadly consistent with previous reviews, which identify convenience, reliability, security, usefulness, service quality, cost, and location as recurring determinants of parcel locker adoption [7,13,14]. To provide a clearer synthesis, the identified factors are grouped into four broader dimensions: service-related factors, trust and assurance factors, value and performance-related factors, and technology and social adoption factors.

Service-Related Factors: Convenience, Location, and Reliability

Service-related factors represent the most constant group of determinants in the SPL literature. Convenience is one of the most frequently reported factors and generally refers to the extent to which SPLs reduce waiting time, failed deliveries, and dependence on courier schedules. Consumers value SPLs because they allow parcels to be collected at a preferred time and location, giving them more control over the delivery process than conventional home delivery [9,21–27].

The literature also shows that convenience is multidimensional. Yuen et al. [23] discuss convenience in terms of geographical, time, and effort-related dimensions, while Wang et al. [22] decompose self-collection convenience into access, benefit, transaction, and post-benefit convenience. These studies indicate that consumers evaluate the entire collection experience, including distance to lockers, opening hours, waiting time, ease of retrieval, and the ability to resolve delivery-related issues efficiently.

Location and distance are closely connected to convenience but should not be treated as identical concepts. Convenience reflects the overall ease and flexibility of using SPLs, whereas accessibility refers specifically to the physical reachability of locker locations. Studies show that lockers located near homes, workplaces, shopping centers, public transport hubs, or regular travel routes are more likely to be accepted because they reduce additional travel effort [12,25,27–30].

Reliability is another important service-related factor. Consumers are more willing to use SPLs when the system provides accurate notifications, timely parcel availability, smooth retrieval procedures, and effective fault handling. Service-quality studies show that reliability, timeliness, responsiveness, and service recovery contribute to satisfaction and perceived service quality [26–30]. Thus, convenience may attract consumers to SPLs, but reliability helps maintain confidence in the service experience.

The importance of service-related factors also differs across contexts. In dense urban markets, convenience is often associated with time saving, flexible collection, and reduced waiting [9,22,27], whereas in settings with less developed or spatially dispersed locker networks, accessibility, travel distance, parking availability, and location suitability become more important [21,25,31,32]. This suggests that convenience is not interpreted uniformly across studies but is shaped by infrastructure, urban density, and consumer mobility patterns.

Trust and Assurance Factors: Security, Privacy, Trust, and Risk

Security, privacy, trust, and perceived risk form a second major dimension of SPL adoption. These factors are particularly important because SPLs involve unattended parcel storage, automated retrieval, and digital access systems. Security refers to consumers' perceptions that parcels are protected from theft, damage, loss, or unauthorized access. Privacy concerns the protection of personal information, delivery data, and digital access details.

Several studies identify security as an important service attribute influencing SPL acceptance [21,25,29,31–33]. Privacy/security is more explicitly examined in studies such as Yuen et al. [23], Tsai and Tiwasing [9], Quan et al. [26], and Chuong et al. [27], where it is linked to perceived value, transaction costs, and adoption intention.

Security and trust are closely connected but conceptually different. Security refers to the safeguards surrounding parcel storage and data protection, whereas trust reflects consumers' broader confidence in the technology, service provider, and delivery process. An et al. [34] show that technological trust influences perceived usefulness and ease of use, suggesting that trust strengthens acceptance of SPLs as self-service delivery technologies. Jang et al. [35] similarly link trust with perceived risk in consumers' evaluation of parcel locker systems. Therefore, security and privacy can be understood as foundations of trust, while trust reduces uncertainty and supports adoption.

The reviewed studies also differ in how they position security. Some treat security as a direct service attribute influencing adoption or satisfaction [21,25,29,31,32], while others present privacy/security as part of perceived value or broader adoption mechanisms [9,23,26,27]. Studies related to trust further show that consumers' confidence in the technology and provider can reduce uncertainty and perceived risk [33–35]. This variation may reflect differences in consumer familiarity with automated delivery systems. Where SPLs are less familiar, security may operate as a necessary condition for adoption; in more mature markets, it may be treated as an expected standard of service.

Value and Performance-Related Factors: Perceived Value, Usefulness, and Relative Advantage

Perceived value, perceived usefulness, performance expectancy, and relative advantage describe how consumers evaluate the benefits of SPLs compared with traditional delivery options. These constructs overlap but are not the same. Perceived usefulness and performance expectancy refer to whether consumers believe SPLs improve delivery performance, save time, or make parcel collection more efficient. These constructs are commonly examined in TAM- and UTAUT-based studies [11,34–37].

