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Research paper

Mobility and the mall: Three solution pathways for efficient and sustainable omnichannel goods transportation for a mall in paris

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ABSTRACT

Urban shopping malls do not only depend on consumer mobility to operate and thrive, but goods mobility as well. With the emergence of omnichannel retail, stores are now multifunctional hubs accommodating collection, delivery, and return of online purchases. As a consequence, goods transportation requirements for stores have intensified. This impacts the malls in which they are localized as well. The scientific literature that covers goods mobility and malls is fairly limited. It has not yet explored the efficiency and sustainability of goods transportation to and from malls in the omnichannel era. To perform a state of practice and suggest improvements, we combine case study and exploratory research for the Beaugrenelle mall in Paris. The research demonstrates three operational issues. First, chaotic supply operations resulting in alternative practices that expose delivery workers to financial, security, and ergonomic risks. Second, patchy delivery practices that are not aligned with the regular supplies. Third, a lack of storage. In response, we explore three solution pathways: i.e., introducing dedicated staff, engaging third parties, and implementing intelligent technology. In doing so, we intend to provide elements for discussion for the mall operator, the retail tenants, their logistics service providers and the city moving forward.

1. Introduction to efficient and sustainable mobility and urban shopping malls

A shopping mall is a retail complex housed in a series of connected or adjacent buildings, or in a single large building, that contains a variety of stores and other establishments. Such establishments can include entertainment, restaurants, banks, and offices. Located within city centers, urban malls tend to be well-connected by public transportation (Erkip & Ozuduru, 2015). In addition, they often provide dedicated parking zones that impede cumbersome cruising or "circling around" for a place to park and allow electric vehicle charging (Kang et al., 2022). Therefore, urban malls can be considered environmentally-friendly alternatives to other ways of shopping, such as out-of-town malls and e-commerce. In confirmation, Banister (1997) points out that urban locations can reduce trip lengths as well as the proportion of trips made by car. At the same time, they facilitate public transportation to access these locations.

Not only their central and connected location enables urban malls to facilitate efficient and sustainable consumer mobility, their concentrated nature plays a critical part as well. A study conducted by consultancy firm EY provides evidence to this end (CNCC, 2021). They find that shopping in urban or suburban malls has a lower environmental impact than online shopping, when consumers purchase at least four items. The French National Council of Commercial Centers, who commissioned the study, highlights that even if consumers travel to the mall by car, they "make the most out of their trips". They do so by chaining it to other activities (i.e., 61.5% of consumers) and by making multiple purchases in one go (i.e., 6.3 on average). For out-of-town malls, the impact remains positive when consumers buy at least nine items and travel less than 20 km by car. Moreover, physical shopping generates significantly less cardboard and other packaging than shopping online (CNCC, 2021).

To operate, urban malls do not only depend on consumer mobility, but goods mobility too. Brettmo and Sanchez-Diaz (2021) consider freight intensity as a healthy indicator of the success of a mall. In theory, what enables urban malls to facilitate efficient and sustainable transportation for consumers, can have the same implications for goods. They can allocate dedicated zones in the building for all establishments' loading and unloading activities (Eidhammer et al., 2016), and consolidate deliveries for different establishments (Brettmo & Sanchez-Diaz,

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2021), among others. In practice, however, this potential does not necessarily materialize. Urban malls' central location is potentially at the root. After all, cities imply a competition for space among various land uses and transportation modes (Eidhammer et al., 2016). They have narrower streets to accommodate goods vehicles and costlier real estate that limits inventory space (Cheah et al., 2021). Cities also play a leading role in climate change regulations (Rosenzweig et al., 2010). Such regulations have profound implications for personal mobility, but are nothing less of disruptive for goods mobility. To illustrate, the C40 Cities (2020) network published support for the transition towards zero-emission goods transportation. The publication elaborates on the technological, operational, and infrastructural challenges for heavy and light goods vehicles and documents examples of financial incentives, charging infrastructure, and regulation, of cities around the world.

Only a few studies have tried to estimate and assess the freight intensity of urban malls. For the Nordstan mall in Gothenburg, Brettmo and Sanchez-Diaz (2021) estimate that 158 establishments generate approximately 300 freight trips per day. Their analysis shows that efficiency enhancements are possible, even for perishable goods. For sixteen malls in Singapore, Cheah et al. (2021) find that the small ones generate between 115 and 211 daily freight trip for 10 to 64 establishments, while the large ones generate between 258 and 548 daily freight trips for 202 to 529 establishments. Medium-sized malls, such as Nordstan, generate between 246 and 556 daily freight trips for 120 to 194 establishments. With an average of 2.3 freight trips per day per establishment for medium-sized malls, both studies highlight the importance of studying and improving goods mobility associated to urban malls.

Moreover, goods transportation requirements for stores have only intensified over the years. Despite what the above-referenced EY study suggests, few consumers today tend to commit to one way of shopping while abandoning the other. Consumers combine online and physical channels in their shopping activities and, as such, have become omnichannel (Rodríguez-Torrico et al., 2017). A lot of retailers are now omnichannel as well, strengthening their physical stores through online resources (e.g., inventory verification online) and upgrading their virtual store through physical capacities (e.g., delivery from store) (Buldeo Rai et al., 2019). In doing so, the role of the store expanded. It has gone from a commercial environment focused on sales transactions, to a multifunctional hub accommodating collection, delivery, and return of online purchases (Hagberg et al., 2017). The presence of omnichannel retailers thus complicates goods mobility associated to urban malls. It does so both for incoming flows for store supplies, as well as for outgoing flows for local deliveries.

The scientific literature that covers goods mobility and malls is fairly limited. As a consequence, research has not yet explored the efficiency and sustainability of goods transportation to and from malls in the omnichannel era. Brettmo and Sanchez-Diaz (2021), for example, consider incoming and outgoing goods flows as happening simultaneously and thus do not account for local deliveries of online purchases. Cheah et al. (2021) relate 84% of freight trips to incoming goods flows and the remainder to outgoing goods flows.

A better understanding of omnichannel goods mobility of urban malls is the objective of this study. In doing so, we aim to answer two research questions: how is omnichannel goods transportation operationalized in urban shopping malls and how can these operations be improved? To perform a state of practice, we carry out case study research using surveys, observations, and expert interviews of a mall in Paris, called Beaugrenelle. To improve the state of practice, we conduct exploratory research using document analyses and expert interviews. Specifically, we explore three solution pathways: i.e., introducing dedicated staff, engaging third parties, and implementing technology. We review existing research on goods mobility and urban malls in the second section, explain our methodology in the third section and elaborate on findings in the fourth section. The fifth section shares concluding remarks.

