Property Owners as Possible Game Changers for Sustainable Urban Freight

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Abstract

Commercial activity and the underlying freight movements supporting them are essential to urban life. Unfortunately, urban freight has negative effects on sustainability and requires innovative approaches to enhance the positive aspects and minimize the negative ones. There is a common understanding among practitioners, with support from the literature, that the negative impacts of urban freight can be alleviated with better knowledge about the system and by identifying and engaging influential stakeholders. This paper focuses on property owners and their role in encouraging initiatives that lead to more sustainable urban freight delivery practices. Property owners engage in sustainability issues in real estate because they are interested in developing their properties to increase their attractiveness, competitiveness, and future market value. A shopping mall is an example of a property that generates a lot of freight traffic due to intense commercial activity. This paper studies the delivery patterns to a centrally located shopping mall in the city of Gothenburg and identifies how property owners could influence the delivery patterns of their tenants. A range of initiatives is proposed based on the literature and considering the delivery patterns observed. The results show that property owners can include freight deliveries in their sustainability strategy, focusing on fostering collaboration and communication between the tenants and promoting supply chain strategies that consider the type of activities that take place and the scope to reduce the number of truck movements and increase the efficient and sustainable goods deliveries.

Key words: urban freight, property owners, sustainability, stakeholders, freight demand management

1. Introduction

Problems associated with urban freight activities have been highlighted by many researchers and practitioners in a range of fields. Many researchers have also noted that urban freight stakeholders play different roles, with some being more influential in supporting the range of possible sustainability improvements. Research on stakeholders in urban freight by Ballantine et al. (2013) classifies these stakeholders and actors, depending on their particular interests in the field. Property owners are named as stakeholders, with an indirect impact on urban freight

transport currently, and the potential to have a more direct impact on it (to become actors). Indeed, it seems that property owners' position in relation to urban freight is peripheral. However, recent research shows that property owners could play a more important role in encouraging initiatives that would lead to more sustainable urban freight delivery practices. Property owners of different commercial establishments along with other organisations, like Business Improvement Districts (BIDs), public procurement organisations (PPOs), and facility management companies (FMCs), have been grouped together and named as influencing organisations, i.e. organisations that can have significant impacts on goods deliveries (Brettmo & Williamsson, 2020). Influencing organisations are defined as organisations that are not directly involved with the handling, selling, buying or transporting of goods, but whose decisions about physical flows and whose relations with the goods receivers (and sometimes other stakeholders and actors) significantly impact how the goods are delivered to the receivers (Brettmo & Williamsson, 2020). Several reasons can be advanced for why property owners in real estate[1] should take an interest in urban freight. One important motivation is to diminish the amount of freight traffic coming to and leaving from the buildings they own, thereby improving accessibility and reducing traffic congestion around the building and in the neighbourhood. Fewer freight trips mean reduced local emissions, together with a smaller environmental footprint for the building and better air quality in the surrounding area. Another motivation would be the public relations benefits of being engaged in sustainable urban freight, as a part of their sustainability responsibility.

Freight flows can be chaotic, but they are not illogic; goods movements to certain urban areas are always the result of, and triggered by, demand. One way to understand and meet the issues of urban freight is to look at those establishments in urban centres that attract and generate the majority of the freight traffic, and to try to understand their delivery patterns. One example of such a freight generator could be a city centre shopping mall. Shopping malls usually consist of a high number of commercial tenants (establishments) with different types of commercial activities, including shops, groceries, restaurants and offices. Usually, the establishments in a shopping mall are independent entities, with their own business operational practices and goods delivery patterns separate from the other tenants in the mall. All of the tenants need regular stock replenishments and supplies for their work.

The role of large commercial facilities in generating large number of freight trips and thus concentrated externalities (traffic congestion, impeded accessibility, pollution and noise) in urban areas has been highlighted by several researchers (Holguín-Veras et al. 2011; Lawson et al. 2012; Holguín-Veras et al. 2013; Jaller et al. 2013, Jaller et al. 2015). These facilities labelled as large traffic generators could be large multi-use buildings, offices, universities, large retail establishments including shopping malls (Cheah et al, 2021, Jaller et al., 2015; Chiara et al., 2020).The commercial activities of tenants attract a large number of customers (and employees), which leads to high freight generation, which in turn results in extensive freight traffic to and from the buildings that constitute the mall. However, the freight traffic could be improved by applying different kinds of organisational or behavioural measures, for example, by consolidating the deliveries of several of the tenants, or by reducing the number of suppliers for similar types of goods, out of business hour deliveries and unattended deliveries (Holguín-Veras et al. 2020; Holguín-Veras & Sánchez-Díaz, 2016; Verlinde et al., 2012; Jaller et al., 2015; Sanchez-Diaz et al., 2016). The main difficulties for such consolidation measures are not only persuading the tenants (establishments in the shopping mall) to change their goods

[1] Real estate sector has a number of important stakeholders as property owners, investors, occupiers, constructors.

replenishment strategy or delivery patterns, but also finding the means to establish communication between the tenants. One way to solve this organisational challenge would be to engage their landlord, i.e. the property owner of the mall where they are located. As such, the property owners could be persuaded to engage in these activities, and to convince the tenants to engage as well. The starting point would be to gain insight into the freight and delivery patterns of the shopping mall in question, and to estimate the scale and scope of the problem in terms of the number of vehicles delivering and the volumes of goods received.

As a vibrant commercial activity requires large volumes of incoming goods, freight intensity is a healthy indicator of the success of the individual establishments and thus of the mall. At the same time, the traffic required to transport this freight generates negative impacts that need to be mitigated to increase the sustainability of the area. This paper aims to understand the role of property owners in diminishing the negative local impacts of freight transportation. To this effect, it is necessary: (i) to understand how property owners engage in sustainability for their properties, identifying the driving forces for this engagement, and exploring how freight questions are considered within the broader scope of sustainability actions; (ii) to quantify freight volumes and assess how this freight is transported to the establishments in the mall (e.g., number of deliveries, transport operators, vehicles); (iii) to identify ways in which property owner-led initiatives can decouple freight generation from freight traffic, i.e. how the delivery and pick up of goods can be achieved with fewer freight trips; and (iv) to identify the benefits that property owners can obtain from relating more sustainable freight transport services to their properties. This paper focuses on reducing local congestion and local emissions, which is why freight trip generation is estimated. Additional research should be conducted to include the transport operational side to assess if by reducing local congestion city congestion and emissions can be reduced as well.

The remainder of the paper is organised as follows. In the next section, the problems and the main drivers for sustainability development in the real estate sector are discussed, followed by an overview definition of green buildings. Next, a review of the literature of the sustainable transportation of goods and people and real estate is provided. Why freight is of particular importance to the real estate sector is also discussed. The main empirical section shows the data analysis of two weeks of goods deliveries to the Nordstan shopping mall in Gothenburg, and the resulting FTG models. The empirical section is followed by a discussion of the results. The final section provides conclusions drawn from the analyses.

2. Literature - What is sustainability in real estate?

2.1. A normative approach in the literature towards sustainability in real estate

The construction and subsequent use of buildings generates major environmental impacts in terms of energy, materials used, and continuous emissions. As a consequence, sustainability in real estate is recognised as an important topic with numerous studies focusing on the role of developers and property owners in reducing environmental impacts (Andelin et al. 2015; Falkenbach et al., 2010; Warren-Myers, 2012). Many studies, papers and reports have adopted a normative approach towards the value of sustainability improvements. In essence, the argument is made that making real estate more sustainable will result in positive outcomes for property owners, investors and tenants. However, this normative approach to the topic and issues involved has drawn some criticism, noting that it lacks suitable assessments and proof

in terms of the potential positive outcomes (Warren-Myers, 2012). In the long run, sustainability improvements for the real estate sector should be beneficial to all involved, yet this is neither straightforward nor guaranteed, as some stakeholders may incur increased costs without short term benefits. For example, the tenants with a short lease contract could be reluctant to join various sustainable initiatives and invest their resources into them because the benefits will probably occur after their lease period expired.