Relative advantage, used mainly in Diffusion of Innovation studies, refers to whether SPLs are perceived as superior to existing delivery methods in terms of flexibility, compatibility, and efficiency [9,21,23,38]. Perceived value is broader because it captures the overall judgement of whether the benefits of using SPLs outweigh the costs, effort, and risks involved. These benefits may include convenience, flexibility, time saving, lower delivery costs, reduced failed delivery attempts, and secure parcel storage [11,23,26,27,39,40].

The distinction between perceived value and relative advantage is important. Relative advantage, mainly used in Diffusion of Innovation studies, focuses on whether SPLs are perceived as superior to existing delivery options in terms of flexibility, compatibility, and efficiency [9,21,23,38]. Perceived value, by contrast, reflects a broader judgement of whether the benefits of using SPLs outweigh the effort, cost, and risk involved [23,26,27,39–41]. Thus, this helps explain why similar constructs appear under different theoretical frameworks and why their reported importance differs across studies.

Technology and Social Adoption Factors: Ease of Use, Readiness, and Social Influence

Ease of use and effort expectancy are important because SPLs require consumers to interact with self-service technologies, digital notifications, access codes, and automated retrieval systems. Studies based on TAM and UTAUT show that consumers are more likely to adopt SPLs when the process is simple, understandable, and requires limited effort [11,30,34–37].

Ease of use and social influence appear more context-dependent than convenience or perceived value. Ease of use may be especially important where consumers have limited experience with self-service technologies or where perceived ability and technology anxiety affect willingness to use SPLs [11,30,35–37,42–45]. Social influence may matter more in early-stage or socially influenced adoption contexts where consumers rely on recommendations, community norms, or others' experiences to reduce uncertainty [11,27,36]. In more established SPL contexts, adoption may depend more on personal experience, service quality, and perceived usefulness.

Social influence is also reported in several studies, particularly those using UTAUT or related behavioral frameworks. It refers to the effect of peers, family members, community norms, and recommendations on consumers' willingness to use SPLs. Studies show that social influence can encourage adoption when consumers observe others using SPLs or receive positive recommendations from trusted people [11,27,36,44–46]. However, social influence is less consistently reported than convenience, reliability, security, and perceived value. Its importance may be stronger in early-stage markets where consumers have limited experience with SPLs and rely on others to reduce uncertainty. In more established markets, adoption may depend more on personal experience, service quality, and perceived usefulness than on social pressure.

Taking together, the reviewed studies suggest that inconsistencies in SPL adoption findings are partly methodological and partly contextual. Studies using different theoretical lenses often label similar consumer evaluations differently, while studies conducted in different markets emphasize different aspects of the delivery experience. This indicates that future SPL research should define key constructs more precisely and account for market conditions such as infrastructure maturity, consumer familiarity with self-service technologies, and local delivery practices. Doing so would improve comparability across studies and support more context-sensitive adoption models.

Table 2. Key influential factors.

Theme	Author(s)
Convenience	[3,9,23–28,32,33,37,39,47,48]
Security	[9,21,23,25–27,29,31,38,46,47,49]
Reliability	[9,23,26–30,49]
Perceived Value	[23,24,26,27,39–41]
Location/Distance	[3,12,26,31,39,42,47]
Perceived Usefulness/ Performance expectancy	[11,25,34–37]
Ease of Use/Effort Expectancy	[11,34–37,42]
Social Influence/Subjective Norms	[11,36,42,45,50]

3.3.2. Methodological Approaches Used in SPL Adoption Studies

Table 3 illustrates the distribution of research methodologies, showing that quantitative methods were the most common approach in SPL adoption research, followed by qualitative and mixed-method studies. Survey-based studies were particularly dominant because they allow researchers to collect data from relatively large consumer samples

and compare responses across different demographic and geographical contexts. This approach was used mainly in several settings, such as Singapore [21,22,41,51], China [11,36], Thailand [9], Vietnam [26,27], and South Korea [35].

Table 3. Summary of Studies' Methodology Style.

Type of Methodology	Author(s)
Survey	[3,11,12,21,23,24,26,27,30,34–36,38–40,43–46,48]
Focus Groups	[25,31,47]
Interviews	[33,42,49]

The dominance of surveys reflects the theory-testing orientation of the field. Many studies applied structured questionnaires to examine adoption models such as TAM, TPB, and UTAUT. These models require measurable constructs and statistical testing, making surveys suitable for examining relationships between consumer perceptions and adoption intention. In this respect, survey methods helped establish broad empirical patterns in SPL adoption research and supported comparison across countries and theoretical frameworks.