2. Literature on freight trips, parking demand, and worker activities in urban shopping malls

In an article titled "the magic of the mall", Goss (1993) describes shopping as the second most important leisure activity in North America. He continues that although watching television is indisputably the first, much of its programming actually promotes shopping, both through advertising and depictions of model consumer lifestyles. Despite increases in catalog sales, shopping remains essentially a spatial activity, i.e., we "go" shopping. The shopping center is its chosen place (Goss, 1993). Three decades later, Goss' (1993) analysis needs an update (e.g., online instead of catalog), but retains its validity more or less. Much of the research published on mobility and the mall looks at the spatial activities of consumers. However, far less consideration is given to how the goods that consumers shop, actually get there. Some studies have been carried out on goods mobility and malls in cities, largely focused on three themes: freight trip generation, freight vehicle parking, and freight worker activities.

Several researchers report on estimates and assessments made of the freight intensity of urban malls. Using freight surveys for a mall in Oslo, Eidhammer et al. (2016) find that it receives 5.1 deliveries per week and per store, on average. This figure is higher than the average of 4.7 weekly deliveries that stores in the city center receive. For 32 malls in Budapest that accommodate between 13 and 300 stores each, Sárdi and Bóna (2021) estimate an average of 67–992 weekly deliveries. Both Brettmo and Sanchez-Diaz (2021) and Cheah et al. (2021) use freight trip generations models to quantify the number of trips attracted and produced by urban malls. They do so based on establishment-level data and traffic count observations. Both studies embed their research in what Jaller et al. (2015) have defined as 'large urban freight traffic generators', i.e., "specific facilities housing businesses that individually or collectively produce and attract a large number of daily truck trips".

For 158 establishments in the Nordstan mall in Gothenburg, Brettmo and Sanchez-Diaz (2021) estimate 300 freight trips per day and on average 1,632 freight trips per week. They find that efficiency improvements are both necessary and possible for the stores in the mall, but also for its offices. Interestingly, their analysis finds that offices require more transportation for less deliveries. The study concludes that consolidation does not happen just because similar establishments are concentrated, but requires dedicated measures (Brettmo & Sanchez-Diaz, 2021). In Singapore, 212 malls hosting 24,375 stores generate an estimated 48,750 freight trips on an average weekday (Dalla Chiara et al., 2020). For sixteen malls of different sizes in Singapore, Cheah et al. (2021) find that small ones generate between 115 and 211 daily freight trips for 10 to 64 establishments, medium ones generate between 246 and 556 daily freight trips for 120 to 194 establishments, and large ones generate between 258 and 548 daily freight trips for 202 to 529 establishments. Freight intensity is found to depend on the establishment type, employment size, and whether or not establishments belong to a retail chain.

This high number of freight trips translates into a high demand for freight parking. Several studies have been conducted on parking demand at urban malls for goods. Alho et al. (2022) apply a microsimulation model to Orchard Road in Singapore, an area that is home to 26 malls and 2,500 establishments. For one morning, the model simulates 1,800 freight trips, 11,400 consumer trips, and 570 freight parking instances. During this time, the total delay yields around 1,461 min, resulting in around 2.6 min for all freight drivers. Freight drivers who experienced queuing, spent around 19.7 min on average. Alho et al. (2022) build on two earlier studies by Dalla Chiara and Cheah (2017) and Dalla Chiara et al. (2020). Using video recordings, parking gates data, driver surveys, and vehicle observations, Dalla Chiara and Cheah (2017) report on freight generation and parking demand for two malls in Singapore. A total of 456 freight vehicles were recorded for 1 day at a first mall, while 546 freight vehicles and 500 freight vehicles were recorded for 2 days at a second mall. The researchers observed that the

malls suffer from long queueing times, around 7.5 min per vehicle on average. It creates a large share of illegal parking and occupation of parking reserved for consumers (Dalla Chiara & Cheah, 2017).

Again studying malls in Singapore, Dalla Chiara et al. (2020) study freight driver parking choice behavior. They conclude that pricing and enforcement made the system worse-off. To reduce queueing and illegal parking, the researchers suggest to reduce parking durations and to provide incentives for light goods vehicles and service vehicles to use carparks reserved for consumers (Dalla Chiara et al., 2020). The researchers acknowledge that findings are context-specific, which the study of Eidhammer et al. (2016) demonstrates. For a mall in Oslo, they state that the mall does not experience difficulties with parking capacity, precisely because goods vehicles have a dedicated space to park. Therefore, they actually recommend the City of Oslo to implement a similar space for goods mobility directed to stores in the city center (Eidhammer et al., 2016).

Finally, Kim et al. (2021) and Ørving et al. (2018) study freight workers' dwell times. They assess the time freight workers spend performing out-of-vehicle activities while their vehicle is parked. For a mall in the outskirts of Oslo, Ørving et al. (2018) found that it takes up to 30 min for a worker to deliver one pallet to a store. They observed that freight workers can be parked at the freight reception area for several hours, if they deliver goods to multiple stores located in the mall. Kim et al. (2021) focus on five large freight traffic generators in Seattle, including a mall. Using observations and generalized linear models, they conclude that certain buildings, including malls, naturally attract large volumes of goods. It causes freight workers to spend more time in the building to carry out their deliveries, thereby increasing dwell times to more than 50 min (Kim et al., 2021).

The research discussed in this literature review gives rise to three observations. First, it highlights the importance of studying goods mobility associated to urban malls in its variety of aspects, i.e., freight trips, parking demand and worker activities. Second, it confirms the necessity of improving the state of practice of goods mobility and malls in many cities around the world. Third, it exposes the lack of understanding of how omnichannel retail affects goods mobility associated to urban malls. Responding to and building on these observations, we carry out case study and exploratory research of a mall in Paris. Both methodologies are described in the next section.

3. Methodology combining case study and exploratory research

The objective of this research is to gain a better understanding of omnichannel goods mobility associated to malls in cities. In doing so, we aim to answer two research questions: how is omnichannel goods transportation operationalized in urban shopping malls and how can these operations be improved? We follow a dual approach, based on case study research in the first place and exploratory research in the second place. Our case study focuses on a mall situated in the south-west of Paris, called Beaugrenelle. Beaugrenelle is operated by Apsys, measures 45,000 m^2, and accommodates 99 stores, 14 restaurants and a cinema. The mall dates from the late seventies but was inaugurated again in October 2013 after a total renovation. The mall depends on one narrow, one-way street for supplying the stores, the Rue de l'Ingénieur Robert Keller (Fig. 1). There, it receives goods vehicles of up to 19 tons.

The City of Paris makes for an interesting case to study goods mobility and malls because of three observations. First, next to a concentration of regular and department stores, Paris is home to fourteen malls. Second, because of its high population density and its ever sharpening transportation regulation to preserve quality of life and combat climate change (City of Paris, 2018), Paris presents challenging circumstances for goods mobility. Third, by following the global trend of growing e-commerce adoption and increasing numbers of online shoppers (Apur, 2020), Paris essentially represents an omnichannel environment. These observations are, however, not unique to the City of Paris, which makes the findings and learnings from this research insightful and potentially applicable as well to other cities.

