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CITIZENS' PERCEPTION ASSESSMENT ABOUT URBAN FREIGHT TRANSPORT

Belo Horizonte

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Orientadora: Profª. Leise Kelli de Oliveira
Coorientadora: Profª. Kinga Elzbieta Kijewska

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Citizens' perception assessment about Urban Freight Transport

JOÃO GUILHERME DA COSTA BRAGA FRANÇA

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RESUMO

O Transporte Urbano de Carga (TUC) desempenha papel fundamental no cotidiano dos cidadãos. Apesar de sua relevância, o TUC é responsável por muitos problemas urbanos, a exemplo do congestionamento, da poluição e dos acidentes envolvendo os veículos de carga. Alinhadas ao conceito de logística urbana, algumas medidas podem ser aplicadas para minimizar essas externalidades negativas. Para alcançar um processo sustentável é essencial incluir o TUC no planejamento urbano e de transportes. Para auxiliar nessa inserção e na formulação de políticas públicas eficientes, esta dissertação tem como objetivo analisar a percepção dos cidadãos sobre o TUC através da resposta à pergunta de pesquisa "Como os cidadãos percebem o transporte de carga urbano?". Um Modelo de Equações Estruturais (MEE) foi estimado com base em seis relações causais entre os problemas e as soluções correlatas ao TUC, avaliadas sob a ótica da percepção dos cidadãos. Este estudo foi realizado em diferentes contextos geográficos (sul e norte do globo), considerando duas cidades: Belo Horizonte (Brasil) e Estetino (Polônia). Os resultados mostraram que em ambas as cidades, à medida que a percepção dos cidadãos sobre os problemas de infraestrutura urbana, os problemas de fluxo urbano e as questões ambientais aumenta, a percepção dos problemas do TUC também aumenta. Apesar disso, as relações de causa e efeito entre problemas e soluções só puderam ser identificadas em Belo Horizonte onde à medida que a percepção dos problemas aumenta, a percepção de medidas de logística urbana envolvendo infraestrutura e sistema de informação; e ações governamentais também aumenta. A não relação de causa-e-efeito em Estetino deveu-se a um alto nível de concordância dos cidadãos para todas as medidas investigadas, mostrando que qualquer solução melhoraria os problemas causados pelo TUC. Esses resultados implicam que os cidadãos percebem homogeneamente que os problemas de carga afetam as cidades, mas a contribuição da percepção de cada um desses problemas é heterogênea, variando de acordo com o contexto local. Da mesma forma, há heterogeneidade em quais medidas para minimizá-los são mais eficazes do que outras.

Palavras-Chaves: Transporte urbano de carga. Cidadãos. Percepção. Logística urbana. Modelos de equações estruturais.

ABSTRACT

Urban Freight Transport (UFT) is fundamental to citizens' daily lives. Despite its relevance, UFT is responsible for many urban problems like congestion, pollution, and freight vehicle accidents. Aligned with the "*city logistics*" concept, some measures can be applied to the urban environment to minimise the negative externalities. To promote sustainable UFT and economic development is essential to include UFT in urban and transport planning. To promote UFT insertion in policymaking, this master's thesis aims to analyse the citizens' UFT perception UFT by the research question, "How do citizens perceive urban freight transport?". A Structural Equation Model (SEM) was estimated based on six causal relationships between freight problems, and solutions evaluated the citizen's UFT perception. This study was carried out in different geographic contexts (Global South and Global North), considering two cities: Belo Horizonte (Brazil) and Szczecin (Poland). The results showed that in both cities, while the citizens' perceptions of urban infrastructure problems, urban flow problems, and environmental issues increase, the freight problems perception also increases. Despite this, the cause-and-effect relationships between problems and solutions could only be identified in Belo Horizonte. In this city, as citizens' freight problems perception increases, the perception of city logistics measures involving infrastructure and information system; and Government Actions; also increase. The lack of cause-effect in Szczecin's data analysis was due to a high level of agreement for all the measures investigated, showing that any freight solutions would improve problems. These results imply that citizens homogeneously perceive that freight problems impact cities. Still, the perception contribution of each problem is heterogeneous, varying according to the local context. Likewise, there is heterogeneity in which measures to minimise them are more effective than others, changing according to the local context.

Keywords: Urban freight transport. Citizen. Perception. Freight problems; Freight solutions. *City logistics*. Structural equation modelling.

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ACRONYMS

ANOVA	analysis of variance
B2B	business to business
B2C	business to consumer
CB-SEM	covariance based
L/U	loading and unloading
MEE	modelo de equações estruturais
MSI	method of successive interval
OLS	ordinary least squares
PLS-SEM	partial least square
SDG	sustainable development goals
SEM	structural equation modelling
TUC	transporte urbano de carga
UDC	urban distribution centres
UFT	urban freight transport
UN	united nations
VIF	variance inflation factor

SUMMARY

1 INTRODUCTION

The urban dynamics are accompanied by freight transport and their movements between industries, distribution centres, terminals, warehouses, and retail activities (Lindholm & Behrends, 2012). Therefore, understanding Urban Freight Transport (UFT) is challenging for developing sustainable cities.

The many different UFT definitions reflect the activity complexity and the lack of consensus on how to address their issues (Ballantyne et al., 2013). Hicks (1977) presented the first formal UFT definition as trips into, out of, and within an urban area by vehicles that pick-up or deliver goods. The last decade's definition, but still recent adherent, Ibeas et al. (2012) define UFT as freight handling carried out by public and private entities, with the society participation, which involves economic and financial resources. According to Oliveira et al. (2014), the primary goods transported are food, medicines, electronics, clothing, correspondence, construction materials, and waste from domestic and industrial activities.

UFT and urban activities interact through supply networks connected by many parts: industrial, warehouses, retail facilities, consumers, and governmental agents (Cui et al., 2015). Due to that, freight transport has a vital role in urban areas since there are no essential establishments without them, e.g., hospitals, stores, offices, supermarkets, and restaurants (Lindholm, 2013). Therefore, UFT is vital for cities' functioning and meeting the needs of stakeholders (Kijewska et al., 2021).

Despite the UFT importance for urban economic functioning and development and urban mobility, this activity generates negative externalities associated with the operation and functioning of the system (Anderson et al., 2005; Ballantyne et al., 2013; Ewbank et al., 2020; Kijewska et al., 2021; Lindholm & Behrends, 2012). Thus, the growth of the population in urban areas increases the demand for goods and, consequently, the freight problems associated with the goods distribution (Oliveira et al., 2017): e.g., congestion, accidents involving trucks, lack of parking areas, noise and pollutant emissions (Amaya et al., 2020, 2021; Anderson et al., 2005; Ballantyne et al., 2013; Carvalho et al., 2019; Dexheimer et al., 2013; Furquim et al., 2018; Hatzistamatis et al., 2019; Jardas et al., 2021; Kijewska et al., 2022; Kijewska & Jedliński, 2018; Kin et al., 2017; Leite et al., 2022; Lindholm & Behrends, 2012; Marsden et al., 2011; Oliveira & Oliveira, 2017; Oliveira et al., 2018, 2019a, 2019b, 2020a, 2021; Quak, 2011; Stathopoulos et al., 2012; Vieira et al., 2015).

The measures that emerge with the "*city logistics*" concept are a way to minimise the freight problems and contribute to achieving sustainable transport (Akgün et al., 2019; Kijewska et al., 2022; Lindholm, 2013; Oliveira et al., 2014). Taniguchi et al. (2001) defined city logistics as optimising logistics and transport activities in urban areas, considering the traffic environment, congestion, traffic safety and energy savings. Thus, the city logistics concept addresses freight problems, i.e., freight solutions.

Some of the freight solutions reported in the literature include truck restrictions, freight loading and unloading (L/U) areas, green vehicles circulation, trucks road pricing, cargo bike, trucks routes, delivery in pick-up points (parcel lockers), and urban mobility plans (Amaya et al., 2020, 2021; Ballantyne et al., 2013; Carvalho et al., 2019; Dias et al., 2018; Jardas et al., 2021; Karakikes & Nathanail, 2020; Kijewska et al., 2021, 2022; Leite et al., 2022; Marsden et al., 2011; Matusiewicz, 2022; Muñuzuri et al., 2005; Oliveira & Oliveira, 2017; Oliveira et al., 2018, 2019a, 2019b, 2020a, 2020b, 2021; Rai et al., 2019; Stathopoulos et al., 2012; Vieira et al., 2015; Zenezini et al., 2018). Despite these possible solutions to reduce freight problems, the primary measure adopted by the local authorities is restricting freight vehicle traffic (Tadić et al., 2015). Nonetheless, these measures do not always promote sustainable cities (Ballantyne et al., 2013; Dablanc, 2007; Holguín-Veras et al., 2013; Quak, 2011; Quak & Koster, 2009).

Moreover, since urban planning focuses on passenger transport, UFT is not as efficient as it should be (Akgün et al., 2019; Ballantyne et al., 2013). This situation is motivated by the lack of data, making it difficult to evaluate and implement effective solutions that increase the efficiency of the UFT (Kijewska et al., 2021). Furthermore, the UFT planning process has flaws and negatively affects urban mobility (Santos Junior & Oliveira, 2020). Also, this process is still not well understood by all the stakeholders, a situation motivated, for example, by the compatibility lack of the interests of each agent (Gatta & Marcucci, 2016; Lindholm & Behrends, 2012).

In this sense, it is necessary to consider all stakeholders' behaviour associated with the UFT in urban planning. One of the stakeholders related to the UFT is the citizen (Kijewska et al., 2021, 2022; Lepori, 2010; Russo & Comi, 2010; Taniguchi et al., 2001; Taniguchi & Tamagawa, 2005). Recent researches indicate that citizens (or residents) have a crucial role in the urban process and are directly involved in the UFT (Amaya et al., 2020; Cassiano et al., 2021; Oliveira & Oliveira, 2017).

However, even given the relevance of this stakeholder in urban planning, citizens' perceptions and participation are not considered enough in the urban planning stages related to UFT (Cassiano et al., 2021; Kijewska et al., 2022). Because of this, understanding the residents' perception of freight problems and solutions is fundamental for directing efficient policies and consistent urban planning, which minimises these negative externalities of the logistics activity.

This perception is analysed in this master's thesis. The research question proposed is: "How do citizens perceive urban freight transport?". Six hypotheses of perception were determined based on the literature about freight problems and solutions. The development of each one is presented in Chapter 3.

- H1: Perception of the problems related to *urban infrastructure* contributes to the perception of UFT problems.
- H2: perception of problems related to *urban flow* contributes to the perception of UFT problems.
- H3: perception of *environmental problems* contributes to the perception of UFT problems.
- H4: perception of UFT problems contributes to the perception of *infrastructure and information system solutions* to minimise them (UFT solutions group).
- H5: perception of UFT problems contributes to the perception of *Government Actions* to minimise them (UFT solutions group).
- H6: perception of UFT problems contributes to the perception of *green solutions* to minimise them (UFT solutions group).

This master's thesis was based on three main justifications that, although independent, are complementary: [i] the central theme of study; [ii] the application of the method; and [iii] the possibility of comparing results in different cities in Global North and Global South, but with the same assumptions. Concerning the theme, UFT is vital in urban dynamics and essential for cities' supply and economic development. Then, citizens' perception needs to be more understood, effectively applied, and explored in UFT planning.

As for the innovative, a structural equation model (SEM) was estimated to analyse the cause-and-effect relationship between residents' perceptions of freight problems and solutions to support decision-making in transport planning. Its replicability was shown in different geographic scenarios which were compared. With these analyses, using appropriate techniques and considering the local context to ascertain the particularities, it is possible to have sustainable fright activities to meet the citizens' aspirations once they are the consumers and one of the main stakeholders in the cities.

Based on what has been presented, this master's thesis aimed to analyse citizens' perception of UFT, estimating SEM. To achieve this primary objective, the following secondary goals were established:

- To analyse the UFT importance in urban mobility through the freight problems perception from the citizen’s perspective.
- To identify solutions for incorporation into urban mobility plans.
- To compare the perception in Belo Horizonte (Brazil) and Szczecin (Poland).
- To find the bests freight propositions, considering the local context.

This master’s thesis has six chapters. After this introductory part, Chapter 2 shows the research contribution by presenting a literature review on stakeholders’ perceptions of UFT. The third Chapter details the development of the hypotheses, and the fourth presents the research approach used in this master's thesis. Chapter fifth describes the data, shows results and discusses the observed findings, comparing Brazil and Poland context. Finally, the last Chapter provides the conclusion of this master’s thesis.

2 STAKEHOLDERS IN UFT

This chapter presents the stakeholders involved in UFT. Based on their importance, a systematic review was developed to address the perception of carriers, shippers, citizens, and authorities about the freight problems and solutions. Finally, an overview was made focusing on citizens' perception research to show the similarities and differences with this master's thesis in the technique applied and variables (by statements) used. Through this conclusive topic, it was hoped to prove the study's relevance and support the hypothesis developed.

2.1 Who Are the Stakeholders in UFT?

The classification of stakeholders in the UFT is holistic, fragmented, and differing among researchers (Kiba-Janiak, 2019b). However, one of the oldest definitions of stakeholders was proposed by Ogden (1992), who pointed out shippers, receivers, trucks firms, forwarders, truck drivers, terminal operators, and other transport companies as entities who are indirectly affected by UFT while the local authorities are the agents.

Table 2-1 summarises the studies that point out four main agents in the UFT: carriers, shippers, citizens, and authorities. These stakeholders were cited by Taniguchi et al. (2001) as fundamental for freight activities. However, these terms vary from author to author, but they refer to the same stakeholders.

In addition, other stakeholders, e.g., own-account operators, producers of freight vehicles, research institutes, experts, media, and public transport operators, are presented by some researchers. These agents were not evaluated for the convenience of being retracted with less recurrence.

Table 2-1 - Main stakeholders involved with UFT.

Stakeholders	Reference
carriers [or transporters, warehouses, and companies]	Amaya et al., 2020, 2021; Ballantyne et al., 2013; Behrends, 2012; Betanzo-Quezada & Romero, 2010; Cui et al., 2015; Gatta et al., 2019; Iwan, 2014; Kiba-Janiak, 2016, 2017, 2019a, 2019b; Kijewska et al., 2021, 2022; Kijewska & Jedliński, 2016, 2018; Le Pira et al., 2017a , 2017b; Małecki et al., 2014; Marcucci et al., 2017; Muñuzuri et al., 2005; Ogden, 1992; Oliveira & Oliveira, 2017; Oliveira et al., 2018, 2019a; 2019b; Russo & Comi, 2010; Stathopoulos et al., 2012a; Tamagawa et al., 2010; Taniguchi et al., 2001; Taniguchi & Tamagawa, 2005; Taniguchi & Thompson, 2004; Taylor, 2005; Teo et al., 2012; van Duin et al., 2012; Verlinde & Macharis, 2016
shippers [or wholesalers and retailers]	Amaya et al., 2020, 2021; Behrends, 2012; Betanzo-Quezada & Romero, 2010; Cui et al., 2015; Gatta et al., 2019; Iwan, 2014; Kiba-Janiak, 2016, 2017, 2019a, 2019b; Kijewska et al., 2022; Kijewska & Jedliński, 2018; Le Pira et al., 2017a, 2017b; Małecki et al., 2014; Marcucci et al., 2017; Muñuzuri et al., 2005; Oliveira & Oliveira, 2017; Oliveira et al., 2018, 2019a, 2019b; Russo & Comi, 2010, 2011; Stathopoulos et al., 2012a; Tamagawa et al., 2010; Taniguchi et al., 2001; Taniguchi & Tamagawa, 2005; Taniguchi & Thompson, 2004; Taylor, 2005; van Duin et al., 2012; Verlinde & Macharis, 2016
authorities [or administrators, planners, and regulators]	Ballantyne et al., 2013; Behrends, 2012; Cui et al., 2015; Gatta et al., 2019; Iwan, 2014; Kiba-Janiak, 2016, 2017, 2019a, 2019b; Kijewska et al., 2021, 2022; Kijewska & Jedliński, 2016, 2018; Le Pira et al. 2017a, 2017b; Małecki et al., 2014; Muñuzuri et al., 2005; Ogden, 1992; Oliveira & Oliveira, 2017; Oliveira et al., 2018, 2019b; Russo & Comi, 2010, 2011; Tamagawa et al., 2010; Taniguchi et al., 2001; Taniguchi & Tamagawa, 2005; Taniguchi & Thompson, 2004; Taylor, 2005; Teo et al., 2012; van Duin et al., 2012
citizens [or residents, visitors, and consumers]	Amaya et al., 2020, 2021; Behrends, 2012; Cui et al., 2015; Gatta et al., 2019; Iwan, 2014; Kiba-Janiak, 2016, 2017, 2019a, 2019b; Kijewska et al., 2021, 2022; Kijewska & Jedliński, 2016, 2018; Le Pira et al. 2017a, 2017b; Małecki et al., 2014; Oliveira & Oliveira, 2017; Oliveira et al., 2018, 2019a, 2019b; Russo & Comi, 2010, 2011; Tamagawa et al., 2010; Taniguchi et al., 2001; Taniguchi & Tamagawa, 2005; Taniguchi & Thompson, 2004; Taylor, 2005; Teo et al., 2012; van Duin et al., 2012

Based on the literature, the main stakeholders are defined as follows:

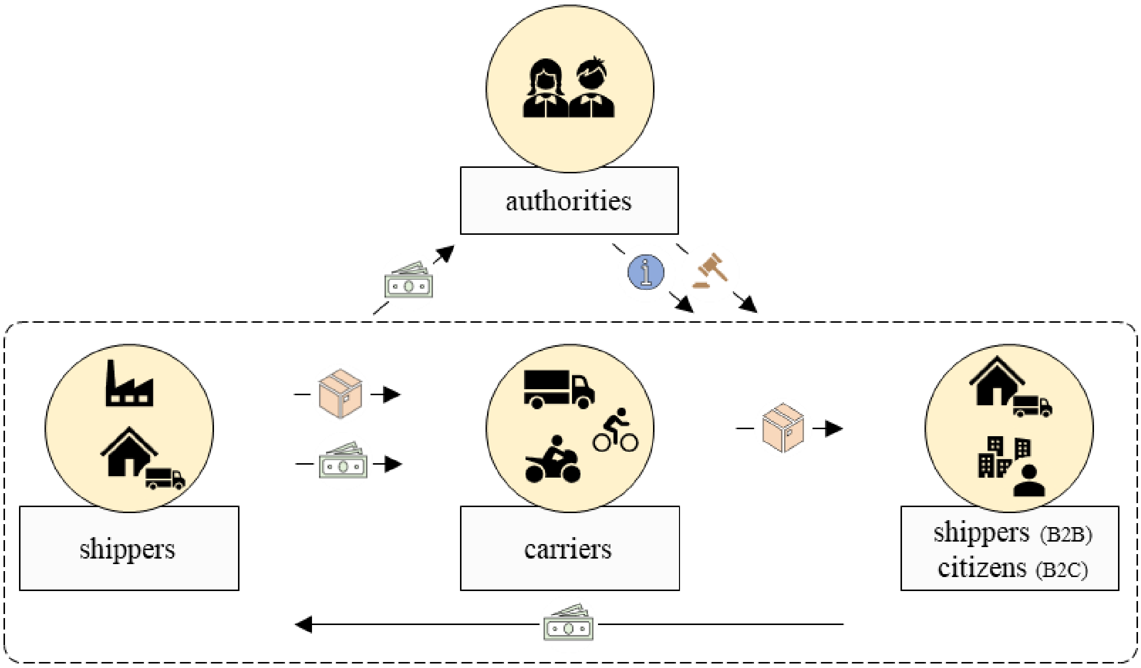
- Carriers are responsible for freight transport. Its business aims for rentability; thus, carriers look for the efficiency of UFT, that is, reducing costs and maximising profit (e.g., using the total capacity of freight vehicles or route optimisation). Moreover, carriers seek to provide the best level of service, i.e., transport or distribute goods efficiently, at the lowest cost and in the shortest period.
- Shippers are the stakeholders who forward the goods in wholesale, retail, or e-commerce. Regardless of sector, the main expectations of shippers are related to the process safes and efficiencies, that is reliability. Shippers wish to send the most significant volume of goods in a business-to-business (B2B) or business-to-consumer (B2C) trade to reach the destination (which may be another shipper or the final consumer) at the lowest cost, without damage to the goods and in the shortest time,

without exceeding the deadlines established with the receiver. Importantly, if the shipper's recipient is the retail trade, this stakeholder (another shipper) wants to receive their goods at the most convenient time for them.

- Authorities are public administrations intended to regulate other stakeholders' roles and promote interaction between them without conflicts. The local authorities seek an attractive urban environment for citizens and an efficient transport operation, which minimises external effects and maximises economic benefits to the city (or country). Another expectation of these authorities is that UFT's activities are carried out by current legislation.
- Citizens are the stakeholders who live, work, and consume the goods circulate in and to the cities, the final consumers of the goods produced and transported. Their interests sometimes are opposite: while the resident wants [i] to receive their orders without damage, in the shortest possible time and with low freight costs, and/or [ii] have the variety and affordability of products, at least impact, i.e., minimum congestion, noise, pollution or accidents caused by the UFT.

Figure 2-1 summarises the interaction of these agents in the B2B and B2C concerning the goods movement (represented by ) and money flow (represented by ). In the representation, shippers, carriers, and citizens act on the supply/demand line while their operating relationships are regulated () and supervised () by the authorities. The reverse demand in this flow occurs due to delivery failures and the need to exchange products (Alves et al., 2019; Behrends et al., 2008; Rai et al., 2017; Visser et al., 2014).

Figure 2-1 - UFT stakeholders and their interaction.



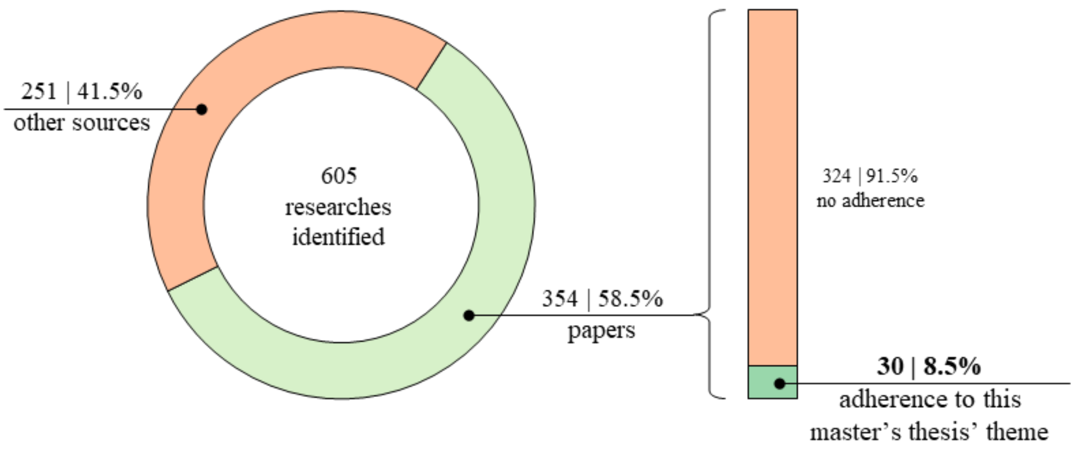
2.2 Stakeholders' Perception in UFT Context

This chapter investigated how the literature has approached the perception of the four main UFT stakeholders. A systematic literature review was carried out using the terms "*urban freight transport*" + "*perception*" + "*stakeholder*" in Scopus, a scientific database platform. Six hundred thirty-three documents were found, twenty-four duplicates, and four could not be accessed due to access restrictions. The 605 remaining documents were opened, one by one, to check the type (scientific article or other sources), title, author/authors, and year of publication.

From that, 58.5% of the results are papers published, e.g., in journals, conference proceedings, and book chapters. The other 41.5% were, e.g., postgraduate dissertations and theses, manuals or reports on public-private interests and book chapters. The following analysis was concentrated on the first publication group.