Although surveys provide broad and comparable evidence, they are less effective in explaining the deeper reasons behind consumer preferences. Their reliance on predefined variables may overlook emerging concerns, contextual barriers, and emotional or experiential aspects of SPLs use [52,53]. This limitation explains the importance of qualitative methods, which were used less frequently but provided richer insight into how consumers interpret delivery experiences in practice.

Focus-group studies were used by Vakulenko et al. [47], Rai et al. [25], and El Mousaoui et al. [31]. These studies allowed participants to discuss their expectations, concerns, and practical experiences more openly than in structured surveys. Their value lies in revealing how consumers make sense of self-collection services, how they compare delivery alternatives, and how local conditions influence acceptance. Interview-based studies, such as Olsson et al. [42] and Asdecker [49], also contributed by examining consumer experience and perceptions in greater depth.

Mixed-method and case-study approaches were less common but offered broader contextual understanding. Vural and Aktepe [33], for example, combined consumer survey data with provider interviews and secondary sources, allowing the study to capture both consumer and service-side perspectives. Neto and Vieira [38] used a case-study approach with survey data, providing insight into SPL adoption within a specific market context.

Overall, the methodological pattern shows that SPL adoption research is strongly shaped by quantitative, survey-based, theory-testing designs. This has helped develop generalizable evidence, but it has also limited understanding of consumer experience, contextual variation, and post-adoption behavior.

3.3.3. Dominant Theoretical Frameworks Applied in SPL Research

The Innovation Diffusion Theory (IDT) was developed by Everett M. Rogers in 1962. This theory explains that innovations are more readily adopted when they offer clear benefits, align with user values, and allow for limited-risk experimentation [54]. IDT is commonly applied in the context of SPLs to understand how consumers adopt this technology based on perceived advantages, compatibility, and trialability [9,21,23,33,38,39].

The correlation between innovativeness and SPL adoption has been particularly highlighted in studies from Singapore and Vietnam [39,42]. The role of consumer attitudes towards new technologies is critical, as higher levels of innovativeness are linked to increased adoption, particularly when coupled with perceived value and ease of use. This suggests that SPL services may be more readily adopted by younger consumers who tend

to be more comfortable with new technology, and more so in regions with high levels of digital literacy.

Yuen et al. [23], Wang et al. [22], Tsai and Tiwasing [9], and Neto and Vieira [38] apply IDT to examine how consumers' perceptions of relative advantages, such as convenience, compatibility, and flexibility, shape the adoption of SPLs. They find that when consumers view SPLs as an improvement over traditional delivery, they are more likely to adopt them.

Another widely used framework is the Technology Acceptance Model (TAM), postulated by Fred D. Davis in 1989. TAM posits that technology adoption is influenced primarily by perceived usefulness and ease of use, two perceptions that directly shape users' attitudes and behavioral intentions towards technology adoption [55]. Chen et al. [24] and An et al. [34] used TAM to examine consumer intentions regarding parcel lockers and found significant relationships involving perceived ease of use and perceived usefulness. Chen et al. [24] identified that consumers' perceived convenience strongly mediates the relationship between perceived ability and usage intentions of automated parcel stations, highlighting convenience as critical in shaping adoption behavior. Similarly, An et al. [34] found that trust in technology-based parcel locker services significantly enhanced consumers' perceptions of ease of use and usefulness, ultimately improving their attitudes and intentions towards adopting these services.

Moreover, Jang et al. [35] highlighted the moderating role of user experience, suggesting that perceptions of usefulness and ease may vary based on prior familiarity and interactions with the technology. Klein and Popp [37] used TAM to assess consumer acceptance of LMD options, including parcel lockers. They found that perceived usefulness and ease of use significantly influenced adoption intentions. In addition, high perceived costs reduced willingness to use parcel lockers, emphasizing the role of affordability alongside convenience and flexibility.

The Unified Theory of Acceptance and Use of Technology (UTAUT), developed by Venkatesh et al. [56], provides a comprehensive framework for understanding SPL adoption by considering factors such as performance expectancy, effort expectancy, social influence, and facilitating conditions. Zhou et al. [11] and Cai et al. [36] applied UTAUT to examine the impact of these factors on consumer interest in SPLs. Performance expectancy, i.e., the belief that SPLs enhance delivery efficiency, has emerged as an important factor. Social influence also plays a key role because consumers are more likely to adopt SPLs when they see them being used within their community.