To perform a state of practice of omnichannel goods mobility at Beaugrenelle, we conducted surveys, carried out observations, and talked to experts. With a questionnaire consisting of around forty questions (Annex 1), we approached each of the 99 stores present on July 2021. Our questionnaire covers five themes: a presentation of the retailer, logistics operations, supply, storage, and future perspectives. The part on logistics operations addresses the presence and the

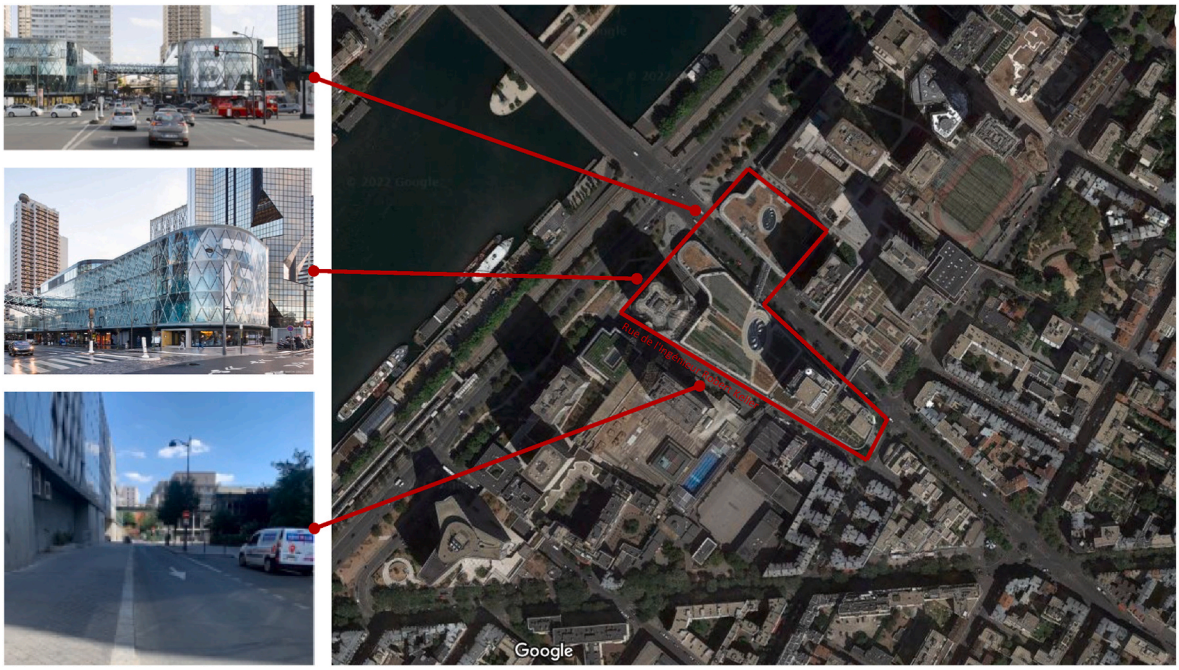

Fig. 1. Google Maps satellite view and photographs of the Beaugrenelle mall in Paris. The mall is outlined in red lines, the Rue de l'Ingénieur Robert Keller is indicated with red text, the locations shown in the photographs are indicated by red lines. Photography credits: Martin Argyroglo (top two) and Paul Marcher (bottom one).

implications of three omnichannel retail activities. First, click-and-collect, which allows consumers to collect webshop orders in the store. Second, ship-from-store, which enables the store to ship webshop orders to consumers. Third, webshop returns, which allows consumers to return webshop orders in the store. We organized the survey in-situ and face-to-face. Some answered our questions quickly, while others elaborated on their answers, of which we took note. One third of the stores agreed to participate in the survey. Some stores refused due to confidentiality or lack of time.

Along with the survey, we observed the logistics operations in and around the mall during three mornings in July 2021. We prioritized morning observations since the mall officially does not allow loading and unloading activities outside of the 6–10 a.m. time window. From the Rue de l'Ingénieur Robert Keller, we recorded supply operations, worker activities, queuing and parking, and physical and technical conflicts and constraints. Worker activities we recorded as well from various locations inside the mall. One of the store staff allowed us to visit the mall's interior loading and unloading zone. Nevertheless, this research not being commissioned by the mall, we experienced reservations and even suspicion from the mall's security staff, whom we informed about our objectives and intentions with average success. For privacy reasons, legible license plates in the photographs displayed are concealed and store staff or delivery workers are shown only if sufficiently unrecognizable. To better understand the omnichannel activities in the mall, we organized interviews with experts from logistics service providers involved in such activities (Table 1).

To improve the state of practice of omnichannel goods mobility at Beaugrenelle, we conduct exploratory research using document analyses and expert interviews. We retrieved solutions for more efficient and sustainable goods transportation at urban malls, mentioned or discussed in the scientific literature, and organized them in broad categories. We then set out to find more information using general Google searches and contacting experts (Table 1). We collected all information and analyzed the solutions in terms of characteristics, advantages and disadvantages, considering the state of practice of our case study at hand. This state of practice is discussed in the first part of the findings section, while the second part elaborates on three solution pathways. These solutions involve the introduction of dedicated staff, engagement of third parties, and implementation of intelligent technology.

4. Findings on omnichannel goods mobility of a mall in paris

4.1. State of practice: chaotic supply operations, patchy delivery practices, and a lack of storage

More than half of the surveyed stores sell clothing (16), while the remaining stores in our sample sell furniture and home decoration (6), beauty products and fragrances (4), and electronic household appliances (2). We surveyed stores across all levels of the mall: the ground floor (8), the lower floor (5), and the two upper floors (8 and 4). All stores belong to chains, who in most cases organize the stores' logistics operations (20). Most stores are supplied several times per week (23), receiving boxes (20), pallets (7), or both (3). Clothing stores note important seasonal changes impacting the frequency of supplies. They affect the volume of supplies as well, with the difference in delivery units varying by a factor two, to more than four.

The majority of stores agree with the statement that the logistics operations of the mall as a whole are well thought out (21 out of 28). Some problems are however noted. Seven stores mention issues with supplies, mainly the time window. The mall only allows loading and unloading activities between 6 and 10 a.m., which is too restricted according to store staff. Some of their statements include: "if there are traffic problems, delivery workers have to carry everything by hand", and "complicated to meet with delivery workers". Indeed, almost all stores receive their supplies from delivery workers in the store (30), while only one store selling furniture has store staff collecting the goods in the loading and unloading area. Four stores report a lack of storage capacity. One employee explains the insufficiencies by declaring that "it's an old mall", despite its relatively recent renovation.