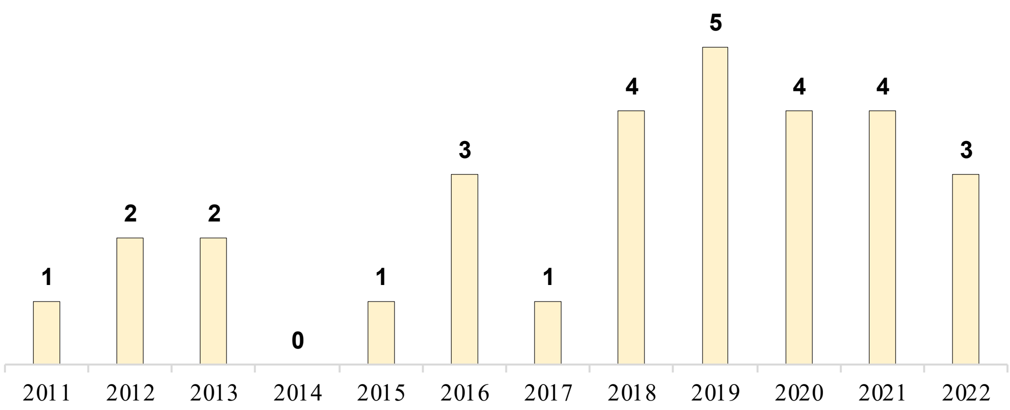
The titles and abstracts were read to verify adherence to the purposes of the theme of this master's thesis: perception about the freight problems and freight solutions, that is, if the papers aim to assess the perception of the four main stakeholders about UFT. Specific research that [i] evaluated the perception of only one freight problem or solution (e.g., Bakås et al., 2017; Carvalho et al., 2019 and Marcucci & Gatta, 2017); [ii] was not possible to separate the perception of each stakeholder; and [iii] presented the perception of another stakeholder, different from those presented in Chapter 2.1; were not included in this review. Only 30 papers fit these criteria (8.5%). These papers were read and evaluated individually, with the main conclusions presented below. Figure 2-2 shows the numbers and percentages of the basic information of this literature review.

Figure 2-2 - Summary of the systematic literature review.



A bibliometric analysis was made with these thirty papers. Regarding publication dates, the first papers about UFT's perception were published after 2011, indicating that the subject is relatively recent. Still, the most significant study volume is concentrated in the last five years, as summarized in Figure 2-3.

Figure 2-3 - Number of papers published by year.



The papers selected had over 1,000 citations, averaging 34 per document. The most cited researchers are Ballantyne et al. (2013), Rai et al. (2019), Oliveira & Oliveira (2016), Stathopoulos et al. (2012a, 2012b), and Vieira et al. (2015). The main conclusions of the papers are presented in the following sections, and his step aims to corroborate the gap in the literature on the topic studied in this master's thesis.

2.2.1 Carriers

Some researchers evaluated the perception of carriers about freight problems and freight solutions (Amaya et al., 2020; Ballantyne et al., 2013; Carvalho et al., 2019; Furquim et al., 2018; Jardas et al., 2021; Jedliński & Kijewska, 2016; Kijewska et al., 2021; Muñuzuri et al., 2016; Oliveira & Oliveira, 2016, 2017; Oliveira et al., 2019a, 2020b; Stathopoulos et al., 2012a, 2012b; Vieira et al., 2015). As general conclusions observed, the lack of L/U areas was the most perceived freight problem among carriers (Ballantyne et al., 2013; Jardas et al., 2021; Jedliński & Kijewska, 2016; Oliveira & Oliveira, 2017; Oliveira et al., 2019a; Vieira et al., 2015). Congestion (Oliveira & Oliveira, 2017; Oliveira et al., 2019a, 2020b; Vieira et al., 2015) and inappropriate use of roads by trucks (Oliveira et al., 2020b; Stathopoulos et al., 2012b) were also perceptions of carriers considered by the researches.

Jardas et al. (2021) pointed out accidents involving trucks as a freight operation negative externality, and Vieira et al. (2015) mentioned cargo theft as a freight problem. Although they do not appear with recurrence in the perception of carriers in the other papers identified, these issues are directly associated with UFT operation in Brazil and contribute to the general perception of negative freight externalities.

Specific perceptions were also identified and are interesting for the context of this master's thesis: Stathopoulos et al. (2012a) concluded that one of the leading freight problems is the lack of control by authorities over the misuse of L/U areas. This conclusion indicates that there is a perception of the other stakeholders' attributions.

Ballantyne et al. (2013) concluded that freight planning conditions are impacted by route restrictions on specific days or hours, characterizing them as freight problems by carriers. The author also identified a lack of knowledge about the operation of the UFT by other stakeholders, making it difficult for others to perceive problems and solutions for freight activities. Jardas et al. (2021) considered environmental issues one of the carriers' main freight problems. Moreover, the pollution caused by freight operations is a latent negative externality of the UFT.

In the same way, the central freight solutions observed in the papers analysed were the new L/U areas (Amaya et al., 2020; Oliveira et al., 2019a; Stathopoulos et al., 2012) and the urban distribution centres (UDC) use (Carvalho et al., 2019; Oliveira & Oliveira, 2016; Stathopoulos et al., 2012). The environmentally friendly freight solutions, such as green vehicles and pick-up points, were also perceived as efficient city logistics measures by carriers (Oliveira et al., 2019a; Stathopoulos et al., 2012a). Carvalho et al. (2019) also realize that the pollution caused by trucks must be considered in sustainable freight solutions.

Regarding technological solutions, such as the L/U area booking, Stathopoulos et al. (2012a) concluded that this measure could not be effective for freight problems. However, real-time traffic information was already perceived as a way to minimize them (Oliveira et al., 2020b; Stathopoulos et al., 2012a).

Ballantyne et al. (2013) and Oliveira et al. (2019a) concluded that freight truck restrictions (the most common measure implemented by the city authorities) are not perceived as efficient measures to minimize freight problems. This happens because the restriction creates longer routes, contributing to higher consumption and emissions and minimizing the expected effectiveness and efficiency of the UFT (Ballantyne et al., 2013). Another inefficient freight solution reported by carriers was off-hour delivery (Furquim et al., 2018; Oliveira & Oliveira, 2016; Oliveira et al., 2020b).

Concluding, the literature shows that the carriers' perception is associated with the interests of these stakeholders: agility and efficiency for UFT. For example, L/U areas are considered a problem (in this case, the lack of these areas) or a solution (in this case, the availability of these areas). Thus, the perception varies according to the impact on freight efficiency.

2.2.2 Shippers

Shippers are the usual stakeholders evaluated in the literature, being identified in seventeen papers (Amaya et al., 2020; Carvalho et al., 2019; Furquim et al., 2018; Jardas et al., 2021; Kijewska et al., 2021; Matusiewicz, 2022; Oliveira & Oliveira, 2016, 2017; Oliveira et al., 2018, 2019b, 2020a, 2020b, 2021; Stathopoulos et al. 2012a, 2012b; Vieira et al., 2015; Zenezini et al., 2018).

For these stakeholders, congestion is the leading freight problem (Furquim et al., 2018; Jardas et al., 2021; Oliveira & Oliveira, 2017; Oliveira et al., 2018, 2020a, 2020b; Stathopoulos et al., 2012; Vieira et al., 2015). The lack of L/U areas (Jardas et al., 2021; Oliveira & Oliveira, 2017; Oliveira et al., 2018, 2021; Stathopoulos et al., 2012) and the lack of UDC (Furquim et al., 2018; Stathopoulos et al., 2012) also appear recurrently as a negative externality in the shippers' perception.

The more efficient and recurrent freight solution from a shippers' perspective is increasing L/U areas (Amaya et al., 2020; Carvalho et al., 2019; Oliveira & Oliveira, 2016; Oliveira et al., 2020b; Stathopoulos et al., 2012). Additionally, off-hour (Oliveira et al., 2018, 2020b), freight trucks restriction (Oliveira et al., 2021), and exclusive lanes for trucks (Stathopoulos et al., 2012) were considered as solutions to freight -problems.

About environmentally friendly measures, Kijewska et al. (2021) concluded that shippers perceive them as freight solutions. The measures found in the literature include using (Stathopoulos et al., 2012a), cargo bikes and pick-up points (Zenezini et al., 2018).

In contrast to effective measures, Oliveira & Oliveira (2016) concluded that shippers do not perceive off-hour deliveries as effective freight solutions, justified by the onus of these measures. Matusiewicz (2022) indicated that off-hour deliveries would be one of the most straightforward measures to implement but the least efficient.

Based on the existing literature, shippers perceive more clearly the congestion as the worst freight problem and the L/U areas as the best solutions. This perception is also in line with the interests of this agent.

2.2.3 City Authorities

The literature regarding the city authorities perception was evaluated by some scholars (Dias et al., 2018; Jardas et al., 2021; Karakikes & Nathanail, 2020; Kijewska et al., 2021; Marsden et al., 2011; Oliveira & Oliveira, 2016, 2017; Stathopoulos et al., 2012a, 2012b). The environmental problems concern the city authorities (Jardas et al., 2021; Marsden et al., 2011), mainly related to freight vehicle emissions (Marsden et al., 2011).

Concerning the freight solutions, many perspectives were presented. Some effective city logistics measures include signalling and information about truck routes (Kijewska et al., 2021; Marsden et al., 2011), L/U areas booking (Stathopoulos et al., 2012a), freight vehicles restriction (Ballantyne et al., 2013; Dias et al., 2018), off-hour deliveries (Karakikes & Nathanail, 2020), UDCs (Kijewska et al., 2021; Oliveira & Oliveira, 2016) and green vehicles (Stathopoulos et al., 2012a).

Ballantyne et al. (2013) concluded that city authorities do not have experience in UFT and rarely consider it in land use planning. Oliveira & Oliveira (2017) showed that the lack of [i] regulation; [ii] interaction between operators and retailers; and [iii] policy; are the worst freight problems in Belo Horizonte (Brazil). From the operational perspective, the main problems are the cargo vehicles' low speed and reduced road safety.

2.2.4 Citizens

Thirteen papers evaluated citizens' perceptive (Amaya et al., 2020, 2021; Carvalho et al., 2019; Dexheimer et al., 2013; Hatzistamatis et al., 2019; Jardas et al., 2021; Jedliński & Kijewska, 2016; Kijewska et al., 2021, 2022; Leite et al., 2022; Oliveira & Oliveira, 2016, 2017; Rai et al., 2019). According to the literature, citizens' perception of freight problems and the solutions is heterogeneous (Amaya et al., 2021; Kijewska et al., 2022).

Also about the problems, residents perceive that freight operation is one of the main problems of the city (Oliveira & Oliveira, 2017), mainly due to the perception that there are trucks parked on the street, using sidewalks as the L/U area, and blocking entrances and passages (Carvalho et al., 2019; Dexheimer et al., 2013; Jardas et al., 2021; Jedliński & Kijewska, 2016; Oliveira & Oliveira, 2017).

The literature also points out that citizens perceive that UFT negatively contributes to city congestion (Jedliński & Kijewska, 2016; Kijewska et al., 2022; Oliveira & Oliveira, 2017), noise and pollutant emissions (Carvalho et al., 2019; Dexheimer et al., 2013; Jardas et al., 2021; Leite et al., 2022; Oliveira & Oliveira, 2017).

Carvalho et al. (2019) concluded that trucks' movement reduces road safety for residents. For Hatzistamatis et al. (2019), trucks also reduce urban mobility. In a cause-and-effect relationship, residents' perception of freight problems decreases as their perception of good infrastructure conditions improves (Amaya et al., 2021).

Regarding freight solutions, for some citizens, increasing the L/U areas would be an efficient measure to minimize the problems (Amaya et al., 2020; Jedliński & Kijewska, 2016). Truck restrictions also appear as a good city logistic measure (Amaya et al., 2020; Oliveira & Oliveira,

2017) because it reduces accidents and pollution (Oliveira & Oliveira, 2017). To citizens, off-hour deliveries (presented by other stakeholders as ineffective solutions) are efficient (Oliveira & Oliveira, 2016) since they would eliminate part of the traffic and reduce congestion.

The literature also points out that citizens perceive environmentally friendly solutions to freight problems, including that alternative delivery systems improve air quality (Kijewska et al., 2021). Some evaluated measures include using green vehicles (Carvalho et al., 2019) and cargo bikes (Kijewska et al., 2022). However, although residents were willing to use pick-up points if short distances were travelled, they would not pay more for deliveries to make it most sustainable (Rai et al., 2017).

Therefore, the heterogeneity of citizens' perceptions regarding freight problems and solutions is more latent. This is because interests, desires, and needs vary from individual to individual, requiring assessing conditions, e.g., geographic, political, and social.

2.3 Literature Gap and Contribution

As presented in this chapter, the UFT literature proved relatively vast. However, few studies give the perception of the main UFT stakeholders, and only thirteen evaluate the citizens' perception. Table 2-2 shows a list of these works.

Table 2-2 - Research found that assesses citizens' perception of UFT.

Reference	Title
Dexheimer et al. (2013)	Society's Perception to the Presence of Urban Distribution Trucks
Oliveira & Oliveira (2016)	Stakeholder's perceptions of city logistics: An exploratory study in Brazil
Jedliński & Kijewska (2016)	The concept of binary evaluation of freight quality partnership impact on the principles of sustainable urban development
Oliveira & Oliveira (2017)	Stakeholder's perception about urban goods distribution solution: exploratory study in Belo Horizonte (Brazil)
Hatzistamatis et al. (2019)	Can night deliveries actually work in a medium size Greek city?
Carvalho et al. (2019)	Criteria to implement UDCs in historical cities: a Brazilian case study
Rai et al. (2019)	The "next day, free delivery" myth unravelled: Possibilities for sustainable last mile transport in an omnichannel environment
Amaya et al. (2020)	Stakeholders perceptions to sustainable urban freight policies in emerging markets
Amaya et al. (2021)	Urban freight logistics: What do citizens perceive?
Kijewska et al. (2021)	Ecological utility of FQP projects in the stakeholders' opinion in the light of empirical studies based on the example of the city of Szczecin

Reference	Title
Jardas et al. (2021)	Defining and Measuring the Relevance of Criteria for the Evaluation of the Inflow of Goods in City Centers
Kijewska et al. (2022)	Evaluation of Urban Mobility Problems and Freight Solutions from Residents' Perspectives: A Comparison of Belo Horizonte (Brazil) and Szczecin (Poland)
Leite et al. (2022)	Opinion of Residents about the Freight Transport and Its Influence on the Quality of Life: An Analysis for Brasília (Brazil)

An analysis of this research was necessary to indicate the differences from what is proposed in this master's thesis. About how the researchers evaluate the residents' perception, Table 2-3 presents the research method used by each paper.

Table 2-3 - Research approach used by existing research.

Technique	Dexheimer et al. (2013)	Oliveira & Oliveira (2016)	Jedliński & Kijewska (2016)	Oliveira & Oliveira (2017)	Hatzistamatis et al. (2019)	Carvalho et al. (2019)	Rai et al. (2019)	Amaya et al. (2020)	Amaya et al. (2021)	Kijewska et al. (2021)	Jardas et al. (2021)	Kijewska et al. (2022)	Leite et al. (2022)
Qualitative analysis	x	x	x	x	x	x	x				x	x	
Ranking modelling								x		x			
SEM									x				x

Most research approaches are based on qualitative analysis to assess the citizens' perception, mainly the descriptive statistics of semi-structured interviews. Descriptive statistics is a very appropriate method when the objective is to express data (Sharma et al., 2018). Still, it is limited to the description and interpretation of the information collected, obtaining conclusions from the data about themselves (Pérez-Vicente & Ruiz, 2009).

Two papers used rankings modelling to identify the citizens' perception of the worst freight problems and the most efficient solutions. This method, already more robust than descriptive statistics, and the method of successive interval (MSI) used for the analysis of other agents, allow for more specific measurements and was even used for another stage of this master's research and resulted in the Kijewska et al. (2022) publication.

Finally, of the 13 studies referring to the citizens' perception, only 2 of them use the same technique proposed here, SEM, and both were published after the beginning of this master's research. As shown in Chapter 4.3, SEM is a multivariate statistical modelling that combines factor analysis and regression and measures the cause-and-effect relationships. Also, in addition to being a more robust technique than the main ones used by other researchers, SEM allows theoretical evaluations through complex relationships between variables that can be measured. It is on these variables that the differences between this master's thesis and other research are shown below.

Before that, however, in addition to collaborating in the gap of a few citizens' evaluations (a crucial stakeholder of UFT), this research uses an approach that has not been significantly explored for these purposes (perception analysis in UFT's context). Then, the modelling process of this master's thesis is one of its most remarkable contributions to UFT analyses.

The freight problems and solutions used by the 13 researchers analysed to assess the citizens' perception are presented in Table 2-4 regarding the variables (by statements) used in this master's research (explained in Chapter 4.1 and Appendix A). That is, which published papers used the same problems/solutions to assess perception were verified.

Table 2-4 - Variables evaluated by existing research.

Variables P | freight problems in the city S | freight solutions that improve traffic	**Dexheimer et al. (2013)**	**Oliveira & Oliveira (2016)**	**Jedliński & Kijewska (2016)**	**Oliveira & Oliveira (2017)**	**Hatzistamatis et al. (2019)**	**Carvalho et al. (2019)**	**Rai et al. (2019)**	**Amaya et al. (2020)**	**Amaya et al. (2021)**	**Kijewska et al. (2021)**	**Jardas et al. (2021)**	**Kijewska et al. (2022)**	**Leite et al. (2022)**
P1: Many cars													
P2: Many trucks			x										
P3: Congestion	x		x	x	x	x			x		x	x	x
P4: Pollution	x			x	x	x			x		x	x	x
P5: Noise from cars	x			x	x	x			x		x		x
P6: Lack of parking areas	x		x	x		x						x	x
P7: Many trucks parked on the street													
P8: UFT is a problem for the city									x			x	x
P9: Accidents involving trucks	x					x					x	x	
P10: Trucks affecting the safety				x	x	x							
P11: Garbage trucks hamper traffic									x				
P12: Trucks parked in inappropriate areas hamper traffic	x												
S1: Truck restriction				x				x				x	
S2: New L/U areas		x				x		x	x	x		x	
S3: Clearer signage in L/U areas													
S4: Circulation of green vehicles						x	x	x	x	x	x	x	x
S5: Road pricing								x				x	
S6: Financial assistance													x
S7: Cargo bike				x			x			x		x	x
S8: Information about truck routes										x		x	
S9: Intelligent signalling for truck routes													
S10: Pick-up points							x			x		x	x
S11: Campaigns for sustainable transport												x	
S12: Mobility plan												x	x
S13: Discussion groups about UFT												x	
S14: Urban planning													

Existing researchers did not use many of the variables used in this research for SEM. Number of cars and trucks in the city (different from congestion) and trucks parking on roads and in inappropriate areas, for example, were not freight problems evaluated in surveys about residents' perception of UFT. About the city logistics measures, a few were the roles that took as variables: signalling of L/U areas, financial assistance by the government, information and signalling of truck routes, environmental campaigns, and urban planning.

Otherwise, the most common variables to assess UFT perception in literature are congestion, L/U areas, environmental problems, truck restriction, and use of active modes to UFT. Furthermore, limited to the two studies that evaluated the perspective using the same technique as this master's thesis, Table 2-4 shows that the other researchers used not half of the freight problems and solutions evaluated here as a measurement object. Thus, this research contributes to evaluating other poorly studied problems and solutions in addition to the commonly studied ones relevant to the UFT context.

Thus, it was concluded that [i] the phenomenon evaluated in this master's thesis is little explored in research on freight context; [ii] those that deal with the citizens’ perception of UFT use more techniques when it is not possible to analyse the cause-and-effect relationship; and [iii] the variables (by statements) used for this perception assessment follow a pattern, not including other that are associated with the UFT operation.

3 CAUSAL RELATIONSHIPS - CITIZENS AND UFT

As previously introduced, for the analysis made in this master's thesis, SEM was applied. The models that base this kind of modelling are elaborated through systematic relations: the hypotheses (Hair et al., 2014b, 2021; Ringle et al., 2020). In this study, the research hypotheses were the basis for building these relationships, developed from theory (literature) and the logic and expertise of the researchers involved.

Thus, this chapter demonstrates the elements, logic, and literature supporting the development of the six research hypotheses. Also, the freight problems and freight solutions are presented, which, collectively, were the basis for this hypothesis and for constructing the statements used in the research questionnaire (see Chapter 4.1 and Appendix A).

The same papers from the previous Chapter (that analysed the UFT stakeholders' perception) were evaluated to identify the problems and solutions presented in the literature. This is because if these researchers consider negative externalities and measures to minimize them in a similar phenomenon to this master's thesis, there is a relationship with what was aimed here.

First, the freight solutions were grouped based on the literature. Russo & Comi (2010) presented propositions to identify homogeneous characteristics that could be used together for decision-making in the context of the problems. The objectives of the researchers relate to those of this master's thesis. These measures were grouped into "material infrastructure", "immaterial infrastructure", "equipment", and "governance".

For the first two groups, freight solutions related to infrastructure and information systems, e.g., changes in the transport network, increase in L/U areas, UDCs, traffic information system, freight capacity exchange system, route optimization, and information services by internet, were cited (Russo & Comi, 2010). Measures related to "equipment" were environmentally biased and included new standards such as green vehicles, pick-up and delivery, and use of metropolitan railways and tram infrastructure to UFT. In the solutions related to "governance", Russo & Comi (2010) grouped measures of traffic regulations, e.g., access restrictions, heavy vehicle networks, road-pricing, and specific permission.

Muñuzuri et al. (2005) have already presented a similar approach. The authors grouped "types of solutions for urban freight transport" related to public infrastructure (e.g., city terminals, and use of rail or ship terminals and public parking lots), land use management (e.g., L/U areas, hub areas, mini-warehouses), access conditions (spatial and time restriction, e.g., road pricing and off-hour deliveries), and traffic management (scope of regulations and information).

Thus, and based on this, the freight solutions were grouped into three classes for this master's thesis related to the essence of their implementations and results associated with minimising the problems. Table 3-1 illustrates this grouping and the associated statements.

From this grouping, the freight problems presented in the literature were associated in a way that they were related to the groups of solutions. More, the problems were grouped so that it was possible (see H1 to H3) to see their contributions to the perception of the negative externalities of the UFT in general.

For this, another three groups were developed. The first one, “urban infrastructure”, grouped the infrastructure-related problems since the literature indicated that these conditions are associated with the perception of freight problems (Amaya et al., 2021). Congestion appeared with more recurrence among the negative freight externalities cited in the analysed papers. This is because it was found that their impact was more easily perceived by the traffic conditions to which the stakeholders were subject daily. Based on this, the second group, "urban flow", grouped congestion and other problems directly correlated with flow conditions.

Finally, to associate the "green solution", the "environmental issues" that appear most in the evaluated literature were grouped so that it was possible to assess the environmental perception of citizens in the UFT context. Table 3-2 illustrates this grouping and the associated statements.

Table 3-1 - Freight solution groups and associated statements.

