



**SPARE CAPACITY IN LIGHT VEHICLE TRAFFIC: AN ENTREPRENEURIAL  
OPPORTUNITY**

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Dissertation

Master's in Innovation and Technological Entrepreneurship



Supervised by

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2021

*Spare capacity in light vehicle traffic: an entrepreneurial opportunity*

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## **Acknowledgments**

First and foremost, I would like to thank my family with all my heart for always believing and supporting me in achieving my dreams and goals. I also would like to thank my advisor, supervisor and Professor Álvaro Costa, by whom I felt motivated, inspired and guided to work on this topic.

This study is the result of my master's degree in Innovation and Technological Entrepreneurship, which was for me a unique experience of growth and learning and for that, I could not fail to thank all the professors with whom I had the privilege of working, learning, and developing myself. Special thanks to Professor João José Pinto Ferreira for all his support throughout this journey. Also, I would like to express my gratitude to all my classmates who contributed so much by sharing their knowledge, experiences and friendships during this period, in particular to Carlos, Eduardo, Danilo, Marconi, Michael and Oseias.

Last but not least, I would like to praise and thank my God for His great love, presence and support in my life.

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## **Abstract**

We live in a society that is increasingly concerned about what we will leave as a legacy to future generations, especially when it comes to issues related to the environment. For this reason, new business models, products and services are emerging to fill this increasingly latent and urgent need.

Although the concept of a shared economy is not new, there are very few studies that explore idle or spare capacity in transport as an entrepreneurial opportunity. This study was created based on the need, values, and entrepreneurial spirit of this researcher to assess whether it is possible to measure spare capacity in vehicular traffic (with the Greater Porto region as the basis for study and research) and combine the concepts of shared economy and crowd logistics for the feasibility of a technologically innovative and disruptive business model.

This exploratory work was prepared based on the literature review of at least four different types of research and keyword combinations so that 36 publications could be obtained to allow the evaluation of these concepts combined with the analysis of available statistical data from the vehicular traffic compared with the responses obtained from 145 people in the metropolitan region of Porto about the possibility of using the spare capacity of their vehicle trunks to transport goods.

Thus, based on theoretical analysis, supported by statistical data and answers obtained from the questionnaire, the reader will be able to verify that there is indeed an entrepreneurial opportunity for companies who want to exploit the spare capacity in light vehicle traffic, when applied to a business model based on crowd logistics and shared economy concepts.

**Keywords:** shared economy, crowd logistics, spare capacity, entrepreneurship, business model

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## **Resumo**

Vivemos em uma sociedade cada vez mais preocupada com o que iremos deixar de legado às futuras gerações, sobretudo no que toca às questões relativas ao meio ambiente. Por esta razão, novos modelos de negócio, produtos e serviços surgem para colmatar esta necessidade cada vez mais latente e urgente.

Apesar de não ser novo o conceito de economia partilhada, existem muito poucos estudos que exploram a capacidade ociosa nos transportes como uma oportunidade empreendedora. Este estudo foi criado com base na necessidade, valores e espírito empreendedor deste pesquisador de avaliar se é possível medir a capacidade ociosa no tráfego de veículos (tendo a região do Grande Porto como base de estudo e pesquisa) e combinar os conceitos de economia partilhada e logística de multidão para viabilidade de um modelo de negócio tecnologicamente inovador e disruptivo.

Este trabalho exploratório foi elaborado com base na revisão de literatura de pelo menos quatro tipos diferente de pesquisas e combinações de palavras-chave para se poder obter uma base mínima de 36 publicações que permitisse avaliar esta combinação de conceitos e também na análise dos dados estatísticos disponíveis do tráfego de veículos comparados com as respostas obtidas de 145 pessoas da região metropolitana do Porto sobre a possibilidade de utilizarem a capacidade ociosa da mala de seus veículos para o transporte de mercadorias.

Desta forma e com base na análise teórica, fundamentada pelos dados estatísticos e respostas obtidas do questionário, o leitor poderá verificar que há de facto uma oportunidade empreendedora para empresas que queiram explorar a capacidade ociosa no tráfego de veículos leves, quando aplicado a um modelo de negócio baseado na logística de multidão e nos conceitos de economia partilhada.

**Palavras-chave:** economia partilhada, logística de multidão, capacidade ociosa, empreendedorismo, modelo de negócio

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# 1. Introduction

The natural tendency of the human being in the face of a problem or difficulty is to look for a solution to solve it, but it is also true that sometimes the solution is in the eyes of people, and they do not see it. When analyzing cargo transportation in urban centers, it is inevitable to face the chaos of traffic, restrictions on access and circulation (whether from streets, such as equipment/vehicles, timetables), transport costs and the environmental impact caused in the need to feed the supply chain of shopping centers and businesses, etc., which continue to grow year after year. Given this fact and dilemma, the trend is the same, that is, the search for very complex solutions to solve problems that can be much simpler.