2.2. Problems in achieving sustainability goals in real estate

The following section explores the barriers and drivers for sustainability implementation in real estate.

Interactions among stakeholders in real estate

The real estate sector's uptake of sustainability measures and implementations is often described as tardy (Feige et al., 2013; Kucharska-Stasiak & Olbińska, 2018; Sayce 2013). Researchers have tried to understand why the industry is taking longer than others to embrace and implement sustainable practices. One theory is that in real estate, the important stakeholders have a tendency to blame each other for this reluctance, which is often referred to as the "vicious circle of blame" in the literature (Cadman, 2000 in Warren-Myers, 2012). For example, the occupiers complain that there are no sustainable buildings available on the market; the investors complain that there is no demand for sustainable buildings; the developers complain that the investors are not willing to pay for sustainable buildings; and the builders complain that there is no interest in, or market for, sustainably constructed buildings.

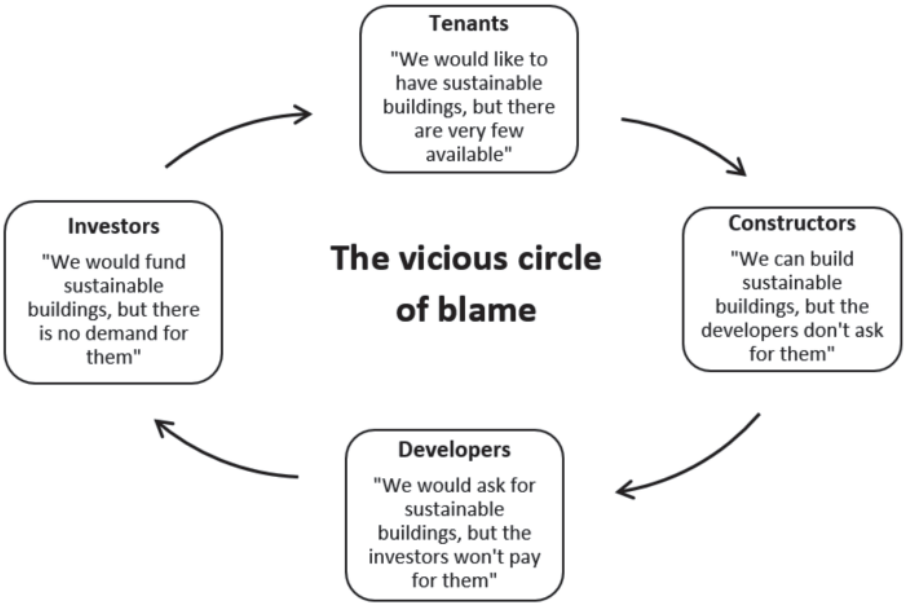

Figure 1: The "vicious circle of blame", adopted from Cadman (2000) in Warren-Myers, (2012).

The main drivers for sustainability improvements of commercial properties

The main drivers for sustainability improvements in real estate include:

(i) An increase in market value as a result of sustainability improvements. It is believed that market value is the main driver to justify investments aimed at improving the sustainability of properties (Kucharska-Stasiak & Olbińska, 2018; Sayce, 2013; Sayce et al., 2007; Sayce et al., 2009). This statement is supported by a number of case studies and statistical models that show the positive correlation between sustainability and the market value of properties (Eichholtz et al., 2010; Miller et al. 2008; Pivo & Fisher, 2010; Wiley et al., 2010;).

(ii) Improvements in the economic and financial characteristics of building operations as a result of sustainability improvements. A number of studies show that sustainability improvements to properties can lead to improved operational costs, occupant productivity, employee retention, payback periods and net present value (Eichholtz et al., 2010).

(iii) Such alternative drivers as enhanced brand and corporate culture, increased consumer and staff demand, concern about climate change, government legislation, financial incentives, and increased productivity (Andelin et al., 2015; Falkenbach et al., 2010; Warren-Myers (2012) based on reports JLL (2007b)).

2.3. What is a green building? Definitions and primary features

The term sustainability originates from the Brundtland Report published by World Commission on Environment and Development (Brundtland, 1987), which defines sustainability development as (p. 54): "Sustainable development is a development that meets the needs of present without compromising the ability of future generations to meet their own needs". The concept of sustainability is complex and includes environmental, social and economic aspects (Elkington, 1998; Norman & Macdonald, 2004). This also applies to sustainability in real estate. One way to switch from a conceptual to a more practical view of sustainability in real estate is to talk about certain physical properties or buildings. The definition of sustainability in buildings has been characterized by various factors by different authors (Berardi, 2013; Falkenbach et al., 2010). In the real estate sector, environmental sustainability is usually associated with energy use and efficiency, water use and waste management (Rogmans & Ghunaim, 2016). Kucharska-Stasiak & Olbinska (2018) include the following criteria that should be met by a sustainable building: (i) energy efficiency; (ii) limited environmental impact; (iii) high functionality and quality of utilities and services; (iv) durability and adaptability to market requirements; (v) ease of maintenance and waste recycling; and (vi) high comfort and better well-being for the users (Kucharska-Stasiak & Olbińska, 2018). It is important to note that sustainability includes not only environmental aspects but also social and economic aspects, all equally important (Reith & Orova, 2015). However, this paper will focus on the environmental aspects of sustainability. Literature suggests that assessing the sustainability of a property is challenging due to different rating systems and the different sustainability indicators used for rating (Berardi, 2012; Nguyen & Altan, 2011; Reed et al., 2006; Rogmans & Ghunaim, 2016). The definition of sustainability indicators used in this paper is adopted from Reed et al. (2006) and it is defined as measurable characteristics of different dimensions of sustainability (Reed et al., 2006).

It is difficult to find a commonly accepted definition of what a sustainable building is in the literature. According to the United States Environmental Protection Agency (EPA), environmentally sustainable building (or green building) is: "the practice of creating structures

and using processes that are environmentally responsible and resource efficient throughout a building's life cycle from determining the site to design, construction, operation, maintenance, renovation, and deconstruction". The building should be constructed and operated in an environmentally responsible and resource-efficient manner during its entire period of exploitation, including design, construction, and demolition. The focus thus is not only on the physical construction of a sustainable building (i.e. walls and windows) but also on its ongoing sustainable operation and maintenance.

Green buildings can bring a variety of additional benefits to different stakeholders. For example, green buildings can provide better working environments for the office tenants, including a healthier microclimate, temperatures, air quality, and anti-stress interior design , all of which can result in higher productivity and work satisfaction rates and lower rates of sick leave absences (Edwards & Naboni, 2013; Heerwagen, 2000; Liang et al., 2014; Singh et al., 2010). Real estate investors seem to benefit from the energy efficiency of green buildings (Christersson et al., 2015) and this parameter is included within a number of building certification schemes (BREEAM, 2015; LEED, 2020). Several studies show that certification could bring such benefits as higher occupancy rates and rent premiums (Eichholtz et al., 2010; Miller et al., 2008).

