Rethinking Urban Freight: Laying the Groundwork for Shared Smart Parcel Lockers in Public Spaces

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Abstract

Urban freight transport faces growing challenges from e-commerce and urbanization. This paper evaluates a pilot of shared public Smart Parcel Lockers (SPLs) in Thessaloniki, Greece, under the DISCO project. It compares pre-implementation public expectations (n=1230 survey) regarding benefits, concerns, and location preferences with post-implementation data from two pilot lockers, including user experiences (n=200 survey) and five months of operational utilization. Findings reveal strong initial public willingness and clear location preferences. However, user satisfaction with pilot sites varied, and locker utilization differed significantly between locations, underscoring the critical role of micro-locational attributes. The study offers practical insights for optimizing future SPL deployments in urban settings, emphasizing the need to bridge the gap between general public expectations and nuanced on-the-ground realities.

Keywords: *Urban logistics, Smart Parcel Lockers, Last-mile delivery, E-commerce, Public perception, Pilot study, Thessaloniki, Expectation-Confirmation.*

1. Introduction

These pressing challenges necessitate transformative solutions. Smart Parcel Lockers (SPLs) have emerged as a significant technological and logistical innovation designed to address these multifaceted issues by consolidating deliveries, offering 24/7 accessibility, and notably reducing failed delivery attempts (Shah et al., 2024). In Thessaloniki, the recent ad-hoc placement of private lockers by various courier providers signals a growing trend and an opportune moment for more integrated solutions.

Against this backdrop, the European research project DISCO (GA. 101103954) aims to transform urban freight towards zero-carbon emissions through collaborative distribution frameworks, akin to the Physical Internet. As part of this initiative, the Municipality of Thessaloniki and the Hellenic Institute of Transport (HIT) are exploring the potential of shared, multi-provider smart parcel lockers in public spaces. This approach is envisioned as a more environmentally friendly and integrated measure for urban freight management.

This paper presents the findings from a pilot study conducted in Thessaloniki. It aims to meticulously compare pre-implementation public expectations regarding these shared public SPLs with post-implementation user experiences—focusing specifically on satisfaction with locker locations and how locker use integrates into daily trips—and actual operational data from the pilot lockers. The ultimate goal is to derive practical lessons that can inform future, more effective deployments of SPLs.

Specifically, this research seeks to answer the following questions:

1. *What were the key pre-implementation perceptions, expectations, and concerns of Thessaloniki residents regarding shared public SPLs?*
2. *What were the actual user satisfaction levels with the pilot locker locations, their integration into daily routines, and the lockers' operational utilization patterns?*
3. *What are the primary similarities and differences between public expectations and the realities observed during the SPL pilot in Thessaloniki?*

The paper is structured to first review relevant literature and theoretical frameworks that underpin the study. It then details the research methodology employed, followed by a presentation of the results, with a core focus on the comparative analysis between expectations and experiences. Finally, the paper discusses these findings, draws conclusions, and offers recommendations for future SPL implementations.

2. Theoretical Background

2.1 Theoretical Underpinnings of Smart Parcel Locker Adoption and Evaluation

The **Technology Acceptance Model (TAM)**, proposed by Davis (1989), is a cornerstone in understanding user intentions towards new technologies like SPLs. TAM posits that Perceived Usefulness (PU)—the belief that a technology will enhance performance (e.g., improve parcel collection)—and Perceived Ease of Use (PEOU)—the belief that using the technology will be effortless—are primary determinants of adoption intention (Davis, 1989; Shah et al., 2024). These constructs are particularly relevant for assessing pre-installation expectations, as they capture anticipated benefits and ease of interaction with SPLs (Encarnación & Amaya, 2024).