Resource Matching Theory and Perceived Value Theory are rooted in the marketing literature, particularly in the work of Zeithaml [57] on perceived value. These theories explain that consumers match their resources such as time and effort with the perceived benefits of a service, and that perceived value influences the adoption of the service. Yuen et al. [23] applied these theories to demonstrate that convenience and security contribute significantly to perceived value, leading to higher adoption rates of SPLs in China.

The Theory of Planned Behavior (TPB) developed by Ajzen [58] examines how attitudes, subjective norms, and perceived behavioral control impact behaviors. TPB is particularly effective in understanding how social factors like community influence and societal endorsement shape SPL adoption [58]. This theory has proved to be valuable in SPL research by examining the social and psychological factors that influence consumers' intentions to use new delivery technologies [9,49]. For example, Asdecker [49] applies TPB to explore how social approval and individual confidence in using SPLs impact consumer adoption, whereas Tsai and Tiwasing [9] integrated TPB with Resource Matching Theory and Innovation Diffusion Theory to examine consumers' intentions to adopt smart lockers for LMD in Thailand. Both studies concluded that TPB effectively explains user intentions, emphasizing the role of behavioral perceptions and attitudes in adopting LMD innovations.

The Protection Motivation Theory (PMT) put forth by Rogers [59] has been applied to SPL research to address consumer concerns about security and privacy. PMT suggests that when individuals perceive a threat, they are motivated to adopt protective behaviors if they trust the recommended measures. PMT has been helpful in SPL studies, particularly in highlighting the importance of security measures and building consumer trust.

An et al. [34] use PMT to study how risk perception impacts consumer decisions, finding that trust in the technology significantly mitigates security concerns. This study highlights the rising importance of security concerns and technological trust in consumer decision-making for SPLs and reflects a growing concern about cybersecurity and privacy risks, particularly in developed economies such as the U.S., where online shopping is highly prevalent. The emphasis on value co-creation [46] adds a further dimension, in which consumers are seen as active participants in enhancing delivery services, particularly through a focus on green knowledge and perceived value.

The Service Quality (SERVQUAL) model developed by Parasuraman et al. in 1985 is widely recognized as the foundational framework for assessing service quality across various dimensions, typically including tangibility, reliability, responsiveness, assurance, and empathy [60]. This model has been applied to diverse service contexts and remains popular for understanding service reliability and responsiveness, especially in areas requiring high service consistency and customer satisfaction [61].

Tang et al. [28] employ the SERVQUAL framework in understanding consumer adoption of SPLs through slightly different theoretical lenses and dimensions. Lai et al. [29] use the Logistics Service Quality (LSQ) framework, focusing on tangibility, responsiveness, security, reliability, and timeliness. This approach is particularly suitable for SPLs as they combine logistical operations with customer service and digital interactions. LSQ emphasizes the tangible aspects associated with the physical infrastructure of SPLs, where locker appearance, security features, and ease of access play a crucial role in consumer perception and trust. Responsiveness and timeliness are two other LSQ dimensions that further emphasize operational efficiency, which is critical in meeting consumer expectations of prompt and accurate delivery.

Tang et al. [28] have used an expanded framework incorporating three theories: SERVQUAL, E-Service Quality (ESQ), and LSQ, to address a wider range of service quality factors, such as service reliability, convenience, fault-handling capability, and service diversity. This comprehensive framework allows for addressing both the digital and physical service dimensions of SPLs. For instance, the ESQ framework is highly relevant to SPLs because these systems rely on digital interfaces for booking, tracking, and communication, thereby highlighting the importance of user-friendly and reliable digital interactions.

The Transaction Cost Theory (TCT) demonstrates how organizations strive to minimize the costs associated with identifying, negotiating, and enforcing agreements, thereby reducing the complexity and inconvenience experienced by customers [62]. In the field of logistics, TCT has been applied to optimize LMD models such as parcel lockers by reducing re-delivery attempts, minimizing opportunistic behavior among partners, and streamlining coordination efforts [23]. Quan et al. [26] have applied TCT to small and medium manufacturing enterprises and reveal that tighter supply chain integration reduces contractual and monitoring overheads, thereby enhancing overall operational efficiency.