The operational difficulties are illustrated by our observations. The mall is supplied via the Rue de l'Ingénieur Robert Keller, a narrow, one-way street. This street provides access to the mall's interior loading and unloading zone via two doors. Only the left one was however used during our observations. This zone has four docks, so it can only accommodate a few vehicles at a time. In Fig. 2, the top left photograph shows the access doors to the loading and unloading zone, the top right photograph shows vehicles waiting in the interior reception area and the bottom photograph presents a panoramic view with the blue docks. Because of the strict time window, many vehicles arrive at the mall at the same time. They park on the road or on the curb while waiting for space to free up in the loading and unloading zone. Because most delivery workers bring the goods to the stores, vehicles remain parked for a considerable amount of time, sometimes up to an hour. It results in delays for the stores, although our survey suggests that only a minority of stores seem to be burdened by it. Delays especially impact delivery workers, who fall behind on their rounds. Exchanging a few words with a delivery worker during activities, he shared that he finds the mall's organization inadequate and is forced to park and unload at the curb to properly complete the rest of his deliveries.

We did detect a number of alternative practices adopted by delivery workers to supply the stores in the mall. As suggested by the delivery worker's quote, some choose to unload directly on the curb rather than waiting to enter the interior zone. Goods are then loaded on hand trucks or dollies and brought to the store via the loading and unloading zone access. After 10 a.m., when the doors are closed, delivery workers use the customer entrances. This practice is not allowed but tolerated, although the use of hand trucks or dollies is forbidden. It means that delivery workers can resort to this solution only when they are supplying boxes, despite ergonomically taxing. In any other case, they are forced to return the next day.

When unloading at the curb, vehicles are left unattended, sometimes with the back door open. Such activities imply a risk of fines and theft. Fig. 3 shows the practices, which are schematized in Fig. 4. Thirteen stores shared the location of the warehouses deployed for supplies: most are located in the Paris region (7) or neighboring regions (4), one is based in Switzerland, and one is based in the Netherlands. Even with regional warehouses, strict time windows can be challenging to meet on rounds for multiple deliveries, including unpredictable traffic and technical problems. Such complications are potentially even more important for remote warehouses. Thus, the efficiency and sustainability of chain stores' logistics operations are often considered maximized from a company perspective. Yet it does not necessarily seem the case

Table 1
List of experts.

Profile	Company	Exchange	Date	Subject
Director of Urban Logistics Projects	Poste Immo	Interview	May 2021	State of practice
Director of Development	DPD	Interview	June 2021	State of practice
CSR Project Manager	Chronopost	Interview	June 2021	State of practice
Public Affairs & Sustainability Director	Stuart	Interview	June 2021	State of practice
Director of Logistics	Pickup	Interview	June 2021	State of practice
Senior Research Engineer	TØI	E-mail	April 2021	Solutions
Director of Network Operations	Urby	Interview	July 2021	Solutions
CEO	Building Intelligence	Interview	July 2022	Solutions

Fig. 2. Photographs of the operations to supply the Beaugrenelle mall in Paris. Photography credits: Paul Marcher.

Fig. 3. Photographs of alternative practices to supply the Beaugrenelle mall in Paris. Photography credits: Paul Marcher.

from a mall perspective and neither from an urban perspective.

Another problem encountered by the stores, is the lack of storage space. About half of the stores consider their space sufficient (15), while the other half disagree (16). To accommodate the lack of storage space, some stores sacrifice a fitting booth (Fig. 5, first photograph), while others rent additional storage units inside the mall or in a building near the mall, despite considerable cost. One store uses a vendor management inventory system to balance storage and to plan supplies. Using the system, store and warehouse inventory is shared in real time. When an item is sold, the system places an order to restock it. In this way, the inventory is fully used for sales and no dedicated storage space is needed. However, the system does require frequent deliveries of small volumes with no efforts for efficiency or consolidation.

Omnichannel activities are on the rise in the mall since the COVID-19 related lockdowns of 2020. Click-and-collect is the most commonly implemented activity, with 19 out of 31 stores offering this service. There are differences between stores on how click-and-collect is operationalized. Some, the smaller ones, prepare orders received by e-mail ("click-and-reserve"), while most, the larger ones, accommodate online purchases for store collection. Most stores only offer items that are already in stock, while some offer the complete assortment. In this case, stores receive click-and-collect items by dedicated delivery. They are

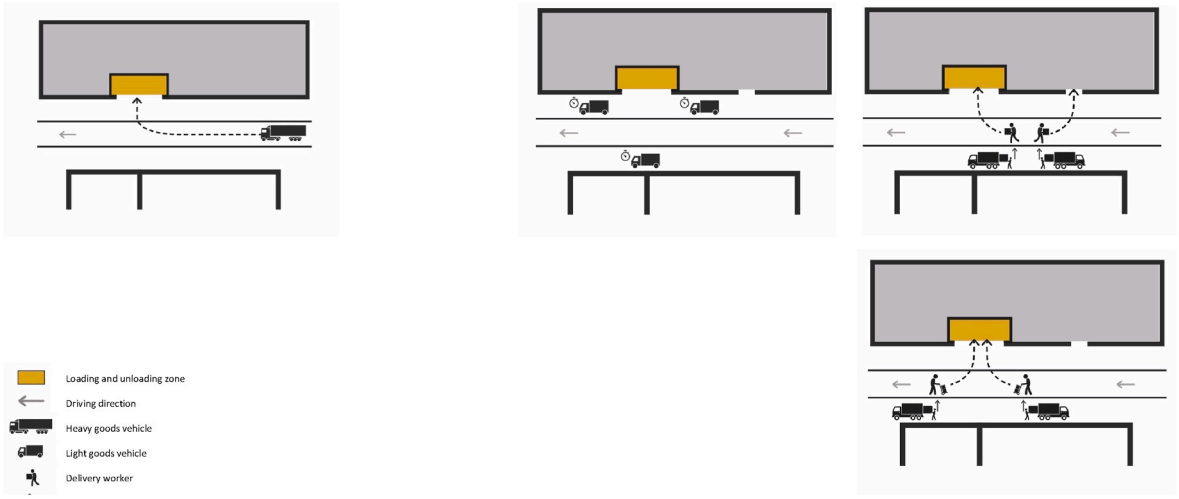

Fig. 4. Schematic overview of alternative practices to supply the Beaugrenelle mall in Paris. Theoretic practice on the left, three alternative practices on the right.