It is important to define which features of the building are considered sustainable, or are designed to increase the building's overall sustainability. According to a survey of office occupiers conducted by van de Wetering & Wyatt (2011), office tenants named the following activities that were included in their company's corporate responsibility or environmental policy: energy management, waste management, staff development, building management, transport policy, source of materials and water management. The survey of office occupiers conducted by Karhu et al. (2012), which was designed to rate their appreciation of the environmental qualities of green buildings, shows that office tenants value (in descending order): location, energy efficiency, video-conferencing, recycling of waste, surface and furnishing, environmental cleaning services, environmental food services, environmental informing, and building certification.

2.4. How the transportation of goods and people is reflected in real estate sustainability

Urban freight transport affects sustainability in those three areas (Quak, 2008): (i) environmental impacts: air pollution, the use of non-renewable natural resources, waste products, (ii) social impacts: physical consequences of pollutant emissions on public health, injuries and death resulting from traffic accidents, the increase in nuisance, reduction in air quality and, damage of buildings and infrastructure, and (iii) economic impacts: traffic congestion, decreasing city accessibility, inefficiency and waste of resources, decrease in journey reliability and delivery punctuality, potentially resulting in less service to customers and lost markets, and decrease in economic development.

As discussed, the literature shows that property owners who engage in real estate sustainability are driven by different reasons and motives including pursuing market value growth, lower operating costs, brand enhancement, tenant attraction and retention, and customer satisfaction. Property owners recognize the following features of green buildings: energy management, water management, waste management and recycling, transport policies for employees and location, and the use of environmentally friendly cleaning materials. It is interesting that personal mobility is included within sustainability criteria and even included in several green

building certification schemes (Feige et al., 2013). However, goods transportation to the buildings is not mentioned in the literature, and it is omitted from the evaluation criteria. Karhu et al. (2012) mention that food should be sourced from local producers to avoid long transportation distances and the resulting externalities. The sourcing of goods is mentioned as a sustainability criterion for a green building, meaning that the goods sourced, for example in terms of materials used, should be sustainable. However, how these goods should be delivered to the building is not specified or mentioned specifically. Yet, goods delivery is a critical ongoing process that supports the maintenance of the building and the main activities of its occupiers that should be continuously assessed through certification schemes along with other criteria. Given the definition of a green building, the business operations of the tenants should also be sustainable. Moreover, a green building should produce minimal possible impact on the environment, and excessive deliveries produce many negative externalities, such as air pollution, traffic congestion, and noise.

There are several reasons why property owners should be concerned about freight questions in connection with their facilities. Concern about freight traffic and its impacts on the larger area around the building would convey a positive image of the property owner being environmentally and socially responsible. Such an image leads to the brand enhancement of both the property owners and the tenants that rent facilities from them. The literature shows that tenants have environmental concerns and they do care about climate change among other factors when choosing a property to rent. It could be expected that tenants would value property owners' actions in support of measures to reduce freight traffic and to increase sustainable goods deliveries. Beyond such image enhancements, reducing freight traffic can positively affect a building's accessibility, infrastructure, and the environment around it, as there will be fewer trucks and vans coming to and from the building. A recent study estimating the external costs caused by extensive freight traffic to and from a mall (and the area around the mall) showed that traffic congestion constitutes 71% of all external costs, which also include CO_2 emissions (11%), air pollution (8%), noise (6%), and traffic accidents (4%) (Alvbåge et al., 2020).

Ranieri et al. (2018) propose similar model for externalities costs estimation for the last mile deliveries. The model relates the external costs to the principal identified factors in the last mile delivery, which are: 1) the demand of freight transport that are the total overall distance travelled by all transport means, 2) the load factor of vehicles, 3) emissions factors, 4) the average speed of travel, and 5) the coefficient that represents the unit cost for each externality. While improving the factors 1, 2, 3 and 4, the externalities produced during the last mile deliveries can be reduced and thus bring environmental and social improvements in sustainability. For example, a reduction in the trip number and length reduces the factor 1), and consequently the overall externalities like traffic congestion and CO_2 emissions (Ranieri et al., 2018). Consolidation of deliveries and cleaner vehicles will lead to less emissions per vehicles. This is something that should be promoted by property owners. Less traffic makes the neighbourhood more appealing, enhances its liveability, and thus bring the benefits to property owners.

Improvements in freight management increase the attractiveness of a building and the area around it, which more broadly contributes to a rise in the building's market value. A better environment around the building contributes to better working conditions for the employees and enhances their productivity, since the tenants generally appreciate better air quality, and less traffic congestion in their commutes to and from work. Clearly, the delivery traffic attracted and produced by the companies located in the building should be carefully considered

and included in the building's sustainability plan. The starting point could be to analyse the scale of the deliveries, for a better understanding of how many delivery trips are actually made to the premises and how they are made. This information can motivate property owners to arrange activities that lead to organising the freight flows of their tenants in a more sustainable way.

3. Methodology

As mentioned in the previous section, one way to clarify the scale of deliveries and to determine how freight traffic could be reduced is to quantify the amount of deliveries and pickups being made. To this effect, comprehensive data was analysed on goods deliveries and pick-ups to the shopping mall Nordstan in Gothenburg. The data was obtained from the original case study on Nordstan, run by the City of Gothenburg's Traffic and Public Transport Authority in 2016. The case is a part of an EU-financed project in the field of sustainable city logistics solutions within the HORIZON 2020 program (NOVELOG[2]).

The data from the case was analysed to quantify freight volumes, and to assess how freight is transported to the establishments in the mall. The results of the analysis are critical to identify what actions could be taken by property owners to disconnect freight generation from freight traffic, leading to lower freight traffic in the area. A description of the shopping mall and the data collected is given in the next subsection.

3.1. General information about Nordstan and a description of the data collected

Nordstan is a relevant case study for this research since it is one of the largest shopping malls in Sweden, with 200 shops and restaurants sharing 70000 square metres of floor space. Nordstan is strategically located in the city centre, very close to Central station (bus and train station). The foot traffic is high, with over 35 million visitors annually, and continued growth. The specific feature of this shopping mall is that it is owned by five real-estate owners. In terms of deliveries, the mall has an underground goods delivery facility, which accepts the majority of the deliveries. It is planned to change and partially reconstruct goods handling facilities in the mall. The reason is the ongoing goods consolidation project (SMOOTh[3]), in which the property owners of the mall together with partners from academia, industry and transport operators are exploring opportunities for establishing a hub which implies to free space at the underground facilities in the mall for transhipments of packages from trucks to cargobikes in order to deliver to other establishments outside the mall at the city centre.

The Nordstan shopping mall data was collected during two periods: January-February, 2016, and August-September 2016, with some missing data added during additional inquiries in 2017. The data were collected in two periods in order to obtain freight related data for a larger share of establishments, which allowed to increase the sample from 50-55% up to 80%. Even though it can be expected that some elements may differ between the periods, it was chosen to consider that as a minor issue since no known external factors that could affect the freight patterns of establishments differed between the periods, and the periods were synchronized in

2 Research project under the title "NOVELOG - New cooperative business models and guidance for sustainable city logistics", funded by the European Commission's Horizon 2020 Programme for Research and Innovation under grant agreement No 636626.
3 SMOOTh is a collaborative project in which stakeholders from industry, academia and society jointly develop and test a consolidation scheme to reduce the number of goods transports to the inner-city area in Gothenburg (SMOOTh).

relation to season fluctuations for clothing retailers and other significant events like festivities (e.g. Christmas festivities) that could potentially impact freight traffic to the mall. Thus the data collected reflects the typical delivery and pick up activity of establishments.