Finally, the Value Co-Creation (VCC) Theory developed by Prahalad and Ramaswamy [63] suggests that consumers gain additional value by actively participating in the service process. VCC is effective in SPL contexts, emphasizing consumer empowerment and personalization, factors that positively influence adoption. This theory shows how consumer involvement in managing delivery schedules, for example, enhances their satisfaction with SPLs [41,46]. Table 4 summarizes the key theories applied in this study.

Table 4. Summary of a commonly used theoretical framework.

Theoretical Framework	Author(s)
Diffusion of Innovation Theory (DOI)	[9,33,38,39,48]
Technology Acceptance Model (TAM)	[24,34,35,37]
Unified Theory of Acceptance and Use of Technology (UTAUT)	[11,27,36]
Theory of Planned Behavior (TPB)	[9,49]

3.3.4. Geographical Contexts

The adoption of SPLs is impacted to a large extent by the geographical context because aspects such as population density, urban development level, infrastructural facilities, and societal customs exhibit significant regional differences [13]. For instance, SPLs are commonly seen as a feasible way to reduce traffic congestion, improve delivery effectiveness, and meet the demands of online purchases in urban areas, whereas these factors are not necessarily as important or relevant in rural and other areas with lower population density [64]. The regional distribution of articles shows a strong focus on Singapore, driven by its advanced logistics infrastructure and policies promoting LMD innovations [43,45,46,48,50,51]. This is followed by China, reflecting its leadership in e-commerce and research on factors such as trust and social influence [11,23,24,28,29,46]. Vietnam also represents growing interest in emerging markets driven by rapid e-commerce adoption and urbanization [26,39]. Whereas Germany, with two studies, and America, Belgium, Poland and Sweden account for one study each of the total, therefore, suggest comparatively fewer studies on the subject.

Studies in Singapore and China have shown that the popularity of SPLs is largely influenced by the convenience and ease of access they offer, as they provide a reliable solution to delivery challenges within restricted spaces and high-rise buildings [11,21]. In areas with a lower population density, SPL adoption might be limited due to fewer installations, longer travel distances to lockers, and reduced demand. For example, studies conducted in countries like Poland and Morocco show that geographical factors and infrastructure constraints hinder SPL acceptance; people in these regions may prefer home delivery, as SPLs are less convenient and accessible because of travel requirements [31,32].

The cultural context and regional familiarity with technology also play an important role. In regions with high technological readiness and a culture of self-service familiarity in Northern Europe, for example, SPLs tend to be more widely accepted and integrated into daily life [25,32,37,49]. By contrast, in regions where traditional delivery is preferred, SPLs may be perceived as complex, and their adoption may face more resistance, as consumers may prefer face-to-face interactions [3,33,34,42]. Therefore, understanding geographical and cultural differences is crucial for planning SPL implementation strategies for specific regions, as it helps enhance the adoption of the technology and its effectiveness across diverse contexts [65].

3.3.5. Included Studies' Research Gaps

Cross-Cultural Adoption Differences

Much of the existing research on SPL adoption is concentrated in regions where technological infrastructure and consumer familiarity with self-service technologies are high [11,24,46]. However, investigation of adoption factors in rural or developing regions, where geographic spread, infrastructure limitations, and cultural attitudes towards technology may significantly impact consumer behavior, remains limited [8,66]. Therefore, cross-cultural studies are imperative to understand how regional and cultural contexts influence adoption across diverse markets [23,29,31,39,48].

Public Policy and Sustainability

The review indicates that most SPL studies adopt a consumer behavior or technology acceptance perspective, with comparatively limited attention given to policy and sustainability considerations. This emphasis reflects the dominance of frameworks such as TAM, UTAUT, and DOI, which focus primarily on individual adoption decisions. Consequently, issues related to public policy, environmental performance, and long-term sustainability have received less attention, particularly in developing countries [67]. Future studies should investigate policy frameworks that support the sustainable integration of SPLs into urban logistics systems, including their potential contributions to reducing congestion, emissions, and delivery inefficiencies [14,68].

Comparative Evaluation with Other Delivery Modes

The review reveals that most studies investigate SPL adoption as a standalone delivery solution rather than examining it alongside competing delivery alternatives. This may reflect the relatively recent emergence of SPLs as a distinct research area, where the primary focus has been on understanding adoption determinants rather than comparing delivery options. Consequently, limited evidence exists regarding how consumers evaluate SPLs relative to home delivery, collection points, or other LMD solutions [29,42,48]. Comparative studies would provide a more comprehensive understanding of consumer preferences within the broader LMD ecosystem [7,13,14,67].