Expanding on TAM, the **Unified Theory of Acceptance and Use of Technology (UTAUT)** and its extension, UTAUT2, offer a more comprehensive lens by integrating constructs such as Performance Expectancy (similar to PU), Effort Expectancy (similar to PEOU), Social Influence, Facilitating Conditions, Hedonic Motivation, Price Value, and Habit (Venkatesh et al., 2003). Research on SPLs has found these factors, along with others like convenience, privacy, security, reliability, and functionality, to be influential (Chuong et al., 2023). UTAUT is well-suited for this study as it helps analyze both pre-installation expectations (e.g., anticipated performance, social norms) and post-installation experiences (e.g., actual convenience, alignment with facilitating conditions like location satisfaction).
The literature also highlights the importance of **Trust** in the technology and service provider, which can significantly impact adoption intentions, sometimes even more than PU and PEOU (Shah et al., 2024). Other factors considered in extended models include user innovativeness, resistance to change (European Proceedings of Social and Behavioural Sciences, 2023) , environmental knowledge (Deutsch & Golany, 2018) , and privacy concerns (An et al., 2022).

A critical insight from technology adoption literature, central to this paper's research design, is the dynamic nature of adoption drivers. Pre-adoption intentions, formed without direct experience, may rely more on social influence and general perceptions of the innovation's characteristics (e.g., usefulness, ease of use, trialability) (Karahanna et al., 1999). In contrast, post-adoption attitudes and continued use are more heavily shaped by the *actual* experienced benefits and usefulness (Karahanna et al., 1999). This temporal shift underscores the necessity of capturing both pre-installation perceptions and post-installation experiences to understand the gap between expected and achieved benefits, a core aim of the Thessaloniki pilot study.

2.2 Consumer Behavior: Value, Trust, Risk, and Convenience

Beyond general adoption models, specific consumer behavior theories further clarify SPL uptake. **Perceived Value**, the consumer's trade-off between perceived benefits and sacrifices (e.g., time, effort, cost), is a significant direct influencer of the intention to use SPLs (Chuong et al., 2023; Jang et al., 2024). Enhanced convenience, privacy, security, and reliability contribute positively to this perceived value (Jang et al., 2024).

Trust, as mentioned, is paramount. It encompasses belief in the SPL system's reliability, integrity, and security, as well as trust in the service provider (Shah et al., 2024). A lack of trust can be a major adoption barrier, especially pre-installation when perceptions are formed based on limited information. Conversely, **Perceived Risk**, including concerns about data security (e.g., personal information misuse) and package security (e.g., theft, damage), acts as a deterrent (Encarnación & Amaya, 2024). SPLs aim to mitigate these risks through security features, and their effectiveness is a key aspect of post-installation evaluation.

Convenience is arguably one of the most powerful drivers of SPL adoption (Shah et al., 2024). It is multifaceted, including:

- **Geographical convenience**: Proximity to homes, workplaces, or transit hubs (Iannaccone et al., 2021). This directly relates to the research question on user satisfaction with pilot locker locations.
- **Temporal convenience**: 24/7 accessibility, freeing users from restrictive home delivery windows (Tang et al., 2021).
- **Operational convenience**: Simplicity and speed of the pickup process (Tang et al., 2021). The post-installation survey's focus on location satisfaction and trip integration will provide valuable data on these dimensions of convenience.

2.3 Analyzing Pre-Post Implementation Perceptions: Expectation-Confirmation Theory

The **Expectation-Confirmation Theory (ECT)** provides a direct theoretical framework for this paper's comparative research question (Karahanna et al., 1999). ECT posits that customer satisfaction is determined by the degree to which initial (pre-use) expectations are confirmed or disconfirmed by actual (post-use) performance (Karahanna et al., 1999; Kadłubek, 2015). Positive disconfirmation (performance exceeding expectations) leads to satisfaction, while negative disconfirmation (performance falling short) leads to dissatisfaction. Satisfaction, in turn, influences continued use.
The principle of comparing pre-adoption expectations with post-adoption experiences is central to understanding the SPL adoption lifecycle (Karahanna et al., 1999).