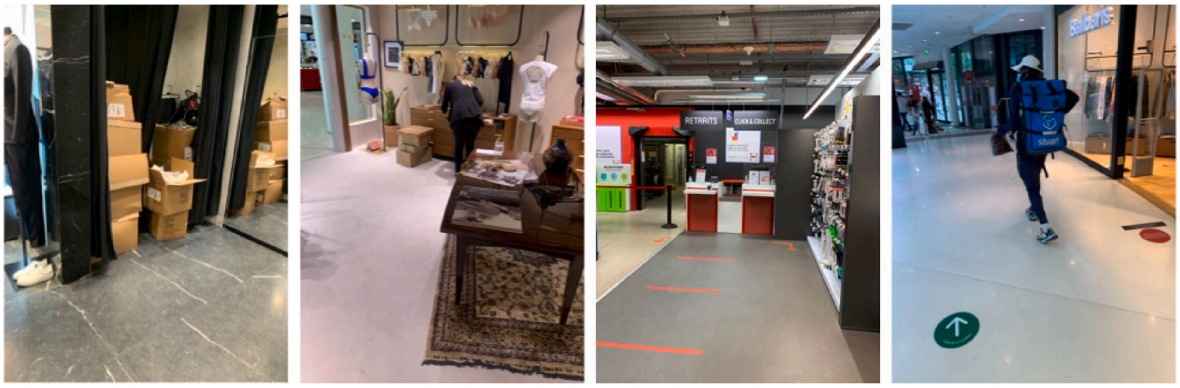

Fig. 5. Photographs of omnichannel activities in the Beaugrenelle mall in Paris. Photography credits: Paul Marcher.

shipped from the warehouse or transferred from another store of the chain by third party, such as DPD and Chronopost. During the interviews, the experts mentioned a number of problems, including limited access to the loading and unloading zone and complex navigation in the customer area of the mall. Click-and-collect volumes differ depending on the size of the retailer, the type of product, and the time of the year. A large electronics retailer accommodates on average 100 orders on a typical day, and up to 500 during the holiday season. Clothing stores have a more active service than stores selling home decoration.

Less than half of the stores propose a ship-from-store service (13), although it is little used. Also in this case, stores engage third parties such as DPD, Colissimo, and DeliverMe.City. One provider called Stuart is mentioned most, with some store staff actually using the expression: "ordering a Stuart". Stuart offers intermediate services between retail and delivery companies. They collect online orders in the stores and deliver them to the right locations, either themselves or via another party. Stuart uses cargo-bicycles for small and local deliveries. Some stores engage store staff to make local deliveries to consumers or transfers to other stores of the chain. Although the number of ship-from-store orders is still modest, it is more common in urban than suburban malls, because of their proximity to consumers. Offering omnichannel retail services to consumers is however not without constraints. During the survey, reference was made to the additional investment needed in store space, time, and staff to process click-and-collect and ship-from-store orders. Fig. 5 shows a store employee preparing online orders in the second photograph, a click-and-collect counter in the third photograph and a delivery worker collecting a ship-from-store order in the fourth photograph.

4.2. Three solution pathways: staff, third party, and technology

The case study research demonstrates a number of operational issues experienced by the Beaugrenelle mall in Paris. First, chaotic supply operations resulting in alternative practices that expose delivery workers to financial, security, and ergonomic risks. Second, patchy delivery practices that are not aligned with the regular supplies. Third, a lack of storage invoking the deployment of alternative storage units on the one hand, but also encourage more frequent supplies of smaller volumes on the other hand. In response to these observations, the exploratory research findings in this section present pathways to three solutions. They involve dedicated staff, third parties, and intelligent technology. In presenting these ideas, we omit the fairly obvious solution to expand the mall's time window for loading and unloading activities. Although it is not separately covered, mall policies on logistics operations are an integral part of implementing other solutions discussed in this section.

4.2.1. Introducing dedicated staff

The first solution draws on the 'common logistics' concept developed in the European CITYLAB project (Nesterova et al., 2017; Ørving et al., 2018), the 'centralized receiving station' recommendation shared by Dalla Chiara and Cheah (2017), and the service put in place by the French urban logistics specialist Urby for a mall in the Paris region (expert interview). The objective of this solution is to exempt delivery

workers from carrying goods from the loading and unloading zone to the store and instead assign these activities to a dedicated staff proposed by the mall. It optimizes loading and unloading activities and allows goods vehicles to pass through the zone faster. In the short term, reducing delivery workers' waiting and dwell time and delivery vehicles' queuing does not only mitigate the need for alternative practices at the curb and in the mall. It also allows to reduce the amount of noise generated and pollutants emitted during the time goods vehicles cruise, queue, and dwell. In the long term, the system allows goods vehicles to load more fully and make more deliveries, as they spend less time parked at the mall. Ørving et al. (2018) describe a time reduction of 4–14 min per pallet at a mall in Oslo, where they tested the common logistics solution.

Across the examples of malls that introduced a dedicated staff, temporarily or permanently, we detect a tendency to partner with specialized parties to operate the team. To Ørving et al. (2018), the choice of partner is critical to its success. Preferably, it is not a direct competitor to the delivery companies supplying the mall. An advantage of partnering with specialized parties is the ability to accommodate fluctuating supplies, as reflected in our case study. Nevertheless, introducing a dedicated staff is labor-intensive. For example, a mall in Malmö requires twelve employees to handle incoming supplies and outgoing waste for 200 establishments, that receive about two weekly pallets each (Ørving et al., 2018). It highlights the main obstacle of the solution, which is the cost. In search of a business model, Ørving et al. (2018) found limited willingness-to-pay among retail companies and no willingness among delivery companies for a mall charging €150 per month for a common logistics system, that includes short term storage and waste collection. Accumulating costs and budgetary restrictions following the COVID-19 related lockdowns were also behind the decision of a mall in the Paris region to discontinue its collaboration with Urby, who managed the ingoing and outgoing goods flows.

The cost of the system can be recovered per establishment or per number of delivery units generated. Perhaps it makes more sense in terms of business model for such solutions to transcend the individual mall and spread costs and benefits across multiple mall locations. Specifically, urban shopping malls usually belong to an umbrella group of multiple malls, including Beaugrenelle which is part of Apsys. Such organizations can negotiate a contract with a dedicated logistics party for the various malls in their group. This approach thus reduces costs through economies of scale. Moreover, it increases awareness and acceptance of the solution among the stores in the mall, which in turn are part of a chain. Overall, success seems most likely when the mall operator mandates the solution from the start to all establishments and integrates the costs into the rent (Nesterova et al., 2017).

The dedicated staff can support the omnichannel operations in several ways. First, it is important that the store staff and dedicated staff jointly schedule supplies, to ensure that they take place at a convenient time (Ørving et al., 2018). Secondly, the dedicated staff does not only need to adopt the incoming goods from delivery workers, but the outgoing flows as well, which fall under the store staff responsibility (Dalla Chiara & Cheah, 2017). In this way, the system is able to operate a counter for click-and-collect orders of the stores in the mall, a shipping service that processes and consolidates ship-from-store orders, and potentially a reception service that manages webshop returns. It frees the store staff from tasks obstructing optimal customer service and aligns the patchy practices that omnichannel activities generate, as our case study demonstrates. Click-and-collect orders and webshop returns were part of the services Urby operated for a mall in the Paris region. Thirdly, window times of the loading and unloading zones need to be expanded, to preserve the route efficiency of delivery companies. They can even be maximized, to facilitate other efficiency and sustainability enhancing measures, such as off-hour deliveries (Dalla Chiara & Cheah, 2017; Ørving et al., 2018).