The freight data were collected with the use of so called "logbooks" handled by the respective establishment. It is important to emphasize that the data collected were based on actual registered events (receiving/shipping) and not on a general survey from the respondents that may include estimations and approximations. However, the information regarding general prerequisites, general information about the establishments, demands and conditions for deliveries was obtained by surveys.The data contains information on the goods received during two weeks, measuring the traffic volumes to the underground loading bay, and surrounding streets. Collected information includes the: (i) name of the destination (receiver) for each delivery, (ii) conditions and routines for deliveries (specifying if this is a reception or a shipping of goods, and if any special goods handing procedures should be applied), (iii) time and date of each delivery, (iv) number of parcels, pallets cages for each delivery, (v) transport operator, (vi) type of goods, and (vii) delivery vehicle. Additional data was collected through a survey sent to the establishments, asking them about their economic characteristics, such as the type of establishment, number of employees, and size. This additional information was used to relate delivery patterns to commercial activity.

There are approximately 200 tenants of different types in Nordstan. Following Sanchez-Diaz (2017), establishments were classified by commercial activity using the Swedish Standard Industrial Classification (SNI), which allows one to study entities in groups that are homogenous in terms of their commercial activity but heterogeneous in terms of their business attributes. The following groups were identified: perishable goods (e.g., retail of food, beverages, flowers, plants, tobacco), non-perishable goods (e.g., household equipment, electronics, clothing, footwear, jewellery), food service providers (e.g., cafes, restaurants), public offices and education establishments, health and wellness services, and other offices. Public and private offices were grouped together, and health and wellness services were merged with other services (i.e. a shoe-repair shop). Although the mall's one hotel includes some food service activities, previous research has shown that hotels have very different freight patterns from food service establishments (Sanchez-Diaz, 2018) so the hotel was studied separately from the food service providers.

The average response rate for the establishment survey was 85%, with the highest response rate from retailers (92%) and the lowest from other services (57%). After reviewing and cleaning the collected data, the sample resulted in 158 observations of establishments located in Nordstan.

3.2. Method for data analysis

The data are analysed in two steps; the data collected are used to characterize establishments based on their attributes (e.g., size, sector, number of employees) and their freight patterns (e.g., type of deliveries, number of delivery/ pick-up trips, number of suppliers, transport operators). The second step aims to capture the systematic relationship between establishments' attributes, delivery patterns and the amount of delivery and pickup trips to Nordstan via regression models and non-parametric statistical tests (e.g., Spearman rank correlation analysis and chi-squared tests). These analyses: (i) capture statistically significant relationships between variables; (ii) formalize the relationships between commercial activity

in a mall and freight trip generation; and (iii) provide an idea of the potential reduction of freight trips that could be obtained from changing delivery patterns.

To analyse the data, Freight Trip Generation (FTG models) were developed, and for each sector the number of trips generated were modelled as the dependent variable, with the business size of the establishment modelled as the independent variable (Sanchez-Diaz, 2017). Sub-sectors (e.g., fast food restaurants) are included to identify and explore differential effects on FTG (Gonzalez-Feliu & Sanchez-Diaz, 2019). The unit of analysis is the number of trips generated per week, including deliveries and pick-ups.

The FTG model development is based on the following concepts (Holguín-Veras et al., 2011; Sánchez-Díaz et al., 2016):

1) Freight Trip Attraction (FTA); defined as the number of trips attracted by the establishment during a certain time period, for example, the deliveries of goods.
2) Freight Trip Production (FTP); which is the number of trips produced by the establishment, for example, the sending of goods to another establishment or returns.
3) Freight Trip Generations (FTG); the sum of FTA, FTP, and trips that involve both goods deliveries and pick-ups; this parameter can be used for the estimation of the traffic congestion generated by a certain establishment. The difference between FTG and general traffic counting is that FTG is more accurate, since in establishments the deliveries and pick-ups can be done at the same time, and one vehicle can deliver to several establishments in the same stop.

Business size can be described as the physical size of the establishment, which is the floor space in our case, and the number of employees per establishment. Such choice of variables was made based on previous research (Bastida & Holguín-Veras, 2009; Brogan, 1979; Holguín-Veras et al., 2011; Holguín-Veras et al., 2012; Lawson et al., 2012; Sánchez-Díaz, 2017).

The relationships between FTA, FTP, FTG, business size and some sub-sectors are captured using regression analyses (i.e., Ordinary Least Squares- OLS). Although there are other methods in the literature that capture non-linear relationships and spatial autocorrelation, or that may ensure a better fit of the data via data analytics, OLS models were considered the most suitable method for this research because of the data's limited number of observations for some commercial sectors, and the spatial concentration of the establishments within the mall.

The generic model for estimating FTG models is expressed in equation 1 (Sanchez-Diaz, 2017):

$$FTG_n = \alpha + \lambda\delta_n + \beta \mathrm{X}_n + \theta\delta_n \mathrm{X}_n + n_n \quad (1)$$

where
FTG_n: A continuous dependent variable for establishment n that includes FTA and FTP per week,
α: The intercept, estimable parameter,
β: A vector of estimable parameter,
X_n: A vector of continuous variables proper to establishment n,
λ: A vector of estimable parameter for the binary variables,

δ_n: A vector of binary variables denoting the commercial sub-sector of the establishment n; each binary variable denotes a sub-sector and takes the value of 1 if establishment n belongs to the sub-sector, 0 if not,
θ: A vector of estimable parameter,
n_n: A random disturbance that follows a normal distribution.

4. Data analysis and modelling results

The first part of this section provides a descriptive analysis of the data, while the second part presents the FTG modelling results and links FTG to the number of transport operators and the ordering policies of establishments.

4.1. Data analysis

Data description - General information about the types of establishments in Nordstan

The general information about the establishments who answered the survey and for which deliveries data were collected is presented in Table 1. The data include the business sector distribution, the size of the establishments per sector (m^2), the number of employees per sector, and the amount of FTG per week per sector.

Table 1: Descriptive statistics of data collected

Type of establishment	Observations		Area, m^2			Employees, people			FTG per week		
	Count	%	Total	Average	%	Total	Average	%	Average	Total	%
Non-perishable goods retailers	81	51%	59349	733	39%	1252	15	25%	9,4	761	47%
Offices	39	25%	65544	1681	43%	3392	87	67%	9,3	363	22%
Perishable goods retailers	4	3%	3268	817	2%	90	22	2%	41,8	167	10%
Food services	29	18%	6146	212	4%	188.5	6	4%	8,7	252	15%
Other services	4	3%	662	165	0,1%	58	14	1%	10,4	42	3%
Accommodation	1	1%	18000	18000	12%	100	100	2%	46	46	3%
Total	158	100%	152969	21608	100	5080	32	100%	n.a.	1631	100%

About half of the establishments perform retail activities of non-perishable goods, while another quarter of the establishments are offices, and about a fifth perform food services. Grocery stores and retailers of perishable goods represent a very small share of the establishments.

Unsurprisingly, the parameters of the business size of the establishments – area and number of employees – are correlated. Although there are twice as many non-perishable goods retailers as offices, offices use about the same amount of space and have more than twice as many employees. This is of course a consequence of non-perishable goods retailers having an average of 733 m^2 and 16 employees per establishment, compared to 1681 m^2 and 87 employees for offices. Perishable goods retailers have a similar establishment size average but a significantly higher number of employees than non-perishable goods retailers (i.e., 16 employees vs 23 employees). Food services and other services have much smaller establishments and also fewer employees. Retailers of non-perishable goods have 2 employees per 100 m^2; perishable goods

retailers and food services have about 3 employees per 100 m^2; offices have 5; and other services have about 9 employees per 100 m^2.