The following table summarizes the core theoretical frameworks discussed:

Table 1: *Core Theoretical Frameworks in SPL Research*

Theory	Key Constructs	Brief Description	Relevance/Application to SPL User Perceptions & Adoption (Example Snippet IDs)
Technology Acceptance Model (TAM)	Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Attitude Toward Using, Behavioral Intention to Use	Explains user acceptance of new technologies based on their perceptions of how useful and easy to use the technology is.	Fundamental for understanding initial willingness to use SPLs based on expected benefits and effort. [6]
Unified Theory of Acceptance and Use of Technology (UTAUT/UTAUT2)	Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic	Integrates multiple models to provide a comprehensive view of technology acceptance and	Offers a broader set of determinants for SPL adoption, including social factors, resource

	Motivation, Price Value, Habit	use in both organizational and consumer contexts.	availability, and perceived value. [20]
Perceived Value Theory	Benefits (functional, emotional, social), Sacrifices (monetary, time, effort), Overall Perceived Value	Consumers evaluate products/services based on a trade-off between what they receive (benefits) and what they give up (sacrifices).	Helps explain how users weigh the convenience, security, and cost aspects of SPLs to form an overall value judgment. [22]
Trust Theories	Trust in Technology, Trust in Provider, Belief in Security/Reliability	Focuses on the user's confidence in the SPL system's ability to perform as expected and protect their interests (parcels, data).	Crucial for SPL adoption, as users entrust valuable goods and personal information to the system. [6]
Risk Perception Theory	Perceived Security Risk (theft, damage), Perceived Privacy Risk (data misuse)	Individuals' subjective assessment of the probability and severity of negative outcomes associated with using a technology or service.	Explains user hesitation or reluctance due to concerns about package safety or data privacy with SPLs. [13]
SERVQUAL Model	Tangibles, Reliability, Responsiveness, Assurance, Empathy (often adapted for SPLs to include Convenience, Fault Handling, etc.)	Measures service quality by assessing the gap between customer expectations and their perceptions of actual service performance.	Directly applicable for comparing expected SPL service quality (pre-installation) with experienced quality (post-installation). [8]
Kano Model	Must-be, One-dimensional, Attractive, Indifferent, Reverse Attributes	Classifies product/service attributes based on their impact on customer satisfaction, helping to prioritize features.	Useful for identifying which SPL functionalities are basic requirements versus those that can delight users and drive higher satisfaction. [12]
Expectation-Confirmation Theory (ECT)	Expectations, Perceived Performance, Confirmation/Disconfirmation, Satisfaction, Continuance Intention	Posits that satisfaction is a function of the confirmation (or disconfirmation) of pre-use expectations by post-use performance, influencing continued use.	Provides a strong framework for analyzing how initial perceptions of SPLs are met or altered by actual experience, impacting long-term usage. [26]

As user perceptions and behavioral drivers can evolve with direct experience, a research design incorporating both pre- and post-installation data collection, as employed in this Thessaloniki study, is essential for accurately assessing how initial expectations align with the realities of SPL use and for deriving meaningful, practical lessons.

3. Methodology

This study employed a mixed-methods approach, integrating both quantitative and qualitative data, to comprehensively evaluate the introduction of shared smart parcel lockers (SPLs) in public spaces within Thessaloniki, Greece.

3.1 Research Design

The research was structured as a pre-post, quasi-experimental pilot study centred around the implementation of two distinct public space SPLs. This design was chosen to capture initial public perceptions, expectations, and concerns before the deployment of the lockers, and subsequently to assess actual user experiences, satisfaction levels, and operational performance once the lockers were in use. The core of the research design involves:

3.2 Data Collection Instruments

3.2.1 Pre-implementation phase

A structured electronic questionnaire, developed within the DISCO European research project and administered via EUSurvey, was used to capture Thessaloniki residents' baseline perceptions prior to the smart parcel locker pilot. The survey, initiated after an introduction to the project and data privacy consent, aimed to assess initial viewpoints on urban freight and sustainable delivery through questions covering:

- Perceived contribution of current freight transport to urban environmental issues, using a multiple-choice format.
- Willingness to adapt purchasing habits for sustainability, such as paying more for greener delivery or accepting longer delivery times, measured via Likert scales.
- Current usage frequency of smart lockers (if applicable) and general willingness to use public smart parcel lockers, assessed with multiple-choice and Likert scale questions.
- Expected impacts of public smart parcel lockers on CO2 emissions and delivery efficiency, evaluated using Likert scales.
- Priorities regarding potential public locker locations, key benefits of locker systems, and main concerns about their deployment in public spaces, all collected through drag-and-drop ranking exercises.
- Opinions on broader urban logistics policies, assessed using Likert scales.