Freight Solutions	Statement	Reference
Infrastructure and information system solutions	Truck restriction improves traffic.	Amaya et al., 2020; Ballantyne et al., 2013; Dias et al., 2018; Kijewska et al., 2022; Muñuzuri et al., 2016; Oliveira & Oliveira, 2017; Oliveira et al., 2018, 2019a 2020a, 2021; Stathopoulos et al., 2012; Vieira et al., 2015)
	Loading and unloading areas improve traffic.	Amaya et al., 2020, 2021; Carvalho et al., 2019; Dias et al., 2018; Karakikes & Nathanail, 2020; Kijewska et al., 2021, 2022; Marsden et al., 2011; Matusiewicz, 2022; Muñuzuri et al., 2016; Oliveira & Oliveira, 2016; Oliveira et al., 2019b, 2021; Stathopoulos et al., 2012a, 2012b; Vieira et al., 2015
	Clearer signage for loading and unloading areas improves traffic.	Oliveira et al., 2019a
	Information about truck routes in the city improves traffic.	Kijewska et al., 2021, 2022; Matusiewicz, 2022; Muñuzuri et al., 2016; Oliveira et al., 2020a; Stathopoulos et al., 2012b
	Smart signalling for truck routes improves traffic.	Dias et al., 2018; Marsden et al., 2011
Government actions solutions	Trucks paying a fee to drive in the city improve traffic.	Amaya et al., 2020; Kijewska et al., 2022; Muñuzuri et al., 2016; Stathopoulos et al., 2012b
	Financial aid from the government to buy new cars improves traffic.	Leite et al., 2022; Oliveira et al., 2018
	Campaigns for sustainable transport improve city traffic.	Kijewska et al., 2022
	Mobility plan improves traffic.	Dias et al., 2018; Kijewska et al., 2022; Leite et al., 2022; Oliveira et al., 2019a
	Discussion groups on freight transport, including residents, improve traffic in the city.	Kijewska et al., 2022
	Urban planning improves traffic in the city.	Karakikes & Nathanail, 2020
Green (environmental) solutions	Only allowing the circulation of new vehicles that are not very polluting improves traffic.	Amaya et al., 2020, 2021; Carvalho et al., 2019; Jardas et al., 2021; Karakikes & Nathanail, 2020; Kijewska et al., 2021, 2022; Leite et al., 2022; Marsden et al., 2011; Matusiewicz, 2022; Oliveira et al., 2019a, 2019b, 2021; Rai et al., 2019; Stathopoulos et al., 2012a, 2012b

Freight Solutions	Statement	Reference
	Delivery of goods by bicycle improves traffic.	Karakikes & Nathanail, 2020; Kijewska et al., 2021, 2022; Leite et al., 2022; Oliveira & Oliveira, 2017; Oliveira et al., 2019a; Rai et al., 2019; Zenezini et al., 2018
	Receiving and picking up products purchased over the Internet from stores or smart cabinets improves traffic.	Dias et al., 2018; Karakikes & Nathanail, 2020; Kijewska et al., 2021, 2022; Leite et al., 2022; Oliveira et al., 2019a; Rai et al., 2019; Stathopoulos et al., 2012b; Zenezini et al., 2018

Table 3-2 - Freight problem groups and associated statements.

Freight Problems	Statement	Reference
Urban infrastructure problems	There are no parking areas in the city.	Ballantyne et al., 2013; Carvalho et al., 2019; Dexheimer et al., 2013; Furquim et al., 2018; Jedliński & Kijewska, 2016; Kijewska et al., 2022; Leite et al., 2022; Oliveira & Oliveira, 2017; Oliveira et al., 2018, 2019a, 2020a, 2021; Stathopoulos et al.,2012a, 2012b; Vieira et al., 2015
	Trucks affect the safety of people walking and cyclists.	Carvalho et al., 2019; Hatzistamatis et al., 2019; Oliveira & Oliveira, 2017; Oliveira et al., 2019b
Urban flow problems	There are many cars in the city.	Oliveira et al., 2018
	There are many trucks/vans in the city.	Jedliński & Kijewska, 2016; Oliveira et al., 2018
	There is a lot of congestion in the city.	Amaya et al., 2021; Carvalho et al., 2019; Dexheimer et al., 2013; Furquim et al., 2018; Hatzistamatis et al., 2019; Jardas et al., 2021; Jedliński & Kijewska, 2016; Kijewska et al., 2022; Leite et al., 2022; Marsden et al., 2011; Oliveira & Oliveira, 2017; Oliveira et al., 2018, 2019a; 2019b; 2021; Stathopoulos et al., 2012a, 2012b; Vieira et al., 2015
	There are many trucks parked on the street.	Stathopoulos et al. 2012a, 2012b
	There are many accidents involving trucks in the city.	Carvalho et al., 2019; Dexheimer et al., 2013; Jardas et al., 2021; Kijewska et al., 2022
	Garbage collection trucks hinder traffic.	Amaya et al., 2021

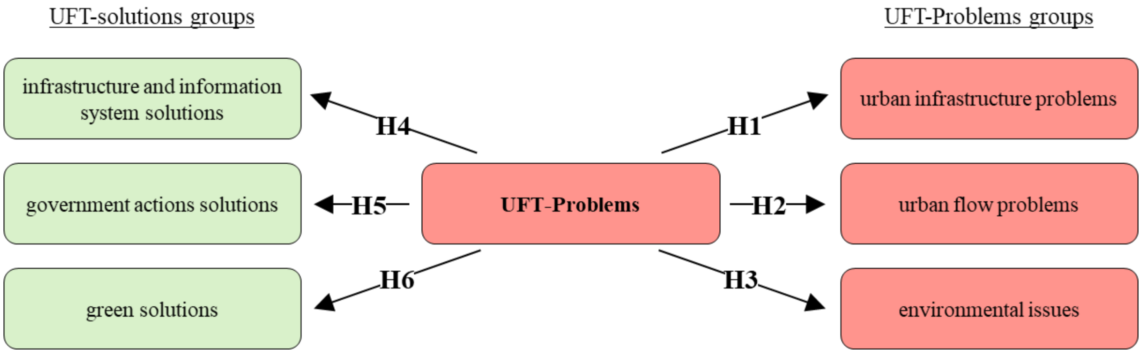
Freight Problems	Statement	Reference
	Trucks parked in inappropriate places hinder traffic in the city.	Dexheimer et al., 2013; Stathopoulos et al., 2012a, 2012b; Vieira et al., 2015
Environmental issues	The city is very polluted.	Amaya et al., 2021; Ballantyne et al., 2013; Carvalho et al., 2019; Dexheimer et al., 2013; Hatzistamatis et al., 2019; Jardas et al., 2021; Kijewska et al., 2022; Leite et al., 2022; Marsden et al., 2011; Oliveira & Oliveira, 2017; Oliveira et al., 2019a; Vieira et al., 2015
	There is a lot of noise because of the cars in the city.	Amaya et al., 2021; Ballantyne et al., 2013; Carvalho et al., 2019; Dexheimer et al., 2013; Furquim et al., 2018; Hatzistamatis et al., 2019; Jardas et al., 2021; Leite et al., 2022; Oliveira & Oliveira, 2017; Oliveira et al., 2019a, 2021

After defining the freight problems and solutions groups, the research hypotheses were developed to answer the research question and reach the predetermined objectives. For this, each group of problems was associated with externalities in general to see their perception contributions in the context of the UFT.

These relations allow to analyse the perception of citizens about the UFT, creating the main hypotheses of this master's thesis, shown in Figure 3-1 and described below:

- H1: perception of the problems related to *urban infrastructure* contributes to the perception of UFT problems.
- H2: perception of problems related to *urban flow* contributes to the perception of UFT problems.
- H3: perception of *environmental problems* contributes to the perception of UFT problems.
- H4: perception of UFT problems contributes to the perception of *infrastructure and information system solutions* to minimise them.
- H5: perception of UFT problems contributes to the perception of *Government Actions* to minimise them.
- H6: perception of UFT problems contributes to the perception of *green solutions* to minimise them.

Figure 3-1 - Hypotheses.



4 RESEARCH APPROACH

This section presents the approach adopted in the analysis development to assess freight problems and freight solutions from the citizens' perspective. After a brief descriptive statistic, the data collected were analysed with SEM, whose concepts, formulations, restrictions, and applications are presented here.

4.1 Data Collection

Based on the hypotheses, a questionnaire was designed for the data collection. The questionnaire had three parts: [Part 1] freight problems perception, [Part 2] freight solutions perception, and [Part 3] socioeconomic information. Table 4-1 presents the structure of the questionnaire, which is in its entirety in Appendix A.

Google Forms, a free online platform, hosted the questionnaire. The survey focused on two cities: Belo Horizonte (Brazil) and Szczecin (Poland), characterized in Chapter 5.1. These two cities were chosen due to the convenience of data collection. Also, they have the same importance regarding the people's movement and services in their respective countries and represent different cities in the global south and global north, respectively.

In Belo Horizonte, the survey was disseminated through social networks between the last quarter of 2020 and the last quarter of 2021. The snowball procedure was indirectly applied since respondents were asked to share the questionnaire. The research focused on collecting data from all regions of Belo Horizonte. In Szczecin, the same questionnaire was administered from mid-2021 until the end of that year in person and through Google Forms. The area delimitation was based on the goods transport impact in the central area. Personal interviews and internet-based surveys produce similar results (Marta-Pedroso et al., 2007). The answers collected were organized in a spreadsheet.

Table 4-1 - Questionnaire structure.

Part / Theme	Variable / Statements	Code	Response Type
Part 1 freight problems	Many cars	P1	Likert scale (1 to 5) [v]
	Many trucks	P2	
	Congestion	P3	
	Pollution	P4	
	Noise	P5	
	No parking areas	P6	
	Trucks parked on the street	P7	
	UFT as a problem	P8	
	Accidents	P9	
	Safety	P10	
	Garbage trucks	P11	
	Trucks parked in inappropriate areas	P12	
Part 2 freight solutions	Truck restriction	S1	Likert scale (1 to 5) [v]
	New L/U areas	S2	
	Signalling in L/U areas	S3	
	Green vehicles	S4	
	Roading pricing	S5	
	Government's assistance	S6	
	Cargo bike	S7	
	Truck routes information	S8	
	Truck routes' signalling	S9	
	Pick-up points	S10	
	Campaigns for sustainable UFT	S11	
	Mobility plan	S12	
	Discussion groups	S13	
	Urban planning	S14	
Part 3 Socioeconomic	Age	A	Categorical (6 classes) [i]
	Income	I	Categorical (6 classes) [ii]
	Educational Level	E	Categorical (2 classes) [iii]
	Vehicle used for work/school trip purposes	V	Categorical (6 classes) [iv]

[i] less than 20; 21-30; 31-40; 41-50; 51-60; more than 60
[ii] less than $200; $200 - $400; $400 - $600; $600 - $1,000; $1,000 - $2,000; More Than $2,000[1]
[iii] higher education (complete or incomplete); high school (complete or incomplete)
[iv] public transport; car; by foot; carsharing; motorcycle; bike
[v] (1) strongly disagree (2) disagree (3) neutral (4) agree (5) strongly agree

[1] In the first quarter of 2022 $ 1.00 was approximately BRL 5.00 and PLN 4.00.

4.2 Data Description

After collecting the data, each city's sample was organised, and incomplete or incoherent answers were removed. Then, descriptive statistics were used to analyse data from the three parts of the questionnaire, characterising citizens' profile, and their perceptions about UFT. Initially, data from Part 3 was described for each socioeconomic group, aiming to characterise the Brazilian and Polish respondents.

The percentage of responses per attribute of the Likert Scale was used to summarise the data and assess their relative importance. Then, the internal data consistency from Parts 1 and 2 was measured using Cronbach's Alpha.

Internal consistency is a measure of scale reliability that, together with the validity of the sample, are fundamental elements in evaluating a measurement instrument (Tavakol & Dennick, 2011; Taber, 2018). The internal consistency of the sample must be determined before any further testing or analysis to ensure its validity (Tavakol & Dennick, 2011; Taber, 2018). Cronbach's alpha, developed by Lee Cronbach in 1951, measures a sample's internal consistency and is expressed as a number between 0 and 1 (Cronbach, 1951). Cronbach's alpha describes the extent to which the items measure the same concept and to what extent it is connected to the other items. Thus, if they are correlated, the alpha value is close to 1; otherwise, it approaches 0 (Cronbach, 1951). Different studies point to different acceptable alpha values, ranging from 0.70 to 0.95, suggesting no clear consensus on the most appropriate labels to describe the values obtained when calculating alpha (Tavakol & Dennick, 2011; Taber, 2018). Thus, a Cronbach's Alpha value above 0.7 was considered acceptable (Bujang et al., 2018).

4.3 Structural Equation Modelling

SEM is a multivariate statistical modelling technique that combines factor analysis and regression. The interest of many researchers in applying SEM derives from the possibility of elaborating theoretical (latent) constructions which are not effectively observed. This is made through complex relationships between variables that can be measured and these constructions (Haenlein & Kaplan, 2004; Hair et al., 2014a, 2014b; Neves, 2018; Sarstedt & Cheah, 2019).

According to Hair et al. (2021), researchers initially relied on univariate and bivariate analyses to understand data and their interactions, with a limited and more sophisticated understanding of multivariate relationships. Table 4-2 lists some of the main statistical methods of multivariate data analysis. The first-generation techniques are frequently used and include regression-based approaches, analysis of variance, exploratory factor analysis, cluster analysis, and multidimensional scaling. When applied, these methods can confirm theories and identify patterns of data relationships. However, many researchers have turned to second-generation techniques to overcome the weaknesses of first-generation methods since these methods allow incorporating unobservable variables indirectly measured by indicator variables and accounting for measurement errors.

Table 4-2 - Multivariate methods (adapted from Hair et al., 2021).

	Exploratory Analyses	**Confirmatory Analyses**
1st Generation Techniques	Cluster; Exploratory Factor; and Multidimensional Scaling	Variance; Logistic Regression; and Multiple Regression
2nd Generation Techniques	PLS-SEM	CB-SEM; and Confirmatory Factor

One of the most applied approaches to SEM is based on covariance (CB-SEM), generally used for confirmatory analyses. However, the Partial Least Square (PLS-SEM) is another alternative technique based on variance. It is increasingly applied as a research method in several disciplines, recognising the distinctive methodological characteristics that make it more viable than the CB-SEM approach (Hair et al., 2021).

The PLS-SEM has advantages over the CB-SEM, like its applicability in smaller samples with normal and non-normal data distribution (Hair et al., 2021). Moreover, the estimated models could be complex, with many indicators and model relationships (Hair et al., 2021). Additionally, PLS-SEM can improve many research situations (Hair et al., 2021).

PLS regression differs from regular regression. However, in developing the regression model, it constructs composite factors from the multiple independent and dependent variables using principal component analysis. Before describing the technique itself, and in connection with the section on data, it is essential to list the considerations necessary for deciding to use multivariate analysis, particularly PLS-SEM. Based on Hair et al. (2021), these conditions were all verified in this study.

Important factors are the measures and their scales. Measurement is assigning numbers to a variable based on a set of rules that accurately represents that indicator (e.g., if the variable is age, an integer can be assigned, and if it is education, numbers can be assigned for each class determined). However, the measurement form is more complex since the variable is abstract if the phenomenon is not directly observed, such as satisfaction or trust (common latent constructs in SEM).

The measurement must be done indirectly from a set of indicators to those variables challenging to measure, each representing a single (separate) aspect within a larger complex. Combining the various elements makes it possible to measure this abstract phenomenon indirectly to obtain a more accurate measurement. Precision assumes that using multiple items to measure a single concept is more likely to represent all aspects of the idea. For this, scales are used in each of the measures.

There are four measurement scales: nominal, ordinal, interval, and ratio. Nominal scales, also called categorical scales, assign numbers to identify and classify groups of objects. Nominal scales must have at least two categories, each of which must be mutually exclusive to all possible to be included.

A variable measured in ordinal scale carries the magnitude of the number that explains it; that is, if the value of the variable increases, the number that represents it increases (e.g. if we encode the use of a product as (1) non-user; (2) low frequency, and (3) recurrent user; we know that if the value of the user variable increases, the level of use will also increase. Therefore, something measured on an ordinal scale provides information about the order of observations, not necessarily equally spaced.

The interval scale measures the rank order in which something is measured and can be interpreted directly from the magnitude of values and their differences (e.g., temperature and age). Finally, the ratio scale provides more information. For example, suppose something is measured on a ratio scale. In that case, a value of 0 means the variable is not present, and the non-zero measurement represents the exact quantity of the measurement (e.g., length, volume, and time).

Coding is associated with the measurement scale, which is nothing more than assigning numbers to categories to facilitate measurements. For example, as shown in Table 4-1, a code was given for each class: a number for the response category. This coding is critical in multivariate analysis because it determines when and how various scales can be used.

The coding of the Likert Scale (ordinal) meets the equidistance requirement, that is, in the 5 points (categories), the distances are the same: the variation of perception between 1 and 2 is the same between categories 3 and 4. The Likert scale is perceived as symmetrical and equidistant, working as an interval scale, even though it is ordinal.

Another important aspect is data distribution. Although there are many different types of distributions, it is only necessary to distinguish normal from non-normal distributions when using SEM. Normal distributions are desirable, especially when working with CB-SEM. However, PLS-SEM generally makes no assumptions about data distributions.

The minimum sample size is one of the most cited reasons for using PLS-SEM (Henseler et al., 2009; Hair et al., 2012). This technique allows for using a small sample (e.g., less than 100) to obtain results that represent the effects to be measured (Hair et al., 2021). Hair et al. (2021) pointed out two equivalences of rules for adopting minimum samples for the application of the PLS path model:

- Ten times the maximum arrows pointed out to the latent variable.
- Cohen (1992) rules, which determine the minimum samples (from the maximum number of arrows pointing to a construct in the model of PLS path) necessary to detect values of R^2 in any constructs, whit three different levels of significance, assuming a statistical power of 80%. In this theory, more arrows pointing at independent variables need more observations to reach 80% statistical power and detect larger R^2 values with less error probability.

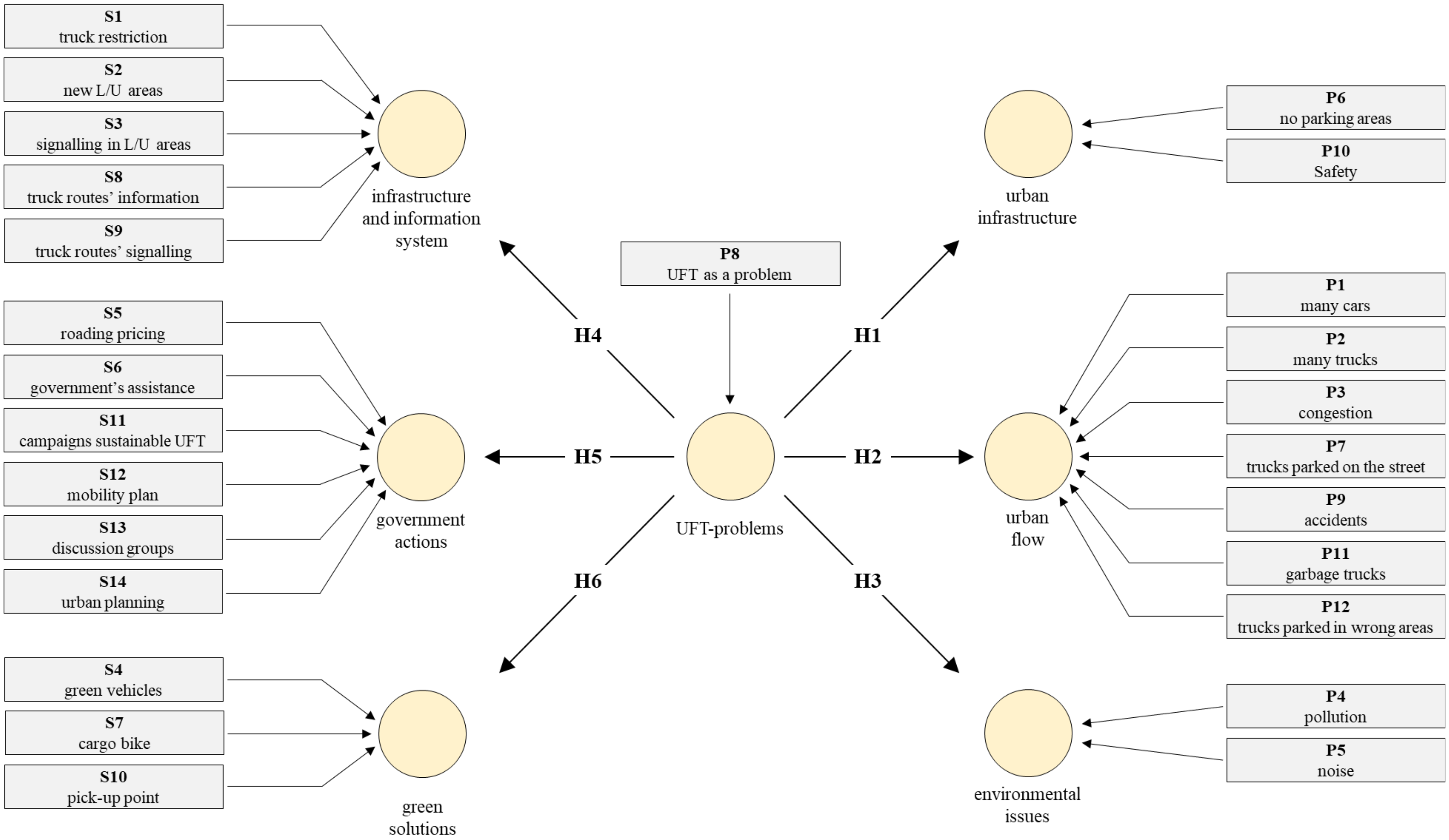
4.3.1 Path Model

Path Models are the diagrams that present the relationships between the variables and the study's hypotheses (Haenlein & Kaplan, 2004; Ringle et al., 2020; Hair et al., 2021). The Path Model is composed of four parts:

- Latent Variables (or constructs): these are the variables that are not measured directly and whose usual representation in the model is the circles.
- Observed Variables (or indicators): these are the directly measured proxy variables and contain the raw data. Observed Variables are usually represented in the models as rectangles, and in this study, they refer to the data from Parts 1 and 2 (see Table 4-1).
- Arrows: represent the relationships between the constructs and their assigned indicators and between the constructs themselves. In PLS-SEM, the arrows are always single-headed and mean directional relationships. In addition, arrows are considered predictive relationships and can be interpreted as causal relationships (Ringle et al., 2020; Hair et al., 2021).
- Errors: represent the unexplained variation when the path models are estimated (Hair et al., 2021).

Path models are developed based on researchers' theory and expertise (and logic) and determine a systematically related set of hypotheses (Hair et al., 2014b; Ringle et al., 2020; Hair et al., 2021). These hypotheses can be used to explain and predict outcomes and must be empirically tested (Ringle et al., 2020; Hair et al., 2021). The constructs cannot have a circular relationship since this violates SEM principles (and the PLS-SEM algorithm can only handle models that do not have a circular relationship between the constructs). Figure 4-1 presents the path model used in this master's thesis based on the hypotheses detailed in Chapter 3.

Figure 4-1 - Path model analysed in this master's thesis.

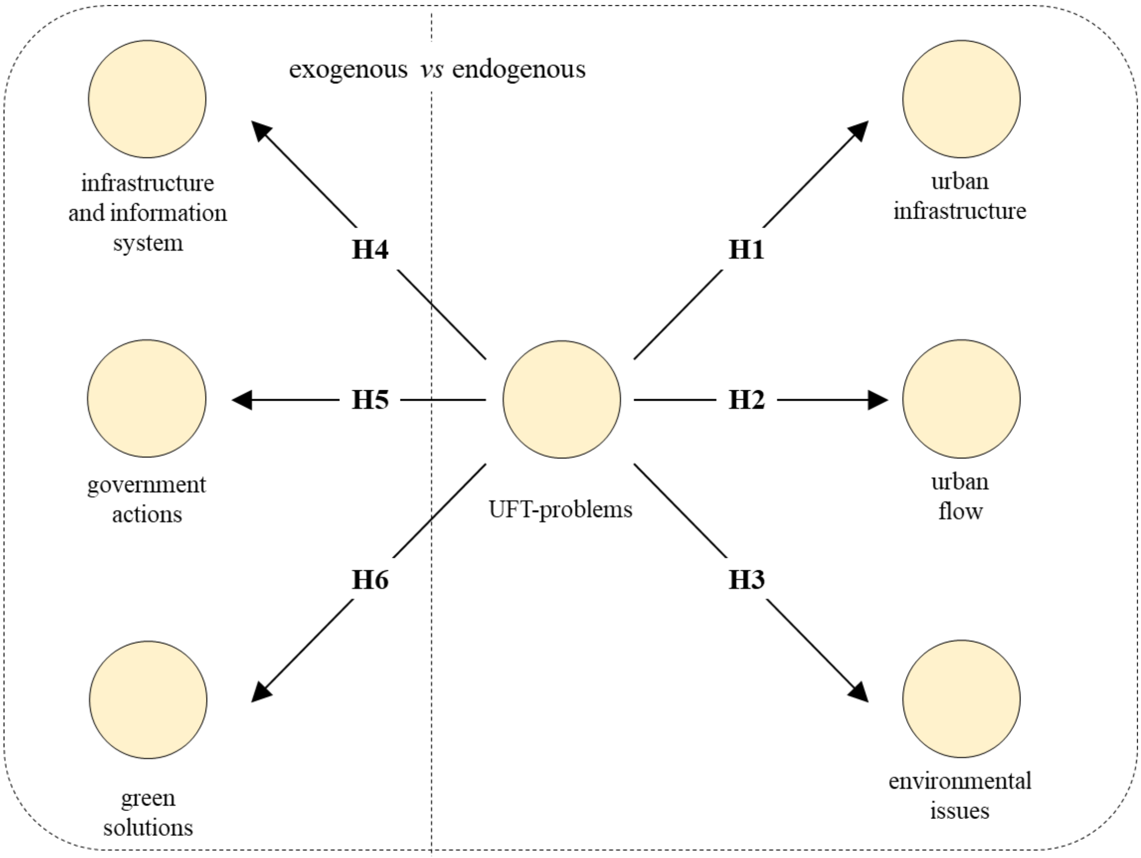


4.3.1.1 Structural Theory and Model

A path model in PLS-SEM consists of two elements: the structural model[2] and the measurement models[3] (one for exogenous latent variables and one for endogenous latent variables). Exogenous constructs act as independent variables and do not have an arrow pointing to them, while endogenous constructs are explained by others (Hair et al., 2014b). Each of these models is detailed below.