4.2.2. Engaging third parties

The second solution draws on the 'urban consolidation center' concept developed extensively in the scientific literature. Allen et al. (2012), Paddeu et al. (2014), Sárdi and Bóna (2017), and Triantafyllou et al. (2014) explore the implementation for malls and the French urban logistics specialist Urby puts the service in place for a new mall in the City of Paris (expert interview). The objective of urban consolidation centers is to avoid poorly loaded goods vehicles, thereby reducing traffic, noise, and emissions that these vehicles bring about. They achieve this by transshipping and consolidating goods at the urban consolidation center onto goods vehicles with high load factors, ideally alternatively powered (Sárdi & Bóna, 2017). The solution of engaging third parties differs from introducing dedicated staff in the way that it implies an additional location, located in proximity to the area that they serve (Triantafyllou et al., 2014). It is also run by third parties that can offer their services to other buildings and areas as well. Analyzing twenty-four evaluation studies, Allen et al. (2012) demonstrate reductions in kilometers travelled between 60% and 80% and in greenhouse gas emissions between 25% and 80%. However, two elements are of primary importance for these reductions to materialize: i.e., the amount of detouring triggered by the urban consolidation center location, and the potential presence of other establishment in the urban area that the targeted goods vehicles are still supposed to supply (Paddeu et al., 2014).

In the classification system by Allen et al. (2012), malls are considered 'large sites with a single operator', similar to airports and hospitals. As a single party is responsible for finances, it is easier for them to achieve urban consolidation center activities that are viable in the long run (Triantafyllou et al., 2014). Urban consolidation centers are particularly effective when deliveries are small, regular, non-perishable, and destined for a specific and clearly defined location (Triantafyllou et al., 2014). This is the case in our case study. Engaging third parties to optimize the logistics operations of a mall benefits from mandatory use, ensuring sufficient participation, and rental arrangements covering the charges, ensuring sufficient funding (Allen et al., 2012; Triantafyllou et al., 2014). In this way, this solution implies similar success factors as required for introducing a dedicated staff. For engaging third parties, it is however less straightforward to imagine a business model across different malls belonging to the same group. Indeed, these malls are usually located in different cities, while the solution is tailored to the city, not the mall. Therefore, the economies of scale are more likely to lie in providing services for other urban activities besides mall operations. Increasing urban regulation, such as low or zero-emission zones, can further stimulate interest. Urban consolidation centers also allow malls to reduce the amount of space allocated to loading and unloading activities and provide additional capacity for seasonal or peak storage (Triantafyllou et al., 2014).

Although the focus of urban consolidation centers is to consolidate loads for incoming flows, it is equally important that the vehicles returning to the centers are as highly utilized as possible. All types of outgoing flows are candidates for return loads, including store transfers, unsold stock, and waste (Allen et al., 2012). The ship-from-store orders and webshop returns from the stores' omnichannel operations can supplement the return loads as well, thereby mitigating the patchy practices that they create in the mall. Triantafyllou et al. (2014) detect great potential for returns management and business-to-customer services for a mall in Southampton. Urban consolidation centers can achieve cost savings and additional revenues by providing these and other added-value activities, including unpacking and ticketing (Allen et al., 2012). Urby acknowledges that the variety of services that they are offering a new mall in Paris are significantly more ambitious because "the stores do not have all their habits yet".

4.2.3. Implementing technology

The third solution draws on the examples of demand management systems for malls introduced by Alho et al. (2022), the mall coordination platform explored by Song et al. (2022), and the service put in place by the American software specialist Building Intelligence for several malls

in the United States (expert interview). According to Alho et al. (2022), demand management systems can range from loading bay capacity or pricing adjustments. They can also rely on technologies such as information provision, booking systems, and guidance. Such systems are particularly useful for large urban freight traffic generators, such as malls. Comparing the impact of various demand management strategies for an area in Singapore home to 26 malls, Alho et al. (2022) find that increasing the capacity of loading and unloading zones reduces travel time and emissions. The strategy performs better than the other ones tested, i.e., centralized receiving through delivery assistance, free parking, prohibited double parking, and directed parking through a guidance system. Testing a technology-based solution, the numerical study by Song et al. (2022) assesses a coordination platform that centrally plans goods vehicle routes and simultaneously schedules dock timeslots. For supplying malls in Singapore, their study demonstrates the value of coordination.

Building Intelligence supports a method that allows malls to optimize the reception and management of vehicles through a coordination platform. The platform comes with mobile apps for delivery drivers, loading dock managers and building operators to engage before, during, and after deliveries and to share information on traffic, incidents, and access in real time. It also introduces a pre-delivery process in which all goods vehicles destined for the mall register prior to the operations. Registration allows them to be recognized as "trusted vehicles" upon arrival at the mall's reception area. For a mall in New York City, the reception area is located on a separate location, called 'marshalling area', to avoid queuing at the mall. While the system expedites trusted vehicles' access to the mall, unregistered vehicles are bound to wait longer. Although the coordination platform was initially introduced in a post 9/11 context to ensure security around and inside buildings, it also eliminates some of the obstacles in malls' logistics operations that our case study provides evidence for. The platform mitigates congestion at the mall, but optimizes transportation flows as well, by mapping the supplies and deliveries of all stores present in the mall. By providing continuous data, Building Intelligence reduced goods transportation to their New York City buildings by 39% on average.

Because both incoming and outgoing flows rely on goods vehicles accessing the mall, the coordination platform works similarly for both types of operations. As with supply, the data provided by the platform can also assist in optimizing delivery. For example, our case study shows that many of the stores entrust their ship-from-store orders to the same delivery company, which can be consolidated in a single trip if managed more carefully and informed. For this solution as well, working on a mandatory rental arrangement seems advisable for the mall to recover the charges from implementing the technology. To proportionally divide costs according to supply frequency or delivery need, the platform provided data can assist as well.

4.2.4. *Summary of potential impacts*

Various solutions exist to optimize logistics operations at urban shopping malls. Dalla Chiara and Cheah (2017) distinguish infrastructural investments and policies and regulation. Brettmo and Sanchez-Diaz (2021) differentiate organizational and behavioral measures, that follow either a voluntary or an administrative approach. The solution pathways discussed in this study are proposed to not only manage incoming flows of goods, but also the outgoing ones triggered by omnichannel practices. They traverse various categories and are summarized in Table 2. While 'supply', 'storage', 'click-and-collect', 'ship--from-store', and 'returns' indicate to what extent the solution can optimize these operations, 'infrastructure' and 'costs' demonstrate the resources that their implementation takes. Finally, 'emissions, noise' and 'congestion' estimate to what extent the solutions can contribute to more efficient and sustainable goods transportation at the urban shopping mall and the city in general.