Overall, retailers of non-perishable goods generate almost half of all freight trips; offices generate about a fifth of freight trips; food services generate 15%; and retailers of perishable goods – despite representing only 3% of the total establishments – generate 10% of freight trips. This can be explained both by the share of establishments, but also by the FTG per establishment. Apart from the hotel, retailers of perishable goods generate the most freight trips per establishment, resulting in around 42 trips per week (or about 8 daily freight trips). This is about four times the amount of FTG than the other sectors, which generate between 9 and 10 freight trips per week.

As shown, the freight traffic generated by Nordstan is a consequence of the mix of activities taking place at the mall. A different composition in types of activities would lead to a different traffic situation. To understand the connection between freight traffic and commercial activity it is necessary to drill down into the data and analyse the types of goods that are being delivered to the different types of establishments, the ordering policies implemented by businesses to get their deliveries when they are needed, and how these deliveries are transported to the mall by different transport operators.

Types of goods delivered to Nordstan

The types of goods delivered to Nordstan per type of establishment are summarised in Table 2. Food and beverage products account for 29% of delivery trips, ready-to-wear clothes for another 29%, while office supplies, electronics and equipment account for 28% of trips, and the remainder of goods account for 14% of delivery trips. Deliveries and pickups trips of food and beverages constitute more than a half of the trips for the hotel. Delivery and pickup trips of clothes constitute 58% of the non-perishable goods retailers, and 20% for the hotel. Office supplies/ IT equipment/ electronics constitute more than half of the delivery trips for the offices; a quarter of the trips for non-perishable goods retailers; and a quarter of the trips for the hotel. Understanding the type of goods being delivered is important because they set some logistics constraints (e.g., most perishable goods need temperature control; electronics tend to be expensive and require safety standards) and, as will be explained in the next section, such constraints also determine the type of interventions that real estate managers can implement.

Table 2: The scope of goods delivered, and quantity of trips made to different commercial sectors

Type of goods deliveries	Non-perishable goods retail		Perishable goods retail		Offices		Food services		Other services		Hotel		All	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Foods and beverages	54,5	7%	161,5	83%	75	17%	179,5	90%	1	2%	24,5	53%	492	29%
Ready clothes	466,5	58%	2,5	1%	26,5	6%	0	0%	2	5%	9	20%	506	29%
Office supply, IT/equipment, electronics, etc.	203	25%	7,5	4%	232,5	54%	8,5	4%	15	36%	12,5	27%	478,5	28%
Others	78	10%	23,5	12%	99,5	23%	11	6%	23,5	57%	0	0%	240,5	14%
Total	802	47%	195	11%	433,5	25%	199	12%	41,5	2%	46	3%	1717	100%

Control of deliveries

One of the logistics factors that affect FTA the most is how the deliveries are ordered and controlled by the establishments (receivers). The survey shows that almost half of the deliveries are managed by a central office or chain; one fifth of establishments receive deliveries where they do not have control on the date and time (later referred as uncontrolled) deliveries; only 8% of goods receivers control or influence their own deliveries (table 3).

The control of deliveries differs in different sectors. A chi-square test revealed that the relationship between the commercial sector and inventory management is statistically significant ($\rho = 1{,}593E-06$). In essence, some sectors are more oriented toward supply chain strategies (e.g., non-perishable goods retail); others have a noteworthy share of establishments controlled by the receiver (e.g., other services); and some sectors have a significant proportion of establishments for which orders are ad hoc and there is no control over deliveries (e.g. offices). This is valuable information when deciding which establishments to target, and how to influence them, when implementing demand management strategies, as the literature shows that establishments with centralized logistics systems tend to generate fewer trips than independent establishments (Cherrett et al., 2012).

Table 3: Control of deliveries by the establishments in Nordstan

Management of deliveries	Non-perishable goods retail		Offices		Food services		Perishable goods retail		Other services		All	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Do not know	2	2%	5	13%	1	5%	0	0%	0	0%	8	5%
Managed by central procurement, chain	57	70%	2	5%	8	38%	1	25%	1	25%	68	46%
Controlled/ influenced by receiver	4	5%	3	8%	3	14%	0	0%	1	25%	12	8%
Uncontrolled by receiver	7	9%	18	46%	6	29%	1	25%	0	0%	32	21%
Partially controlled and uncontrolled	9	11%	7	18%	1	5%	1	25%	1	25%	19	13%
Other	2	2%	4	10%	2	10%	1	25%	1	25%	10	7%
Total	81	100%	39	100%	21	100%	4	100%	4	100%	149	100%

Transport operators that deliver to Nordstan

Another important aspect that explains the relationship between goods deliveries and freight traffic is the number of transport operators involved in deliveries, which varies across sectors. The results are summarized in Table 5. There were more than 200 transport operators delivering and picking up goods at Nordstan during the weeks of study. Offices' deliveries involve the most operators (87); followed by non-perishable goods retailers (57); food services (45); and perishable goods retailers (30). However, when looking at the number of operators involved relative to the number of establishments, perishable goods retailers have the largest amount of operators per establishment (7,5), followed by food services, offices and other services with a similar number (slightly over 2), and non-perishable goods retailers have a significant smaller number (0,1).

Looking at the average amount of deliveries and pickups per operator, the transport operators that deliver to non-perishable goods retailers have the largest amount of deliveries and pickups per operator (14), followed by transporters for perishable goods retailers and offices (6,5 and 5, respectively). The transport operators that provide service to foods services and other services have on average slightly over 4 deliveries per operator. The hotel has a very particular

pattern, as it is served by many operators and the ratio of deliveries per operator is very low compared to the others (2,4 deliveries per operator). The number of transporters per sector and the average FTG per sector have a relatively high correlation (i.e., r=0,66), which shows that this relationship is statistically significant at the 5% level ($p - value = 0{,}0397$).

As shown in Table 4, offices rank 5th for FTG but 6th for number of transport operators, and for non-perishable goods retailers it is the inverse. This shows that offices require more traffic to fulfil fewer deliveries. Potentially, offices (along with other sectors like other services, food services and the hotel) could improve their efficiency in terms of traffic fulfilment of demand of deliveries by applying freight demand management principles.

The data shows that out of over 200 transporters, five transporters conduct almost 60% of all deliveries and pick-ups. These five transport operators are responsible for five out of six deliveries and pickups for non-perishable goods retailers, and around two-thirds of deliveries and pickups both for offices and for other services. These five big transporters account for one-third of the deliveries and pickups at the hotel. For food services and perishable goods retailers, the share of these five big transporters is not significant.

Table 4: Transport operators delivering to Nordstan

Type of establishment	Obs.	Amount of transporters per sector	Ranking of transporters per sector	Estimated FTG/week per sector	Ranking of FTG/week	Transporters per est.	Average deliveries per transporter	Total amount of deliveries		Amount of deliveries by five big transporters*		
								Count	%	Count	% **	% ***
Non-perishable goods retailers	81	57+	5	761,4	6	0,1	14	802	46%	670,5	84	39%
Perishable goods retailers	4	30+	3	167,2	3	7,5	6,5	195	12%	21,5	11	1%
Food services	21	45+	4	252,3	4	2,1	4,4	199	11%	6,5	3	0%
Offices	39	87+	6	362,7	5	2,2	5	433,5	26%	268,5	62	16%
Other services	4	10	1	41,6	1	2,5	4,1	41,5	2%	31	68	2%
Hotel	1	19	2	46	2	19	2,4	46	3%	16	35	1%
Total	**150**	**204+**	**n.a.**	**1631,2**	**n.a.**	**1,36**	**8,4**	**1717**	**100%**	**1014**	**n.a.**	**59%**

**Five big transporters are the transporters with the highest number of deliveries to Nordstan during survey period*
***Percentage to each type of establishment*
****Percentage to total amount of deliveries*

In essence, the data suggest that delivery consolidation (i.e., more deliveries per transporter) does not happen just because establishments with similar types of deliveries are concentrated in a mall; it requires a big operator that coincidentally or purposively is hired to serve multiple establishments.