Longitudinal Trends and Post-Adoption Behavior

The review shows that the majority of SPL studies employ cross-sectional survey designs and focus on behavioral intention rather than actual usage behavior [9,21]. As a result, the literature provides limited insights into long-term adoption patterns, satisfaction, continued usage, and consumer retention. This methodological emphasis on initial acceptance is largely driven by the widespread application of technology adoption frameworks, which typically examine intention-based outcomes. Future longitudinal studies are therefore needed to explore post-adoption behavior and identify the factors that sustain or diminish SPL usage over time [7,16].

Demographic Information

Although several studies have considered demographic characteristics such as age, gender, income, and shopping behavior when examining SPL adoption [12,30,43], these variables have generally been included as descriptive characteristics or control variables rather than being systematically examined as primary determinants of adoption. This results in studies examining general consumer behavior without considering how these characteristics shape preferences and technology adoption barriers. Addressing this gap would provide insights for more targeted SPL services [9,27,39].

In contrast, other demographic and socio-economic factors, such as education level, occupation, digital literacy, household composition, and residential environment (urban versus rural), remain largely unexplored in the SPL literature. Consequently, limited understanding exists regarding how different consumer segments perceive, evaluate, and adopt SPL services. Therefore, addressing these gaps would support the development of more targeted adoption strategies and provide a more nuanced understanding of consumer heterogeneity in SPL adoption.

4. Conclusions

The findings show that SPL adoption is shaped by consumers' evaluation of the overall delivery experience rather than by a single determinant. Consumers are more likely to

adopt SPLs when the service is convenient, accessible, reliable, secure, useful, and easy to integrate into their daily routines. Also, existing studies are largely guided by technology adoption and behavioral frameworks, including TAM, UTAUT, DOI, and TPB. Literature is methodologically dominated by quantitative survey-based studies, while qualitative and mixed-method studies remain limited. Geographically, evidence is concentrated mainly in Asian markets, with fewer studies from rural areas, developing regions, and less mature e-commerce contexts.

Overall, this review contributes by organizing fragmented evidence on SPL adoption into a clearer structure covering factors, theories, methods, geographical patterns, and gaps. The findings will also provide a foundation for researchers to understand adoption of SPLs, refining theoretical models, and identifying future research directions across different consumer groups and markets.

4.1. Practical Implications

4.1.1. Implications for Service Providers

The findings suggest that successful SPL deployment depends on more than expanding locker networks. Service providers should prioritize the overall consumer experience by ensuring that lockers are located in places that align with consumers' daily activities, such as residential areas, workplaces, universities, transport hubs, and shopping centers. Since accessibility and convenience consistently emerged as the most influential adoption factors, strategic location planning should be considered a priority.

The results also highlight the importance of reliability, security, and trust. Providers should therefore focus on dependable service operations, including accurate parcel notifications, timely parcel availability, efficient fault resolution, and secure retrieval processes. Investments in authentication systems, parcel protection measures, and transparent privacy practices can further strengthen consumer confidence and reduce uncertainty associated with automated delivery services.

Finally, providers should support consumer familiarity and trialability. Simple user interfaces, step-by-step guidance, trial campaigns, and customer support can help first-time users and consumers with lower confidence in self-service technologies.

4.1.2. Implications for Policymakers

The findings indicate that SPLs can support broader goals related to delivery efficiency, urban mobility, and sustainability. Policymakers can facilitate adoption by incorporating SPLs into urban logistics planning and supporting their deployment in accessible public and semi-public locations. Such integration can improve delivery efficiency while reducing pressure on traditional home-delivery systems.

The results also emphasize the importance of consumer confidence in automated delivery services. Policymakers should therefore establish clear regulations concerning consumer protection, privacy, data security, and service reliability. Consistent regulatory standards can help strengthen trust and encourage wider public acceptance of SPLs.

Finally, policymakers should encourage more inclusive SPL development by supporting deployment beyond highly urbanized areas and promoting research on underrepresented consumer groups and regions. Such efforts can help ensure that the benefits of SPLs are distributed more broadly and that future delivery systems remain accessible across diverse socio-economic and geographic contexts.

4.1.3. Limitations and Future Research Avenues

This review has several limitations that should be considered when interpreting the findings. First, studies focused primarily on mathematical optimization, routing, and cost-minimization models were excluded because the review concentrated on consumer

adoption and behavioral determinants of SPL usage. As a result, the findings primarily reflect consumer perspectives and may underrepresent operational and system-design considerations that could influence the effectiveness and implementation of SPL services. Future reviews incorporating mathematical and operational studies could provide a more comprehensive understanding of both behavioral and logistical aspects of SPL adoption.