The structural theory specifies how latent variables are related by showing the paths between them (Hair et al., 2021). The location and sequence of constructs (i.e., these relationships) are based on literature and the researcher's experience. Figure 4-2 presents the structural model in the full path model.

Figure 4-2 - Structural model.



[2] Also called Inner model.
[3] Also called Outer model.

In path models, the structural model must always describe the sequence of the relationships from left to right. The constructs on the left are independent (exogenous), while those on the right are treated as dependent (endogenous) variables. Also, the variables on the left are sequentially preceded and predict the variables on the right (Hair et al., 2021). It is important to remember that the structural model visually presents the hypotheses.

Any latent variable with only arrows is an exogenous latent variable. In contrast, endogenous latent variables can have arrows [i] going to and from them [ii] or just arriving at them. Furthermore, exogenous latent variables do not have error terms, as the constructs are independent and explain the other variables of the path model (Hair et al., 2021).

Direct or indirect effects between constructs can be observed in an SEM model. Direct effects are the relationships between two constructs with a single arrow. In contrast, indirect effects involve a sequence of relationships with a third (or more) construct: mediating effect (Hair et al., 2021). Thus, an indirect effect is a sequence of two or more direct effects.

4.3.1.2 Measurement Theory and Model

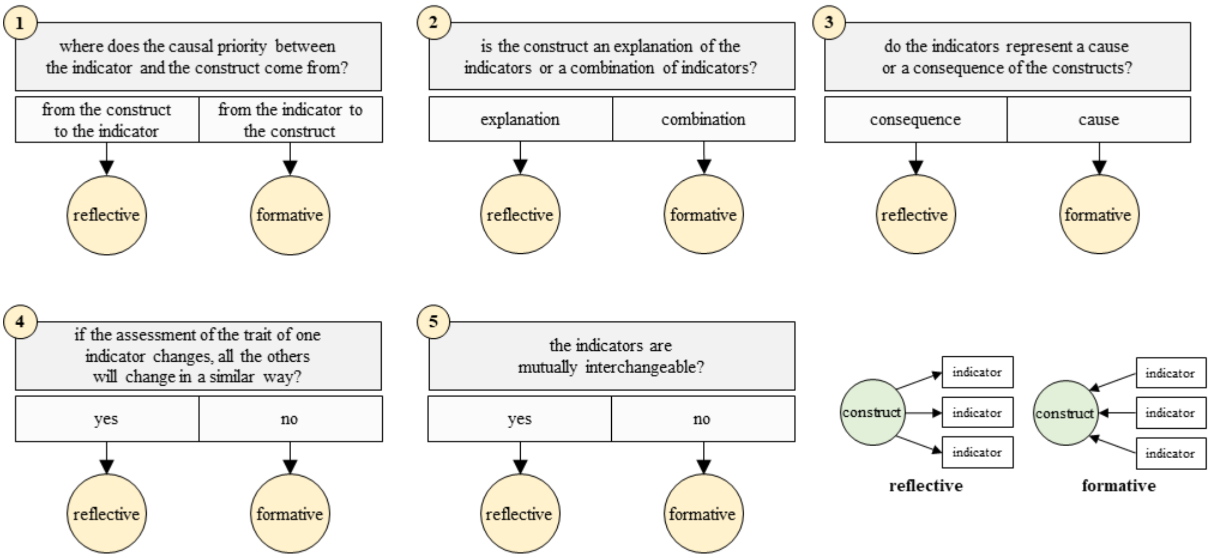
Measurement theory specifies how latent variables are measured. There are two ways to measure unobservable variables: reflectively and formatively (Hair et al., 2021). In the formative measurement model, the arrows point from the observed variables to the latent variable, indicating a causal (and predictive) relationship. In contrast, in the reflective measurement model, the arrows point from the construct to the indicators, indicating that the latent variable causes the measurement of these indicators. Only reflective measurements have errors associated with the indicators since the formative measures are understood and error-free (Hair et al., 2021).

Reflective models (Mode A in PLS-SEM) are based on classical test theory, where measures represent the effects of the construct. Therefore, causality is from the construct to its measures (Hair et al., 2021). Reflective indicators are then a sample of all items conceptually possible to explain that construct (Thorndike, 1995). The indicators associated with that construct must [i] be correlated with each other, [ii] be interchangeable, and [iii] any item can be left out without changing the meaning of the construct (Hair et al., 2021).

In contrast, formative models (Mode B in PLS-SEM) assume that causal indicators form the construct through linear combinations. Formative indicators are not interchangeable, and each construct indicator captures a specific aspect of the construct domain (Hair et al., 2021). Figure 4-3 shows a guideline for choosing a reflective or formative measurement model.

Based on this choice flow, all measurement models of this master's thesis path model are formative.

Figure 4-3 - Guideline for choosing measurement model mode.



4.3.2 Model Evaluation

The SmartPLS software developed by Ringle et al. (2015) was used to estimate the path model present in Figure 4-1. In the following subsections, the modelling equations that make up the software algorithm are the basis for evaluating reflective, formative, and structural models. Hair et al. (2019) detail the interpretation of the results of a PLS-SEM from SmartPLS outputs.

4.3.2.1 PLS-SEM Algorithm

The PLS-SEM algorithm is based on [i] Ordinary Least Squares (OLS) regression and [ii] variance analysis to estimate the path coefficients. In the estimation process, the unexplained variance is minimised for each construct (Hair et al., 2021). In addition, the algorithm uses the known data (collected with the questionnaire) to estimate the unknown elements of the model.

The PLS-SEM involves the structural model and the measurement models. Therefore, the regression model configuration will depend on whether the construct is reflexive or formative (Hair et al., 2021; Sarstedt & Cheah, 2019). In the reflective model, the coefficients are called loadings. They are estimated by a single regression one for each indicator (simple correlations between the construct and each of its initiators), as shown in Equation 1, where Z is a vector of all indicators of each measurement model, C is a matrix of weights relating, and ε is the error term for indicators.

$$Z = C\gamma + \varepsilon \tag{1}$$

In the formative models, the coefficients are called weights. They are estimated by partial multiple regression in which the latent construct represents a dependent variable, and the indicators are the independent variables. Equation 2 shows the calculation base, where H is the loading matrix of the regressions of each latent variable in its associated indicators, and θ is the error term of the latent variables, which, however, is set to zero.

$$\gamma = H\gamma + \theta \tag{2}$$

Given the weights and loadings, they are used to measure the path coefficients of the latent variables as linear combinations of their indicators into a series of least squares regressions. In addition to the path coefficients, the algorithm determines the resulting R^2 values of the endogenous latent variables. For this, model equations are used. First, the structural equations are defined as shown in Equation 3, where γ is a vector of all latent variables, B is a matrix of path coefficients, and ω is the error term of the endogenous latent variables:

$$\gamma = B\gamma + \omega \tag{3}$$

After presenting the context of the PLS-SEM algorithm used in SmartPLS, the following subsections present the evaluation of the outputs. These evaluation outputs were essential steps in this study since, through them, it is possible to interpret the cause-and-effect relationships proposed in the Path Model. This interpretation aims to validate or reject the hypotheses of the structural and research model.

4.3.2.2 Formative Measurement Models Evaluation

In evaluating formative models, each indicator represents an independent cause of the construct and does not necessarily have a high correlation. According to Hair et al. (2021), the formative measurement models evaluation includes [i] the convergent validity, [ii] the collinearity analysis, and [iii] the significance and relevance of the indicators (outer weight).

Convergent validity (in formative models) is a measure that positively correlates with other measures of the same construct using different indicators: redundancy analysis (Hair et al., 2021). These analyses treat the formative model construct as exogenous and predict the same endogenous latent variable with a single indicator. However, this step was not performed since no questions concerning the hypotheses were included in the questionnaire.

High correlations between two formative indicators, which are not expected, are called collinearity and are problematic from a methodological and interpretive point of view. The most severe collinearity form occurs if the same formative indicator is inserted into the same construct or not to measure more than one construct (Hair et al., 2021). Although this situation rarely occurs, high levels of collinearity are expected. In such cases, modelling can result in incorrect estimation of the weights and reversal of their signs.

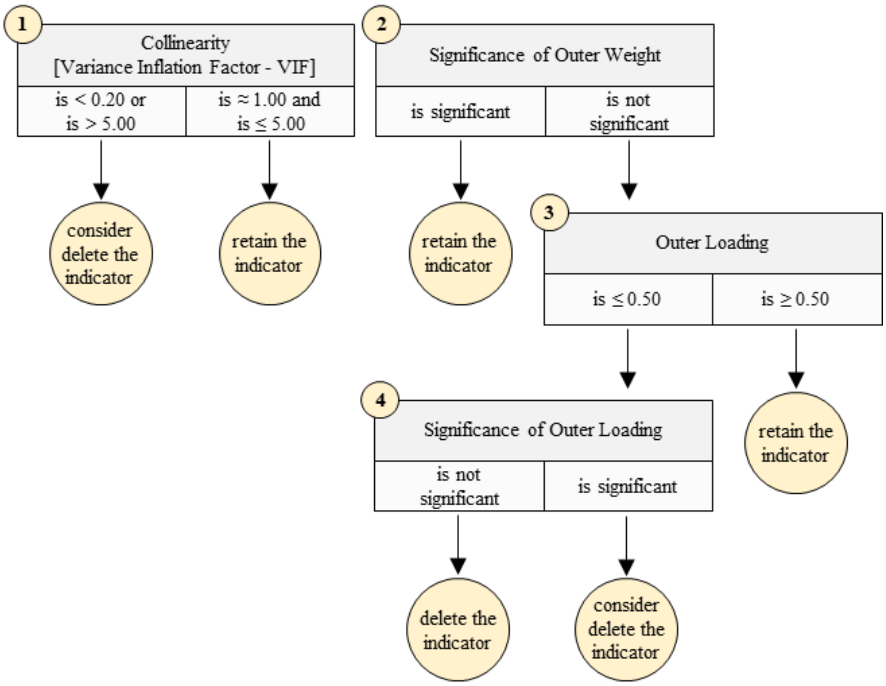
The most common measure to evaluate collinearity levels is the variance inflation factor (VIF), defined by the calculation of tolerance, that is, by the amount of variance of a formative indicator not explained by other indicators in the same construct. In PLS-SEM, VIF values close to 1.00 are expected (Hair et al., 2021). If the collinearity level is outside the desired parameters, consideration should be given to removing the corresponding indicators. However, this can only occur if the other indicators still capture the construct's content from a theoretical point of view (Hair et al., 2021).

Another output for evaluating formative models is the outer weight resulting from multiple regression. The outer weight values express the relative contribution of each indicator to the construct and, as they are standardised, can be compared with each other. If a construct has many indicators, low or even insignificant external weights become more likely (Hair et al., 2021). However, to know if the formative indicators contribute to the construct, the outer weights must be tested to see if they are statistically significant (Hair et al., 2021). The statistical significance is obtained through the bootstrapping procedure.

Non-significant outer weights should not be automatically interpreted as indicating the poor quality of the measurement model (Hair et al., 2021). The outer loading must be evaluated if the initial bootstrapping result indicates non-significant indicators. When the outer weights are insignificant, but the outer loading values are 0.50 or more, the indicator should be interpreted as absolutely important but not as relatively necessary (Hair et al., 2021). When an indicator has non-significant outer weights and outer loading less than 0.50, the indicator may or may not be excluded depending on its theoretical relevance and outer loading significance. Formative indicators should never be ruled out based on statistical results. Before removing an indicator from the formative measurement model, researchers must verify its relevance from a content validity point of view (Hair et al., 2021).

In conjoint analysis, if, even after treating the collinearity problems, the VIF values are still greater than 5.00, the outer weights should not be analysed for their significance and relevance, and the formative measurement model should be discarded. Figure 4-4 presents the evaluation process of formative measurement models in this study (since all the measurement models of the path model are formative).

Figure 4-4 - Evaluation process of formative measurement models.



4.3.2.3 Structural Model Evaluation

The structural model evaluation is possible when the measurement models are reliable and valid. According to Hair et al. (2021), this step includes [i] the collinearity analysis, [ii] the relationships (hypotheses) significance and relevance, and [iii] the model predictive ability.

VIF evaluates collinearity, and values close to 1.00 are expected. If a critical level of collinearity is indicated, consideration should be given to eliminating or clustering constructs. The SmartPLS output for the structural model is the path coefficients, which represent the path model assumptions (hypothesis). These coefficients are standardised and range from -1.00 to +1.00: values close to +1.00 represent strong positive relationships (and vice versa), and the closer to 0, the weaker the relationships (Hair et al., 2021). Because the coefficients are standardised, they can be compared. The interpretation of Path Coefficients values must be associated with the significance tests of the structural model relationships: t-values, p-values and confidence intervals, all measured through bootstrapping. Hair et al. (2021) pointed out that the significance analysis cannot be the only one done and that the relevance of the relationships needs to be evaluated. Therefore, assessing the "size" of the path coefficients is crucial to interpret the results and concluding that small coefficients, although significant, may not deserve managerial attention.

Another measure used to evaluate the structural model is the coefficient of determination (R^2 value). R^2 measures the model's predictive power for endogenous constructs. The value of R^2 ranges from 0 to 1, with higher levels indicating higher levels of predictive accuracy, and represents the amount of variance from that endogenous construct explained by all exogenous constructs linked to it. As with multiple regression, the adjusted coefficient of determination (R^2_{adj}) can be used as a criterion to avoid bias for complex models. The R^2_{adj} value reduces the R^2 value by the number of explanatory constructs and the sample size and thus systematically compensates for the addition of non-significant exogenous constructs to increase the explained variance R^2 (Hair et al., 2021).

5 RESULTS AND DISCUSSIONS

5.1 Study Area

Belo Horizonte is the sixth-largest city in Brazil, and according to the IBGE (Brazilian Statistics Institute), the estimated population in mid-2021 was 2.5 million inhabitants, spread over an area of approximately 330 km². The city is in the southeastern region of the country, about 600 km from Brasilia (the Brazilian capital) and 480 km from São Paulo (the largest city in Brazil).

Figure 5-1 presents the Belo Horizonte's map. The city is divided into nine regions, each with its characteristics. The central area concentrates on the primary services and urban infrastructure, housing the planned city of Belo Horizonte (shown in red on the map). Their residential area marks the East, Northeast, Northwest, and North regions and has their centrality of activity and services. The regional Pampulha are many urban facilities, including the Pampulha Architectural Complex, tourist attractions, the Federal University of Minas Gerais, and the regional airport. Finally, Barreiro and Venda Nova are regions with their particularities. Equally to Pampulha, these areas are independent of the central region of Belo Horizonte regarding access to essential services. Due to this diversity, the questionnaire respondents were distributed in all nine city regions but more concentrated in Pampulha and the Central Area.

Szczecin is the seventh-largest city in Poland, and the estimated population in mid-2019 was 400,000 inhabitants, spread over an area of approximately 300 km². The city is located in the extreme northwest of the country (Figure 5-2), about 450 km from Warsaw (Poland's capital and largest city), on the banks of the River Oder, close to the Baltic Sea coast and Germany's border. Green spaces and water occupy more than 60% of Szczecin's area. The city has one of the significant Polish seaports. The historical city centre has developed a series of lower-density residential areas around denser inner districts of apartment blocks in recent years. In Szczecin, most of the answers are concentrated in the central area.

Figure 5-1 - Belo Horizonte's map.

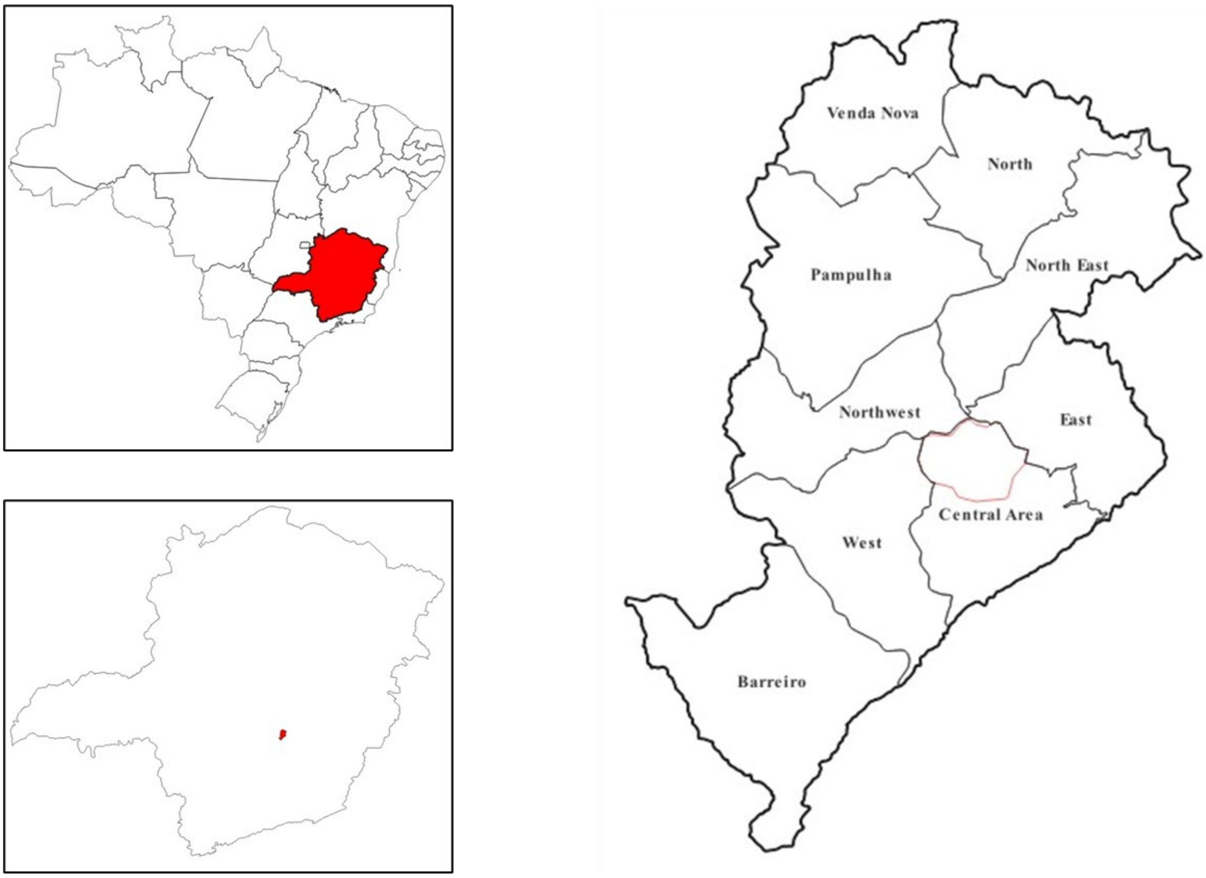
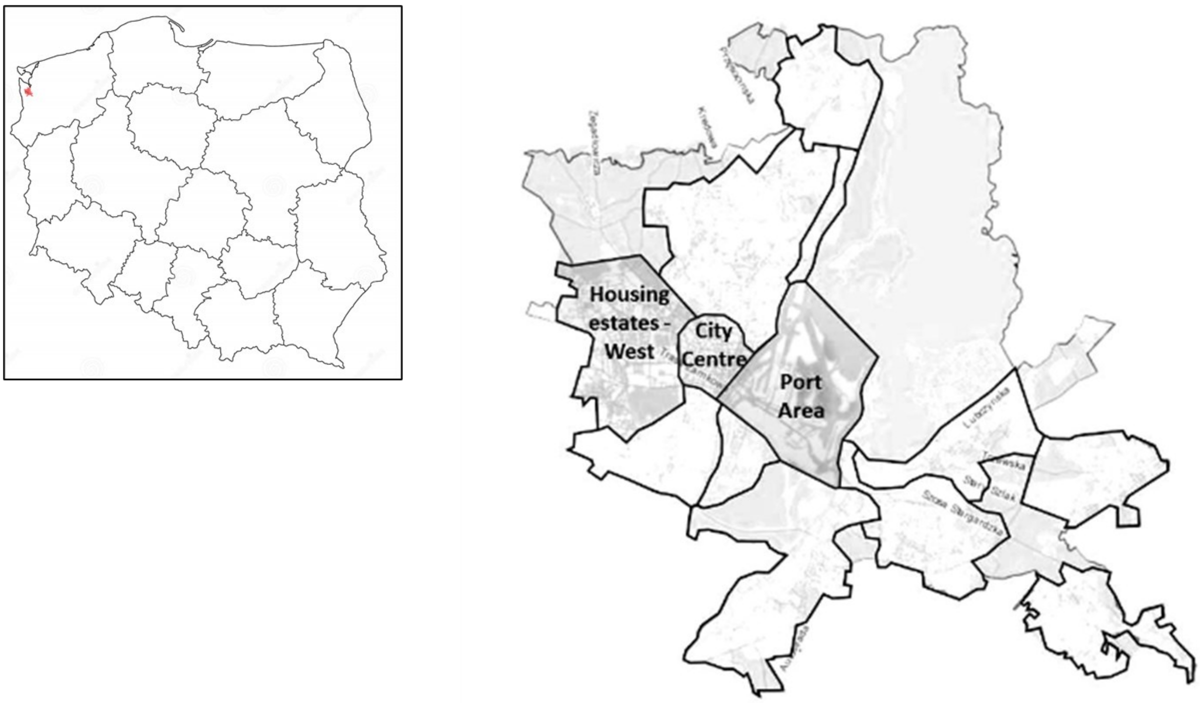


Figure 5-2 - Szczecin's map (adapted from Iwan, 2014).



Despite the population differences between the cities, Belo Horizonte and Szczecin occupy positions of equal magnitude and importance in their countries. Both hold just over 1.1% of the national population and are equally relevant regarding the movement of people, services, and the economy. Furthermore, they can potentially attract visitors to their tourist areas and concentrate large industrial and educational centres in their countries. These cities were chosen to stud for these facts, in addition to the convenience and possibility of collecting data.

5.2 Sampling Size

The answers obtained from these two cities were compiled into a database. After removing all incomplete and inconsistent responses, 762 valid responses resulted: 497 for Belo Horizonte and 265 for Szczecin. This sample is adequate to estimate a PLS-SEM model for each city, with high predictive power and a statistical significance of 99.0% (Cohen, 1992). Although the sample is sufficient, obtaining a stratified sample with a convenience sampling procedure is not always possible. Table 5-1 shows the socioeconomic characteristics of Brazilian and Polish respondents, compared in detail below.

Respondents under 18 years old did not have their answers computed. In both cities, the highest percentage is between 21 and 30 years old, with this value being more expressive in Belo Horizonte (73.0%) than in Szczecin (30.6%). The sum of the categories corresponding to Polish respondents between 21 and 50 years old (71.7%) indicates that the sample is older than the Brazilian one.

Concerning the educational levels, about 55% of respondents in Belo Horizonte have higher education (are graduate or postgraduate). In Szczecin, most residents (61%) have completed high school. Regarding family income, almost 90% of Polish respondents have an income between \$400 and \$1,000, while only 28.4% of Brazilians are in this same range. In Belo Horizonte, the most expressive categories (60.6%) concentrate on income above \$1,000. This result may be biased since some respondents may have considered the individual income, not the family, as asked in the questionnaire.