3.2.2 Post-installation User Survey Design

To assess the initial experiences of actual users, a dedicated survey was administered to 200 individuals who utilized one of the two newly installed public space smart parcel lockers in Thessaloniki. This instrument aimed to capture feedback primarily related to the specific locker's location, the user's trip context, and desired ancillary services. The key data points collected included:

- **Locker Identification:** The specific identifier of the locker unit used by the respondent.
- **Locker Location:** The name or address of the locker site.
- **Satisfaction with Locker Location:** A question to measure the user's level of satisfaction with the placement of the particular locker they used, likely captured via a rating scale or predefined satisfaction categories.
- **Reason for Location Satisfaction Rating:** An open-ended question allowing users to provide qualitative explanations for their satisfaction level regarding the locker's location.
- **Main Purpose of Trip:** A question designed to understand the primary reason for the user's journey when they interacted with the locker, which could involve predefined options or an open-text response.
- **Desired Supplementary Functions:** A question to identify any additional services or functionalities that users would find beneficial at the locker locations, likely using a checklist or open-ended format.

3.2.3 Locker Utilization Data

To complement the survey data and provide objective insights into the operational performance and actual usage patterns of the two pilot smart parcel lockers, utilization data was collected for the period spanning from December 2024 to April 2025. This dataset, corresponding to the file data1.csv, provided aggregated metrics for each of the two locker locations. The key information captured in this dataset included:

- **Locker Identification:** A name or ID for each locker unit.
- **Locker Address:** The physical address of the locker installation (Address).
- **Locker Capacity:** The number of available compartments in each locker unit (Compartments).

- **Average Parcel Dwelling Time:** An aggregated measure representing the typical number of days a parcel remained in a locker from the time it was placed until it was picked up by the recipient (Avg_Dwelling_Days).
- **Monthly Parcel Volumes:** The total number of parcels processed by each locker for each month of the pilot period (i.e., Parcels_Dec, Parcels_Jan, Parcels_Feb, Parcels_Mar, Parcels_Apr).
- **Total Parcel Volume:** The cumulative number of parcels processed by each locker over the entire reported five-month period (Parcels_Total).

3.3 Sampling and Data Collection Procedures

The pre-installation survey, designed to capture baseline public perceptions in Thessaloniki, was administered as an online questionnaire using the EUSurvey platform. The survey was disseminated through multiple channels to reach a broad segment of the city's residents. These channels included posts on social media platforms, distribution via the Municipality of Thessaloniki's official newsletter (email), and a link made available on the Municipality of Thessaloniki's website aimed to maximize reach, primarily employing a convenience sampling strategy, likely supplemented by snowball sampling as users could share the survey link. The data collection period for this phase concluded in November 2024. A total of 1230 complete and valid responses were obtained. The survey focused on attitudinal and perceptual data rather than collecting specific demographic information from respondents.

Following the installation and operationalization of the two public space smart parcel lockers, a post-installation survey was conducted to gather feedback from actual users. Participants were recruited directly at the point of service or shortly after using one of the two pilot lockers. This could have been achieved through methods such as QR codes displayed on the lockers leading to the online survey, or brief intercept invitations extended to users interacting with the lockers. The survey aimed to capture immediate user experiences and satisfaction, particularly concerning the locker locations. A total of 200 valid responses were collected from users of these two lockers.