4.2. Statistical analysis

To understand how economic variables relate to the amount of delivery and pick up trips to Nordstan, FTG regression models were estimated for offices, non-perishable goods retailers and food services. The results are summarised in Table 5. The table shows the t-statistics for each variable, p-value, the number of observations, and the goodness-of-fit measure for the model (R^2).

The analysis of data for food services in Nordstan shows that several restaurants (all of them are franchise chains, i.e., fast food chains) use the same logistics provider for almost all of their deliveries and pick-ups, i.e., between 30 and 100% of the fast food establishment deliveries are done by a common transport operator. Based on secondary data sources, this transport operator also provides logistics services such as, marketing analysis, supply chain management, supply chain optimisation and sourcing, freight management, warehousing and distribution, including taking responsibility and control of their customers' replenishment practices and inventory maintenance. This is a good example of how centralized delivery systems—or a consolidation strategy that replicates them—could lead to a reduction of about 80% of the trips. Since these fast food chains use a special logistics setup, and thus generate fewer trips per establishment, they were identified using a binary variable ($Est_{Fastfood}$). The FTG models for food services have an interaction effect on business size and fast food restaurants, meaning that being a fast food restaurant decreases the effect of business size. The results are summarized in Table 5.

The R^2 shows that the employment model has a slightly better goodness-of-fit for FTG than the area model. The FTG area model shows the relations between the size of the physical area of certain types of establishments and the number of freight trips generated by the establishment.

Table 5: Summary of the FTG model results

Commercial sector	Area models					Employment models				
	Obs	Const.	Area	Fast food chains*	R^2	Obs.	Const.	Emp.	Emp. in Fast food chains*	R^2
Offices	37	n.a.	0,43	n.a.	0,63	37	n.a.	0,08	n.a.	0,70
			(7,68; 8E-04)					*(9,06; 0,01)*		
Non-perishable goods retailers	81	6,48	0,40	n.a.	0,52	81	5,73	0,24	n.a.	0,55
		(8,27; 2,6E-12)	*(9,19; 4,11E-14)*				*(7,29; 2,09E-10)*	*(9,80; 2,75E-15)*		
Food services	29	7,69	0,99	-6,54	0,21	29	3,32**	1,27	-1,11	0,34
		(6,14; 1,7E-06)	*(2,42; 0,023)*	*(-2,15; 0,04)*			*(1,82; 0,08)*	*(3,63; 0,001)*	*(-3,60; 0,001)*	

Note: Const. denotes the intercept of the model, Emp. denotes the parameter of employees, the parameter for area is in 100m2, t-stat parameters and p-value are displayed between parentheses under each parameter.
**Binary variable is a variable assigned for fast food chains that use the same logistics provider. For the employment model of the fast food chains the binary variable alone was not significant, but the interaction with the employment (Fast_food*emp) was.*
***For this model the intercept is significant at the 90% level of confidence*

The area FTG model shows that an average office establishment generates about 0,43 trips per 100 m^2 per week. For retailers of non-perishable goods, each establishment generates about 6,5 trips every week, plus 0,4 extra trips per 100 m^2 (e.g., a very small establishment generates about 6,5, while a 100 m^2 establishment generates about 7 trips per week, and a 400 m^2 establishment generates about 8 trips per week). For food services, the results show that a fast food establishment generates 1,2 freight trips every week, compared to 7,7 trips for a typical restaurant (i.e., 6,5 fewer trips); in both cases an increase in area of 100 m^2 entails an additional trip per week.

The FTG employment model shows that typical office establishments generate 0,08 trips per employee. The retailers of non-perishable goods generate 5,73 trip per week plus 0,23 extra

trips per each employee (e.g., establishments with one full-time employee generate about 6 trips per week, while establishments with 10 employees generate about 8 trips per week). A food service establishment generates a base of 3,3 trips per week plus a number of deliveries that depends on the number of employees, for example, an establishment with 4 employees generates around 8,4 trips per week. If this food service establishment falls in the category of "fast food service provider" then it accounts for slightly less than 4 trips per week. The fast food service establishment generates 0,16 (1,27-1,11) extra deliveries per week per employee whereas a regular restaurant generates 1,27 extra deliveries per week per employee.

5. Discussion

Why should property owners engage in sustainability through improved freight practices?

Demand from occupiers or tenants is an important driver of sustainability implementation for property owners, as mentioned in the literature (Falkenbach et al, 2010, Karhu et al., 2012). Business occupiers at commercial properties value being located in a green building and in a clean neighbourhood (Andelin et al., 2015; Karhu, et al., 2012). Better air quality, together with other working environment features contribute to the well-being of employees and improves their productivity (Edwards & Naboni, 2013; Liang et al., 2014; Singh et al., 2010). Tenants become environmentally aware and they demand to be located at green facilities. This means that sustainable facilities could be easier to rent out, and they could attract higher rents. In addition, actions directed at changing the building (and the operations within and around it) to be more sustainable would enhance the brand of the property owners and, among other benefits, lead to an increase in the market value of their assets (Eichholtz et al., 2010; Miller et al., 2008; Pivo & Fisher, 2010). Such changes also guard against the properties becoming obsolete.

Goods deliveries are an important part of the business operations for occupiers of commercial real estate properties. However, goods deliveries bring externalities that cause negative effects like traffic congestion, poor air quality, and limited accessibility to the building. Delivery trucks driving around negatively affect traffic safety and decrease the attractiveness of the building and its surrounding neighbourhood. While tenants are interested in working in a sustainable building and liveable neighbourhood, they generate a high amount of the freight trips because of their commercial activities. Often, they are not aware of their role in this "contribution". We propose systems by which property owners focus on the goods deliveries to their buildings and facilitate tenant arrangements for more sustainable delivery practices.

It is important that the property owners of a shopping mall consider goods delivery patterns as a part of their sustainability strategy. According to the results of this study, 158 establishments in Nordstan generate approximately 300 freight trips per day; the amount of deliveries per week is on average 1632, with deliveries made almost entirely during weekdays. To compare, the study conducted by Sanchez-Diaz (2017) estimated that 171 establishments located in the central part of Gothenburg (Domkyrkan) would generate 239 trips per day. Considering the results of both studies, it is clear that decisions made by a small number of property owners at the shopping mall can impact more than half of the deliveries made to the city centre of Gothenburg. Having so many establishments located at one mall gives the property owners a unique opportunity to reach many fragmented establishments and to broadly facilitate goods delivery sustainability. They can aim, for example, to reduce the amount of delivery trips, while maintaining sufficient goods replenishment to the establishments. The way to do so is to

decouple goods deliveries from freight trips, which means having the same volume of goods delivered by fewer delivery trips.