Second, the database search relied mainly on Scopus. Although Scopus provides broad multidisciplinary coverage, using a single primary database may have limited the range of studies identified. Future reviews could extend the search to databases such as Web of Science and ScienceDirect to improve coverage and assess whether broader database inclusion changes the pattern of findings.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/logistics10080180/s1>, Table S1: Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist.

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Abbreviations

The following abbreviations are used in this manuscript:

SPL	Smart Parcel Locker
SPLs	Smart Parcel Lockers
LMD	Last-Mile Delivery
DOI	Diffusion OF Innovation
TAM	Technology Acceptance Model
UTAUT	Unified Theory of Acceptance and Use of Technology
TPB	Theory of Planned Behavior

Appendix A

Table A1. Summary of studies on the influential factors of customers' intention to use SPLs.

Author(s)	Theory	Methodology	Region/Country	Influential Factors of SPL Adoption
Vakulenko et al. [47]	-	Focus group	New Zealand	Location, Convenience, And Security of Collection Delivery Point 'CDP'
Yuen et al. [48]	Diffusion of Innovation (DOI)	Survey	Singapore	Relative Advantage, Compatibility and Trialability
Wang et al. [21]	Diffusion of Innovation (DOI)	Survey	Singapore	Convenience, Function, Design, security, Enjoyment, Assurance, Customization, Attitude Cognitive and Affective
Wang et al. [51]	Affect-Cognitive Perspectives (AFC), Service Quality (SERVQUAL)	Survey	Singapore	Compatibility, Trialability, Relative advantage, Attitude
Yuen et al. [23]	Resource Matching Theory (RMT), Perceived Value (PV), Transaction Cost (TC)	Survey	China	Convenience, Privacy Security, and Reliability on Customers, Mediated by Perceived Value and Transaction Costs
Wang et al. [22]	Service Convenience (SERVCON), Kano Model	Survey	Singapore	Operating Hours, Waiting Time, Being Enroute, Easy Retrieval, Easy Return
Chen et al. [24]	Technology Readiness and TAM	Survey	Taiwan/China	Perceived ability, Perceived Value, Role Identification, Service Convenience, Technology Anxiety
Wang et al. [41]	Value Co-Creation (VCC)	Survey	Singapore	Consumers' Innovativeness, Consumers' Self-Enhancement Value Orientation, Consumers' Perceived Values, Consumers' Green Knowledge

Table A1. Cont.

Author(s)	Theory	Methodology	Region/Country	Influential Factors of SPL Adoption
Zhou et al. [11]	Unified Theory of Acceptance and Use of Technology (UTAUT2)	Survey	China	Performance Expectancy, Effort Expectancy, Social Influence and Facilitating Conditions
Rai et al. [25]	-	(6) Focus groups with (49) e-shoppers divided into heavy buyers and light buyers	Belgium	Security, Perceived Usefulness, Convenience and Flexibility
Cai et al. [36]	Unified Theory of Acceptance and Use of Technology (UTAUT), Attitude Theory, Habit Theory	Survey	China	Habit, Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Condition, Habit, Attitude
Wang et al. [50]	Affect-Cognitive-Social Perspectives	Survey	Singapore	Risk Appraisals, Action and Coping planning, Subjective Norms
Wang et al. [46]	Value Co-Creation (VCC), Fairness Heuristic	Survey	China	Perceived Service Value, Perceived Involuntariness, Perceived Fairness, Inferred Motive, Perceived Enjoyment
Tsai and Tiwasing [9]	Resource Matching (RMT), Diffusion of Innovation (DOI), Theory of Planned Behavior (TPB)	Survey	Thailand	Convenience, Reliability, Privacy Security, Compatibility, Relative Advantage, Complexity, Perceived Behavioral Control, And Attitude
Tang et al. [28]	Service Quality (SERVQUAL), E-Service Quality (ESQ), Logistics Service Quality (LSQ)	Survey	China	Service Reliability, Convenience, Fault Handling, Capability and Service Diversity
Wang et al. [44]	Protection Motivation Theory (PMT), Automation Acceptance Theory (AAT)	Survey	Singapore	Perceived susceptibility and severity of COVID-19, Trust, compatibility, Overall value of the service
Asdecker [49]	Theory of Planned Behaviours (TPB)	Interviews	Germany	Increased Flexibility: Better Reliability, Independence, Safety and Security, Privacy, Cost and Spatial Constraints
Lai et al. [29]	Logistics Service Quality (LSQ)	Survey	China	Tangibility, Responsiveness, security, Reliability, Timeliness

Table A1. Cont.