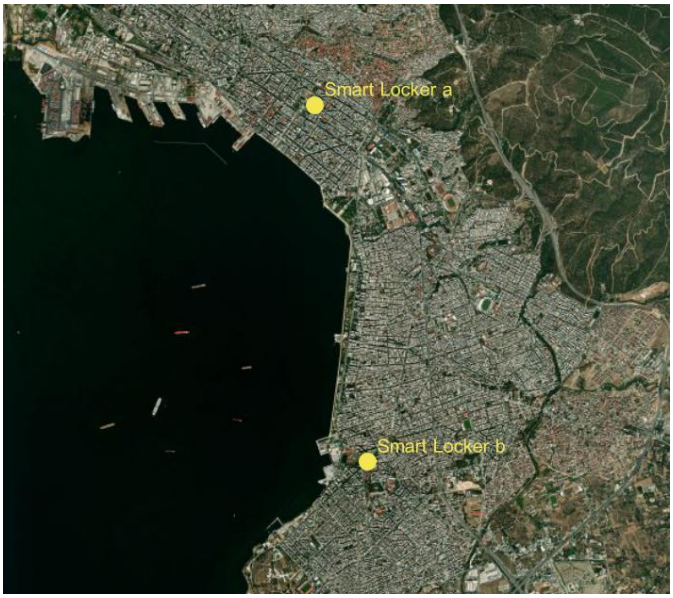

Figure 1: *The locations of the two pilot smart lockers in public spaces of Thessaloniki, Greece*

Objective operational data regarding the usage of the two pilot smart parcel lockers was acquired directly from the operator's locker service system. This data covered the initial five-month operational period from December 2024 to April 2025, inclusive. The dataset provided aggregated metrics for each of the two locker installations, including the total number of parcels processed per month, the

cumulative total for the period, the number of compartments per locker, and an average parcel dwelling time (days from loading to pickup) for each unit. This information was used to assess the actual uptake and operational patterns of the lockers.

The data collected from the pre-installation survey, the post-installation user survey, and the locker utilization records were analyzed using a combination of quantitative and qualitative methods. Statistical analyses were performed using Python with its data analysis libraries for inferential statistics.

The analysis was structured to address each research question as follows:

- To address **Research Question 1** (Pre-implementation perceptions, expectations, and concerns):
    - Data from the pre-installation EUSurvey (n=1230) were analyzed using descriptive statistics. For categorical and Likert scale questions (covering perceived freight impact, sustainability willingness, current locker usage, future willingness, expected CO2/efficiency impacts, and opinions on logistics policies), frequency distributions (counts and percentages) were calculated and visualized using bar charts. For Likert scale responses, where appropriate, ordinal data was numerically coded to compute means and medians to summarize central tendencies.
    - For the ranking questions (preferred locations, expected benefits, and key concerns), analysis focused on identifying the frequency with which each item was ranked as the top choice and the overall mention frequency of each item across all rankings. Results were presented in tables and visualized using horizontal bar charts.
    - Chi-square tests of independence were planned to explore significant associations between key attitudinal variables, such as the relationship between willingness to use lockers and perceived environmental benefits.

- To address **Research Question 2** (Post-installation user satisfaction with location, routine integration, and operational utilization patterns):
    - **Post-installation user survey data (n=200):**
        - Descriptive statistics (frequencies, percentages, and means/medians where applicable for numerically coded scales) were used to analyze user satisfaction ratings with specific locker locations.
        - Open-ended responses, particularly those explaining location satisfaction ratings and suggesting desired supplementary functions, were analyzed using thematic analysis to identify recurring themes and qualitative insights.
        - Data on the main purpose of users' trips to the lockers were categorized (if open-ended) or summarized using frequency distributions to understand how locker use integrated with daily routines.
        - Where applicable, satisfaction ratings were compared across the two different locker locations using appropriate statistical tests (e.g., Chi-square test for categorical satisfaction responses or t-test/ANOVA for numerical satisfaction scores, depending on data characteristics).
    - **Locker utilization data:**
        - Descriptive statistics were calculated for total and monthly parcel volumes for each of the two pilot lockers, as well as for the provided average parcel dwelling times.

        - Usage trends over the five-month operational period (December 2024 - April 2025) were visualized using line graphs to illustrate patterns of adoption or seasonality.
        - A direct comparison of utilization metrics (total parcels, monthly averages, average dwelling times) between the two locker locations was conducted.
- To prepare for **Research Question 3** (Comparative analysis of pre-implementation expectations vs. post-implementation realities – to be detailed in Chapter 4: Results):
    - The analytical plan included a systematic comparison of findings derived from the pre-installation survey (addressing RQ1) with those from the post-installation user survey and locker utilization data (addressing RQ2). This comparative approach was designed to identify key convergences (where expectations aligned with experiences/data) and divergences (where they differed), particularly concerning location preferences versus actual location satisfaction, anticipated willingness to use versus observed usage volumes, and expected benefits versus inferred user experiences and operational efficiencies. The specific framework for this comparative analysis will be detailed in Chapter 4.

