The Final 50 Feet Urban Goods Delivery System:
Common Carrier Locker Pilot Test at the Seattle Municipal Tower October 2018

Urban Freight Lab
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Cover Photo: Locker wrap, three lower photos: Anna Alligood

EXECUTIVE SUMMARY

"In this research we've proven that parcel lockers can dramatically reduce delivery times; that the obstacles of ownership and multiple stakeholders can be overcome; that customers are interested in, and will use, the lockers. In short, we've proven that lockers are a good solution for some of our urban freight challenges and should be part of our solutions toolkit."

Dr. Anne Goodchild, Founding Director, Supply Chain Transportation & Logistics Center, and Professor of Civil and Environmental Engineering at the University of Washington

This report provides compelling evidence of the effectiveness of a new urban goods delivery system strategy: Common Carrier Locker Systems that create parcel delivery density and provide secure delivery locations in public spaces. Common carrier locker systems are an innovative strategy because they may be used by any retailer, carrier and goods purchaser, and placed on public property. This contrasts to branded lockers such as those operated by Amazon, UPS and FedEx that are limited to one retailer's or one carrier's use. Common carrier lockers use existing smart locker technology to provide security and convenience to users.

The Common Carrier Locker System Pilot Test in the Seattle Municipal Tower was uniquely designed for multiple retailers' and delivery firms' use in a public space. In spring 2018, a common carrier locker system was placed in the 62-floor Seattle Municipal Tower for ten days as part of a joint research project of the Urban Freight Lab (UFL) at the University of Washington's Supply Chain Transportation & Logistics Center and the Seattle Department of Transportation (SDOT), with additional funding from the Pacific Northwest Transportation Consortium (PacTrans). This report demonstrates common carrier lockers' potential to reach both public and privates goals by reducing dwell time (the time a truck is parked in a load/unload space in the city) and the number of failed first delivery attempts to dense urban areas. This research provides evidence that delivering multiple packages to a single location such as a locker, rather than delivering packages one-by-one to individual tenants in an urban tower increases the productivity of public and private truck load/unload spaces.

The concept for this empirical pilot test draws on prior UFL-conducted research on the Final 50 Feet of the urban goods delivery system. The Final 50 Feet is shorthand for the last segment of the supply chain. It begins when a truck parks in a load/unload space, continues as drivers maneuver goods along sidewalks and into urban towers to make the final delivery, and ends where the customer takes receipt of the goods. The UFL's 2017 research[1] documented that of the 20 total minutes delivery drivers spent on average in the Seattle Municipal Tower, 12.2 of those minutes were spent going floor-to-floor in freight elevators and door-to-door to tenants on multiple floors. The UFL recognized that cutting those two steps from the delivery process could slash delivery time in the Tower by more than half—which translates into a substantial reduction in truck dwell time.

The research team designed and executed the Municipal Tower pilot test to:

1. Compare the total average parcel delivery time between traditional door-to-door deliveries, with delivery to a common-carrier locker system that is located as close as possible to truck load/unload spaces.

2. Track the total number of failed first delivery attempts to the common carrier locker system. The rate of failed first delivery attempts is as high as 15% in some cities; reducing it would significantly lower traffic congestion and emissions, as trucks could make up to 15% fewer trips while delivering the same number of packages.

3. Show how, in real-world conditions, common carrier locker systems could meet multiple partners' diverse goals and be incorporated into their business models. A common carrier locker system, by this pilot test's definition, is open to many retailers and delivery firms. To reduce the amount of complexity in this pilot, the number of potential carriers was intentionally scaled down to two: UPS and USPS, both UFL members.

The pilot test found that a delivery to the common carrier locker system reduced total delivery time in the Seattle Municipal Tower <u>by 78%</u> when compared to traditional floor-to-floor, door-to-door delivery in the building. This result shows what is possible. The pilot compares a single locker delivery of one package to eight door-to-door deliveries in the building. But this best case, real-world example powerfully demonstrates a proof of concept. Strip away what prior UFL research has identified as the time-consuming process of delivery drivers navigating multiple floors and addresses *inside* buildings, replace it with a one-stop dense delivery node, and time savings will accrue. Of course, myriad factors can slow the delivery process; consistent across-the-board 78% reductions in time would not be expected for all deliveries to common carrier smart lockers. But UFL researchers anticipate that well-sited lockers will afford substantial time savings when compared with door-to-door delivery in urban towers.

The pilot test also found that seven parcels failed to be delivered in traditional door-to-door delivery; **there were zero failed deliveries to the locker**.

In other words, this pilot demonstrates that parcel locker systems substantially reduced both delivery time and the number of failed deliveries in dense urban settings.

With the explosion of e-commerce, parcel lockers in the United States and the European Union are a growing phenomenon, as an exhaustive literature review documents in a 2018 UFL evaluation of Sound Transit train stations and Transit Oriented Development areas for common carrier locker systems.[2] That same report documents strong transit rider interest in using the lockers.

As part of the Municipal Tower pilot, researchers collected additional delivery data at the Tower over 10 days without the locker and over the 10 days with the locker in place to provide fuller understanding of the pilot context, including the total number of:

- Trucks that parked in the underground freight bays,
- Parcels delivered in the building,
- Failed first delivery attempts in the building.

These research findings will help Seattle and other cities seeking new load/unload management concepts and technologies to meet growing demand for a secure and convenient urban goods delivery system. Thanks to the e-commerce boom, delivery trucks are flooding cities like Seattle at the same time those cities' populations are soaring. The City of Seattle grew by almost 20,000 people from 2016 – 2017[3] and U.S. e-commerce sales growth has averaged more than 15% year-over-year since 2010.[4] Retailers need a more efficient, reliable, and cost-effective way to deliver goods in increasingly congested urban environments. Cities like Seattle, for their part, want to minimize gridlock, both to sustain quality of life for residents and to ensure the smooth flow of goods and services. Common carrier parcel lockers are an evidence-based strategy for streamlining the urban goods delivery system and addressing these challenges.

"By definition, common carrier lockers allow all retailers and carriers to use the same lockers. They are accessible to everyone and may be placed on public property without providing a special advantage to any one firm."

Barb Ivanov, Urban Freight Lab Director

Recommendations stemming from this Municipal Tower pilot test are designed to improve future tests in Seattle and other interested cities and to help cities wisely manage the transition from pilot test to full implementation. The UFL recommends further research into creating delivery density and is working with relevant agencies to plan and propose future pilot tests.

This short pilot test required extensive multi-sector collaboration from UFL members (including the two participating delivery companies, UPS and USPS), SDOT, Seattle Municipal Tower building management (CBRE), the parcel locker vendor (Parcel Pending), and building tenants. All parties had a hand in shaping the project and it is only due to the cross-sector collaboration that the pilot overcame obstacles such as project budget uncertainty (due to the novel approach) and the need to secure multiple entities' approval.

Based on lessons learned during the Municipal Tower pilot, the researchers recommend that future tests:

- Last 12 months or more to both capture data on seasonal usage patterns that can better inform implementation, and to recruit the maximum number of pilot participants. During the pilot, researchers invited up to 100 of the 5,000 workers in the building to participate, and 36 people quickly signed on. Although more expressed interest once the smart locker system was on site, it was too late to include them.

- Site lockers next to commercial load/unload spaces, which the Tower pilot could not do because the building's loading bay area was not constructed to conform to accessibility regulations under the Americans with Disabilities Act (ADA). Based on the project's findings, cities should consider reviewing existing building codes to provide ADA accessibility to parcel lockers placed close to private loading bays.

- Build in ample planning time and obtain executive sponsorship from all authorities; it took nearly a year to secure permission from various parties to conduct the Tower pilot.
- Consider the requirements of fully implementing common carrier locker systems when planning pilot tests in public locations so there will be room to expand if desired.
    - This pilot and UFL's market research for Seattle's transit agencies indicates that there will be significant demand for lockers when they are fully implemented in public spaces. Where will large banks of lockers go? The pilot test plan should consider how a later expansion could work on site.
    - Operational rules should be established up front to ensure productivity of the locker space, such as creating a 24-hour limit (or up to a maximum of three days) for packages to sit in the locker before they are considered a return, and picked up by delivery firms. The locker system's software allows users to set up special cases such as vacations where longer tem storage may be permitted.
    - Adding (a) additional carriers and (b) more advanced integration of multiple carriers' ITS platforms should be phased in gradually over a 12- to 24-month pilot test. As a proof of concept the research team kept the Tower pilot simple, limiting it to two carriers, and purposively not integrating the locker vendor's ITS with the carriers' upstream technology. Full implementation with multiple carriers would require much more coordination, time and attention to inform them of the operating rules, and integrate the parcel vendor's platform with some carriers' tracking technologies.
    - Future pilots should build in an adequate marketing budget to support a broader and longer marketing campaign to sign up a larger number of users.

COMMON CARRIER
LOCKER SYSTEM

COMMON CARRIER LOCKER SYSTEM

A parcel locker system is a self-service technology that has helped reshape the urban goods delivery system in both the U.S. and Europe. These systems allow customers to pick up their packages when it is convenient for them to do so, and provide secure deliveries. The number of lockers and the number of carriers involved in parcel lockers has grown since Amazon first piloted parcel lockers in the U.S. in 2011, in Seattle. To date, many lockers in the U.S. are company-branded lockers that are limited to either a single retailer, such as Amazon lockers, or a single carrier, such as UPS Access Point lockers. Branded lockers are often sited in privately-owned locations such as apartment buildings, convenience and grocery stores. In fact, the site for the UFL pilot test, the 62-floor Seattle Municipal Tower, contains an Amazon locker that the building manager reports is always in use.