The most significant difference between these two cities is observed in the mode of transport used for the usual trips to school or work. Motorcycles and carsharing services (e.g., uber) are not typical among the residents of Szczecin, while in Belo Horizonte, they represent almost 10% of the respondents. On the other hand, commuting by bicycle represents more than 7% of the Polish city, while only one respondent uses it in Belo Horizonte. In both cities, most travel takes place by private car and public transport.

Table 5-1 - Respondents socioeconomic characteristics.

Socioeconomic Variables		Belo Horizonte (Brazil)		Szczecin (Poland)	
		Respondents	Percentage	Respondents	Respondents
Age	Less than 20	53	10.7 %	13	4.9 %
	21-30	363	73.0 %	81	30.6 %
	31-40	35	7.0 %	48	18.1 %
	41-50	16	3.2 %	61	23.0 %
	51-60	22	4.4 %	38	14.3 %
	More than 60	8	1.6 %	24	9.1 %
Education	Higher education	269	54.1 %	104	39.2 %
	Secondary education	228	45.9 %	161	60.8 %
Income	Less than $ 200	7	1.4 %	1	0.4 %
	$ 200 - $ 400	48	9.8 %	12	4.5 %
	$ 400 - $ 600	50	10.1 %	92	34.7 %
	$ 600 - $ 1.000	91	18.3 %	141	53.2 %
	$ 1.000 - $ 2.000	147	29.6 %	10	3.8 %
	More than $ 2.000	154	31.0 %	9	3.4 %
Vehicle used for work/school trip purposes	Car	207	41.6 %	152	57.4 %
	Carsharing	37	7.4 %	0	0.0 %
	Public transport	187	37.5 %	82	30.9 %
	Motorcycle	12	2.4 %	0	0.0 %
	Bike	1	0.2 %	19	7.2 %
	By foot	53	10.7 %	12	4.5 %

5.3 Data Reliability

Table 5-2 shows the results of the internal consistency of the sample. The values indicate that the reliability of Szczecin's responses is low. The relative "lowness" could be an artefact of a highly homogeneous sample (Bernardi, 1994). This result may reflect a homogeneous perception among citizens, with a lower variance than Belo Horizonte's perception. The low values of Cronbach's alpha did not rule out the sample since the objectives of this research are multiple and aim to verify the reality with the data that we have.

Table 5-2 - Internal consistency (Cronbach's alpha results).

Problems	Belo Horizonte (Brazil)	Szczecin (Poland)	Solutions	Belo Horizonte (Brazil)	Szczecin (Poland)
P1	0.82	0.39	S1	0.75	0.43
P2	0.81	0.39	S2	0.74	0.45
P3	0.82	0.38	S3	0.74	0.45
P4	0.82	0.39	S4	0.75	0.47
P5	0.82	0.40	S5	0.76	0.44
P6	0.82	0.41	S6	0.76	0.40
P7	0.82	0.31	S7	0.75	0.43
P8	0.82	0.27	S8	0.74	0.41
P9	0.82	0.37	S9	0.73	0.45
P10	0.82	0.39	S10	0.75	0.47
P11	0.84	0.35	S11	0.73	0.41
P12	0.82	0.30	S12	0.74	0.42
			S13	0.75	0.41
			S14	0.74	0.44

5.4 Data Description

Figure 5-3 and Figure 5-4 illustrate the problems description for the respondents in Belo Horizonte and Szczecin, respectively. In Belo Horizonte, many cars in the city (P1 - 93%), congestion (P3 - 92%), and trucks parked in inappropriate areas (P12 - 82%) concentrate, respectively, the most considerable problems percentages sums between the two agreement categories. In Szczecin, no parking areas (P6 - 91%) have the highest percentage, followed by many cars in the city (P1 - 87%) and trucks parked in inappropriate areas (P12 - 87%).

There is a more significant difference between the two cities regarding the problems. In Belo Horizonte, garbage trucks (P11 - 46%) and many trucks parked on the street (P7 - 30%) have the highest sum of the disagreement categories. In Szczecin, the two problems in this circumstance are pollution (P4 - 27%) and many trucks/vans in the city (P2 - 15%). Despite this, (P7 - 39%) and (P4 - 35%) concentrated on the highest neutral responses in Belo Horizonte and Szczecin, respectively.

Figure 5-3 - Percentage of response: problems in Belo Horizonte.

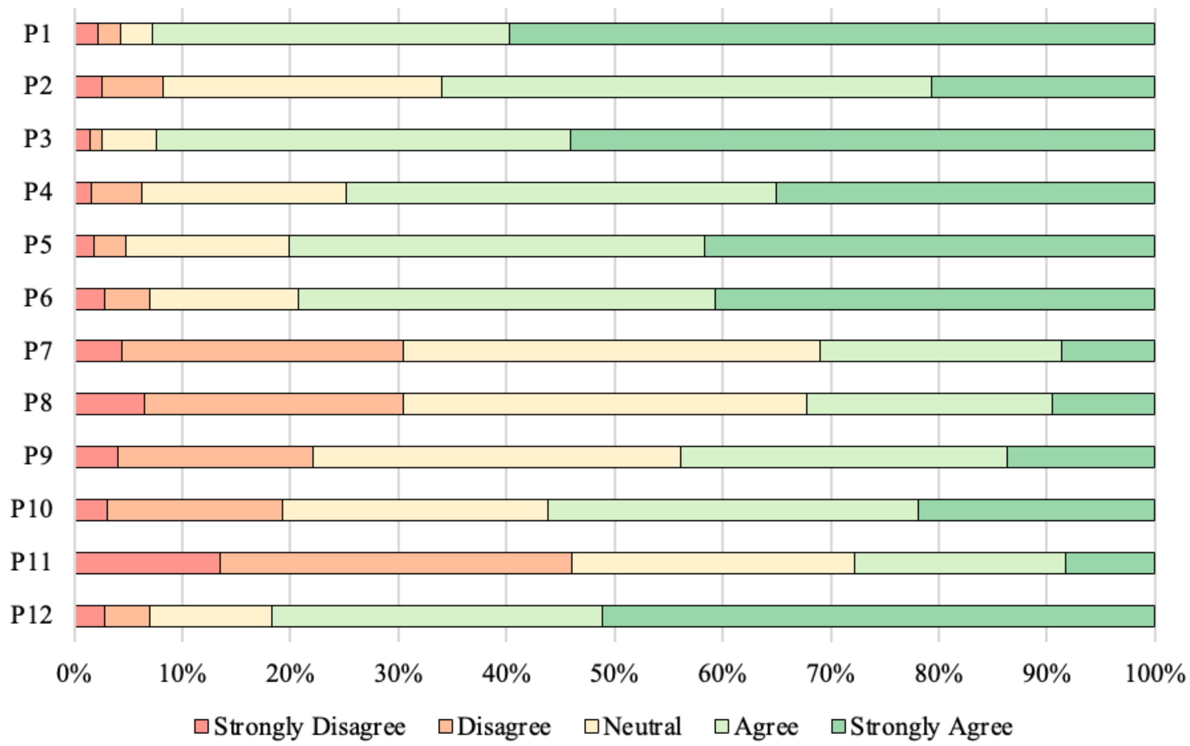


Figure 5-4 - Percentage of response: problems in Szczecin.

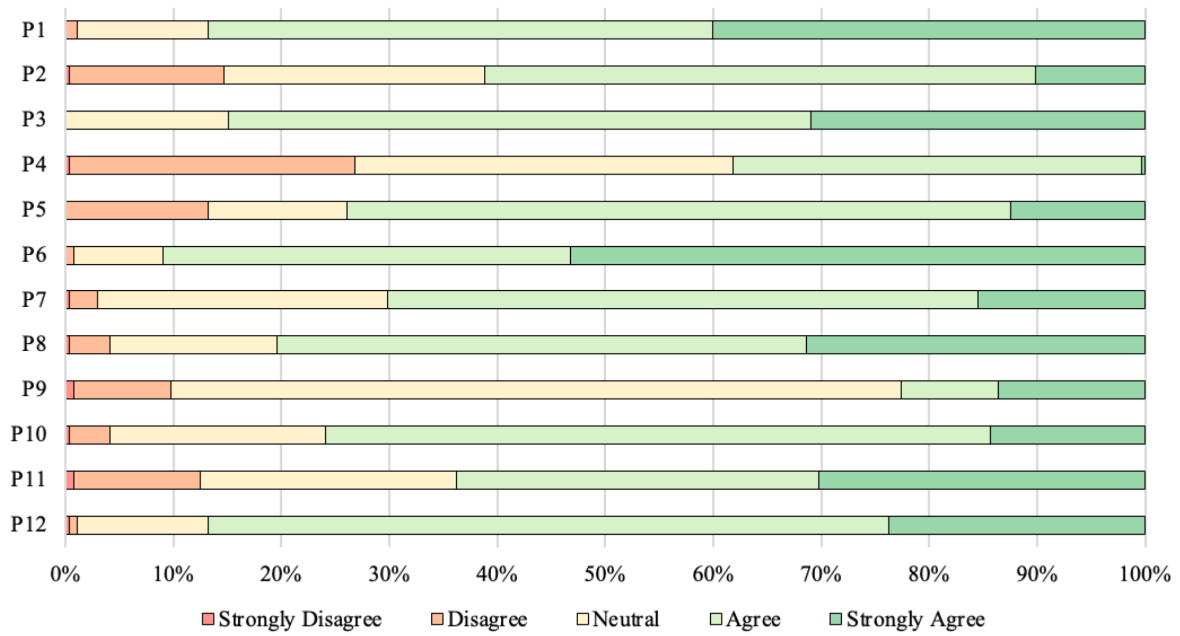


Figure 5-5 and Figure 5-6 show the responses regarding the solutions for Belo Horizonte and Szczecin, respectively. There is a difference in the opinion of residents about freight solutions. For Brazilian respondents, the highest percentages of agreement are for solutions related to urban planning (S14 - 95%), mobility plans (S12 - 94%), truck routes signalling (S9 - 87%), and new L/U areas (S2 - 86%). On the other hand, fee assistance from the government (S6 -

56%) and road pricing (S5 - 52%) have the highest percentage sum of the two categories of disagreement.

In Szczecin, cargo bikes (S7 - 91%), road pricing (S5 - 88%), truck restriction (S1 - 86%), and delivery at pick-up points (S10 - 86%) are solutions with more agreement, while urban planning (S14 - 26%) and discussion groups about UFT (S13 - 24%) have less agreement. It is observed that [i] the highest percentage of agreement among Brazilians (S14) is the same as the highest percentage of disagreement among Poles, and [ii] the second-highest percentage of agreement by Szczecin (S5) is the same as the second-highest percentage of disagreement among Brazilians.

The comparison between the scores of the responses shows heterogeneity in the behaviour of the citizens' responses. Nevertheless, for some problems (e.g., parked in inappropriate areas - P12) and solutions (e.g., signage in L/U areas - S3), there is a similarity in the behaviour of the percentages of each response category.

Figure 5-5 - Percentage of response: solutions in Belo Horizonte.

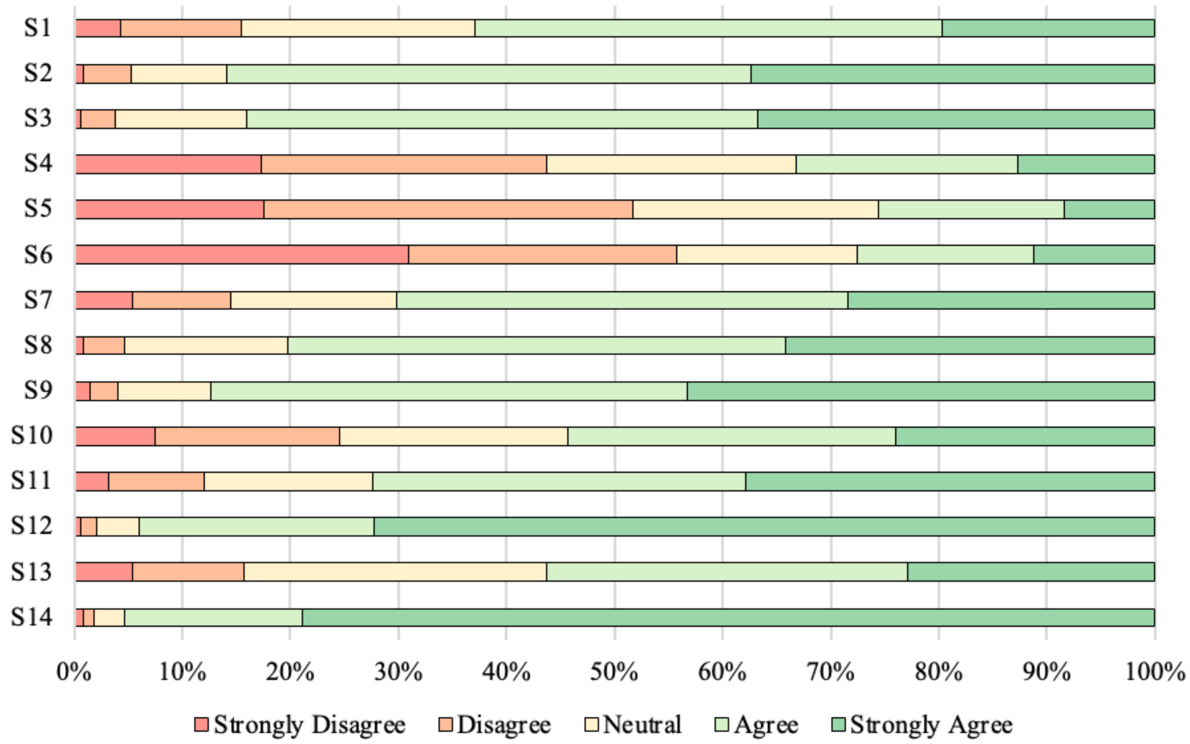
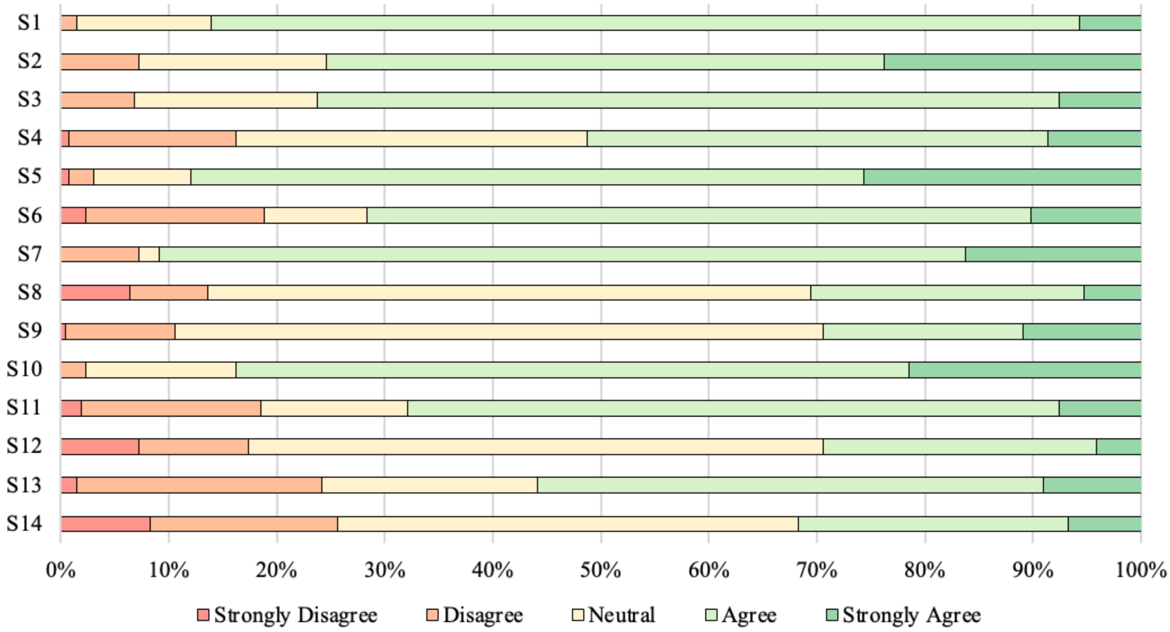


Figure 5-6 - Percentage of response: solutions in Szczecin.



5.5 PLS-SEM

5.5.1 Model 1

Model 1 was illustrated in Figure 4-1 and considered all freight problems [Part 1] and solutions [Part 2] presented in Table 4-1. This model aimed to evaluate the citizens' perception without adjusting the Path Model's variables.

Table 5-3 shows the structural model's path coefficients and the endogenous constructs' R-squared. VIF values were close to 1, as recommended by the literature, indicating no collinearity of the constructs.

Table 5-3 - Model 1: structural model evaluation results.

Structural (cause and effect) relationships	Belo Horizonte (Brazil)			Szczecin (Poland)		
	Path Coefficients	VIF	R^2	Path Coefficients	VIF	R^2
urban infrastructure problems → UFT-problems	0.392 ***	1.000	0.153	0.209 **	1.000	0.044
urban flow problems → UFT-problems	0.487 ***	1.000	0.237	0.395 ***	1.000	0.156
environmental issues → UFT-problems	0.288 ***	1.000	0.083	0.163 **	1.000	0.027
UFT-problems → infrastructure/information system solutions	0.223 ***	1.121	-	-0.167 NS	1.057	-
UFT-problems → government actions solutions	0.175 ***	1.315	-	0.227 NS	1.126	-
UFT-problems → green solutions	0.038 NS	1.121	-	0.094 NS	1.073	-

Significance level: ***0.001; **0.050; *0.100; NS Not Significant

Path coefficients without statistical significance reject the established causal relationships for the structural model. Thus, Figure 5-7 and Figure 5-8 present the hypotheses where "solid arrows" indicate that the hypothesis was confirmed, while "dashed arrows" indicate the rejection of the hypothesis.

For both Brazilian and Polish contexts, the perception of the specific group problems contributes to the perception of freight problems. In Belo Horizonte and Szczecin, as the citizens' perceptions of [i] urban infrastructure problems; [ii] urban flow problems; and [iii] environmental issues; increased, the freight problems perception also increase. All these three causal relationships had positive path coefficients and statistical significance.

Figure 5-7 - Hypothesis according to Model 1: Belo Horizonte.

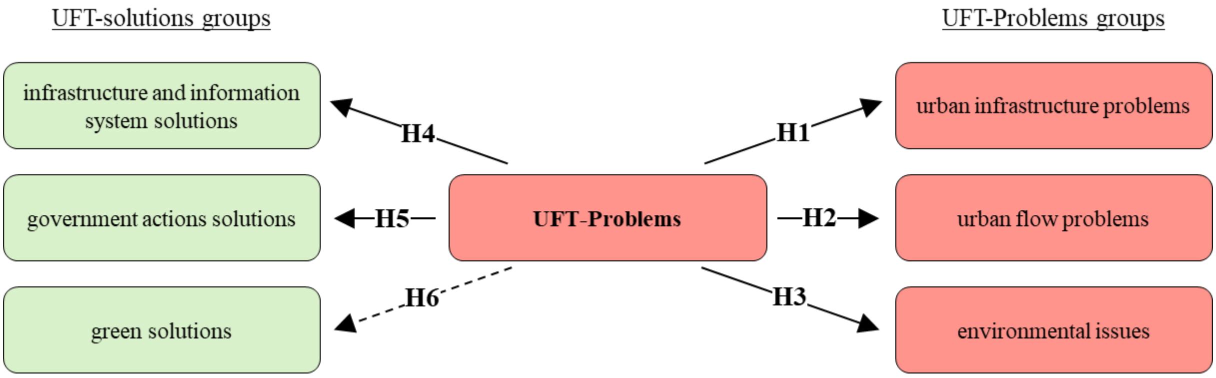
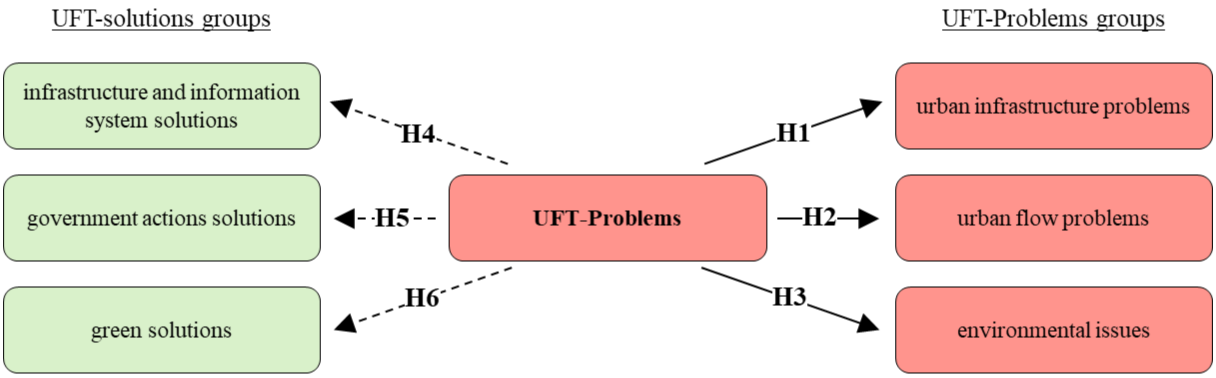


Figure 5-8 - Hypothesis according to Model 1: Szczecin.



These findings align with the realities of these cities, where the impact of freight vehicles is latent in citizens' perceptions (Kijewska et al., 2022). Since the coefficients are standardized and can be compared, the results of Model 1 indicate that the relationship between the perception of urban flow problems is more latent than that of infrastructure problems, which are more perceived than environmental issues. This finding also aligns with the reality of Belo

Horizonte and Szczecin since it is easier to perceive the problems they live with daily and effectively feel, like traffic problems, than “abstract situations” such as air and noise pollution.

Regarding freight solutions, the results of Model 1 have a different reality. In Belo Horizonte, as the citizens' perception of freight problems increases, the perception of city logistics measures involving [i] infrastructure and information system; and [ii] Government Actions; also increase. The “green solutions” construct has no relationship with the perception of freight problems.

This result is in line with the reality of Belo Horizonte. In Brazil, alternative and sustainable measures to reduce negative freight externalities are still uncommon. Few carriers have freight vehicles powered by renewable energy or fleets that emit fewer pollutants. Furthermore, the city has a limited number of bicycle lanes, which contributes to the non-use of this transport mode for deliveries (even small packages). Finally, pick-up points are unusual in Belo Horizonte, unlike Szczecin, where they are inserted in the urban context.

For Szczecin, Model 1 did not present any cause-and-effect relationship with statistical significance, in which a construct effectively contributes to the perception of others. Thus, assessing how citizens correlate freight solutions with the associated problems was not possible.

A possible reason is that the input data variance is necessary for an adequate estimation. However, the variables have a homogeneous behaviour of the responses (see Figure 5-6), where most citizens' statements are concentrated in concordance classes: all freight solutions would be adequate to minimize traffic problems.

Table 2-1 presents the results of the formative measurement model for both cities. Through these results, it is possible to understand the contribution of each freight problem and solution (causes) in constructing the constructs. Values in italics refer to indicators belonging to constructs with no statistical significance in the causal relationships (do not contribute to the research hypotheses).

All VIF values were close to 1, indicating no collinearity between the variables. Some observed variables are not statistically significant and cannot be considered a contributor to the constructs and, consequently, do not contribute to the cause-and-effect relationships (research hypotheses). Like the structural model, according to the literature, this happens because the statements' agreement (or disagreement) level has no variance. As the PLS-SEM is estimated by variance, it will lack significance for problems such as this characteristic.

Table 5-4 - Model 1: formative measurement model results.