4. Results

This chapter presents the findings derived from the data analysis, addressing the research questions outlined in Chapter 1. Section 4.1 details the pre-installation public perceptions and expectations regarding shared smart parcel lockers (SPLs) in Thessaloniki. Subsequent sections will cover post-installation user experiences and satisfaction (Section 4.2), operational utilization patterns of the pilot SPLs (Section 4.3), and a comparative analysis bridging pre-implementation expectations with post-implementation realities (Section 4.4). (Adjust the reference to 4.4 if your Chapter 4 is solely the comparative analysis).

4.1 Pre-installation Public Perceptions and Expectations

Data for this section were drawn from a survey of 1230 Thessaloniki residents conducted prior to the pilot installation of public space SPLs.

4.1.1 Perceptions of Urban Freight and Sustainability Stance

Respondents' perceptions of the contribution of freight transport to urban environmental issues (Q1_Freight_Pollution_Contrib) are summarized in Table 4.1.1. A significant portion of residents perceived a notable impact, with 35.1% stating it contributes "Quite a bit (10-30%)" and 25.9% indicating "30-50%".

Table 4.1.1: *Perceived Contribution of Freight Transport to Urban Environmental Issues (N=1230)*

Response Category (Q3)	Count	Percentage (%)
Quite willing	381	30.98
Partially willing	322	26.18
A little willing	189	15.37
Very willing	186	15.12
Not at all willing	152	12.36

Regarding willingness to adapt for more sustainable deliveries by accepting longer delivery times (Q3_Willing_Accept_Delay_Green), responses varied, as shown in Table 4.1.2. The largest group (31.0%) reported being "Quite willing," followed by 26.2% "Partially willing."

Table 4.1.2: *Willingness to Accept Longer Delivery Times for Sustainability (N=1230)*

Response Category (Q1)	Count	Percentage (%)
Quite a bit (10-30%)	432	35.12
Significant (30-50%)	319	25.93
A little (<10%, attributed to passenger vehicle traffic)	256	20.81
Very much (>75%)	223	18.13

4.1.2 Familiarity and General Willingness to Adopt Smart Parcel Lockers

Current usage of smart lockers, when the option is available (Q4_Current_Locker_Usage), is detailed in Table 4.1.3. A majority (55.6%) reported using them "Always, if the option exists."

Table 4.1.3: *Current Frequency of Using Smart Lockers (N=1230)*

Response Category (Q4)	Count	Percentage (%)
Always, if the option exists	684	55.61
In 75% of my orders	194	15.77
In half of my orders	154	12.52
In 2 out of 10 orders	106	8.62
Never	92	7.48

There was a strong positive sentiment towards using future public smart parcel lockers as an environmentally friendly alternative, as shown in Table 4.1.4. The majority (58.3%) were "Very willing," with an additional 28.9% "Quite willing."

Table 4.1.4: Willingness to Use Future Public Smart Parcel Lockers (N=1230)

Response Category (Q5)	Count	Percentage (%)
Very willing	717	58.29
Quite willing	355	28.86
A little willing	70	5.69
Partially willing	60	4.88
Not at all willing	28	2.28

4.1.3 Expected Impacts of Public Smart Parcel Lockers

Regarding the expected impact of public SPLs on CO2 emissions reduction, nearly half (49.3%) believed it would be "Quite effective," and 15.9% anticipated it would be "Very effective" (Table 4.1.5).

Table 4.1.5: *Expected Impact of Public SPLs on CO2 Emissions Reduction (N=1230)*

Response Category (Q5)	Count	Percentage (%)

Quite effective	606	49.27
Partially effective	286	23.25
Very effective	189	15.37
A little effective	93	7.56
Not at all effective	56	4.55

Similarly, for the expected impact on improving urban delivery efficiency, 54.0% expected SPLs to be "Quite effective," and 28.1% "Very effective" (Table 4.1.6).
A Chi-square test indicated a statistically significant association between the willingness to use future public lockers (Q5) and the expected CO2 impact of these lockers (Q6) ($\chi 2(16)=436.70, p<0.001$), suggesting that anticipation of higher environmental benefits correlated with greater willingness to use the lockers.