In an extensive literature review,[5] the UFL research team found references to *common carrier* lockers in the U.S. only on private property. In July 2017, Amazon introduced Amazon Hub, a common carrier locker system for installation on private property, designed to exclusively serve occupants of residential or office buildings. Although Amazon's materials state that the "Hub" accepts packages not just from Amazon but from any sender, many competing retailers suspect that Amazon will have visibility into their proprietary data and will not use it.

The Municipal Tower pilot tested the use of common carrier lockers in a public space that all retailers and carriers may use without risking revealing their information to rivals. Building managers and public agencies are also interested in common carrier locker systems as they reduce the total footprint needed for lockers in a building or a transit station. They do this by providing one set of lockers for all retailers and all carriers to use, instead of placing many company-branded lockers in a much larger space.

In Seattle and other growing cities, a common carrier locker system can provide convenient access for both delivery workers and office building tenants. The locker system can eliminate the need for tenants to rush out of a meeting to intercept a delivery person at their office. By creating a delivery density node, delivery drivers can avoid wasted time in freight elevators and looking for the right office suite to deliver the parcel. As this pilot test's key findings show, a locker can reduce both the number of failed delivery attempts and truck dwell time.

While common carrier locker systems offer cities many potential benefits, little publicly accessible data exists on how to measure the performance and effectiveness of these locker operations. This pilot test in the Seattle Municipal Tower in the city's urban core helps fill the void. (See Figure 1 below.)

Figure 1. Common Carrier Locker Installed at Seattle Municipal Tower for Pilot Study

This project used a locker manufactured (and loaned at no cost for the research pilot's duration) by Parcel Pending, one of the leading third-party locker vendors in the U.S. The lockers are modular units designed to fit small, medium, large, and oversized parcels. Each of the three towers used in the pilot is approximately 3' wide 6'-7" height and 2' deep; the main controller tower labeled D13 below has the locker control screen. (See Appendix C for locker details.)

Figure 2. Parcel Pending Common Carrier Locker with Three Towers at Seattle Municipal Tower
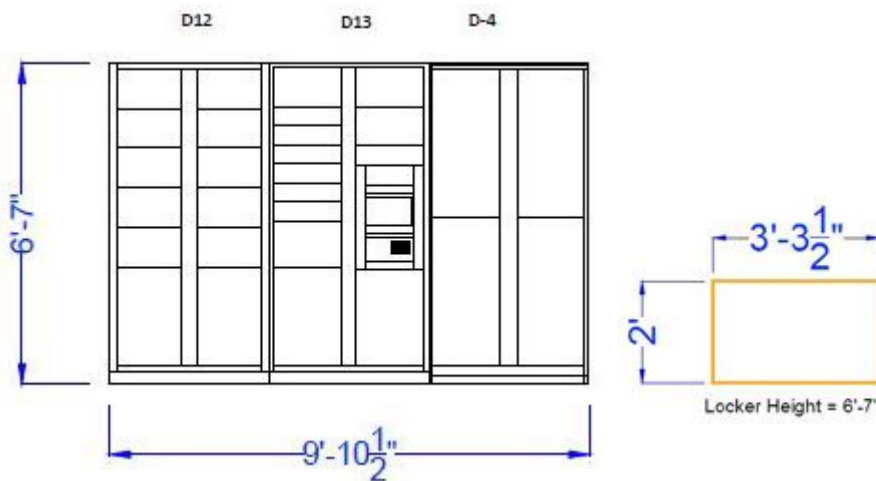
The site requirements for the locker to be installed was a height clearance of at least 6'-7", a standard 110 V electrical outlet, and an Ethernet outlet.

SEATTLE MUNICIPAL TOWER AND PILOT AT A GLANCE

The fourth-tallest building in the city, the Seattle Municipal Tower is in the south end of Seattle's downtown in the heart of the Central Business District. The 62-story Class A tower has nearly 5,000 tenants and is owned and occupied by the City of Seattle; the firm CBRE manages the building.

From Floors 3 to 6, the building has gift shops, restaurants, coffee shops, and security desks, with primarily offices filling upper floors. Various goods including parcels, office supplies, and furniture are delivered daily. The initially proposed locker site was next to the loading bay (on Floor 6) to facilitate deliveries, but the site was ruled out as it is not compliant with the Americans with Disabilities Act (ADA). Instead, the locker was installed on Floor 3 by the 5th Avenue building entrance, as shown in Figure 3. With the loading bay on Floor 6, drivers had to take elevators, stairs, or escalators to deliver to the locker.

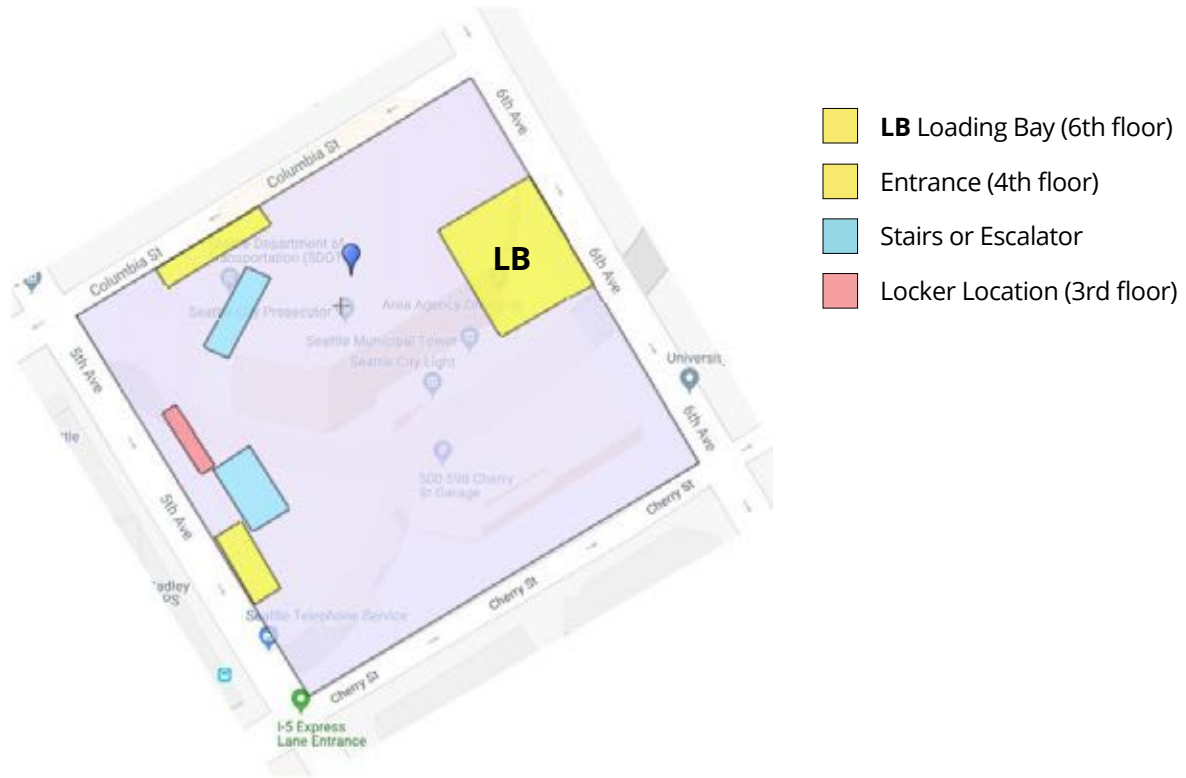**Figure 3.** Seattle Municipal Tower Locker and Loading Bay Layout

🟨	**LB** Loading Bay (6th floor)
🟨	Entrance (4th floor)
🟦	Stairs or Escalator
🟥	Locker Location (3rd floor)