Hypothesis	Construct	Indicators	Belo Horizonte (Brazil)		Szczecin (Poland)	
			Outer Weights	VIF	Outer Weights	VIF
H1	urban infrastructure	P6	0.387 ***	1.059	0.072 NS	1.021
		P10	0.835 ***	1.059	1.008 ***	1.021
H2	urban flow	P1	-0.027 NS	1.777	0.340 **	1.062
		P2	0.170 NS	1.814	-0.046 NS	1.022
		P3	0.160 NS	1.641	0.224 NS	1.056
		P7	0.358 ***	1.567	0.139 NS	1.169
		P9	0.346 ***	1.340	0.406 ***	1.082
		P11	0.422 ***	1.115	0.533 ***	1.030
		P12	0.093 NS	1.327	0.377 **	1.193
H3	environmental issues	P4	0.854 ***	1.519	0.991 ***	1.001
		P5	0.221 NS	1.519	0.167 NS	1.001
H4	infrastructure and information system	S1	0.991 ***	1.064	*-0,550 NS*	*1.036*
		S2	0.003 NS	1.415	*0.052 NS*	*1.482*
		S3	-0.019 NS	1.405	*0.764 NS*	*1.498*
		S8	0.109 NS	1.542	*-0.329 NS*	*1.027*
		S9	-0.158 NS	1.728	*-0.085 NS*	*1.039*
H5	government actions	S5	0.898 ***	1.099	*0.771 NS*	*1.087*
		S6	-0.022 NS	1.138	*0.195 NS*	*1.487*
		S11	0.293 NS	1.394	*-0.118 NS*	*1.215*
		S12	-0.132 NS	1.718	*0.412 NS*	*1.605*
		S13	0.105 NS	1.221	*-0.490 NS*	*1.415*
		S14	0.233 NS	1.643	*-0.031 NS*	*1.707*
H6	green solutions	*S4*	*0.699 *** *	*1.039*	0.798 NS	1.047
		S7	*0.371 **	*1.097*	-0.447 NS	1.081
		S10	*0.372 **	*1.059*	0.050 NS	1.050

Significance level: ***0.001; **0.050; *0.100; NS Not Significant

Among the freight problems, the road safety reduction (P10) has a higher coefficient and contribution to the urban infrastructure problems perception both in Belo Horizonte (0.835) and in Szczecin (1.008). Lack of parking areas (P6) also contributes to construct formation in Belo Horizonte (0.387) but has no statistical significance in Szczecin. Since outer weights are standardized and can be compared, P10 contributes more than P6 in Belo Horizonte.

Regarding urban flow problems with seven observed variables, only 3 and 4 negative externalities contribute to the construct formation in Belo Horizonte and Szczecin, respectively. In the Brazilian city, garbage trucks hindering traffic (P11) is the most latent problem and had the most contribution to the construct (0.422), followed by trucks parked on the street (P7 - 0.358) and accidents involving trucks (P9 - 0.346).

In the global north context, the perception of Szczecin's citizens about garbage trucks (P11) is also the one that most contributed to the formation of the construct (0.533), with a higher coefficient than in the global south. This freight problem is followed by accidents (P9 - 0.406), trucks parked in inappropriate areas (P12 - 0.377), and a high number of cars in the city (P1 - 0.340) as problems that contribute to this construct and, consequently, to the causal relationships.

Although the literature indicates congestion (P3) as one of the freight problems most perceived by citizens (Amaya et al., 2021; Kijewska et al., 2022; Oliveira & Oliveira, 2017), in the measurement model of Model 1, this variable did not show the statistical significance and did not contribute to explaining the phenomenon by this method. This happens because the results are also associated with the sample's behaviour: lack of variance between perceptions, implying that the estimated model does not present considerable weights and/or statistical significance.

However, this does not mean congestion is not an issue in the UFT context. Otherwise, as shown in Figure 5-3 and Figure 5-4, in both contexts evaluated, more than 90% of citizens agree or completely agree that congestion is a problem.

The last endogenous construct, related to environmental issues, presents the same behaviour for Brazilian and Polish cities: only pollution (P4) is statistically significant. It contributes to the formation of the construct in Belo Horizonte (0.854) and Szczecin (0.991).

The evaluation of exogenous constructs, that is, those that were determined through freight solutions, is limited to the Brazilian context. This is because [i] only Belo Horizonte has the hypotheses associated with them proved; and [ii] in Szczecin, none of the observed variables showed statistical significance.

For the solutions related to the infrastructure and information system, only the trucks' restriction (S1) was significant and contributed to this construct's formation and perception (0.991). This result is in line with the literature that indicates restrictive measures as the most recurrent solution implemented in the context of cities (Tadić et al., 2015) and even in the view of citizens (Amaya et al., 2020; Kijewska et al., 2022; Oliveira & Oliveira, 2017). Based on the Model 1 results, it is possible to conclude that "withdrawing is more effective than trying to improve", that is, that off-road freight vehicles are more assertive than regulating or informing their routes, for example.

In contrast to the previous perception, for Belo Horizonte's citizens, roading pricing is the only city logistics measure contributing to the formation of the construct of solutions related to government actions (S5 - 0.898). This result of Model 1 is at odds with the perception of vehicle restriction which, when comparing the coefficients, is shown to be more latent. However, it is a positive indication of solutions that may be more effective than removing trucks.

Even though the research hypothesis related to green solutions (H6) has not been proven, all three solutions in the construct were statistically significant in Belo Horizonte. Thus, and connecting this result with Figure 5-5, it can be inferred that the citizens of the global south, even if it is not a daily reality, perceive these solutions as positive to minimise freight problems.

5.5.2 Model 2

Based on Model 1, Model 2 was adjusted following the PLS-SEM literature. Model 2 aims to assess if it is possible, with the recommended changes, to confirm the other (and all) research hypotheses. Collinearity, outer weight significance, outer loading and their significance were evaluated. Table 5-5 and Table 5-6 present the results of the analysis of the Belo Horizonte and Szczecin, respectively, which considered the premises of Figure 4-4:

- Step 1 - Collinearity: keep the indicator if VIF is close to 1.00. Otherwise, consider deleting it.
- Step 2 - Significance of outer weight: keep the indicator if it is statistically significant. Otherwise, evaluate the outer loading.
- Step 3 - Outer loading: keep the indicator if it is greater than or equal to 0.5. Otherwise, evaluate the significance of outer loading.
- Step 4 - Significance of outer loading: remove the indicator if it is not statistically significant. If not, evaluate whether to keep it.

Table 5-5 - Formative measurement models evaluation (Belo Horizonte).

Construct	Indicator	VIF	Outer Weight	Outer Loading	Steps 1	Steps 2	Steps 3	Steps 4	Decision
urban infrastructure	P6	1.059	0.387 ***	0.584 ***	✓	✓	✓	✓	✓
	P10	1.059	0.835 ***	0.927 ***	✓	✓	✓	✓	✓
urban flow	P1	1.777	-0.027 NS	0.330 ***	✓	×	×	?	✓
	P2	1.814	0.170 NS	0.667 ***	✓	×	✓	✓	✓
	P3	1.641	0.160 NS	0.395 ***	✓	×	×	?	✓
	P7	1.567	0.358 ***	0.770 ***	✓	✓	✓	✓	✓
	P9	1.340	0.346 ***	0.695 ***	✓	✓	✓	✓	✓
	P11	1.115	0.422 ***	0.643 ***	✓	✓	✓	✓	✓
	P12	1.327	0.093 NS	0.484 ***	✓	×	×	?	✓
environmental issues	P4	1.519	0.854 ***	0.984 ***	✓	✓	✓	✓	✓
	P5	1.519	0.221 NS	0.721 ***	✓	×	✓	✓	✓
infrastructure and information system	S1	1.064	0.991 ***	0.991 ***	✓	✓	✓	✓	✓
	S2	1.415	0.003 NS	0.185 NS	✓	×	×	×	×
	S3	1.405	-0.019 NS	0.117 NS	✓	×	×	×	×
	S8	1.542	0.109 NS	0.118 NS	✓	×	×	×	×
	S9	1.728	-0.158 NS	-0.041 NS	✓	×	×	×	×
government actions	S5	1.099	0.898 ***	0.908 ***	✓	✓	✓	✓	✓
	S6	1.138	-0.022 NS	0.302 *	✓	×	×	?	✓
	S11	1.394	0.293 NS	0.406 **	✓	×	×	?	✓
	S12	1.718	-0.132 NS	0.125 NS	✓	✓	✓	×	×
	S13	1.221	0.105 NS	0.290 *	✓	×	×	?	✓
	S14	1.643	0.233 NS	0.247 NS	✓	✓	✓	×	×
green solutions	S4	1.039	0.699 ***	0.813 ***	✓	✓	✓	✓	✓
	S7	1.097	0.371 *	0.580 ***	✓	✓	✓	✓	✓
	S10	1.059	0.372 *	0.583 ***	✓	✓	✓	✓	✓

Significance level: ***0.001; **0.050; *0.100; NS Not Significant

Considerations: ✓ Retain the indicator; × Delete the indicator; ? Consider deleting the indicator

Table 5-6 - Formative measurement models evaluation (Szczecin).

Construct	Indicator	VIF	Outer Weight	Outer Loading	Steps				Decision
					1	2	3	4	
urban infrastructure	P6	1.021	0.072 NS	-0.074 NS	✓	×	×	×	×
	P10	1.021	1.008 ***	0.997 ***	✓	✓	✓	✓	✓
urban flow	P1	1.062	0.340 **	0.354 **	✓	✓	✓	✓	✓
	P2	1.022	-0.046 NS	0.059 NS	✓	×	×	×	×
	P3	1.056	0.224 NS	0.288 *	✓	×	×	?	✓
	P7	1.169	0.139 NS	0.364 **	✓	×	×	?	✓
	P9	1.082	0.406 ***	0.502 ***	✓	✓	✓	✓	✓
	P11	1.030	0.533 ***	0.636 ***	✓	✓	✓	✓	✓
	P12	1.193	0.377 **	0.595 ***	✓	✓	✓	✓	✓
environmental issues	P4	1.001	0.991 ***	0.986 ***	✓	✓	✓	✓	✓
	P5	1.001	0.167 NS	0.140 NS	✓	×	×	×	×
infrastructure and information system	S1	1.036	-0,550 NS	-0.466 NS	✓	×	×	×	×
	S2	1.482	0.052 NS	0.434 NS	✓	×	×	×	×
	S3	1.498	0.764 NS	0.747 NS	✓	×	✓	✓	✓
	S8	1.027	-0.329 NS	-0.401 NS	✓	×	×	×	×
	S9	1.039	-0.085 NS	-0.215 NS	✓	×	×	×	×
government actions	S5	1.087	0.771 NS	0.807 NS	✓	×	✓	✓	✓
	S6	1.487	0.195 NS	0.059 NS	✓	×	×	×	×
	S11	1.215	-0.118 NS	-0.149 NS	✓	×	×	×	×
	S12	1.605	0.412 NS	0.349 NS	✓	×	×	×	×
	S13	1.415	-0.490 NS	-0.419 NS	✓	×	×	×	×
	S14	1.707	-0.031 NS	0.002 NS	✓	×	×	×	×
green solutions	S4	1.047	0.798 NS	0.893 NS	✓	×	✓	✓	✓
	S7	1.081	-0.447 NS	-0.618 NS	✓	×	×	×	×
	S10	1.050	0.050 NS	0.228 NS	✓	×	×	×	×

Significance level: ***0.001; **0.050; *0.100; NS Not Significant

Considerations: ✓ Retain the indicator; × Delete the indicator; ? Consider deleting the indicator

Figure 5-9 and Figure 5-10 illustrate the path model configuration considering the previous decisions for Belo Horizonte and Szczecin, respectively.

Figure 5-9 - Model 2 (Belo Horizonte).

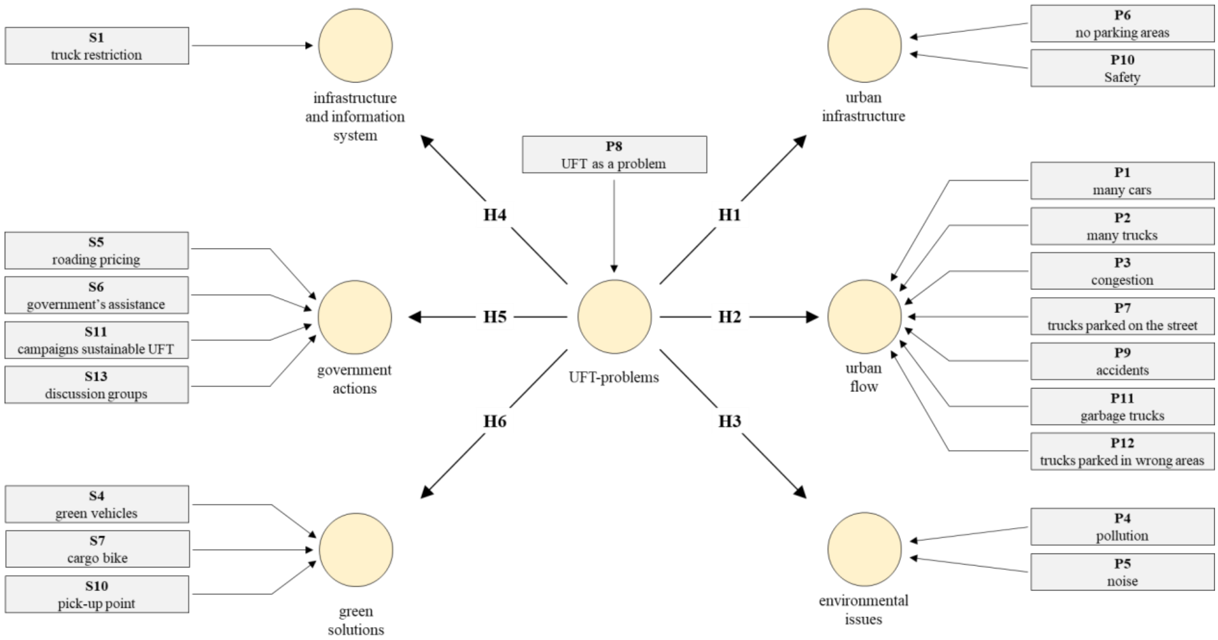
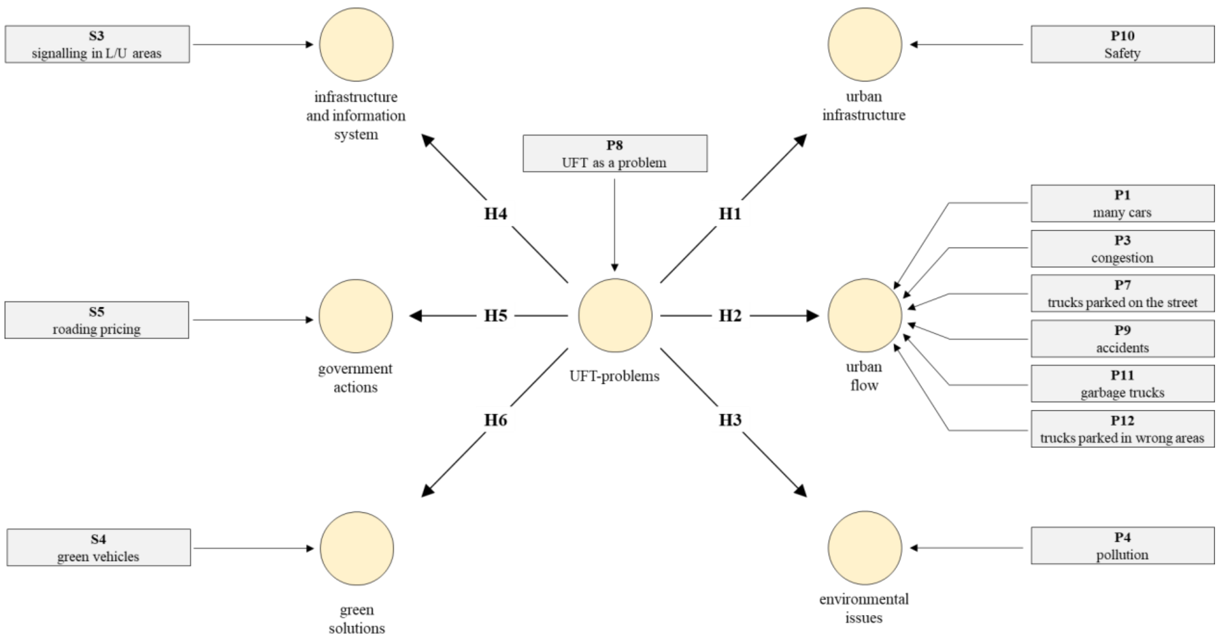


Figure 5-10 - Model 2 (Szczecin).



With the application of the literature recommendations, many of the path model's constructs start to have only one indicator, which is more evident in Szczecin. For these cases, called "single-item construct", the literature recommends that the evaluation be performed using other alternatives, considering that in PLS-SEM, these configurations are empirical and harm the predictive validity of the models (Hair et al., 2014).

Since the main objective of this master's thesis is to understand the phenomenon of perception of freight problems and solutions, the models were applied as presented in the previous figures. Table 5-7 shows the structural model path coefficients and the R-squared. All VIF values were also close to 1, as recommended by the literature.

Table 5-7 - Model 2: structural model evaluation results.

Structural (cause and effect) relationships	Belo Horizonte (Brazil)			Szczecin (Poland)		
	Path Coefficients	VIF	R^2	Path Coefficients	VIF	R^2
urban infrastructure problems → UFT-problems	0.392 ***	1.000	0.153	0.209 **	1.000	0.040
urban flow problems → UFT-problems	0.487 ***	1.000	0.237	0.395 ***	1.000	0.153
environmental issues → UFT-problems	0.288 ***	1.000	0.083	0.161 **	1.000	0.026
UFT-problems → infrastructure/information system solutions	0.224 ***	1.111	-	-0.194 **	1.009	-
UFT-problems → government actions solutions	0.175 ***	1.294	-	0.219 **	1.050	-
UFT-problems → green solutions	0.036 NS	1.228	-	0.130 **	1.047	-

Significance level: ***0.001; **0.050; *0.100; NS Not Significant

Figure 5-11 and Figure 5-12 present the hypotheses where "solid arrows" indicate the hypothesis is confirmed and the "dashed arrows" hypothesis is rejected.

Figure 5-11 - Hypothesis according to Model 2: Belo Horizonte.

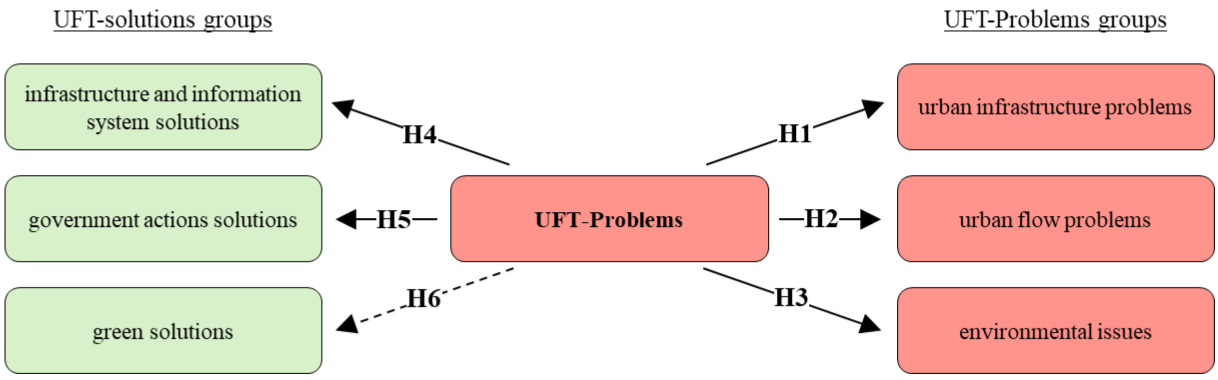
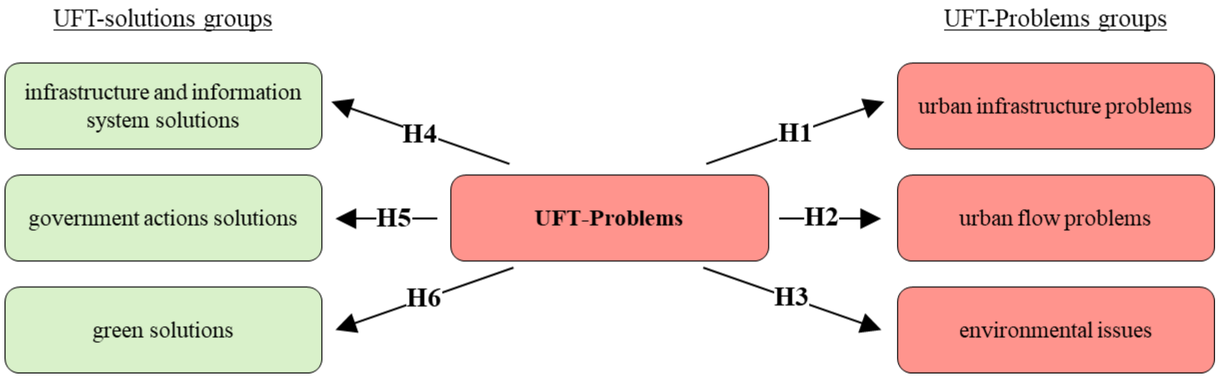


Figure 5-12 - Hypothesis according to Model 2: Szczecin.



The Model 2 PLS-SEM results did not change the confirmation/rejection of the hypotheses for Belo Horizonte. However, all hypotheses for the Polish city were proven, contrasting Model 1. By these results, as the perception of Szczecin's citizens about the freight problems increases, the perception of the three groups of solutions (infrastructure and information systems, governmental and environmentally friendly actions) also increases.

Although these results seem attractive for this research purpose, according to the literature, the model that originates it is flawed and does not make sense, precisely due to the single items constructs. Szczecin's Model 2 uses an observed variable to "create" a perception by a group of freight problems/solutions, masking the actual perception of Szczecin's. Even if it does not prove all the hypotheses, Model 1 is more appropriate for the available date. As demonstrated, it relates to the literature and the reality of the analysed cities.

5.5.3 Model 3

The results of Model 1 show that (possibly) the indicators that did not present statistical significance have variance problems, that is, homogeneity of responses and perception. Since this condition violates the principles of PLS-SEM, Model 3 restricted the analyses to those freight problems and solutions with variance.

The Analysis of Variance test (ANOVA) was used to assess the variance. ANOVA is a practical parametric statistical test and is an extension of the independent t-test for comparing the means of more than two independent groups (Azizi et al., 2022). The ANOVA test analyses the mean values of a series dataset at once. The rejection of the null hypothesis of the ANOVA test, that is, when there is statistical significance, indicates that there is a difference between the means of the groups: there is variance between the indicators. This condition is suitable for modelling by PLS-SEM. Table 5-8 and Table 5-9 show ANOVA test results.

Table 5-8 - ANOVA test result to Belo Horizonte.

	P12	P11	P10	P9	P8	P7	P6	P5	P4	P3	P2	P1			-	S14
P1	*	***	***	***	***	***	***	***	***	NS	***	-		-	***	S13
P2	***	***	*	***	***	***	***	***	**	***	-		-	***	NS	S12
P3	*	***	***	***	***	***	***	***	***	-		-	***	***	***	S11
P4	*	***	***	***	***	***	NS	NS	-		-	***	***	NS	***	S10
P5	NS	***	***	***	***	***	NS	-		-	***	***	***	***	***	S9
P6	NS	***	***	NS	NS	NS	-		-	NS	***	NS	***	***	***	S8
P7	***	***	***	***	NS	-		-	***	***	***	NS	***	*	***	S7
P8	***	***	***	***	-		-	***	***	***	***	***	***	***	***	S6
P9	***	***	**	-		-	NS	***	***	***	***	***	***	***	***	S5
P10	***	***	-		-	NS	***	***	***	***	***	***	***	***	***	S4
P11	***	-		-	***	***	***	***	NS	NS	***	*	***	***	***	S3
P12	-		-	NS	***	***	***	***	NS	NS	***	**	***	***	***	S2
		-	***	***	***	***	***	NS	***	***	NS	***	***	NS	***	S1
		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	

Significance level: ***0.001; **0.050; *0.100; NS Not Significant

Table 5-9 - ANOVA test result to Szczecin.