4.1.4 Preferences for Locker Locations

Respondents ranked potential public locations for smart parcel lockers (Q8_Rank_Locations). The locations most frequently ranked as the top choice are presented in Table 4.1.7. "Near residential areas" and "Near shopping centers/retail areas" were the most preferred.

Table 4.1.7: *Top-Ranked Preferences for Public Locker Locations (N=1230)*

Preferred Locker Location (Top Ranked)	Times Ranked First
Near residential areas	390
Near shopping centers/retail areas	329
Near parking areas	175
At public transport stops/stations	141
In central areas with intense business activity	90
Near parks/recreational areas	84
Near educational institutions (schools, universities)	18
Other	3

4.2 Post-installation User Experiences with Pilot Locker Locations

Following the pilot deployment of two public smart parcel lockers, a survey was administered to 200 users to gather feedback on their initial experiences. Of these responses, 119 pertained to 'Locker b' and 81 to 'Locker a'. The survey primarily focused on user satisfaction with the locker locations, the context of their trips to use the lockers, and any desired supplementary functionalities.

4.2.1 User Satisfaction with Locker Locations

User satisfaction with the specific location of the locker they utilized is presented in Table 4.2.1. A notable proportion of users (28.0%) reported being "Very satisfied" with the locker's placement. Conversely, 19.5% of users were "Not at all satisfied," and another 19.5% indicated they were "Very satisfied". Qualitative feedback regarding the reasons for these satisfaction levels indicated a range of experiences. Positive comments often highlighted aspects such as good nighttime illumination and ease of pedestrian access. Conversely, some users reported difficulties in locating the lockers, issues related to perceived exposure of the location, or challenges with parking availability nearby.

4.2.2 User Trip Integration

To understand how locker usage integrated into users' daily routines, respondents were asked about the main purpose of their trip when accessing the locker. As shown in Table 4.2.2, a notable percentage (24.0%) preferred not to disclose this information. Among those who responded, making a trip exclusively for parcel pickup was the most cited primary purpose (21.0%). This was closely followed by users who combined their parcel pickup with a walk in the area (20.0%) or with short-term parking (18.5%).

4.2.3 Desired Supplementary Locker Functionalities

Users were also asked about additional functions or services they would find beneficial at the locker locations. The most frequently mentioned individual requests included charging points for electric bicycles/scooters (28 mentions) and designated parking areas for bicycles/scooters (28 mentions). Twenty users suggested electric vehicle charging stations, while 22 respondents noted "Other" unspecified functions. Several users also indicated a desire for combinations of these services (e.g., 10 users requested both bicycle/scooter charging and parking). Approximately 10.5% of respondents (21 users) did not specify any desired supplementary functions or this data was missing.

4.3 Actual Utilization Patterns of Pilot Smart Parcel Lockers

Operational data collected from the two pilot smart parcel lockers over a five-month period (December 2024 - April 2025) provided insights into their actual usage.

During the pilot phase, a total of 4,895 parcels were processed through the two lockers. Locker 'a' handled a significantly larger volume, accounting for 3,594 parcels, while Locker 'b' processed 1,301 parcels. The average time parcels remained in the lockers before collection is detailed in Table 4.3.1.

Locker ID	Total Parcels Processed (Dec-Apr)	Average Parcel Dwelling Time (Days)
Locker 'a'	3594	0.7
Locker 'b'	1301	0.91
Overall Total	4895	**0.75**

Analysis of monthly parcel volumes indicated distinct usage patterns for the two lockers. For instance, in March 2025, Locker 'a' processed 681 parcels, and Locker 'b' processed 283 parcels. In April 2025, the volumes were 650 for Locker 'a' and 301 for Locker 'b'. A detailed visualization of these monthly trends would illustrate the adoption trajectory and any fluctuations over the five-month period for each location.