Figure 4. Locker View from 5th Avenue to Seattle Municipal Tower
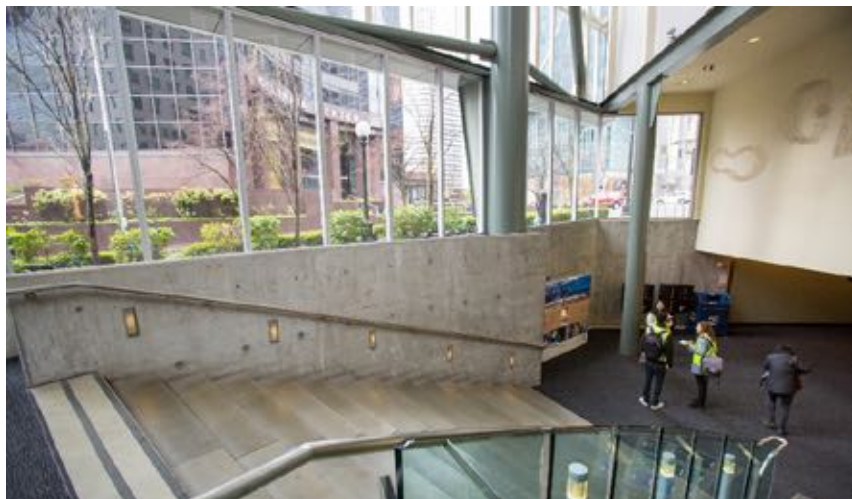
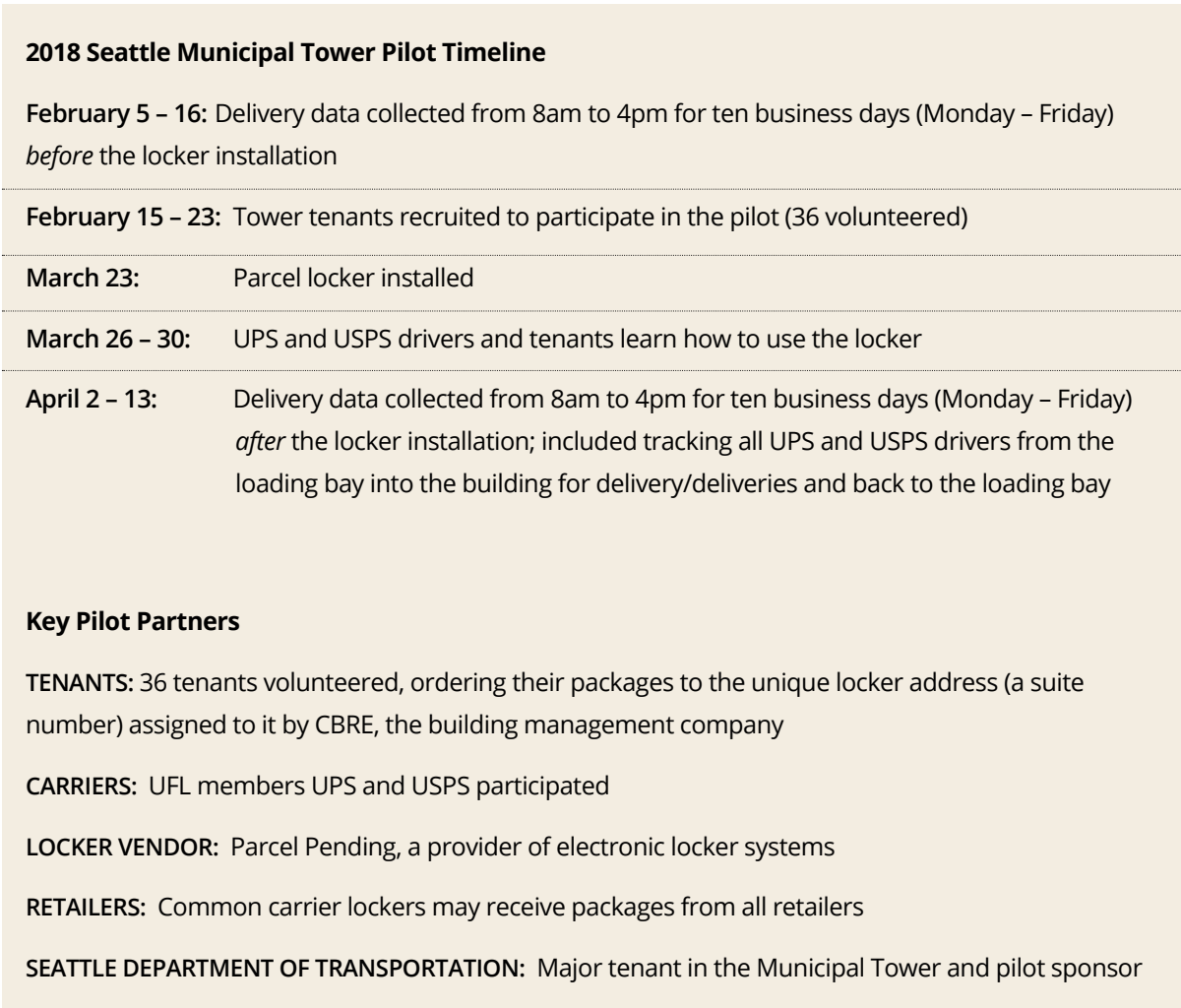**Figure 5.** Seattle Municipal Tower 2018 Pilot at a Glance

2018 Seattle Municipal Tower Pilot Timeline

February 5 – 16: Delivery data collected from 8am to 4pm for ten business days (Monday – Friday) *before* the locker installation

February 15 – 23: Tower tenants recruited to participate in the pilot (36 volunteered)

March 23: Parcel locker installed

March 26 – 30: UPS and USPS drivers and tenants learn how to use the locker

April 2 – 13: Delivery data collected from 8am to 4pm for ten business days (Monday – Friday) *after* the locker installation; included tracking all UPS and USPS drivers from the loading bay into the building for delivery/deliveries and back to the loading bay

Key Pilot Partners

TENANTS: 36 tenants volunteered, ordering their packages to the unique locker address (a suite number) assigned to it by CBRE, the building management company

CARRIERS: UFL members UPS and USPS participated

LOCKER VENDOR: Parcel Pending, a provider of electronic locker systems

RETAILERS: Common carrier lockers may receive packages from all retailers

SEATTLE DEPARTMENT OF TRANSPORTATION: Major tenant in the Municipal Tower and pilot sponsor

KEY FINDINGS: DELIVERY TIME AND FAILED FIRST DELIVERY

The 2018 common carrier locker pilot at the Seattle Municipal Tower found that the locker both reduced total delivery time by 78% when compared to traditional door-to-door delivery and reduced to zero the number of failed first parcel deliveries.

In UFL research conducted in 2017, the researchers collected and analyzed data to better understand delivery activities *after* the driver leaves the truck, tracking drivers' paths vertically through five different types of buildings in downtown Seattle, including the Seattle Municipal Tower. That research found that adding a mini-delivery-node (such as a common carrier locker system, concierge or mailroom drop point) as close as possible to trucks' load/unload spaces would significantly reduce the average total delivery time. In the Municipal Tower specifically, researchers documented that a common carrier locker system located close to the freight bays could cut up to 61% of the average total delivery time, as shown in Figure 7.

Figure 7. 2017 Analysis of Floor-to-Floor, Door-to-Door Delivery in Seattle Municipal Tower Documents Parcel Locker Potential to Reduce Total Delivery Time by Up to 61%
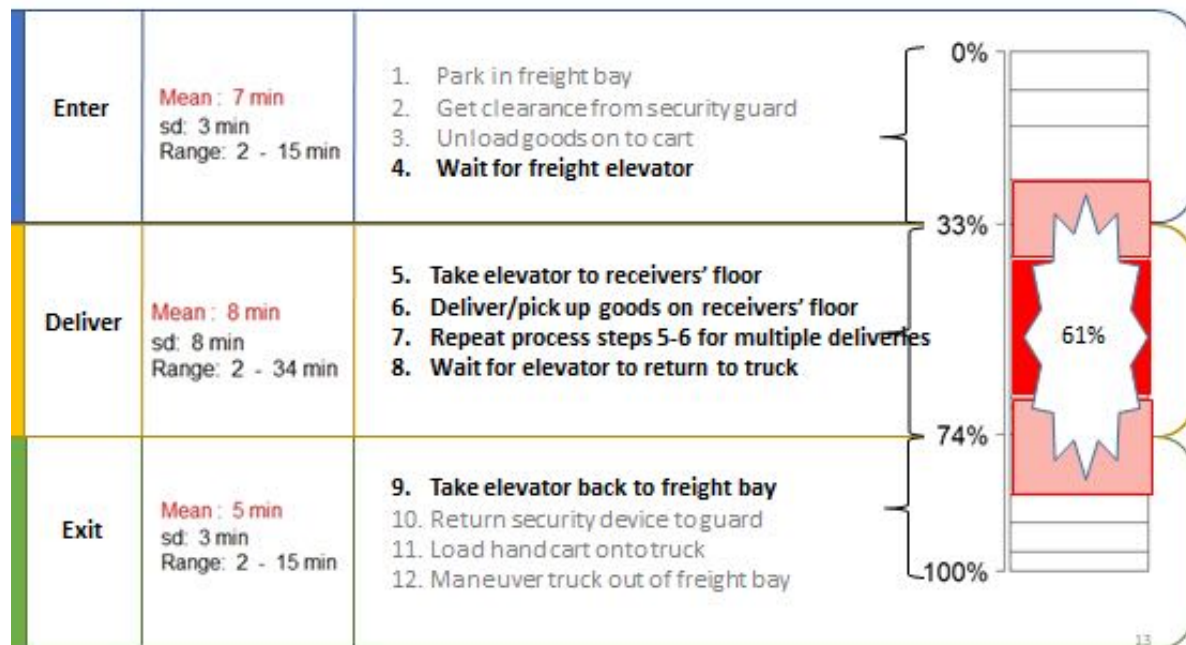
This finding led to the spring 2018 common carrier locker pilot study at the Municipal Tower, designed as a real-world test of the promising strategy developed in the 2017 analysis. Researchers had a narrow window to recruit pilot test participants among the Municipal Tower tenants and successfully recruited 36 tenants to use the locker for parcels delivered to them at the Tower. Over ten business days between April 2-13, data collectors used a UFL-designed mobile app to track UPS and USPS drivers from the loading bay into the Tower and back to the loading bay after their deliveries. (See Appendix A for data-collection details.) During that time, UPS drivers made eight floor-to-floor, door-to-door deliveries and two locker deliveries from the loading bay. One of the two locker deliveries in the pilot was eliminated for analysis because it did not offer an accurate measure of locker delivery alone: after delivering to the locker, the driver went door-to-door for packages not addressed to the locker. In addition, the driver spent time to learn how the locker works by scanning multiple packages, including those not addressed to the locker.

As shown in Figure 8 below, the average time it took the UPS driver to make door-to-door deliveries in the Municipal Tower was 27 minutes, with a range of between 15 minutes and 34 minutes per trip (with a standard deviation of 6 minutes). The driver visited seven different floors on average. The door-to-door deliveries involved waiting and taking freight elevators, walking through the hallways, looking for the parcel receivers, and securing permission to enter the office spaces to finally deliver a parcel (or parcels) to the end customer(s).