5. Conclusion on malls, omnichannel goods mobility and urban planning

Integrating e-commerce in urban planning does not only concern deliveries to households and residential areas. Online shopping also has important implications on traditional retail structures in cities' commercial areas. This research aims to answer two research questions: how is omnichannel goods transportation operationalized in urban shopping malls and how can these operations be improved? To this end, we carry out case study research using surveys, observations, and expert interviews of a mall in Paris, and conduct exploratory research using document analyses and expert interviews.

The supply and storage practices of the Parisian mall presented in this case study are described as 'chaotic' and 'lacking', despite the mall's total renovation in 2013. The state of practice of this particular mall suggests that goods transportation is still treated as an afterthought in commercial building design today. It seems the case as well for many other urban malls covered in the literature review and mentioned by the experts during the interviews. Disappointingly so, as supplies and deliveries are essential to the functioning of such buildings. Even more so, their well-functioning is vital for urban malls to minimize nuisances for the communities in which they operate and contribute positively to the environmental objectives pursued by their cities in general.

As Brettmo and Sanchez-Diaz (2021) so aptly describe, "freight flows can be chaotic, but they are not illogic". After all, freight workers do not operate in isolation but are part of a supply chain, linking shippers of goods with their envisioned receivers (Holguín-Veras et al., 2015). It highlights the important but challenging task to align global freight networks of individual retailers with local goods mobility objectives. It also requires to translate varying practices into efficient, sustainable, and attainable solutions. The decisions made by a small number of property owners at the mall can impact more than half of the deliveries made to the city center of Gothenburg, state Brettmo and Sanchez-Diaz (2021). This illustrates the impact that can potentially be made, especially for larger malls located within dense urban areas.

If 'chaotic' describes the logistics operations required for the traditional retail activities in the mall, it is definitely the case for the online

Table 2
Potential impacts of the three solution pathways on omnichannel goods mobility of a mall in Paris. Cells in dark colors imply more impact than cells in lighter colors, empty cells imply no impact.

	Supply	Storage	Click-and-collect	Ship-from-store	Returns	Infrastructure	Costs	Emissions, noise	Congestion
Staff	+	+	++	+	+		++	+	+
Third party	++	++	+	++	++		++	++	++
Technology	+		+	+	+	+	+	+	++

retail activities it supports through retailers' omnichannel pursuits. The case study illustrates a patchy variety of delivery practices that are in need of professionalization. Urban malls' incoming flows, for store supplies, need to be addressed with their outgoing flows, for local deliveries. We propose three solution pathways that build on the inherent qualities of urban malls that are, in theory, instrumental for efficient and sustainable omnichannel goods transportation, i.e., a concentration of similar activities, a central location, a coordinated management, and dedicated spaces inside and outside the mall for logistics operations. In practice, however, they are inadequately deployed and do not seem to materialize as such qualities.

The three solutions proposed, i.e., introducing dedicated staff, engaging third parties, and implementing intelligent technology, are no silver bullets either. In examining the potential impacts of the three solution pathways on omnichannel goods mobility for our case study mall, we intend to provide elements for discussion for the mall operator, the retail tenants, their logistics service providers and the city moving forward. Our observations not being unique to our case study of choice, we hope the findings and learnings from this research are insightful and potentially applicable to other cities as well. For future research, we suggest business model analyses to successfully implement any of the solutions, also for existing malls.

CRediT authorship contribution statement

Heleen Buldeo Rai: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration. **Paul Marcher:** Conceptualization, Methodology, Investigation, Visualization, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Annex 1.

Presentation of the retailer

1. Store name?
2. Store floor? 0, 1, 2, 3, 4
3. Chain store? Yes, No
4. Products sold?
5. Multichannel practices? Multichannel, Omnichannel

Logistics operations

1. Are the **logistics operations** of the mall well thought out? Yes, No
2. What part of the logistics operations cause the most problems?
3. Why?
4. Who organizes the logistics operations? Store, Chain
5. How?
6. Do you offer **click-and-collect**? Yes, No
7. How?
8. Since when?
9. Number of click-and-collect orders per day? Per week?
10. Have you seen an increase since 2020? Yes, No
11. Do you offer **ship-from-store**? Yes, No
12. How?
13. Since when?
14. Number of ship-from-store orders per day? Per week?
15. Have you seen an increase since 2020? Yes, No
16. Do you accept **webshop returns**? Yes, No
17. How?
18. Have you seen an increase since 2020? Yes, No
19. What are the **implications** on the logistics operations? More store storage, More mall storage, More fulfilment space, More tasks for staff, More contracts with logistics service providers, More exchange with logistics service providers, More exchange with other stores of the chain, More exchange with warehouse, Other
20. Which logistics service providers are used?
21. Which vehicles types are used? Thermal, Electric, Hybrid, Unknown

Supply

1. Number of deliveries per day? Per week?
2. Unit of deliveries? Pallets, Boxes, Roll containers, Packages
3. Number of warehouses?
4. Type of warehouses? Urban, Outskirts, Both, Unknown
5. Location?
6. Is the warehouse shared with other brands? Yes, No, Unknown
7. Are the deliveries shared with other brands? Yes, No, Unknown
8. Which logistics service providers are used?
9. Which vehicles types are used? Thermal, Electric, Hybrid, Unknown

Storage

1. Do you have sufficient storage space? Yes, No
2. Do you have a remote storage area? Yes, No
3. Do you use unified inventory between the other stores of the chain? Yes, No
4. How do deliveries reach the store? Delivered, Collected

Future perspectives

1. Are you aware of any future developments of logistics operations in the mall? Yes, No
2. Do you have ideas for future developments of logistics operations in the mall? Yes, No

References

Alho, A., Oh, S., Seshadri, R., Dalla Chiara, G., Chong, W. H., Sakai, T., Cheah, L., & Ben-Akiva, M. (2022). *An agent-based simulation assessment of freight parking demand management strategies for large urban freight generators*. Research in Transportation Business & Management, Article 100804. https://doi.org/10.1016/J.RTBM.2022.100804

Allen, J., Browne, M., Woodburn, A., & Leonardi, J. (2012). The role of urban consolidation centres in sustainable freight transport. *Transport Reviews, 32*(4), 473–490. https://doi.org/10.1080/01441647.2012.688074

Apur. (2020). *Le e-commerce dans la métropole du grand Paris. Impacts de la vente en ligne sur le commerce de rue et nouvelle organisation de la logistique*.