Author(s)	Theory	Methodology	Region/Country	Influential Factors of SPL Adoption
Merkert et al. [3]	Random utility theory and Discrete choice models	Survey	Australia	Perceived Risk, Cost, Convenience, and The Availability of Secure Locations for Delivery
An et al. [34]	Protection Motivation Theory (PMT) Technology Acceptance Model (TAM)	Survey	U. S	Technological Trust Perceived Usefulness and Ease of Use
Wang et al. [69]	Self-identity (SI)	Survey	Singapore	Prevalence of Social Distancing, Perceived Individualistic Culture, Self-Identity, Innovativeness
Klein and Popp [37]	Technology Acceptance Model (TAM)	Survey	Germany	Perceived Ease of Use and Perceived Usefulness
Vural and Akartepe [33]	Diffusion of Innovation (DOI)	Survey, semi-structured interviews (12) service providers, and Secondary sources such as blogs, news reports, and customer complaints.	Turkey	Supply Chain-Related and Market-Related Factors Influence the Adoption: Network Structure, Service Diversity, Security and Trust, low Environmental impact, and Convenience.
Quan et al. [26]	Transaction Cost (TC)	Survey	Vietnam	Convenience (Locker Location), Privacy and Security, Reliability and Perceived Value
Olsson et al. [42]	Service-Dominant (S-D) Logic	Interviews with (9) households	Sweden	Cognitive Experience (Ease of Use, Time Saving, Security, Safe Condition) Emotional Experience (Flexibility, Location, Luxury, Frequency, Ahead of Time) Behavioral Experience (Willingness to Pay, Subscription Service, Invest, Word of Mouth, Exaltation) Sensorial Experience (Design of The Reception Box, Size of The Reception Box) Physical Experience (Order Collection) Social Experience (Human Interaction)
Neto and Vieira [38]	Diffusion of Innovation Theory (DOI)	Case study Survey	Brazil	Trialability, compatibility, and Relative advantage

Table A1. Cont.

Author(s)	Theory	Methodology	Region/Country	Influential Factors of SPL Adoption
Cieřla [32]	Kano model	Survey	Poland	Parcel Size, Location, Accessibility, Security, Parking Availability, High-Quality Mobile Application, Convenience and Operating Time, and 24/7 Customer Support
El Moussaoui et al. [31]	-	Case study; focus groups	Morocco	Location Pick-up Points Security Opening Hours Parking Availability
Wang et al. [43]	Risk, Attitude, Norms, Abilities, and Self-regulation (RANAS) model	Survey (500)	Singapore	Risk, Attitude, Norm, Ability and Self-regulation
Wu and Li [30]	-	Survey (279)	China	Time pressure, Perceived behavioral control, Self-delivery box Reliability, and socio-demographic factors.
Wang et al. [70]	Consumer Logistics	Survey (483)	Singapore	Willing to contribute physical effort but less interested in social interactions and attentive to informational updates. Also, socio-demographic factors and product value.
Chen et al. [40]	Push-Pull-Mooring (PPM)	Survey (496)	China	Push Factors: Low perceived value of home pick-up. Pull Factors: Attractiveness of smart lockers. Mooring Factors: Inertia.
Tsai et al. [39]	Diffusion Of Innovation Theory (DOI)	Survey (245)	Vietnam	Innovativeness And Location Convenience Through the Mediators of Perceived Value and Transaction Costs.
Chuong et al. [27]	Unified Theory of Acceptance and Use of Technology (UTAUT)	Survey (277)	Vietnam	Convenience, Privacy Security, Reliability, Functionality, Service Diversity, Social Influence, Facilitating Conditions, Perceived Value
Chen et al. [12]	Discrete choice modelling (based on random utility maximization theory)	A context-dependent stated preference survey	Nanjing, China	Access distance, socio-demographic attributes, Dwell time, Weather condition factors
Jang et al. [35]	Technology Acceptance Model (TAM)	Survey (459)	Seoul, Korea	Perceived Usefulness, Ease of Use, Perceived Risks (Specifically Related to Health During the Pandemic), and Trust in the Technology.
Li et al. [45]	Signaling Theory	Survey (612)	Singapore	Green Attributes, Green Information, Green Social Norms, and Green Participation

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