Figure 8. On Average, Door-to-Door Delivery Took 27 Minutes in the 2018 Seattle Municipal Tower Pilot

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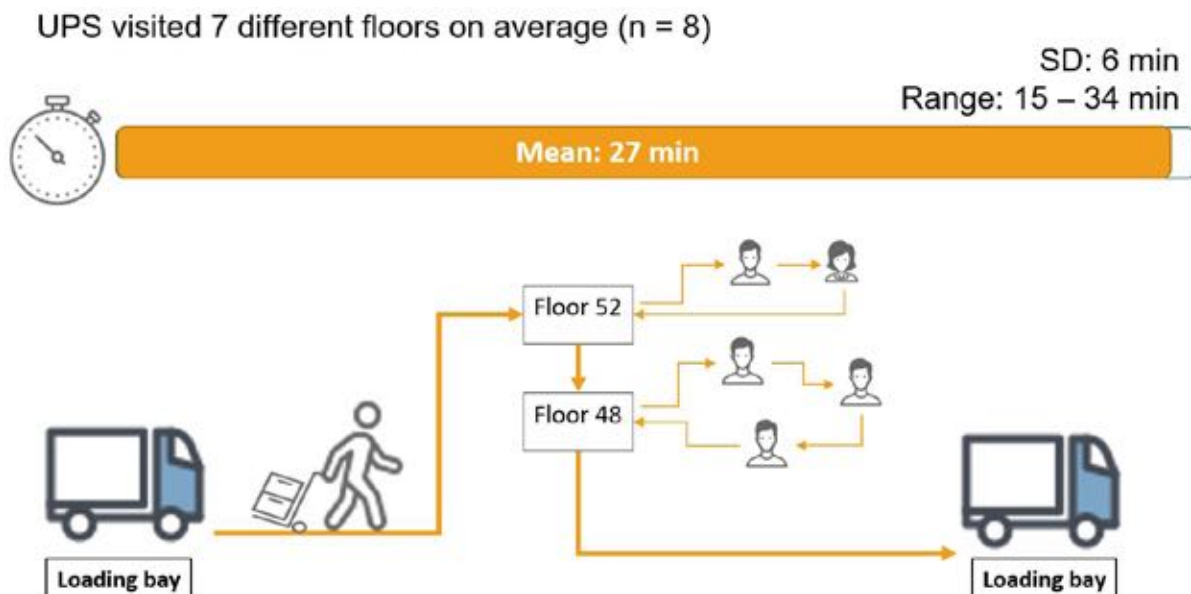
In contrast, the total time it took the UPS driver to make a round-trip delivery to the locker was 5.6 minutes, as shown in Figure 9. **This represents a 78% reduction in delivery time when compared with the conventional door-to-door delivery above.** Figure 9 below breaks down the time spent. It took 0.6 minutes (35 seconds) for the locker operation itself when the driver had just one parcel to deliver to the locker.

Figure 9. Delivery to the Locker Took 5.6 Minutes, 78% Less Time than Door-to-Door Delivery
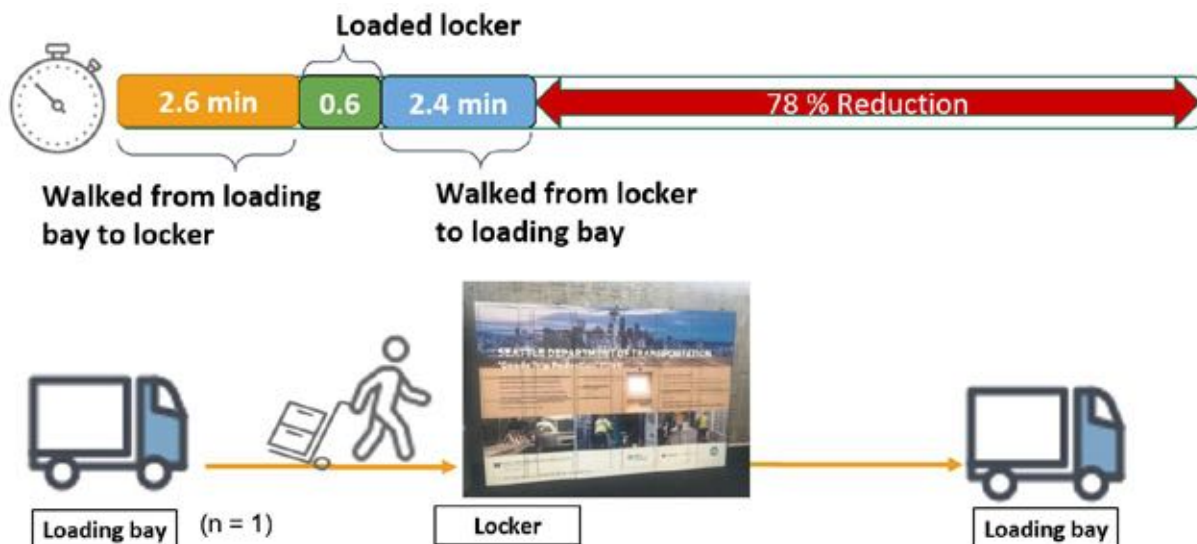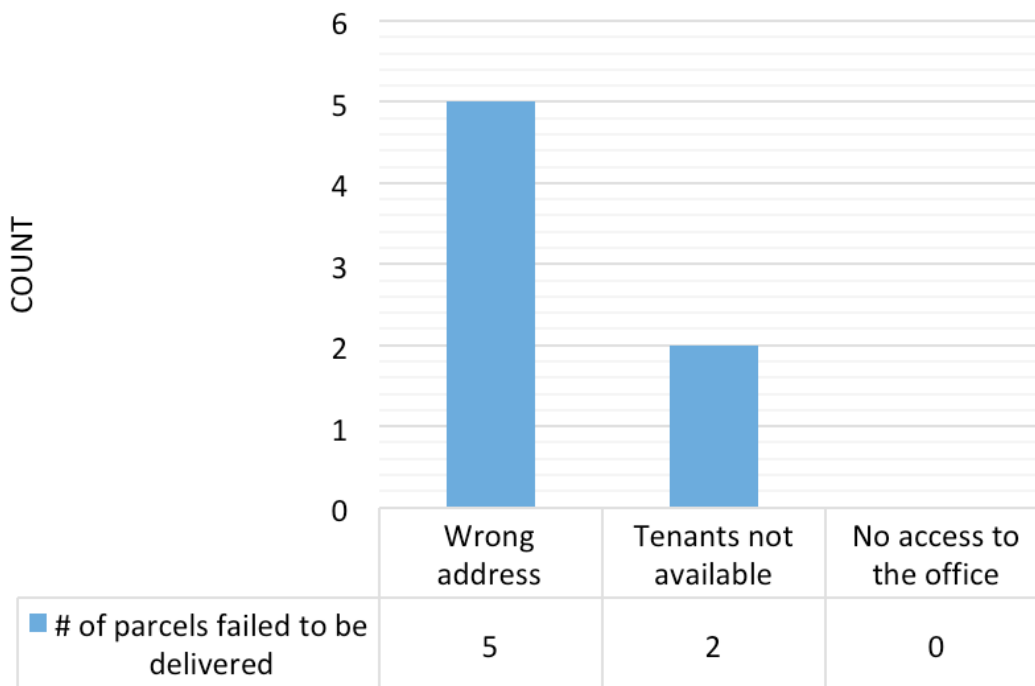

While the locker system did not require the driver to walk the Municipal Tower hallways or search for the parcel receivers, the driver did have to conduct other delivery operations, such as operating the common carrier locker and scanning parcels with the locker's built-in camera. In addition, drivers had several ways to travel from the loading bay to the locker. From the loading bay on Floor 6 drivers could either ride a freight elevator or walk up a ramp to get to the locker on Floor 3. Once on Floor 3, regardless of whether drivers rode the elevator or walked up a ramp to get there from the loading bay, they would still have to either ride an escalator or elevator to reach the locker due to the mezzanine-like Floor 3 layout and the locker's specific location there.

This dramatic reduction in delivery time is based on a best-case scenario, when the driver had a single package to deliver and then returned directly to the loading bay after making the delivery. This demonstrates that a locker system has the potential to substantially slash delivery time. While delivery time will increase if multiple parcels are delivered to the locker, it will still be significantly shorter than going to door-to-door for deliveries.

In addition to the locker substantially reducing delivery time, the locker also cut the parcel failed first delivery rate to zero. Out of 545 total parcels delivered via the conventional door-to-door delivery method over the 20-day pilot period, data collectors observed seven parcels that failed to be delivered. As shown in Figure 10, the most frequent reason for failed delivery attempt was due to an incorrect address (the most common scenario observed was that the tenant for whom the parcel was intended was no longer working at the Tower), with the second-most-frequent reason being the tenant was unavailable to receive the parcel at the time of delivery. While a common carrier parcel locker cannot solve for an incorrect address, it can eliminate failed first delivery for reasons such as tenants being unavailable to receive the package or drivers not being able to locate the person authorized to sign for a parcel.