Banister, D. (1997). Reducing the need to travel. *Environment and Planning B: Planning and Design, 24*(3), 437–449. https://doi.org/10.1068/B240437

Brettmo, A., & Sanchez-Diaz, I. (2021). *Property owners as possible game changers for sustainable urban freight*. Research in Transportation Business & Management, Article 100745. https://doi.org/10.1016/J.RTBM.2021.100745

Buldeo Rai, H., Verlinde, S., Macharis, C., Schoutteet, P., & Vanhaverbeke, L. (2019). Logistics outsourcing in omnichannel retail: State of practice and service recommendations. *International Journal of Physical Distribution & Logistics Management, 49*(3), 267–286. https://doi.org/10.1108/IJPDLM-02-2018-0092

C40 Cities. (2020). *Zero-emission freight: Vehicle market and policy development briefing for C40 Cities*.

Cheah, L., Mepparambath, R. M., & Ricart Surribas, G. M. (2021). Freight trips generated at retail malls in dense urban areas. *Transportation Research Part A: Policy and Practice, 145*, 118–131. https://doi.org/10.1016/J.TRA.2021.01.015

City of Paris. (2018). Paris Climate Action Plan. Towards a carbon neutral city, 100% renewable energies, resilient, fair and inclusive. https://cdn.paris.fr/paris/2020/11/23/a10afc931be2124e21e39a1624132724.pdf.

CNCC. (2021). Le CNCC présente les résultats d'une étude réalisée par EY : Évaluation comparée de l'impact environnemental et social des centres commerciaux. In *Communiqué de presse*. https://www.cncc.com/wp-content/uploads/2021/10/Le-CNCC-presente-les-resultats-dune-etude-realisee-par-EY-Evaluation-comparee-de-limpact-environnemental-et-social-des-centres-commerciaux.pdf.

Dalla Chiara, G., & Cheah, L. (2017). Data stories from urban loading bays. *European Transport Research Review, 9*(50). https://doi.org/10.1007/s12544-017-0267-3

Dalla Chiara, G., Cheah, L., Azevedo, C. L., & Ben-Akiva, M. E. (2020). A policy-sensitive model of parking choice for commercial vehicles in urban areas. *Transportation Science, 54*(3), 606–630. https://doi.org/10.1287/TRSC.2019.0970/SUPPL_FILE/TRSC.2019.0970.SM1.PDF

Eidhammer, O., Johansen, B. G., & Andersen, J. (2016). Comparing deliveries to on-street consignees and consignees located at shopping centers. *Transportation Research Procedia, 14*, 1221–1229. https://doi.org/10.1016/J.TRPRO.2016.05.193

Erkip, F., & Ozuduru, B. H. (2015). Retail development in Turkey: An account after two decades of shopping malls in the urban scene. *Progress in Planning, 102*, 1–33. https://doi.org/10.1016/j.progress.2014.07.001

Goss, J. (1993). The "magic of the mall": An analysis of form, function, and meaning in the contemporary retail built environment. *Annals of the Association of American Geographers, 83*(1), 18–47. https://doi.org/10.1111/J.1467-8306.1993.TB01921.X

Hagberg, J., Jonsson, A., & Egels-Zandén, N. (2017). Retail digitalization: Implications for physical stores. *Journal of Retailing and Consumer Services, 39*, 264–269. https://doi.org/10.1016/j.jretconser.2017.08.005

Holguín-Veras, J., Aros-Vera, F., & Browne, M. (2015). Agent interactions and the response of supply chains to pricing and incentives. *Economics of Transportation, 4*(3), 147–155. https://doi.org/10.1016/J.ECOTRA.2015.04.002

Jaller, M., Wang, X. C., & Holguín-Veras, J. (2015). Large urban freight traffic generators: Opportunities for city logistics initiatives. *Journal of Transport and Land Use, 8*(1), 51–67. https://doi.org/10.5198/JTLU.2015.406

Kang, J., Kong, H., Lin, Z., & Dang, A. (2022). Mapping the dynamics of electric vehicle charging demand within Beijing's spatial structure. *Sustainable Cities and Society, 76*, Article 103507. https://doi.org/10.1016/J.SCS.2021.103507

Kim, H., Goodchild, A., & Boyle, L. N. (2021). Empirical analysis of commercial vehicle dwell times around freight-attracting urban buildings in downtown Seattle. *Transportation Research Part A: Policy and Practice, 147*, 320–338. https://doi.org/10.1016/J.TRA.2021.02.019

Nesterova, N., Rooijen, T. van, Talen, S., Verlinde, S., Kin, B., Dablanc, L., Liu, Z., Marcucci, E., Gatta, V., McLeod, F., Eidhammer, O., Orving, T., & Leonardi, J. (2017). CITYLAB Deliverable D 5.4 Sustainability analysis of the CITYLAB solutions. https://www.citylab.soton.ac.uk/deliverables/D5_4.pdf.

Ørving, T., Fossheim, K., Eidhammer, O., Andersen, J., Leonardi, J., van Rooijen, T., Nesterova, N., Talen, S., Kin, B., Verlinde, S., Cherrett, T., McLeod, F., Marcucci, E., Gatta, V., Romagnoli, G. C., Dablanc, L., Liu, Z., Lazarevic, N., & Rouhier, J. (2018). CITYLAB deliverable 5.3 (2018). *Impact and process assessment of the seven CITYLAB implementations*.

Paddeu, D., Fadda, P., Fancello, G., Parkhurst, G., & Ricci, M. (2014). Reduced urban traffic and emissions within urban consolidation centre schemes: The case of bristol. *Transportation Research Procedia, 3*, 508–517. https://doi.org/10.1016/J.TRPRO.2014.10.032

Rodríguez-Torrico, P., San José Cabezudo, R., & San-Martín, S. (2017). Tell me what they are like and I will tell you where they buy. An analysis of omnichannel consumer behavior. *Computers in Human Behavior, 68*, 465–471. https://doi.org/10.1016/j.chb.2016.11.064

Rosenzweig, C., Solecki, W., Hammer, S. A., & Mehrotra, S. (2010). Cities lead the way in climate–change action. *Nature, 467*(7318), 909–911.

Sárdi, D. L., & Bóna, K. (2017). Developing a mesoscopic simulation model for examination of freight traffic of shopping malls in Budapest. In *2017 smart cities symposium prague, SCSP 2017 - IEEE proceedings*. https://doi.org/10.1109/SCSP.2017.7973835

Sárdi, D. L., & Bóna, K. (2021). A geometrical structure-based new approach for city logistics system planning with cargo bikes and its application for the shopping malls of budapest. *Applied Sciences, 11*(8), 3300. https://doi.org/10.3390/APP11083300

Song, R., Lau, C., Luo, X., Zhao, L., & Lau, H. C. (2022). Coordinated delivery to shopping malls with limited docking capacity. *Transportation Science, 56*(2), 501–527. https://doi.org/10.1287/TRSC.2021.1109

Triantafyllou, M. K., Cherrett, T. J., & Browne, M. (2014). Urban freight consolidation centers: Case study in the UK retail sector. *Transportation Research Record: Journal of the Transportation Research Board, 2411*, 34–44. https://doi.org/10.3141/2411-05