4.4 Bridging Expectations and Reality: A Comparative Analysis

Comparing the pre-implementation preferences with the post-implementation findings offers valuable insights. The strong general preference for lockers "Near residential areas" and "Near shopping centers/retail areas" provides a clear directive for future large-scale deployments. The mixed satisfaction levels observed for the two pilot locations underscore that even if a general location *type* is preferred (e.g., residential), the specific micro-location attributes (visibility, accessibility, perceived safety, parking) are critical determinants of user satisfaction. The disparity in usage between Locker 'a' (higher utilization) and Locker 'b' (lower utilization) warrants further investigation in relation to their specific locational characteristics and how these align with the top public preferences. For instance, if Locker 'a' was situated in a manner that more closely matched the highly-ranked preferences (e.g., high residential density with good accessibility) compared to Locker 'b', this could explain its higher adoption rate. The qualitative feedback from users about difficulties or positive aspects of each specific site

further enriches this comparison, highlighting practical considerations beyond general location categories. This suggests that while broad preferences guide initial strategy, on-the-ground site assessments and user-centric micro-location planning are paramount for optimizing both satisfaction and utilization.

5. Conclusions

This study, conducted within the framework of the European research project DISCO, embarked on an investigation into the introduction of shared, multi-provider Smart Parcel Lockers (SPLs) in public spaces in Thessaloniki, Greece. The research was driven by the pressing need to address escalating challenges in urban logistics, exacerbated by e-commerce growth, and to explore SPLs as a viable, sustainable, and user-centric solution. The core objective was to compare pre-implementation public expectations with post-implementation user experiences and operational realities, thereby deriving practical lessons for future deployments.

The research addressed three primary questions:

1. Understanding the initial landscape of public perceptions, expectations, and concerns regarding shared public SPLs among Thessaloniki residents before their installation.
2. Assessing actual user satisfaction with the pilot locker locations, how SPL use integrated into their daily routines (trip purpose), and the objective operational utilization patterns of the two pilot lockers.
3. Identifying and analyzing the key similarities and divergences between the pre-implementation public expectations and the post-implementation realities observed during the pilot.

Key findings from the pre-installation survey indicated a general public awareness of the environmental impact of freight transport and a notable willingness among Thessaloniki residents to adopt SPLs, driven by expectations of increased delivery efficiency and positive environmental contributions, such as CO2 emissions reduction. Preferences for locker locations leaned towards residential areas and shopping centers, highlighting convenience as a primary anticipated benefit.

Post-implementation data from actual users and locker utilization metrics provided a nuanced view of the "after" picture. While a segment of users expressed high satisfaction with the pilot locker locations, others reported challenges, underscoring the criticality of micro-locational attributes beyond general area types. The integration of locker use into daily routines varied, with a significant portion of users making dedicated trips for parcel pickup, while others combined it with other activities. Operational data revealed distinct utilization patterns between the two pilot lockers, suggesting that specific locational characteristics significantly influence adoption rates.

The comparative analysis, bridging these pre- and post-implementation findings, highlighted that while general willingness to use SPLs was high, actual satisfaction and uptake are profoundly influenced by the tangible aspects of convenience, accessibility, and the perceived safety and suitability of specific micro-locations. The disparity in utilization between the two pilot lockers, when juxtaposed with pre-defined public preferences, offers critical insights for optimizing future network design. It underscores that while broad public preferences can guide initial strategy, meticulous on-the-ground site assessments and user-centric micro-location planning are paramount for maximizing both user satisfaction and operational efficiency.

The practical lessons derived from this Thessaloniki pilot are manifold. Future SPL deployments should prioritize not only general preferred location types but also invest heavily in understanding and optimizing micro-locational factors. Public awareness and education campaigns remain important, but the tangible experience of convenience and reliability will be the ultimate drivers of sustained adoption. Furthermore, the data on trip integration suggests opportunities to enhance the value proposition of SPLs by co-

locating them with other services or along frequently travelled routes to better align with users' existing travel patterns. For the Municipality of Thessaloniki and other cities considering similar initiatives, this research emphasizes the need for a data-driven, iterative approach to SPL network development, continuously refining deployment strategies based on user feedback and operational performance. The findings contribute valuable, context-specific knowledge to the DISCO project's broader goals of fostering zero-carbon urban freight and provide a foundational understanding for scaling up shared SPL networks effectively and sustainably.

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