Figure 10. Reasons for Failed Parcel Delivery in Door-to-Door Delivery over the 20-Day Pilot Period

COUNT	Wrong address	Tenants not available	No access to the office
■ # of parcels failed to be delivered	5	2	0

Of the 423 vehicles parked at the Municipal Tower loading bay during the 20-day data collection, 17 percent (or 71 vehicles) were delivering or picking up parcels, as shown in Figure 11. Most of the 423 vehicles, 82% (or 347 vehicles), entered the loading bay for reasons other than delivering or picking up parcels, such as for delivering furniture or providing repair services for printers or vending machines.
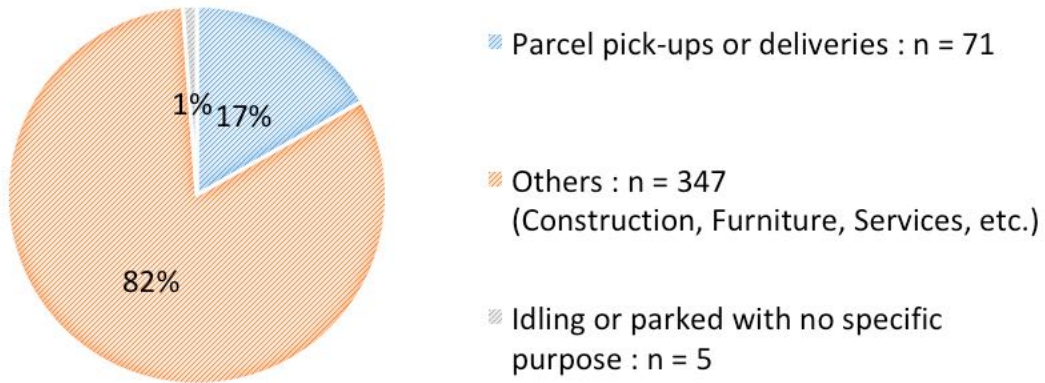
Of course, not all items can be delivered to a locker: Oversized goods still need to go to the tenant's door, as shown in Figure 12.

Figure 12. Oversized Goods Delivered to Seattle Municipal Tower

That said, locker configuration and the number of units could potentially be tailored to the demand and specific needs of a building. At the Seattle Municipal Tower, of the 545 parcels delivered door-to-door over the 20-day data collection, 60% were large-size parcels, as shown in Figure 13. The Tower had locker compartments capable of accommodating parcels up to 39.5" x 19" x 24." (In other words, some of the large-size parcels could have fit in the locker.) The research team used UPS sample parcel packaging dimensions for tracking parcel size, as reflected in Figure 13 below.

Figure 13. Size Distribution of Parcels Delivered to the Seattle Municipal Tower over 20-Day Data Collection

	Small (13" x 11" x 2")	Large (16.5" x 13.25" x 10.75")	Oversized
# of Parcels	166	327	52
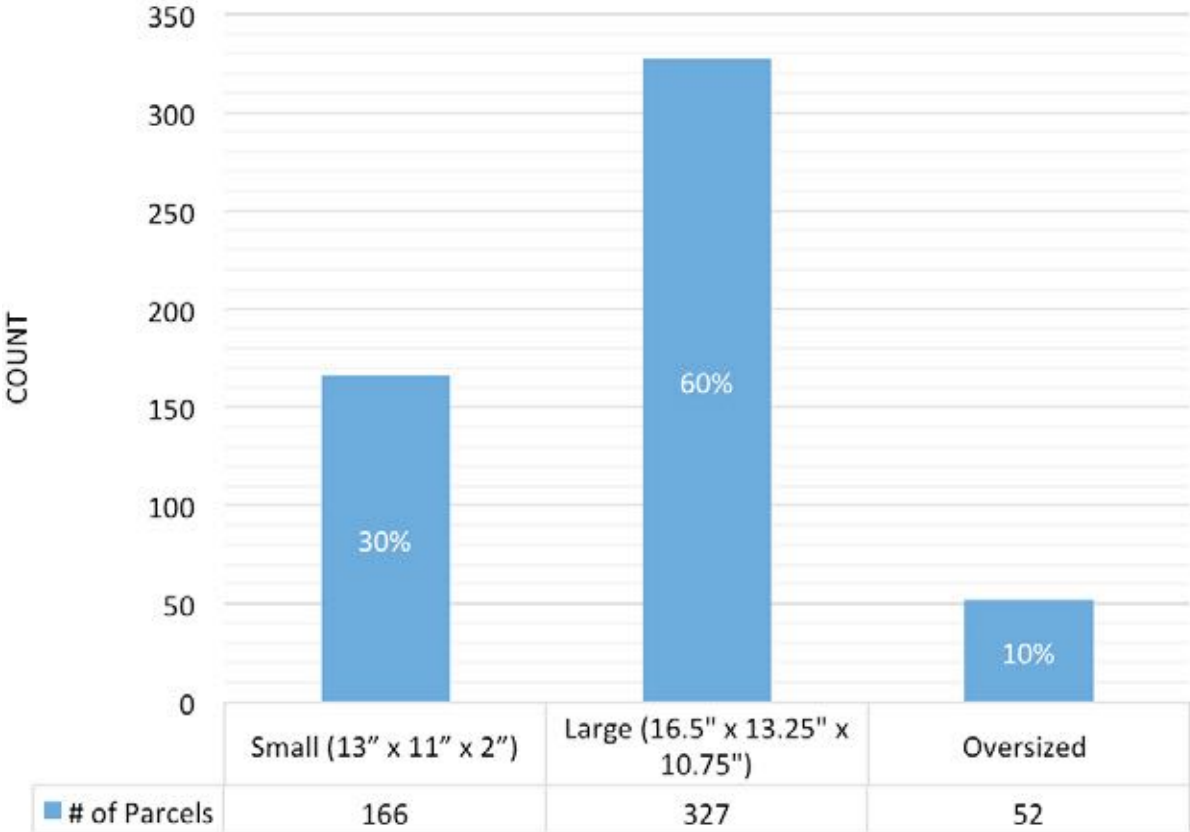
Other factors beyond the specifications of any locker system itself may significantly impact delivery efficiency, such as parking availability and operation conditions at the loading bay. As shown in Figure 11, 1% of vehicles (5 of 423 vehicles) occupied the Tower loading bay for no specific purpose that was obvious to the data collectors. In some cases, the driver was engaged in a conversation with the people at the building and left after the conversation. Data collectors observed one vehicle leave the loading bay area after lingering for 5 minutes when it was clear no parking was available. The vehicle returned to the loading bay a few hours later.

ADDITIONAL FINDINGS: HOW THE COMMON CARRIER LOCKER SYSTEM SUPPORTED PARTNERS' NEEDS

The Seattle Municipal Tower pilot enabled the research team to conduct an empirical test in real-world conditions to see how common carrier locker systems in large office towers could meet multiple partners' diverse goals and be incorporated into their business models.

Key Partners in the Seattle Municipal Tower Pilot

TENANTS: 36 tenants volunteered

BUILDING MANAGEMENT: Management firm CBRE

CARRIERS: UFL members UPS and USPS participated

LOCKER VENDOR: California-based Parcel Pending, a leading provider of smart parcel lockers

RETAILERS: Common carrier lockers allow packages from all retailers

SEATTLE DEPARTMENT OF TRANSPORTATION: Pilot sponsor

Tenant needs: The locker provided additional security and convenience for tenants.

Key learning: Putting a highly-visible design wrap on the locker explaining the purpose and 'how to participate' in the pilot was an effective tool to market the locker to tenants/potential users. Larger future pilots must include more advance marketing and an adequate marketing budget to sign up more users. The research team had to rely on no-cost opportunities to publicize the Tower pilot to tenants, including three push emails from the building manager followed up by three push emails from key SDOT managers to their colleagues.

Building management needs: The locker allowed building management to offer a valuable amenity to tenants at a small cost.

Key learning: Lockers carry a cost, but with careful planning around locker siting (e.g. finding a site inside a building that does not require construction, etc.), it is possible to keep capital expenditure costs low. To accommodate the locker system for the pilot, CBRE assigned a temporary suite # to the locker, provided use of an existing electrical outlet, and moved two plants. Through the pilot, the firm learned that buildings can lease lockers (rather than buy them outright) to spread out capital expenditure cost. A common carrier locker system requires a smaller footprint than having multiple single-carrier or branded lockers. For this pilot, the UFL paid for the marketing design wrap on the locker, round-trip locker shipping between the California factory and Seattle, and locker installation at the Tower.

Carrier needs: A locker system must be fast, reliable, and easy for drivers to use.

Key learning: In a crowded new marketplace, the choice of locker vendor matters. UFL extensively researched the capabilities of more than 15 vendors, interviewed five that appeared to meet project requirements, and interviewed references of the finalist, California-based Parcel Pending, before selecting them. UFL selected Parcel Pending based on the level of customer service as reported by references; the firm's understanding of current and future locker markets and willingness to share that information with the research team; and the firm's readiness to support the Seattle Municipal Tower pilot test that explored the U.S. office-building market. (To date, most lockers in U.S. towers are predominantly located in residential settings.) In addition to providing their lockers and technology at no charge for the pilot, Parcel Pending communicated with the participating pilot delivery firms and had staff on-site to direct carriers through use of the locker for the initial stage of the pilot.

In consultation with USPS and UPS, the research team elected to keep the pilot technology simple and not integrate the locker technology into the carriers' ITS platforms. The simpler system allowed drivers to learn if there was space in the locker when they arrived at the locker and entered their company code. In the future, pilots could take advantage of integrated ITS between the locker vendor and the delivery entities to inform drivers of available locker space before they load their truck that morning, leading to better planning for their day's route.

All of this added to researchers' knowledge base to improve the likelihood of success when offering common carrier smart locker systems in larger, longer-lasting pilots in the future.

CONCLUSION AND RECOMMENDATIONS

For ten days in spring 2018 a common carrier parcel locker was installed in the 62-floor Seattle Municipal Tower as part of a 20-day pilot test designed to measure in real-world conditions if the locker could reduce both delivery time and failed first delivery attempts, as well as meet multiple partners' diverse goals.