	P12	P11	P10	P9	P8	P7	P6	P5	P4	P3	P2	P1			-	S14
P1	NS	***	***	***	NS	***	NS	***	***	NS	***	-		-	***	S13
P2	***	**	***	***	***	***	***	NS	***	***	-		-	***	NS	S12
P3	NS	***	***	***	NS	***	***	***	***	-		-	***	NS	***	S11
P4	***	***	***	NS	***	***	***	***	-		-	***	***	***	***	S10
P5	***	NS	NS	***	***	NS	***	-		-	***	**	NS	NS	**	S9
P6	***	***	***	***	***	***	-		-	NS	***	***	NS	*	NS	S8
P7	***	NS	NS	***	***	-		-	***	***	NS	***	***	***	***	S7
P8	NS	***	*	***	-		-	***	***	***	***	NS	***	NS	***	S6
P9	***	***	***	-		-	***	NS	***	***	NS	***	***	***	***	S5
P10	**	NS	-		-	***	NS	***	*	NS	***	NS	***	NS	***	S4
P11	***	-		-	***	***	NS	*	***	***	**	NS	***	***	***	S3
P12	-		-	NS	***	NS	***	NS	***	***	NS	***	***	***	***	S2
		-	NS	NS	***	NS	***	NS	***	***	NS	***	***	***	***	S1
		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	

Significance level: ***0.001; **0.050; *0.100; NS Not Significant

The results of the ANOVA test indicate that practically all indicators have variance problems in at least one relationship with other indicators. This does not happen with P2, P10, P11, S11, S12 and S14 for Belo Horizonte. If all variance problems were removed, no data would remain for PLS-SEM analyses.

For this reason, Model 3 disregarded the indicators that most often did not show statistical significance in the relationships between variables observed: P5, P6, S1, S2 and S3 for Belo Horizonte and P1, S1 and S2 for Szczecin. Figure 5-13 and Figure 5-14 illustrate the path model configuration considering the variance decisions for Belo Horizonte and Szczecin, respectively.

Figure 5-13 - Model 3 (Belo Horizonte).

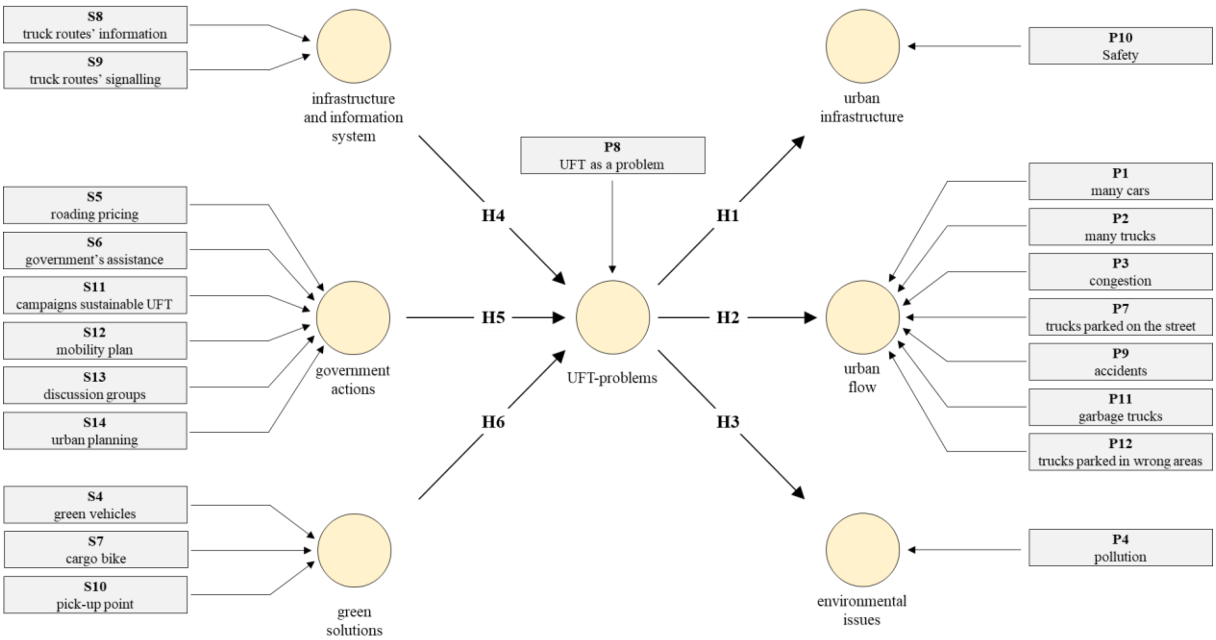


Figure 5-14 - Model 3 (Szczecin).

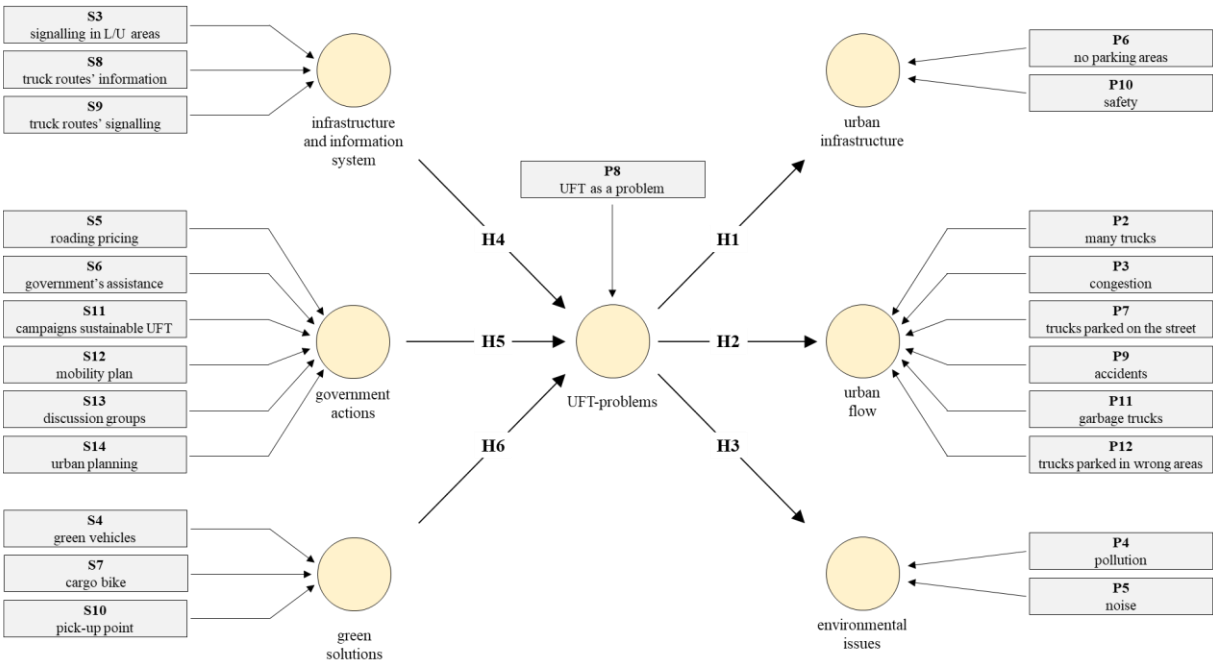


Table 5-10 shows the path coefficients of the structural model. Like Model 1, the estimated coefficients of the Model 3 do not confirm the hypotheses associated with freight solutions to Szczecin. Still, there is a reduction in the path coefficient in the relationships of the endogenous constructs that had the indicators removed. For Belo Horizonte, Model 3 reduces some of the coefficients but also rejects hypothesis H4, which was confirmed by Model 1. Due to that, Model 3 also does not bring results to explain the phenomenon under study that are better than Model 1. Figure 5-11 and Figure 5-12 present the hypotheses where "solid arrows" indicate the hypothesis is confirmed and the "dashed arrows" hypothesis is rejected.

Table 5-10 - Model 3: structural model evaluation results.

Structural (cause and effect) relationships	Path Coefficients	
	Belo Horizonte	Szczecin
urban infrastructure problems → UFT-problems	0.363 ***	0.209 **
urban flow problems → UFT-problems	0.487 ***	0.373 ***
environmental issues → UFT-problems	0.283 ***	0.163 **
UFT-problems → infrastructure/information system solutions	0.017 NS	-0.168 NS
UFT-problems → government actions solutions	0.238 ***	0.245 NS
UFT-problems → green solutions	0.053 NS	0.107 NS

Significance level: ***0.001; **0.050; *0.100; NS Not Significant

Figure 5-15 - Hypothesis according to Model 3: Belo Horizonte.

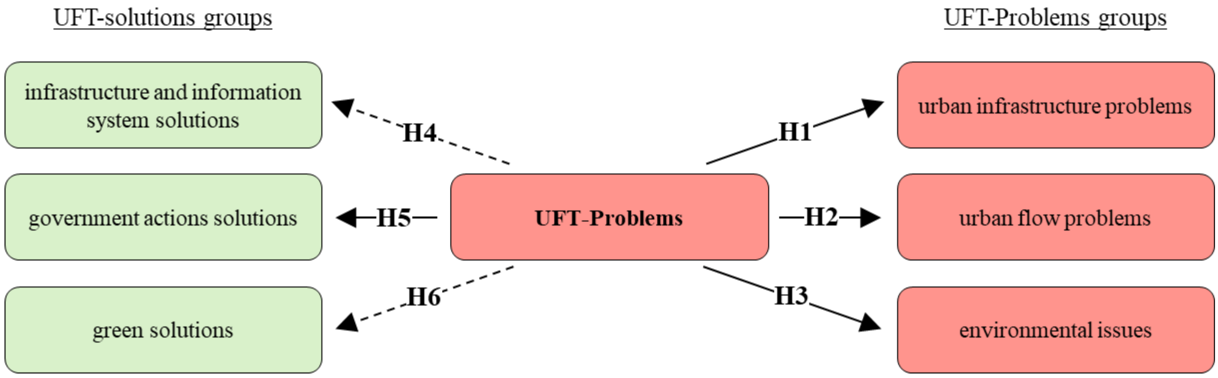
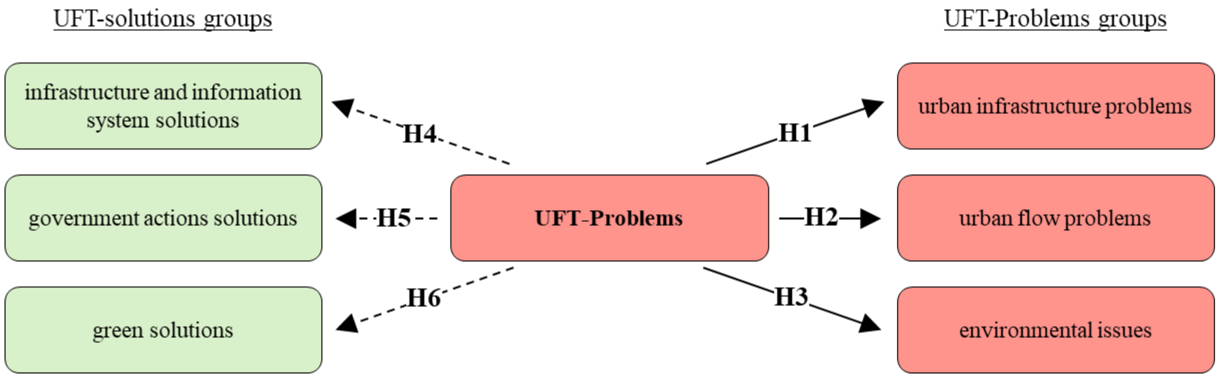


Figure 5-16 - Hypothesis according to Model 3: Szczecin.



5.6 Discussions

Based on the results obtained, inferring other conclusions about citizens' UFT perceptions and their problems/solutions is possible. Regarding freight problems, the causal relationships indicated [i] that while freight problems perception increases, problems' groups perception also increases; and [ii] all the perceptions are more latent in Belo Horizonte than in Szczecin (higher coefficients). Combining this fact with the geography of the cities, both have the same area, while the population is five times greater in Belo Horizonte than in Szczecin. Demographic concentration can play a fundamental role in this perceiving ease of freight problems since (in a simple association) they impact the mobility of the Brazilian city on a larger scale.

Despite the slight difference between the path coefficients, the results show that regardless of the local context, the urban mobility problem associated with the UFT is latent and daily experienced by residents, impacting their activities and routine. That is, there is an agreement with "the UFT is a problem for cities and/or generates impacts on cities". These negative externalities are more or less perceived by residents and how they contribute to the relationships of specific groups with the whole.

Comparing the data description and estimates coefficients of Model 1, the three equally significant problems in Belo Horizonte and Szczecin (P10, P11 and P12) are precisely those in which the citizens' agreement presents the most variation. This finding indicates that these negative externalities should be considered in mobility studies and that they impact residents to different extents.

On the contrary, those more latent problems, e.g., congestion (P3) and number of cars in cities (P1), are “unanimous” when understanding that they impact cities and are those on which proposals for changes in freight policies should focus. However, since they are internalized in the residents' perception, they do not contribute to the perception of the whole.

This same logic can be applied to the lack of parking areas (P6) and the trucks parked in inappropriate places (P12), which were significant in only one of the cities, contributing to the perception of relationships only in that context. This also results from how citizens live with that impact in their local context since the homogeneity of perception does not play a role in the structural model but explains city mobility problems.

On the other hand, freight solutions have a completely different perception among residents in the two analysed contexts. Through causal relationships, it was not possible to identify which solutions group has a perception affected by freight problems in Szczecin. However, the data description allows us to verify that, through statements of agreement, sustainable measures (cargo bike and pick-up points) and restriction and charging policies are more effective. Thus, the results indicate that these solutions would be more conducive to being incorporated into urban mobility plans, especially those with an environmental character in line with the Sustainable Development Goals (SDGs) of the United Nations (UN).

Since environmentally friendly measures are not yet a reality in Brazil, the causal relationships of Model 1 indicate that the most appropriate freight solutions would be those related to infrastructure, information systems and government actions, more precisely, the freight vehicles restriction and road pricing. By analysing the data statement, urban planning, mobility plans, and new L/U areas are also well-regarded measures by the citizens of Belo Horizonte.

Since the estimated PLS-SEM model presented the main problems affecting citizens’ perception of freight problems, city authorities could improve freight transport polices based on the results. For example, the results indicate a positive association (in a higher coefficient) between urban flow problems and freight problems, therefore, the authorities could provide measures that reduce congestion, regularize the L/U areas and minimize accidents. Using these strategies, city authorities begin to work in the citizens interests developing solutions that meet community needs and promote improvements in urban mobility. Moreover, there is a correlation between the externalities of the UFT and environmental issues, thus, the authorities would focus on measures to reduce the emissions, making the UFT more sustainable.

The strategies indicated in the results could create awareness about UFT and its importance to the city. By sharing the results with citizens and other stakeholders, city authorities can increase the understanding of the challenges and opportunities associated with UFT.

The conclusions contribute to evaluating the effectiveness of existing policies since the hypotheses related to freight solutions did not have statistical significance for Szczecin and showed a low coefficient for Belo Horizonte. Based on this perception, the city authorities can improve the current city logistics measures implemented.

Finally, the results can assess the effectiveness of interventions over time. With the present perception (t0), the city authorities can compare the results after implementing the best interventions (t1), assessing whether they were successful based on a new perception survey. This can help authorities refine their interventions and continually improve the quality of UFT in the city.

6 CONCLUSIONS

UFT is an essential activity for cities and has a fundamental role in citizens' daily lives. Despite this, UFT is responsible for city problems, such as congestion, lack of parking areas, pollution and accidents involving freight vehicles. To minimize these negative externalities is essential to include UFT in urban and transport planning so that these problems are partially or entirely remedied, promoting a sustainable UFT and leading to sustainable economic development. The measures to reduce the UFT's negative externalities align with the “city logistics” concept.

In the UFT context, there are four main stakeholders: carriers, shippers, city authorities and citizens. Each has specific interests and objectives, which vary according to their role and behaviour in the freight cycle. This master's thesis evaluated the citizens' perception of UFT by evaluating freight problems and solutions.

The choice of this stakeholder was motivated by the fact that citizens are a fundamental part of UFT and are often not included in urban planning. On the other hand, they live with freight daily, impacting their movements, that is, urban mobility.

This analysis was carried out in two different geographic contexts, considering cities with similar predominant activities (services) located in the Global South and Global North: Belo Horizonte (Brazil) and Szczecin (Poland). This choice was made for convenience in data collection. Six causal relationships were determined using SEM, a multivariate statistical technique that combines factor analysis with linear regressions to assess this perception. Three models were estimated, only one of which portrays the reality of the evaluated phenomenon.

The model results allowed for answering the research question and identifying how citizens perceive the UFT, in addition to confirming five of the six hypotheses for Belo Horizonte (H1 to H5) and three for Szczecin (H1 to H3). For both cities, the endogenous constructs path coefficients were positive and statistically significant, indicating that as the citizens' perceptions of [i] urban infrastructure problems; [ii] urban flow problems; and [iii] environmental issues; increased, the freight problems perception also increase. That is, each problems group perception contributes to freight problems perception.

Identifying the cause-and-effect relationships between problems and solutions was possible only for Belo Horizonte, confirming two hypotheses (H4 and H5). For them, it was concluded that as the citizens' perception of freight problems increases, the city logistics measures perception involving [i] infrastructure and information system; and [ii] Government Actions; also increase.

None of the hypotheses was confirmed for Szczecin. However, the descriptive analysis of the data reveals a high level of agreement for all the measures investigated. Based on this, any freight solutions would improve freight problems in the Polish city. Although the causal relationship between the problems and the green solutions has not been proven, the model's indicators had statistical significance, indicating a good perception to implementing environmentally friendly measures.

Additionally, the results imply that citizens homogeneously perceive that freight problems impact cities. Still, the perception contribution of each problem is heterogeneous, varying according to the local context. Likewise, there is heterogeneity in which measures to minimize them are more effective than others, varying according to the local context.

The objectives proposed in this master's thesis were achieved. This is because it was possible to analyse the citizens' perception of the UFT, indicating [i] the urban mobility importance through the problems perception; [ii] the best freight solutions to consider in urban and transport planning. Furthermore, it was possible to compare the results between two different scenarios, assessing the similarities and differences between the Global South and Global North contexts.

For further studies, it is suggested that the spatial analysis of citizens' perception of urban freight transport is the main suggestion for future research. The perceptions could vary according to the cities' internal context. Another suggestion is to explore the cultural and historical context of urban freight transport in different classes (age, income, schooling) to verify how these conditions change the perception of freight transport and its impacts (heterogeneity among the socioeconomic conditions).

REFERENCES

Akgün, E. Z., Monios, J., Rye, T., & Fonzone, A. (2019). Influences on urban freight transport policy choice by local authorities. *Transport Policy*, *75*, 88–98. https://doi.org/10.1016/j.tranpol.2019.01.009

Alves, R., Lima, R. S., Custódio Sena, D., Ferreira Pinho, A., & Holguín-Veras, J. (2019). Agent-Based Simulation Model for Evaluating Urban Freight Policy to E-Commerce. *Sustainability*, *11*(15), 4020. https://doi.org/10.3390/su11154020

Amaya, J., Arellana, J., & Delgado-Lindeman, M. (2020). Stakeholders perceptions to sustainable urban freight policies in emerging markets. *Transportation Research Part A: Policy and Practice*, *132*, 329–348. https://doi.org/10.1016/j.tra.2019.11.017

Amaya, J., Delgado-Lindeman, M., Arellana, J., & Allen, J. (2021). Urban freight logistics: What do citizens perceive? *Transportation Research Part E: Logistics and Transportation Review*, *152*, 102390. https://doi.org/10.1016/j.tre.2021.102390

Anderson, S., Allen, J., & Browne, M. (2005). Urban logistics—how can it meet policy makers' sustainability objectives? *Journal of Transport Geography*, *13*(1), 71–81. https://doi.org/10.1016/j.jtrangeo.2004.11.002

Azizi, F., Ghasemi, R., & Ardalan, M. (2022). *Two Common Mistakes in Applying ANOVA Test: Guide for Biological Researchers* [Preprint]. MATHEMATICS & COMPUTER SCIENCE. https://doi.org/10.20944/preprints202207.0082.v1

Bakås, O., Bjerkan, K. Y., Nordtømme, M. E., & Sund, A. B. (2017). *Viable solutions for green urban freight: A business model for consolidation*. https://doi.org/10.13140/RG.2.2.20036.12165

Ballantyne, E. E. F., Lindholm, M., & Whiteing, A. (2013). A comparative study of urban freight transport planning: Addressing stakeholder needs. *Journal of Transport Geography*, *32*, 93–101. https://doi.org/10.1016/j.jtrangeo.2013.08.013

Behrends, S., Lindholm, M., & Woxenius, J. (2008). The Impact of Urban Freight Transport: A Definition of Sustainability from an Actor's Perspective. *Transportation Planning and Technology*, *31*(6), 693–713. https://doi.org/10.1080/03081060802493247

Behrends, S. önke. (2012). The Urban Context of Intermodal Road-Rail Transport – Threat or Opportunity for Modal Shift? *Procedia - Social and Behavioral Sciences*, *39*, 463–475. https://doi.org/10.1016/j.sbspro.2012.03.122

Bernardi, R. A. (1994). Validating Research Results when Cronbach'S Alpha is Below .70: A Methodological Procedure. *Educational and Psychological Measurement*, *54*(3), 766–775. https://doi.org/10.1177/0013164494054003023

Betanzo-Quezada, E., & Romero, J. A. (2010). An urban freight transport index. *Procedia - Social and Behavioral Sciences*, *2*(3), 6312–6322. https://doi.org/10.1016/j.sbspro.2010.04.040

Bujang, M. A., Omar, E. D., & Baharum, N. A. (2018). A Review on Sample Size Determination for Cronbach's Alpha Test: A Simple Guide for Researchers. *Malaysian Journal of Medical Sciences*, *25*(6), 85–99. https://doi.org/10.21315/mjms2018.25.6.9

Buldeo Rai, H., Verlinde, S., Merckx, J., & Macharis, C. (2017). Crowd logistics: An opportunity for more sustainable urban freight transport? *European Transport Research Review*, *9*(3), 39. https://doi.org/10.1007/s12544-017-0256-6

Buldeo Rai, H., Verlinde, S., & Macharis, C. (2019). The "next day, free delivery" myth unravelled: Possibilities for sustainable last mile transport in an omnichannel environment. *International Journal of Retail & Distribution Management*, *47*(1), 39–54. https://doi.org/10.1108/IJRDM-06-2018-0104

Carvalho, N., Ribeiro, P. C., Oliveira, L., Silva, J. E. A. R., & Vidal Vieira, J. (2019). Criteria to implement UDCs in historical cities: A Brazilian case study. *European Transport\Trasporti Europei*, *June*, 1–29.

Cassiano, D. R., Bertoncini, B. V., & Oliveira, L. K. (2021). A Conceptual Model Based on the Activity System and Transportation System for Sustainable Urban Freight Transport. *Sustainability*, *13*(10), 5642. https://doi.org/10.3390/su13105642

Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*(1), 155–159. https://doi.org/10.1037/0033-2909.112.1.155

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3), 297–334. https://doi.org/10.1007/BF02310555

Cui, J., Dodson, J., & Hall, P. V. (2015). Planning for Urban Freight Transport: An Overview. *Transport Reviews*, *35*(5), 583–598. https://doi.org/10.1080/01441647.2015.1038666

Dablanc, L. (2007). Goods transport in large European cities: Difficult to organize, difficult to modernize. *Transportation Research Part A: Policy and Practice*, *41*(3), 280–285. https://doi.org/10.1016/j.tra.2006.05.005

Dexheimer, L., Larrañaga, A. M., & Lindau, L. A. (2013). Society's Perception to the Presence of Urban Distribution Trucks. *Journal of Traffic and Logistics Engineering*, *1*(2), 111–115. https://doi.org/10.12720/jtle.1.2.111-115

Dias, J. M., Sobanski, G. B., Silva, J. E. A. R. da, Oliveira, L. K. de, & Vieira, J. G. V. (2018). Are Brazilian cities ready to develop an efficient urban freight mobility plan? *Urbe. Revista Brasileira de Gestão Urbana*, *10*(3), 587–599. https://doi.org/10.1590/2175-3369.010.003.ao07

Ewbank, H., Vidal Vieira, J. G., Fransoo, J., & Ferreira, M. A. (2020). The impact of urban freight transport and mobility on transport externalities in the SPMR. *Transportation Research Procedia*, *46*, 101–108. https://doi.org/10.1016/j.trpro.2020.03.169

Furquim, T. S. G., Vieira, J. G. V., & Oliveira, R. M. (2018). Restrições de carga urbana e desafios logísticos: Percepção de varejistas e motoristas em Sorocaba. *TRANSPORTES*, *26*(1), 142–156. https://doi.org/10.14295/transportes.v26i1.1354

Gatta, V., & Marcucci, E. (2016). Behavioural implications of non-linear effects on urban freight transport policies: The case of retailers and transport providers in Rome. *Case Studies on Transport Policy*, *4*(1), 22–28. https://doi.org/10.1016/j.cstp.2015.08.001

Gatta, V., Marcucci, E., Delle Site, P., Le Pira, M., & Carrocci, C. S. (2019). Planning with stakeholders: Analysing alternative off-hour delivery solutions via an interactive multi-criteria approach. *Research in Transportation Economics*, *73*, 53–62. https://doi.org/10.1016/j.retrec.2018.12.004

Haenlein, M., & Kaplan, A. M. (2004). A Beginner's Guide to Partial Least Squares Analysis. *Understanding Statistics*, *3*(4), 283–297. https://doi.org/10.1207/s15328031us0304_4

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2012). Partial Least Squares: The Better Approach to Structural Equation Modeling? *Long Range Planning*, *45*(5–6), 312–319. https://doi.org/10.1016/j.lrp.2012.09.011

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2014). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)* (1st Edition). Sage Publications.