The "vicious circle of blame" is frequently mentioned in the literature as a "reason – outcome" explanation of the real estate sector's slower uptake of sustainability (Andelin et al., 2015; Cadman, 2000 in Warren-Myers, 2012;). One way to break this circle is to begin with an initiative that does not demand a major commitment, but which begins to implement smaller, noticeable changes. Property owners are uniquely placed to be the facilitators for such activities. Implementing several freight-related logistics changes – such as consolidating goods at the transport operations level or changing the frequency of ordering – does not require large investments but can bring positive effects from decreased freight traffic around the properties. The way to start is to persuade the tenants to acquire better control over their deliveries, then to design plans to consolidate their flows with their neighbouring tenants. The results from the data analysis show that it is hard for many establishments in the shopping mall to gain control over their deliveries when acting individually.

What our analyses show

The empirical section shows that goods deliveries affect local traffic congestion that could be partially tackled by the shopping mall's property owners. The results of the FTG models are twofold. First, the results prove the hypothesis that there is a relationship between the business size (parameters like physical area of establishment, the number of employees) of establishments and the amount of freight trips generated by the establishment's commercial activities. This means that establishments of the same sector that have larger premises and/or higher numbers of employees tend to generate more delivery and pick-up trips (Table 6). Second, to a certain extent, the application of FTG models gives property owners a tool to estimate freight flows to and from the mall, depending on the business sector(s) of the tenants. This might be useful when deciding on the constellation and location of the tenants in the mall, for the organisation and planning of the goods receiving area for the mall, for creating a proactive freight strategy for future freight needs, or for planning different goods consolidation schemes. Decision-makers can use FTG models as an extra argument in support of different freight-related infrastructure improvements in the area near the certain shopping mall or shopping high streets.

The study's data and analysis clarify the main freight-related patterns of each sector in terms of control over the deliveries, the number of transport operators per sector and per establishment, and the type of goods delivered to the businesses within each sector. This information is valuable because it gives property owners insight on how influencing ordering policies for different sectors, or inducing collaboration between operators, could lead to a more sustainable freight traffic outcome. Inventory policy and control over goods deliveries is the primary factor that influences the freight traffic to and from the shopping mall. The analysis of the inventory strategies of the sectors shows that some sectors are more oriented toward supply chain strategies (e.g., non-perishable goods retail); others have a noteworthy share of establishments controlled by the receiver (e.g., other services); and some sectors have a significant proportion of establishments that do not have receivers control over deliveries (e.g. offices). This helps to clarify which sector might be more receptive to change and should be targeted when implementing demand management strategies. By looking into who has control over the delivery patterns for each sector, the property owners can better understand how to influence the ordering decisions for different types of ordering policies.

Measures that foster coordination between transport operators are more efficient in those cases where occupiers have control over their own delivery patterns, and there is no control from receivers or centrally, such as the offices (receivers control over deliveries is 8%; centrally controlled deliveries – 5%). Moreover, for offices, the number of transporters per establishment is 2,2, which is relatively high compared to non-perishable retailers with 0,1 transporters per establishment. However, five transport companies are responsible for 62% of the freight trips for non-perishable retailers, while the total number of transporters for offices is more than 87 companies per week. This means that coordinating such a large number of transport operators could be more efficient and could lead to a significant decrease in the number of freight trips.

The consolidation strategy for the food services establishments should be focused on decreasing of frequency of orders, but also on the coordination of suppliers and transporters, as these establishments have mixed inventory control patterns (one-third of establishments have centralized control over their deliveries, and almost one third have receivers control of the deliveries). Food services have a comparatively high number of transporters per establishment (2,1). At the same time, 90% of the goods are food and beverages, which might be a constraint for consolidation due to temperature control and handling standards. For those goods, the strategy should be focused on initiatives that seek coordination at the suppliers' level. The results of the analysis show that efficiency enhancement on the transport operation level is possible even for perishable goods deliveries. This group of fast food services establishments uses the same logistics provider, which leads to a significantly decreased number of freight trips to and from the establishments (1,2 freight trips compared to 7,7 trips for a typical restaurant). These results support our argument that some measures should focus on inducing collaboration between the transport operators for those deliveries that are controlled by the receivers.

The establishments that provide other services have similar delivery control as foods services: one-fourth of other service establishments have centralised control over their deliveries, and one-fourth have receivers control over their deliveries. On average, they have 4,1 transporters per establishment, and 68% of trips are made by five transporters. This means that smaller transport operators make many deliveries, and there is an opportunity for improvement of transporter coordination and upstream consolidation. Other services received varied by type of non-perishable goods (other goods – 57%, office supplies and IT equipment – 36%), so the property owners could foster initiatives that decrease order frequency since these establishments have the largest share of receiver-controlled deliveries, and since most of the goods are non-perishable they can be ordered in bigger batches.

Non-perishable goods retailers are the largest group of establishments in the mall. However, the majority of perishable goods retailers (2/3) have centralised control over their deliveries, with the lowest number of transporters per establishment (0,1); five transporters are accountable for 84% of delivery and pick up trips. This highlights that a significant amount of consolidation is already taking place at the transporters level. The major part of the goods are non-perishable (92,5%) which facilitates the application of different consolidation strategies. The property owners could focus on initiatives that seek to coordinate suppliers (on the centralized level), in an attempt to phase out the sporadic and uncontrolled deliveries performed by smaller fragmented transport operators.

Perishable goods retailers have the highest number of transporters per establishment (7,5). One-fourth of establishments have centralised control over their deliveries. Given that 83% of goods are food and drinks, constraints may be put on consolidation at the transport operator level.

However, it is important to note that 12 transport operators are responsible for 95% of the deliveries made to these establishments. One suggestion would be that where there is no control over ordering practices from receivers or centrally then the focus should be on initiatives that foster more efficient coordination between transport operators.

We have mentioned the following strategies that property owners could adopt to influence goods deliveries, and by extension, the sustainability of their properties: (i) influencing ordering policies, for example decreasing the frequency of ordering, (ii) inducing collaboration between transport operators, (iii) diversifying strategies depending on the control of deliveries and inventory management and transportation patterns in order to influence larger deliveries for each sector, (iv) inducing consolidation at the supplier level, altering supply chain strategies, (v) planning better goods handling facilities based on FTG estimates to decrease traffic impacts. The summarized recommendations on strategies for different groups of establishments depending on their freight patterns are summarized in Table 6.

Table 6: Strategies recommended to property owners for different groups of establishments depending on their freight patterns

Initiative	Target group
Demand management strategies Consolidated demand, decreasing of frequency of orders, applying replenishment policies of planned in advance and scheduled deliveries of the goods, increased stock, and ordering in big batches of the goods leads to reduced amount of freight trips;	- Establishments that have control over their delivery patterns, including those that have receivers control over deliveries and those that have uncontrolled deliveries (other services, some food services) - Establishments that receive various mainly non-perishable goods (offices, other services)
Fostering coordination between transport operators Coordinating a large number of transport operators could increase efficiency and lead to a significant decrease in the number of freight trips	- Establishments that have control over their deliveries patterns, and there is not receivers control or central control over deliveries (offices, some food services, - Establishments that have a large number of transporters per establishment that deliver the goods (offices, food services, other services, perishable goods retailers with uncontrolled ordering practices) - Establishment that receive perishable goods with limited shelf life and shorter expiry date (other services, food services, perishable goods retailers); -Establishments that receive the goods from many suppliers and cannot apply supplier coordination strategies (some non-perishable goods retailers, offices, other services)
Coordination of suppliers and supply chain coordination Coordination at the suppliers level could lead to decrease of number of freight trips	- Establishments that have centralised or supply chain control over their deliveries (non-perishable goods retailers); - Establishment that have a big number of suppliers (non-perishable goods retailers, perishable); - Establishments that receive non-perishable goods (non-perishable goods retailers)
Phasing out sporadic and uncontrolled deliveries performed by fragmented transport operators Eliminating fragmented and uncontrolled deliveries can lead to significantly decreased number of freight trips and would concern re-organisations of deliveries for a smaller portion of goods	- Establishments with numerous small transport operators (perishable goods retailers) - Establishments that have high number of uncontrolled deliveries (all kind of establishments)