This pilot's findings demonstrate that lockers are a promising strategy on all these fronts.

A delivery to the common carrier locker reduced total delivery time in the Seattle Municipal Tower by 78% when compared to traditional floor-to-floor, door-to-door delivery in the building. This result shows what is possible.

Seven parcels failed to be delivered in traditional door-to-door delivery, while there were zero failed deliveries to the locker.

For participating Seattle Municipal Tower tenants, the locker provided additional security and convenience. For building management, the locker allowed them to offer a valuable amenity to tenants at a small cost. (To accommodate the locker, CBRE only had to move two plants, offer use of an existing electrical outlet, and assign the locker a temporary suite number). For delivery drivers, the locker proved fast, reliable, and easy to use, thanks to the use of a highly rated locker vendor.

In short, this pilot shows that lockers can dramatically reduce delivery times and failed first delivery rates. Challenges, such as juggling the diverse needs of multiple stakeholders, can be overcome. And customer interest in using the locker is clear. Common carrier parcel lockers are a promising solution to various urban freight challenges.

All these learnings added to researchers' knowledge base to improve the likelihood of success when offering common carrier smart locker systems in larger, longer-lasting pilots in the future.

Recommendations stemming from this Municipal Tower pilot test are designed to improve future tests in Seattle and other interested cities and to help cities wisely manage the transition from pilot test to full implementation. The UFL recommends further research into creating delivery density and is working with relevant agencies to propose future pilot tests. Based on learnings from this short-term Municipal Tower pilot, the researchers recommend that future pilot tests:

- Last 12 months or more to both capture data on seasonal usage patterns that can better inform any implementation and to recruit the maximum number of pilot participants; 36 people in the Tower participated in the pilot, but more expressed interest once the smart locker system was on site and it was too late to include them.
- Site lockers next to loading bays, which the Tower pilot could not do because the building's loading bay area was not constructed to conform to accessibility regulations under the Americans with Disabilities Act (ADA).
- Build in ample planning time; it took nearly a year to secure permission from the various parties to conduct the Tower pilot.

- Consider full implementation when shaping any pilot test.
  - Pilots should be run in locations where they can grow to full implementation.
  - Key operational rules should be established up front to ensure productivity, such as creating a 24-hour limit (or a maximum of three days) for packages to sit in the locker before they are returned to retailers/senders.
  - Additional carriers should be phased in gradually; due to its short-term nature, the small Tower pilot included just two carriers and did not utilize the smart technology that enables carriers to have full visibility into a locker system's available space. Full implementation across myriad carriers requires more coordination and more time and attention to all parties' technology capacity.
  - Future pilots need to build in an adequate marketing budget to support more advance marketing and sign up a larger number of users.

ACKNOWLEDGEMENTS

2018 Seattle Municipal Tower Pilot Timeline

February 5 – 16: Delivery data collected for ten business days (Monday – Friday) *before* the locker installation

February 15 – 23: Tower tenants recruited to participate in the pilot (36 volunteers signed on)

March 23: Parcel locker installed

March 26 – 30: UPS and USPS drivers and tenants learn how to use the locker

April 2 – 13: Delivery data collected for ten business days (Monday – Friday) *after* the locker installation; included tracking all UPS and USPS drivers from the loading bay into the building for delivery/deliveries and back to the loading bay

Data was collected over a total of 20 days, covering the period both before and after the locker installation at the Seattle Municipal Tower. Data collectors at the loading bay systematically tracked the number of trucks, total truck dwell time, truck parking location, the number and size distribution of parcels delivered, the number of packages picked up at the Tower, and the number of failed deliveries. After the locker was installed, data was collected to compare delivery time between floor-to-floor, door-to-door delivery and delivery to the locker.

The research team developed a thorough data-collection process that included:

• Developing two mobile applications in iPhone Operating System (IOS) as a data-collection tool

• Recruiting and scheduling 11 data collectors to cover the 8 am to 4 pm shifts at the Seattle Municipal Tower during the pilot test

• Training data collectors with both theoretical and in-field sessions

• Managing data-collection tools (e.g. clipboards, iPads, safety vests)

• Performing quality control on collected data (data cleaning)

For the entire 20-day pilot, two data collectors were stationed at the loading bay from 8 am to 4 pm, as shown below.
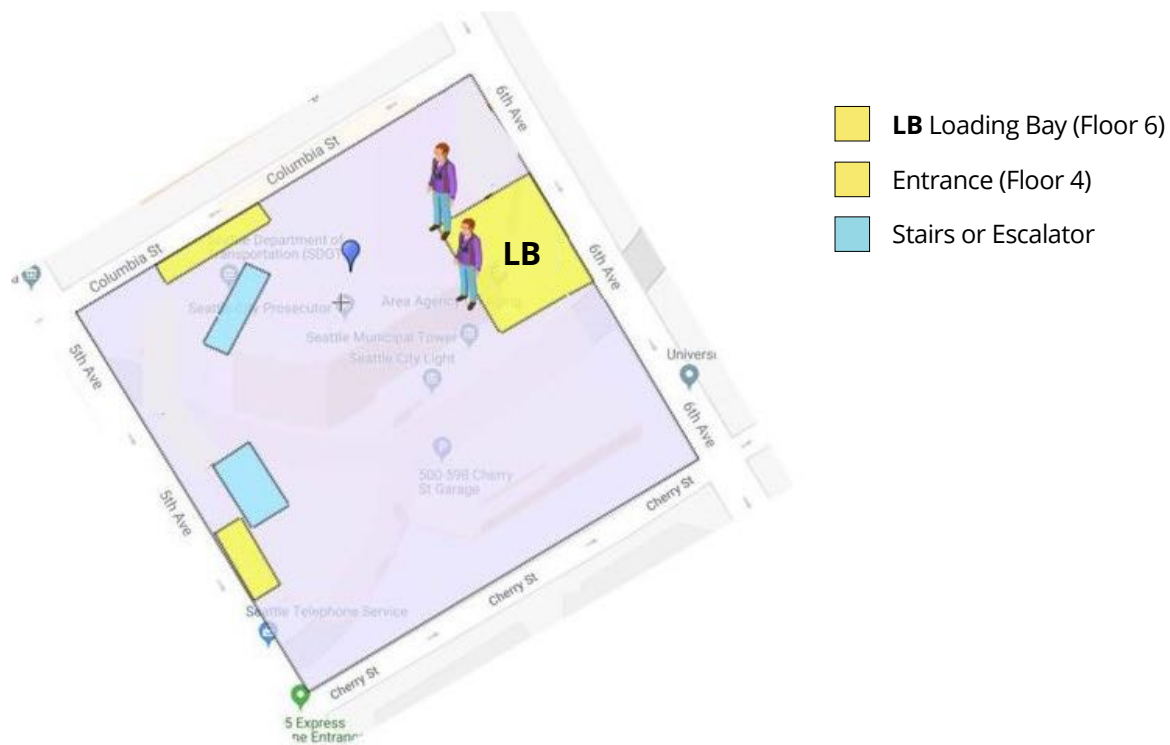
Using UFL-Designed Mobile App to Record Truck and Parcel Data at Loading Bay

The research team created a unique mobile application for data collection, as shown in Figure 15. Data collectors were trained to use the app on iPads in the field to collect data on the:

• Time the truck entered the loading bay ('Parked' button)

Time the truck finished parking ('Engine off' button)

Time the truck turned off the engine ('Engine on' button)

Time the truck moved away from the loading bay parking area ('Leave' button)

Truck's parked location

Number of packages that entered the building

Number of packages picked up from the building

Number of failed deliveries

**Figure 15.** Mobile App User Interface for Recording Truck and Parcel Data at Tower Loading Bay

Tapping the 'Parked', 'Engine off', 'Engine on', 'Leave' buttons records the time in hours, minutes and seconds. Buttons L1-L7 correspond to each of the seven parking areas inside the loading bay as shown in Figure 16.