Hair, J. F., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. G. (2014). Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. *European Business Review*, *26*(2), 106–121. https://doi.org/10.1108/EBR-10-2013-0128

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, *31*(1), 2–24. https://doi.org/10.1108/EBR-11-2018-0203

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2021). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)* (3rd Edition). Sage Publications.

Hatzistamatis, N., Nathanail, E., & Karakikes, I. (2019, October). *Can night deliveries actually work in a medium size Greek city?*

Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. In R. R. Sinkovics & P. N. Ghauri (Eds.), *Advances in International Marketing* (Vol. 20, pp. 277–319). Emerald Group Publishing Limited. https://doi.org/10.1108/S1474-7979(2009)0000020014

Hicks, S. (1977). Urban Freight. In *Urban Transport Economics*. David A. Hansher.

Holguín-Veras, J., Cruz, C. A. T., & Ban, X. (Jeff). (2013). On the comparative performance of urban delivery vehicle classes. *Transportmetrica A: Transport Science*, *9*(1), 50–73. https://doi.org/10.1080/18128602.2010.523029

Ibeas, A., Moura, J. L., Nuzzolo, A., & Comi, A. (2012). Urban Freight Transport Demand: Transferability of Survey Results Analysis and Models. *Procedia - Social and Behavioral Sciences*, *54*, 1068–1079. https://doi.org/10.1016/j.sbspro.2012.09.822

Iwan, S. (2014). Adaptative Approach to Implementing Good Practices to Support Environmentally Friendly Urban Freight Transport Management. *Procedia - Social and Behavioral Sciences*, *151*, 70–86. https://doi.org/10.1016/j.sbspro.2014.10.009

Jardas, M., Perić Hadžić, A., & Tijan, E. (2021). Defining and Measuring the Relevance of Criteria for the Evaluation of the Inflow of Goods in City Centers. *Logistics*, *5*(3), 44. https://doi.org/10.3390/logistics5030044

Jedliński, M., & Kijewska, K. (2016). The Concept of Binary Evaluation of Freight Quality Partnership Impact on the Principles of Sustainable Urban Development. *Transportation Research Procedia*, *16*, 130–145. https://doi.org/10.1016/j.trpro.2016.11.014

Karakikes, I., & Nathanail, E. (2020). Using the Delphi Method to Evaluate the Appropriateness of Urban Freight Transport Solutions. *Smart Cities*, *3*(4), 1428–1447. https://doi.org/10.3390/smartcities3040068

Kiba-Janiak, M. (2016). Key Success Factors for City Logistics from the Perspective of Various Groups of Stakeholders. *Transportation Research Procedia*, *12*, 557–569. https://doi.org/10.1016/j.trpro.2016.02.011

Kiba-Janiak, M. (2017). Urban freight transport in city strategic planning. *Research in Transportation Business & Management*, *24*, 4–16. https://doi.org/10.1016/j.rtbm.2017.05.003

Kiba-Janiak, M. (2019a). EU cities' potentials for formulation and implementation of sustainable urban freight transport strategic plans. *Transportation Research Procedia*, *39*, 150–159. https://doi.org/10.1016/j.trpro.2019.06.017

Kiba-Janiak, M. (2019b). *Logistics in the cities' development strategies*. Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu.

Kijewska, K., & Jedliński, M. (2016). The Idea of “FQP Projectability Semicircle” in Determining the Freight Quality Partnership Implementation Potential of the City. *Transportation Research Procedia*, *16*, 191–201. https://doi.org/10.1016/j.trpro.2016.11.019

Kijewska, K., & Jedliński, M. (2018). The Concept of Urban Freight Transport Projects Durability and Its Assessment within the Framework of a Freight Quality Partnership. *Sustainability*, *10*(7), 2226. https://doi.org/10.3390/su10072226

Kijewska, K., Jedliński, M., & Iwan, S. (2021). Ecological utility of FQP projects in the stakeholders’ opinion in the light of empirical studies based on the example of the city of Szczecin. *Sustainable Cities and Society*, *74*, 103171. https://doi.org/10.1016/j.scs.2021.103171

Kijewska, K., Oliveira, L. K., Santos, O. R., Bertoncini, B. V., Iwan, S., & Eidhammer, O. (2021). Proposing a tool for assessing the level of maturity for the engagement of urban freight transport stakeholders: A comparison between Brazil, Norway, and Poland. *Sustainable Cities and Society*, *72*, 103047. https://doi.org/10.1016/j.scs.2021.103047

Kijewska, K., França, J. G. C. B., Oliveira, L. K., & Iwan, S. (2022). Evaluation of Urban Mobility Problems and Freight Solutions from Residents’ Perspectives: A Comparison of Belo Horizonte (Brazil) and Szczecin (Poland). *Energies*, *15*(3), 710. https://doi.org/10.3390/en15030710

Kin, B., Verlinde, S., & Macharis, C. (2017). Sustainable urban freight transport in megacities in emerging markets. *Sustainable Cities and Society*, *32*, 31–41. https://doi.org/10.1016/j.scs.2017.03.011

Le Pira, M., Marcucci, E., Gatta, V., Ignaccolo, M., Inturri, G., & Pluchino, A. (2017a). Towards a decision-support procedure to foster stakeholder involvement and acceptability of urban freight transport policies. *European Transport Research Review*, *9*(4), 54. https://doi.org/10.1007/s12544-017-0268-2

Le Pira, M., Marcucci, E., Gatta, V., Inturri, G., Ignaccolo, M., & Pluchino, A. (2017b). Integrating discrete choice models and agent-based models for ex-ante evaluation of stakeholder policy acceptability in urban freight transport. *Research in Transportation Economics*, *64*, 13–25. https://doi.org/10.1016/j.retrec.2017.08.002

Leite, C. E., Granemann, S. R., Mariano, A. M., & Oliveira, L. K. (2022). Opinion of Residents about the Freight Transport and Its Influence on the Quality of Life: An Analysis for Brasília (Brazil). *Sustainability*, *14*(9), 5255. https://doi.org/10.3390/su14095255

Lepori, B. (2010). Funding for Which Mission? Changes and Ambiguities in the Funding of Universities of Applied Sciences and Their Research Activities. In S. Kyvik & B. Lepori (Eds.), *The Research Mission of Higher Education Institutions outside the University Sector* (Vol. 31, pp. 61–76). Springer Netherlands. https://doi.org/10.1007/978-1-4020-9244-2_4

Lindholm, M., & Behrends, S. (2012). Challenges in urban freight transport planning – a review in the Baltic Sea Region. *Journal of Transport Geography*, *22*, 129–136. https://doi.org/10.1016/j.jtrangeo.2012.01.001

Lindholm, M. (2013). Urban freight transport from a local authority perspective – a literature review. *European Transport/Trasporti Europei*, *3*. https://www.openstarts.units.it/bitstream/10077/8869/1/ET_2013_54_3%20Lindholm.pdf

Małecki, K., Iwan, S., & Kijewska, K. (2014). Influence of Intelligent Transportation Systems on Reduction of the Environmental Negative Impact of Urban Freight Transport Based on Szczecin Example. *Procedia - Social and Behavioral Sciences*, *151*, 215–229. https://doi.org/10.1016/j.sbspro.2014.10.021

Marcucci, E., Le Pira, M., Gatta, V., Inturri, G., Ignaccolo, M., & Pluchino, A. (2017a). Simulating participatory urban freight transport policy-making: Accounting for heterogeneous stakeholders' preferences and interaction effects. *Transportation Research Part E: Logistics and Transportation Review*, *103*, 69–86. https://doi.org/10.1016/j.tre.2017.04.006

Marcucci, E., & Gatta, V. (2017b). Investigating the potential for off-hour deliveries in the city of Rome: Retailers' perceptions and stated reactions. *Transportation Research Part A: Policy and Practice*, *102*, 142–156. https://doi.org/10.1016/j.tra.2017.02.001

Marsden, G. R., Ballantyne, E. E. F., & Whiteing, A. E. (2011). An analysis of local authority views and treatment of urban freight in the UK. *Universities' Transport Study Group*, *3rd Universities' Transport Study Group Conference*.

Marta-Pedroso, C., Freitas, H., & Domingos, T. (2007). Testing for the survey mode effect on contingent valuation data quality: A case study of web based versus in-person interviews. *Ecological Economics*, *62*(3–4), 388–398. https://doi.org/10.1016/j.ecolecon.2007.02.005

Matusiewicz, M. (2022). Modeling Stakeholders Openness to Sustainable Logistics Measures Using a Data Analysis Approach. *Processes*, *10*(6), 1096. https://doi.org/10.3390/pr10061096

Muñuzuri, J., Larrañeta, J., Onieva, L., & Cortés, P. (2005). Solutions applicable by local administrations for urban logistics improvement. *Cities*, *22*(1), 15–28. https://doi.org/10.1016/j.cities.2004.10.003

Muñuzuri, J., Guadix, J., Cortés, P., & Onieva, L. (2016). Use of discrete choice to obtain urban freight evaluation data. *European Journal of Transport and Infrastructure Research*, Vol 16 No 1 (2016). https://doi.org/10.18757/EJTIR.2016.16.1.3111

Neves, J. A. B. (2018). *Modelo de equações estruturais: Uma introdução aplicada*. Enap Fundação Escola Nacional de Administração Pública.

Ogden, K. W. (1992). *Urban Goods Movement: A Guide to Policy and Planning*. Routledge. https://doi.org/10.4324/9781315235288

Oliveira, G. F., & Oliveira, L. K. de. (2016). Stakeholder's Perceptions of City Logistics: An Exploratory Study in Brazil. *Transportation Research Procedia*, *12*, 339–347. https://doi.org/10.1016/j.trpro.2016.02.070

Oliveira, G. F., & Oliveira, L. K. (2017). Stakeholder's perception about urban goods distribution solution: Exploratory study in Belo Horizonte (Brazil). *Transportation Research Procedia*, *25*, 942–953. https://doi.org/10.1016/j.trpro.2017.05.468

Oliveira, L. K., Oliveira, B. R. P. e, & Correia, V. A. (2014). Simulation of an Urban Logistic Space for the Distribution of Goods in Belo Horizonte, Brazil. *Procedia - Social and Behavioral Sciences*, *125*, 496–505. https://doi.org/10.1016/j.sbspro.2014.01.1491

Oliveira, L. K., Santos, O. R., Nóbrega, R. A. A., Dablanc, L., & Oliveira, R. L. M. de. (2017). Análise do espraiamento logístico: Um estudo para a região metropolitana de Belo Horizonte. *TRANSPORTES*, *25*(4), 42. https://doi.org/10.14295/transportes.v25i4.1214

Oliveira, L., Barraza, B., Bertocini, B., Isler, C., Pires, D., Madalon, E., Lima, J., Vieira, J., Meira, L., Bracarense, L., Bandeira, R., Oliveira, R., & Ferreira, S. (2018). An Overview of Problems and Solutions for Urban Freight Transport in Brazilian Cities. *Sustainability*, *10*(4), 1233. https://doi.org/10.3390/su10041233

Oliveira, L. K., Nascimento, C. O. L., Sousa, P. R., Resende, P. T. V., Silva, F. G. (2019a). Transport Service Provider Perception of Barriers and Urban Freight Policies in Brazil. *Sustainability*, *11*(24), 6890. https://doi.org/10.3390/su11246890

Oliveira, L. K., Macedo, A. D. R., Sampaio, J. C. L., Oliveira, T. P. M., Oliveira, R. L. M., & Vieira, J. G. V. (2019b). Challenges to urban freight transport in historical cities: A case study for Sabará (Brazil). *Transportation Research Procedia*, *39*, 370–380. https://doi.org/10.1016/j.trpro.2019.06.039

Oliveira, L. K., Nascimento, C. O. L., Sousa, L. T. M., Costa e Silva, T. G., Pinto, P. H. G., Pereira, R. M., Farias, L. P., Oliveira, R. L. M., Ferreira, S. C., Jesus, M. C. R. (2020a). Analysis of problems and solutions for urban freight transport in Brazilian cities. *Gospodarka Materiałowa i Logistyka*, *2020*(7), 37–44. https://doi.org/10.33226/1231-2037.2020.7.4

Oliveira, L. K. D., Nascimento, C. O. L., Sousa, P. R. D., Resende, P. T. V. D., & Isa, S. S. (2020b). Prioritisation of city logistics solutions based on stakeholders' point of view. *International Journal of Supply Chain and Operations Resilience*, *4*(2), 187. https://doi.org/10.1504/IJSCOR.2020.109190

Oliveira, L. K., França, J. G. C. B., Nascimento, C. O. L., Oliveira, I. K., Meira, L. H., & Rabay, L. (2021). Evaluating problems and measures for a sustainable urban freight transport in Brazilian historical cities. *Sustainable Cities and Society*, *69*, 102806. https://doi.org/10.1016/j.scs.2021.102806

Pérez-Vicente, S., & Expósito Ruiz, M. (2009). Descriptive statistics. *Allergologia et Immunopathologia*, *37*(6), 314–320. https://doi.org/10.1016/j.aller.2009.10.005

Quak, H. J. (Hans), & Koster, M. (René) B. M. (2009). Delivering Goods in Urban Areas: How to Deal with Urban Policy Restrictions and the Environment. *Transportation Science*, *43*(2), 211–227. https://doi.org/10.1287/trsc.1080.0235

Quak, H. J. (Hans). (2011). Urban Freight Transport: The Challenge of Sustainability. In C. Macharis & S. Melo, *City Distribution and Urban Freight Transport* (p. 14398). Edward Elgar Publishing. https://doi.org/10.4337/9780857932754.00008

Ringle, C. M., Wende, S., & Becker, J.-M. (2015). *SmartPLS 3* (Version 3). https://www.smartpls.com

Ringle, C. M., Sarstedt, M., Mitchell, R., & Gudergan, S. P. (2020). Partial least squares structural equation modeling in HRM research. *The International Journal of Human Resource Management*, *31*(12), 1617–1643. https://doi.org/10.1080/09585192.2017.1416655

Russo, F., & Comi, A. (2010). A classification of city logistics measures and connected impacts. *Procedia - Social and Behavioral Sciences*, *2*(3), 6355–6365. https://doi.org/10.1016/j.sbspro.2010.04.044

Russo, F., & Comi, A. (2011). Measures for Sustainable Freight Transportation at Urban Scale: Expected Goals and Tested Results in Europe. *Journal of Urban Planning and Development*, *137*(2), 142–152. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000052

Santos Junior, J. L. dos, & Oliveira, L. K. de. (2020). Analysis of the Level of Service of Unloading Zones Using Diversity Measures in a Multiplex Network. *Sustainability*, *12*(10), 4330. https://doi.org/10.3390/su12104330

Sarstedt, M., & Cheah, J.-H. (2019). Partial least squares structural equation modeling using SmartPLS: A software review. *Journal of Marketing Analytics*, *7*(3), 196–202. https://doi.org/10.1057/s41270-019-00058-3

Sharma, S. K., Kanchan, T., & Krishan, K. (2018). Descriptive Statistics. In S. L. López Varela (Ed.), *The Encyclopedia of Archaeological Sciences* (pp. 1–8). John Wiley & Sons, Inc. https://doi.org/10.1002/9781119188230.saseas0165

Stathopoulos, A., Valeri, E., & Marcucci, E. (2012a). Stakeholder reactions to urban freight policy innovation. *Journal of Transport Geography*, *22*, 34–45. https://doi.org/10.1016/j.jtrangeo.2011.11.017

Stathopoulos, A., Valeri, E., Marcucci, E., Gatta, V., Nuzzolo, A., & Comi, A. (2012b). *Acceptability of freight policy innovation for Rome's LTZ: A stakeholder perspective*.

Taber, K. S. (2018). The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education. *Research in Science Education*, *48*(6), 1273–1296. https://doi.org/10.1007/s11165-016-9602-2

Tadić, S., Zečević, S., & Krstić, M. (2015). CITY LOGISTICS – STATUS AND TRENDS. *INTERNATIONAL JOURNAL FOR TRAFFIC AND TRANSPORT ENGINEERING*, *5*(3), 319–343. https://doi.org/10.7708/ijtte.2015.5(3).09

Tamagawa, D., Taniguchi, E., & Yamada, T. (2010). Evaluating city logistics measures using a multi-agent model. *Procedia - Social and Behavioral Sciences*, *2*(3), 6002–6012. https://doi.org/10.1016/j.sbspro.2010.04.014

Taniguchi, E., Thompson, R., Yamada, T., & Van Duin, R. (2001). *City logistics: Network modelling and intelligent transport systems*. Bingley, Emerald. https://trid.trb.org/view.aspx?id=673352

Taniguchi, E., & Thompson, R. G. (Eds.). (2004). *Logistics Systems for Sustainable Cities: Proceedings of the 3 rd International Conference on City Logistics (Madeira, Portugal, 25–27 June, 2003)*. Emerald Group Publishing Limited. https://doi.org/10.1108/9780080473222

Taniguchi, E., & Tamagawa, D. (2005). *EVALUATING CITY LOGISTICS MEASURES CONSIDERING THE BEHAVIOR OF SEVERAL STAKEHOLDERS*. Eastern Asia Society for Transportation Studies. https://doi.org/10.11175/easts.6.3062

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, *2*, 53–55. https://doi.org/10.5116/ijme.4dfb.8dfd

Taylor, M. (2005). *The city logistics paradigm for urban freight transport*. https://www.researchgate.net/publication/242213289_The_City_Logistics_paradigm_for_urban_freight_transport

Teo, J. S. E., Taniguchi, E., & Qureshi, A. G. (2012). Evaluating City Logistics Measure in E-Commerce with Multiagent Systems. *Procedia - Social and Behavioral Sciences*, *39*, 349–359. https://doi.org/10.1016/j.sbspro.2012.03.113

Thorndike, R. M. (1995). Book Review: Psychometric Theory (3rd ed.) by Jum Nunnally and Ira Bernstein New York: McGraw-Hill, 1994, xxiv + 752 pp. *Applied Psychological Measurement*, *19*(3), 303–305. https://doi.org/10.1177/014662169501900308

van Duin, J. H. R., van Kolck, A., Anand, N., Tavasszy, L. óránt A., & Taniguchi, E. (2012). Towards an Agent-Based Modelling Approach for the Evaluation of Dynamic Usage of Urban Distribution Centres. *Procedia - Social and Behavioral Sciences*, *39*, 333–348. https://doi.org/10.1016/j.sbspro.2012.03.112

Verlinde, S., & Macharis, C. (2016). Innovation in Urban Freight Transport: The Triple Helix Model. *Transportation Research Procedia*, *14*, 1250–1259. https://doi.org/10.1016/j.trpro.2016.05.196

Vieira, J. G. V., Fransoo, J. C., & Carvalho, C. D. (2015). Freight distribution in megacities: Perspectives of shippers, logistics service providers and carriers. *Journal of Transport Geography*, *46*, 46–54. https://doi.org/10.1016/j.jtrangeo.2015.05.007

Visser, J., Nemoto, T., & Browne, M. (2014). Home Delivery and the Impacts on Urban Freight Transport: A Review. *Procedia - Social and Behavioral Sciences*, *125*, 15–27. https://doi.org/10.1016/j.sbspro.2014.01.1452

Zenezini, G., Mangano, G., Tanda, A., & Carlin, A. (2018). *The impact of City Logistics on Retailers inventory management: An exploratory analysis*.

APPENDIX A

Research Questionnaire

What is your perception about the goods' delivery in your city?

This questionnaire has academic purposes and is being used in the Transport master's thesis of student João Guilherme França (UFMG). The research aims to identify how the population sees/perceives freight transport in the city. Your participation is voluntary and takes approximately 5 minutes. Your anonymity is guaranteed, and, in addition, we are interested in your personal opinion: answer how each situation applies to you.

Thank you so much!

Leise (UFMG), João (UFMG) and Kinga (MUS).

Section 1: How do you see the goods' delivery in your city?

We want your opinion about the problems and solutions for the trucks and vans circulating to deliver freight to stores and supermarkets throughout your city.

Part 1: What is your opinion on each of the problems below?

	strongly disagree	disagree	neutral	agree	strongly agree
P1: There are many cars in the city.	◯	◯	◯	◯	◯
P2: There are many trucks/vans in the city.	◯	◯	◯	◯	◯
P3: There is a lot of congestion in the city.	◯	◯	◯	◯	◯
P4: The city is very polluted.	◯	◯	◯	◯	◯
P5: There is a lot of noise because of the cars in the city.	◯	◯	◯	◯	◯
P6: There are no parking areas in the city.	◯	◯	◯	◯	◯
P7: There are many trucks parked on the street.	◯	◯	◯	◯	◯
P8: Freight transport is a problem for the city.	◯	◯	◯	◯	◯
P9: There are many accidents involving trucks in the city.	◯	◯	◯	◯	◯
P10: Trucks affect the safety of people walking and cyclists.	◯	◯	◯	◯	◯
P11: Garbage collection trucks hinder traffic.	◯	◯	◯	◯	◯
P12: Trucks parked in inappropriate places hinder traffic in the city.	◯	◯	◯	◯	◯

Part 2: What is your opinion on these solutions for transporting goods? We want to know if you think these solutions improve traffic in your city

	strongly disagree	disagree	neutral	agree	strongly agree
S1: Truck restriction improves traffic.	○	○	○	○	○
S2: Loading and unloading areas improve traffic.	○	○	○	○	○
S3: Clearer signage for loading and unloading areas improves traffic.	○	○	○	○	○
S4: Only allowing the circulation of new vehicles that are not very polluting improves traffic.	○	○	○	○	○
S5: Trucks paying a fee to drive in the city improves traffic.	○	○	○	○	○
S6: Financial aid from the government to buy new cars improves traffic.	○	○	○	○	○
S7: Delivery of goods by bicycle improves traffic.	○	○	○	○	○
S8: Information about truck routes in the city improves traffic.	○	○	○	○	○
S9: Smart signalling for truck routes improves traffic.	○	○	○	○	○
S10: Receiving and picking up products purchased over the Internet from stores or smart cabinets improves traffic.	○	○	○	○	○
S11: Campaigns for sustainable transport improve city traffic.	○	○	○	○	○
S12: Mobility plan improves traffic.	○	○	○	○	○
S13: Discussion groups on freight transport, including residents, improve traffic in the city.	○	○	○	○	○
S14: Urban planning improves traffic in the city.	○	○	○	○	○

Section 2 (Part 3): We want to know a little about you.

Question 1: How old are you? (only numbers)

Question 2: What is the approximate sum of the income of the people who live in your house? (only numbers)

Question 3: What is your zip code?

Question 4: What mode of transport do you use to go to work/school? (that trip you take every day)

Question 5: What is your education level?

- ◯ Incomplete elementary school
- ◯ Complete elementary school
- ◯ Incomplete high school
- ◯ Complete high school
- ◯ Technical course
- ◯ Incomplete higher education
- ◯ Completed higher education
- ◯ Postgraduate studies
- ◯ Master's degree
- ◯ Doctorate

Question 6: What is your experience with freight transport?

- ◯ I live close to shops with daily delivery.
- ◯ Work near shops with daily delivery.
- ◯ Work with freight transport.
- ◯ I am a person who occasionally sees a truck/van delivering in town.
- ◯ Other: _________________________