We are suggesting that property owners focus on the mall's offices, or office-related establishments in the first stage. This group of tenants is numerous, with many deliveries and

the results of the analysis confirm that efforts directed at this group will require fewer investments and possibly yield the most significant outcomes in terms of freight traffic improvements. From a broader perspective, offices are important freight trip generators in cities. A recent study on FTG of offices in Stockholm shows that offices are important to consider, as they represent 36% of establishments and employ 62% of workers. Their FTG varies from 18 to 46 freight trips per month (which is 4 to 10 freight trips per week), depending on the type of business they engage, but altogether they contribute to 15% of FTG (Sanchez-Diaz, 2020). In essence, effective consolidation strategies for office-based establishments at a mall could serve as an example of efficiency and sustainability that could be expanded, with greater benefits, for offices throughout urban centres.

As for the tools that property owners could use in their freight strategy for offices, the strategy described above could be extended by adding some of the following activities (based on the study of freight traffic in office buildings in London conducted by Browne et al., 2016):

- Increasing load consolidation – to order higher batches at once, in case there is space for storage (which potentially could also be facilitated by the property owners)
- Collaborative purchasing[4] between different tenants (offices) of similar goods
- Reducing the number of suppliers of similar goods
- Better demand planning – to plan the demand for recurrent goods in advance
- Retiming of deliveries and pick-ups –to avoid traffic congestion during peak hours
- Using common service providers that could consolidate some flows in and out, provide concierge services, or manage common post rooms. An example of such companies are facility management companies (FMC).

As a starting point, it could be valuable to conduct a survey of the office tenants to get to know their freight preferences, attitudes towards freight issues, willingness to change their ordering policy and suppliers base, sensitivity to less frequent deliveries, and willingness to pay for extra services provided by the property owners that would impact the freight traffic (e.g., concierge services, facility management services or similar services).

There are several ways how property owners can promote suggested urban freight strategies among their customers. One way is to use voluntary approach, which includes persuasion, promotion and knowledge dissemination; another way is administrative approach, which is based on rules, regulations and legal mechanisms. Property owners can use both voluntary methods like promotion and persuasion, but also some regulatory methods based on their legal and contractual relationships with their customers. Establishments benefit from better environment, and for voluntary programs property owners can act as coordinators and not enforce nor execute the leverage, rather influence establishments for a better outcome. That is important to measure the effect they produce. At the same time, the location of this particular mall is attractive and competitive. The demand for being located in the mall exceeds the supply of commercial space, thus property owners can impose certain rules for the tenants on their delivery policies, but also provide incentives to establishments that put efforts into consolidation of their flows and decreasing the amount of generated freight trips.

6. Conclusions

[4] There are constraints to collaborative purchasing in form of existing contracts and agreements that are concluded on a headquarter level. Transport for London provide an example and guidance good on how to identify the type of deliveries that can be combined or goods that could be purchased together (TfL, 2020)

This study demonstrates that property owners could play an important role in promoting sustainable deliveries. Property owners do engage in sustainability issues in real estate and are interested in developing their properties in ways to increase its attractiveness, competitiveness, profitability, and future market value. Urban deliveries cause a lot of negative externalities and should be considered in connection with the freight demand triggering the deliveries, and land use. Somehow property owners should be connected to and accountable for the freight generated by the establishments located at their premises, just as they are with other rates of use and externalities of the building such as energy, water, or waste. Property owners should create opportunities and incentives for their tenants to organise their deliveries in a more sustainable way. Considering the benefits for property development, tenant satisfaction and the environment in general, engagement in sustainable freight is a win-win for everybody. The important step would be to educate and engage the property owners as they have a unique position to be the fulcrum for such a change.

With the help of academic literature, this paper shows how property owners engage in the sustainability of their properties, and explores the driving forces for that engagement, as well as the benefits that property owners obtain in return, particularly from more sustainable freight transport services related to their properties. The empirical part provides a quantification and assessment of freight transportation to the commercial tenants in the mall, followed by an analysis of the data and the identification of initiatives that property owners could facilitate and implement, depending on the type of business sector and the way the deliveries to the establishments are organized. Such initiatives like goods consolidation at the level of the transport operators or the suppliers would allow for the delivering and picking up of goods with fewer freight trips – i.e. the decoupling of freight generation from freight traffic – which leads to more sustainable freight deliveries. Going further, the property owners can take the role of orchestrator for some of the flows to and from the mall, and help to facilitate communication between the establishments and bigger transport operators, and some of the suppliers. Property owners could enable communication and collaboration between the establishments, especially those within the same industry sector, collaborations that could lead to more environmental deliveries to the building, and perhaps even better service provided to the establishments.

The study supports the idea that freight to and from the shopping mall should be considered and included in property owners' sustainability strategies. Freight traffic, as an integral part of the business activities of building occupiers creates environmental externalities and should be managed in the best possible way. Being aware of the scope and nature of the freight traffic generated by the occupiers, and, as a next step, including freight in the building's sustainability strategy could lead to a lower environmental footprint for the building. Freight traffic must be considered, because without goods deliveries, there could be no shopping mall. At the same time, understanding the scale of freight traffic to a particular place, and finding opportunities to make it more efficient and better organised could lead to less freight traffic without compromising, and perhaps improving, goods replenishment practices for the businesses. This study also shows that property owners are the stakeholders with the best capacity and most explicit interests to engage in, and address, the freight issues related to their properties.

This paper aimed to understand the role of property owners in diminishing the negative impacts of freight transportation, in particular on reducing local congestion and local emissions, which is why freight trip generation were estimated. Research question (i) was answered by the literature review; research question (ii) was answered by primarily data collection and analysis of the delivery and freight patterns of establishments, the results of freight patterns analysis were used as a ground for to answering of the research question (iii); research question (iv) was

answered by the means of literature review and interviews with property owners. Additional research should be conducted to include the transport operational side to assess if by reducing local congestion city congestion and emissions can be reduced as well.

The following limitations of the research should be considered. Since the research was designed as a case study, the results obtained were particular to that case, to the city of Gothenburg and Swedish environment in general. Moreover, not every property owner will be interested in engaging in sustainability issues related to freight transport. Thus, there is a need to understand what incentives and interests of property owners would encourage them to engage in freight transport questions. Some of the interests might be similar, but other might be different and might be in conflict to the ones mentioned in this study. The results reported in this paper could not connect impact produced by the deliveries (e.g. tonne-kilometres, emissions, accidents) with the amount of deliveries. For that more comprehensive data from different actors would be required and/or implementation of simulation techniques. This paper focused on the demand side of deliveries, and used some estimates from secondary data to show the potential environmental benefits. At the same time, the use inferential statistics in this research allows to extrapolate some of the results, such as FTG that is connected to establishments' size, order activity, business sector and transporters. The quantitative scope of the paper was limited to the freight trip generation, but further research has been conducted by other researchers using the same mall with a focus on the impact that using cleaner modes can have and on the effect that a consolidation centre in the outskirt of the city could have on the tonne-kilometres (Edh et al, 2021, Alvbåge et al., 2020).

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