Figure 16. Each Loading Bay Parking Number Matches L1-L7 Buttons on the App to Record Parking Location
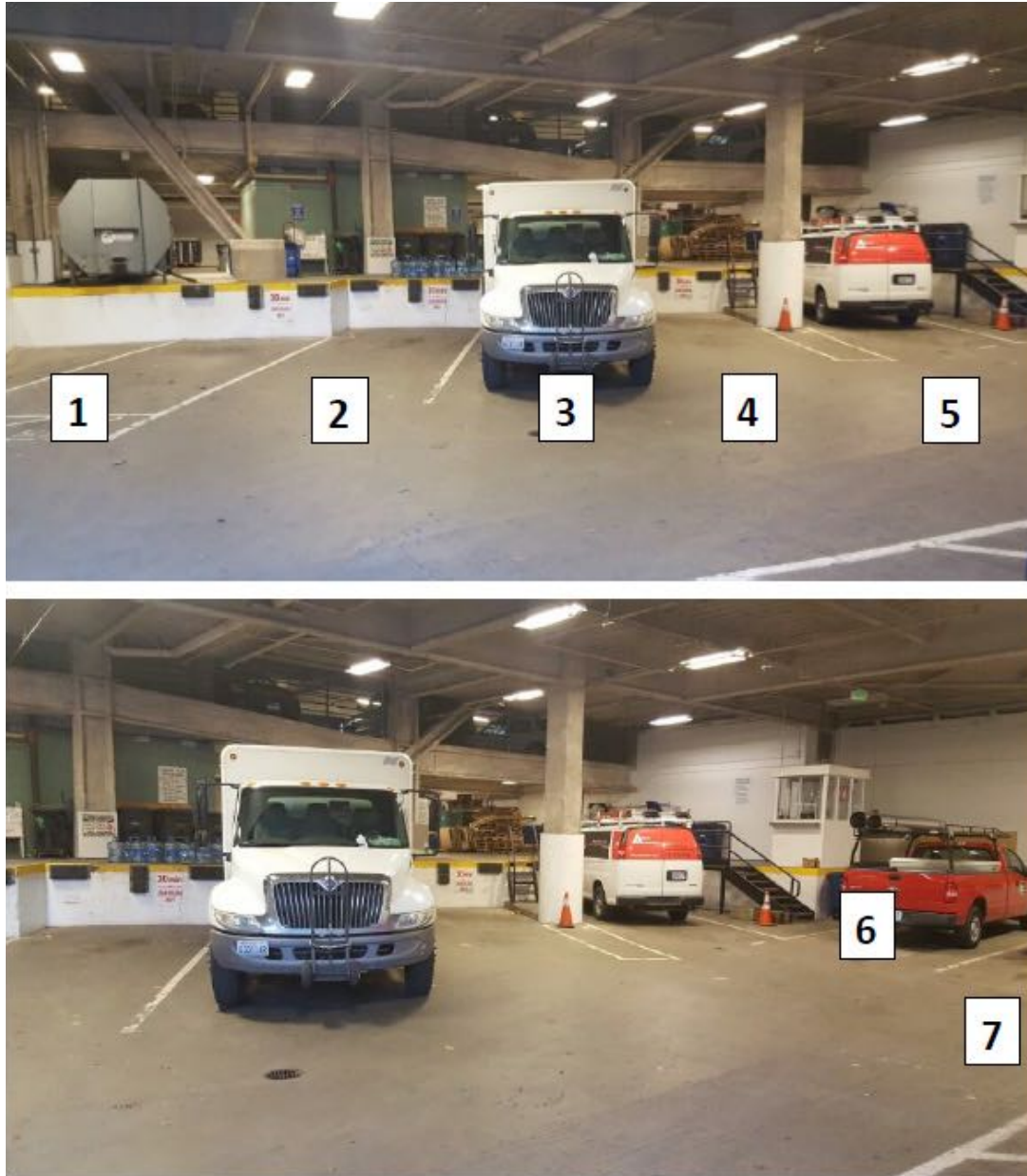
Data collectors at the loading bay counted the numbers of packages entering the building when drivers unloaded and moved their packages to the freight elevators; the app includes a simple counter and a place to record package size as small, large, or oversized based on UPS size guidelines.6   On a paper form (see Appendix B), data collectors also recorded vehicle type, delivery company name, and whether a hand truck was used.

To track and record the number of failed first deliveries, data collectors approached any UPS or USPS driver returning to the loading bay with parcels after making their deliveries in the building. The questionnaire below was used to accurately distinguish a failed delivery from a parcel pick-up in the Tower.

Figure 17. To Record Failed First Delivery, Data Collectors Surveyed UPS/USPS Drivers Returning with Packages
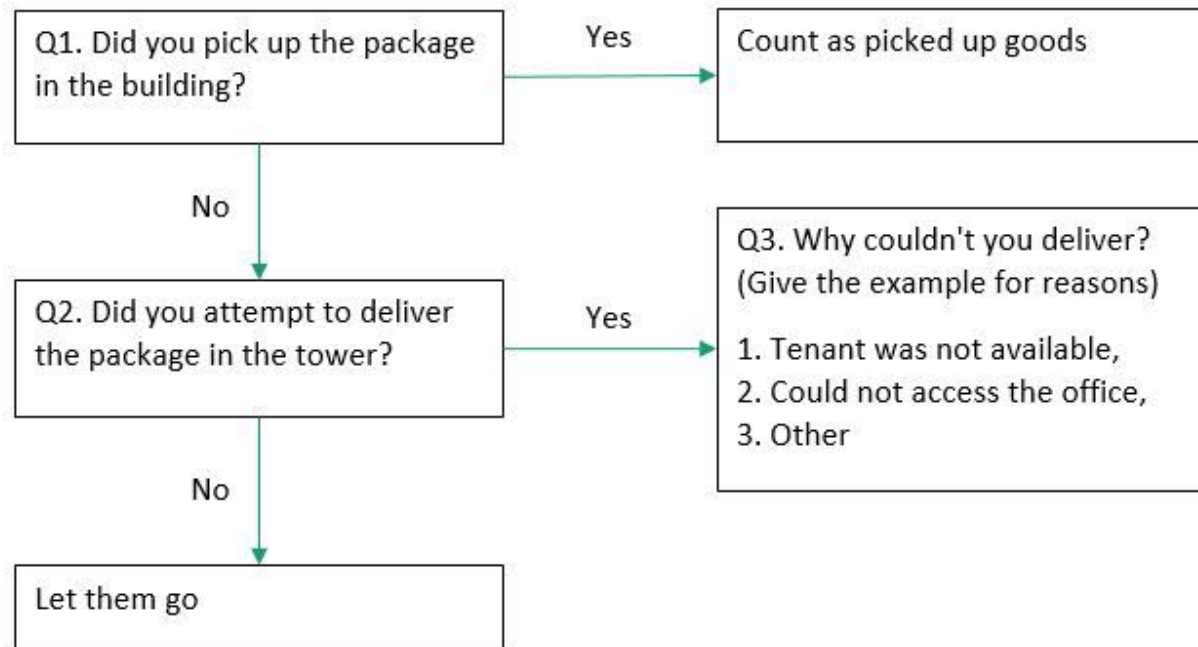
After the locker was installed, two more data collectors (for a total of four) joined the team at the Tower. This enabled the team to record (and, ultimately, compare) the time needed to make for door-to-door deliveries versus locker delivery. Three data collectors were at the loading bay; one was at the locker, as shown in Figure 18. Two data collectors at the loading bay continued collecting the same data as before the locker was installed. One data collector at the loading bay was assigned to follow UPS/USPS drivers throughout the building to observe and record delivery details. To track the process inside the Tower for any UPS/USPS drivers delivering parcels using an entrance other than the loading bay (including any locker use), one data collector was posted at the locker near alternate building entrances.
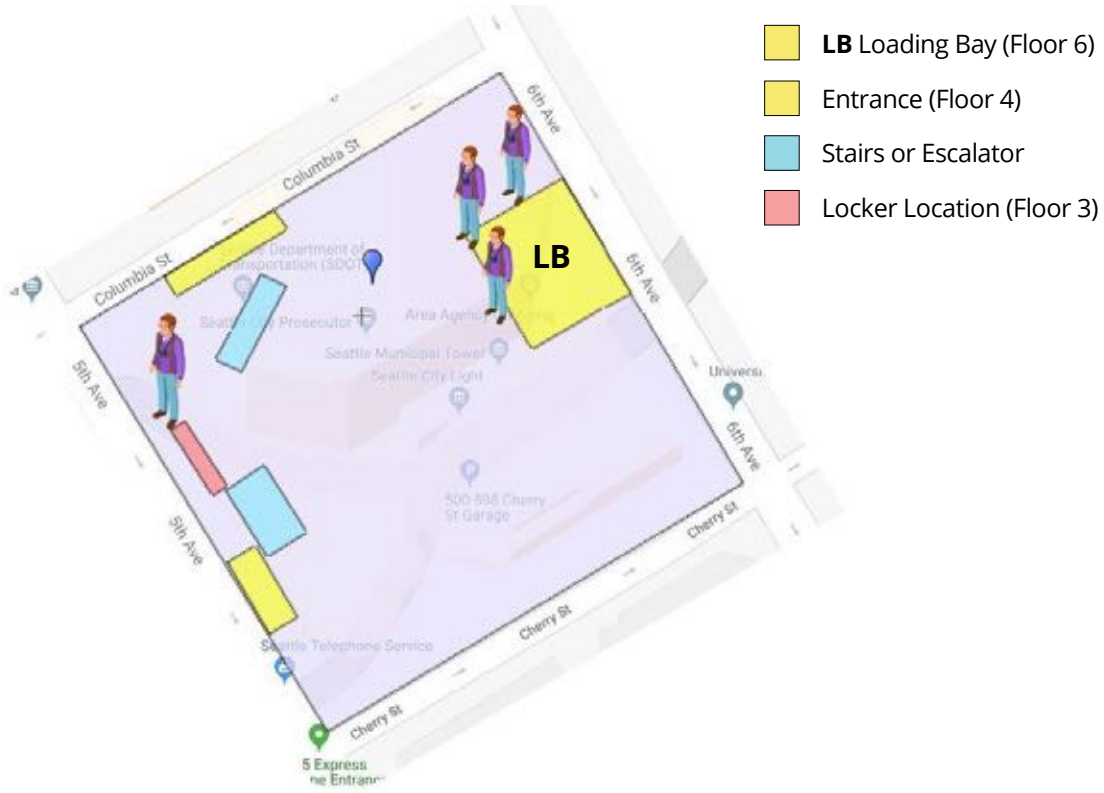
Using a Second UFL-Designed Mobile App to Track Time of the Full Delivery Process: From Loading Bay to Inside the Tower and Back to the Loading Bay

As shown in Figure 19, the UFL research team created an additional mobile app to accurately record complex delivery activities as data collectors followed all UPS/USPS drivers from the loading bay, through all their delivery activities inside the Tower, and back to the loading bay. This enabled data collectors to track both total delivery time and time for discrete activities involved in the delivery process for both door-to-door delivery and locker delivery.
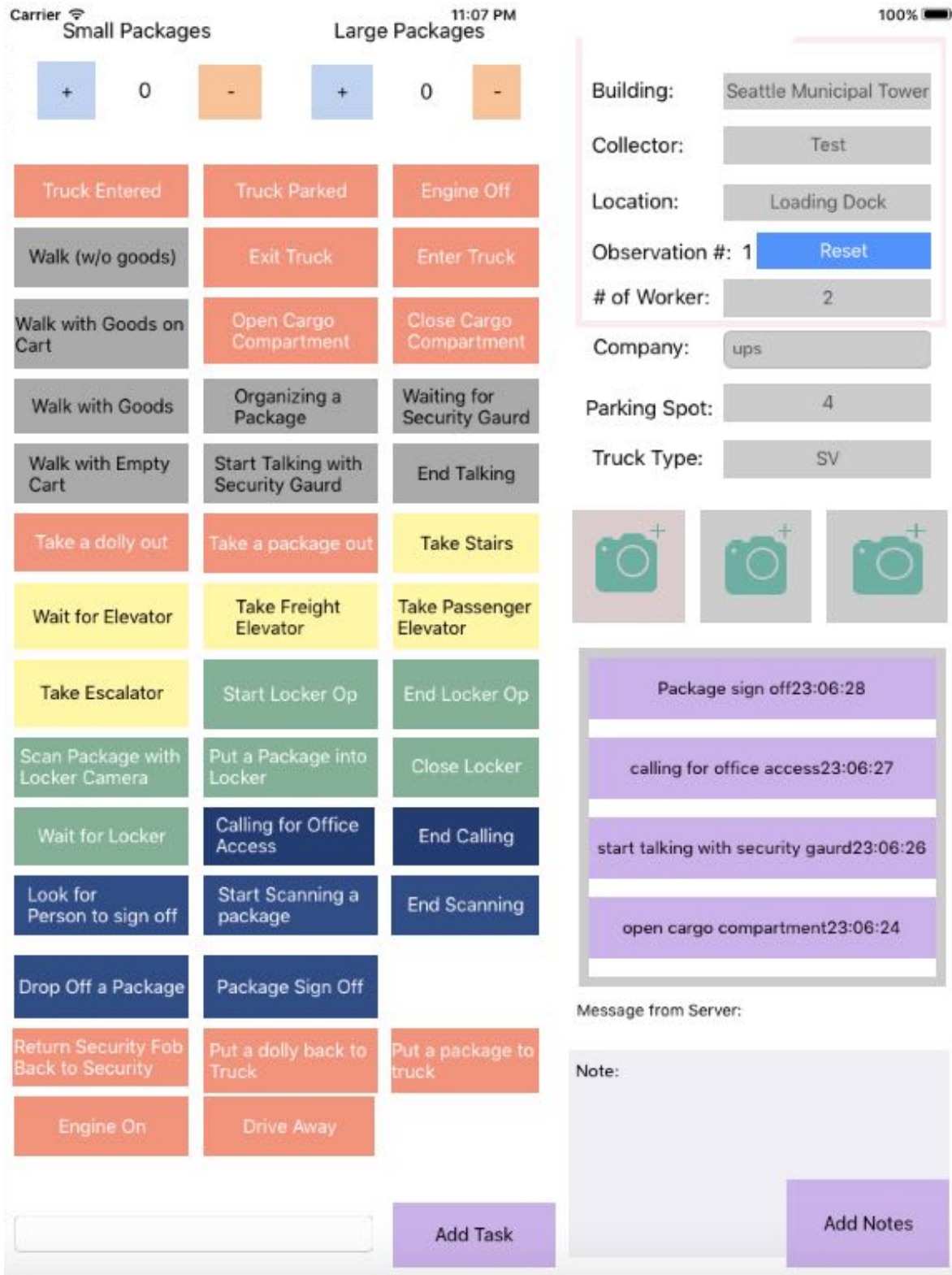
Data collectors used the app to capture timestamps of each task or step an individual driver performed to make a delivery. Task buttons on the left are color-coded based on the activity:

- Red: Activities at the loading bay (e.g. park, open/close cargo compartments)

- Gray: Common activities throughout the delivery process

- Yellow: Travel mode (e.g. wait/take an elevator, take stairs)

- Blue: Delivering goods (e.g. operate locker, receiver signs for goods)

When the data collector taps the task button, the app immediately records the time and calculates each task's duration. If the driver performed a task not listed in the identified task buttons, the app enabled data collectors to add the task via the "add task" button. Data collectors recorded failed first delivery attempts in the "add notes" section.

To ensure accurate data collection, the app automatically saves all entered information to the project's web-based database in real time. If there is no, or low, Wi-Fi connectivity, the information can be stored offline on the mobile device; this can then be uploaded to the database when Internet connection is restored.

Figure 20. Three Data Collectors at the Loading Bay after Parcel Locker Was Installed

Figure 21. One Data Collector at the Parcel Locker

Figure 22. Using the UFL-Created App on iPad to Track Complex Delivery Process

Q1. Hello, I am _____, a UW student conducting urban freight research.
Q2. Did you pick up the package in the building? (Yes -> Write 'P', No -> Ask Q3)
Q3. Did you attempt to delivery the package in the tower?

Yes -> Q4b: Why couldn't you deliver? (Give the example for reasons)   - >
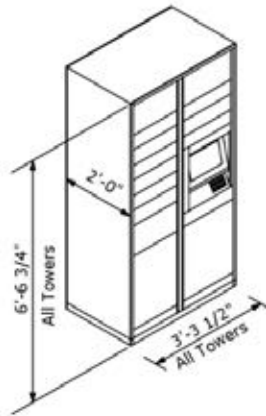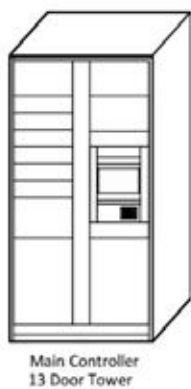
No -> Let them go

Reasons:
1. Tenant was not available,
2. Could not access the office,
3. Other

Num	Data_Collector	Day	Work_Start_Time	Truck_Enter_Time	Parked_Time	Engine_Off_Time	Parked_Location	Vehicle_Type	Company_Name	HandTruck (Y/N)	Num_Small_Package	Num_Large_Package	Num_Oversized_Package	Num_Delivery_Workers	Num_Package_Back	Pickup_or_Failed	Reason for Failed	Engine_On_Time	Truck_Leave_Time
				Truck In												Truck Out			
0	Haena	1/31/2018	7:45:00 AM	8:15:00 AM	8:15:45 AM	8:15:53 AM	1	CV	UPS	Y	3	1	0	2	1	F	0	8:40:15 AM	8:40:45 AM
1																			
Notes																			
2																			
Notes																			
3																			
Notes																			
4																			
Notes																			
5																			
Notes																			

PARCEL //// PENDING
THE PACKAGE MANAGEMENT SOLUTION

TOWER SPECIFICATION

2'-0"

6'-6 3/4" All Towers

3'-3 1/2" All Towers

Main Controller
13 Door Tower

STANDARD COLORS

OYSTER WHITE   BROWN GREY   STONE GREY

Outlet Information:

Power and Ethernet outlets flush mounted and located behind the D13 Kiosk tower indicated on the provided floor plan. The preferred height is 48" from the finished floor. There is some leeway if the outlet is already installed, although it should not be above the height of the tower.

Exception: If the wall is concrete and surface mounted outlets are necessary, the preferred height is above the D13 Kiosk tower not any lower than 79".

• Power outlet: Standard 110V electrical outlet
• Ethernet Outlet: Dedicated RJ45 Keystone Data Jack

Built-in Alcove System Clearances:

In order for a successful installation into alcove spaces, please add 1" clearance to finished height and depth and 2" to the finished width.

Additional Note:

The space between the wall and the back of the system will be between ½" to ¾" based on the electrical plug and site conditions (i.e. baseboard).

[1] Supply Chain Transportation & Logistics Center. *The Final 50 Feet Urban Goods Delivery System*. Seattle: University of Washington, 2018. https://depts.washington.edu/sctlctr/research/publications/final-50-feet-urban-goods-delivery-system-final-report

Kim, H.K, L.N. Boyle, and A. Goodchild, Delivery Process for an Office Building in the Seattle Central Business District, Transportation Research Board, 2018. https://depts.washington.edu/sctlctr/research/publications/delivery-process-office-building-seattle-central-business-district

[2] Supply Chain Transportation & Logistics Center. *Evaluation of Sound Transit Train Stations and Transit Oriented Development Areas for Common Carrier Locker Systems.* Seattle: University of Washington, 2018. https://depts.washington.edu/sctlctr/research/publications/evaluation-sound-transit-train-stations-and-transit-oriented-development-areas

[3] Census Bureau "Quick Facts Seattle City Washington" https://www.census.gov/quickfacts/fact/table/seattlecitywashington/EDU685216, accessed June 4, 2018.

[4] Supply Chain Transportation & Logistics Center. *The Final 50 Feet Urban Goods Delivery System.* Seattle: University of Washington, 2018. https://depts.washington.edu/sctlctr/research/publications/final-50-feet-urban-goods-delivery-system-final-report

[5] Supply Chain Transportation & Logistics Center. *Evaluation of Sound Transit Train Stations and Transit Oriented Development Areas for Common Carrier Locker Systems.* Seattle: University of Washington, 2018. https://depts.washington.edu/sctlctr/research/publications/evaluation-sound-transit-train-stations-and-transit-oriented-development-areas

[6] "Package Type Help." Packaging Type, UPS, 4 June. 2018, www.ups.com/us/en/shipping/create/package-type-help.page.

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