The reader may have already stopped to think that each particular vehicle can carry at least one box of any product or goods, or has considered the hypothesis that any individual, with or without a vehicle, can transport small volumes of cargo, without large efforts and without changing their routes or routine? Given these questions, has the reader already stopped to think about the amount of idle capacity that exists today in the traffic of cities?

This master's thesis aims to raise these issues and problems, but in a more optimistic, creative, and entrepreneurial perspective, where it will seek to prove, based on a literature review and qualitative and quantitative research, that there is an idle capacity available in city traffic which could be better explored, both by companies and individuals, if we consider the application of shared economy concepts as a business model, aligned with the application of a good technological solution.

This research aims to verify, after a thorough analysis of papers and collected data, that the use of spare capacity in urban transport, associated with the concepts of sharing economy and crowd logistics, can be an excellent alternative for the transport of light bulky loads, without the need for investment in infrastructure or a substantial change on the current flow of vehicles and people.

## 1.1. Context

Traffic jams in city centres is a very well-known problem as its effects can be felt by a huge number of citizens that need to drive from place to place in crowded narrow roads that do not support the high traffic of vehicles. Supplying these large urban centres with goods is even harder, confusing, and more problematic. Congestion occurs by the reduction of traffic speed caused entropies on the transportation flow. It slows down the life of the population and has an enormous impact on the economy (Dong et al., 2019).

Several alternatives and projects to reduce and optimize this traffic of people and goods together have been created and implemented in recent years. Governments and local authorities don't stop

working to find solutions to minimize such impacts on urban centres. Some initiatives and regulations like the time limitation on heavy vehicle traffic in the city centres, or cargo deliveries during the night or other schedule different from the rush hours, the ban on circulating large vehicles and trucks during the day in city centres or around the cities have been implemented but still, traffic jam, logistics, distribution issues and the pressure to reduce the pollution created on this road supply chain are far to be resolved.

However, and motivated by the observation of the researcher, it was found that there's a "hidden" capacity in the vehicles of individuals or public transportation that could be used to transport cargoes. Instead of using the usual freight services that implicate bringing downtown more and more vehicles and as a side effect, increase the traffic jams, restrict the cargoes distribution, increase the level of pollutions, etc., an alternative would be looking to the existing spare capacity already in place and take it as an opportunity to entrepreneur or individual to explore.

This dissertation aims to find out innovative possible solutions for goods distribution in city centres to help readers understand the advantages of using existing channels and networks to reduce vehicle traffic and/or carbon emissions in downtown, based on the concepts of shared economy and crowd logistics.

## **1.2. Motivation and objective of the Research**

One of the reasons this researcher has chosen the Master's in Innovation and Technological Entrepreneurship is because he believed that it could even enlarge his capabilities to identify and develop most of the entrepreneurs' ideas he had when observing and questioning the surrounding environment. It was in one of the classes from professor Álvaro Costa, his mentor, when discussed the problem of spare capacity in transport, linked with his carrier background (mainly build by several years of experience in supply-chain management transport and logistics, associated with the development of technological solutions for industries) and his constant search for entrepreneurial opportunities, that this researcher decided to further investigate this subject by questioning: "Is there a better way to deliver and distribute cargoes in city centres without changing the existing network and structure and at the same time, reduce or minimize the traffic and environmental effects?"

It is estimated that freight transport is responsible for 30-40 % of vehicles driving on city roads. The problem in the final part of the delivery, or last mile, is in this aspect related to the cost of the delivery, the environmental and structural impact. Small volumes could maybe be delivered by



vehicles in passenger cars or public transports with spare capacity circulating around the city centres anyway (Kin et al., 2018), however, the most commonly used type of transport are medium-sized vans. This type of vehicles causes an increase in traffic in addition to facing parking problems (Singh & Gupta, 2020).

Based on that, the researcher looked into this reality and saw there was an entrepreneur opportunity. Although does it make any sense? What do other researchers say about it? It was when it started looking deeper into this topic, it was found out that utilizing spare transportation capacity is a relatively new subject. However, it builds upon the concepts of crowd logistics, which is increasingly applied for business-to-consumer deliveries and the “physical internet” (Kin et al., 2018), based on the concept of shared mobility and economy (Shaheen et al., 2017).

The motivation of this dissertation was to identify how innovative it would be to optimize the city transport network by the usage of vehicles’ spare capacity, other than transporting passengers alone, through an innovative and disruptive technological solution and find out what other authors or researchers’ but also the society has to say about this matter. This dissertation aims to check perspectives and alternatives on how transport of cargoes can be better distributed and optimized by the usage of existing spare capacity as a sustainable alternative to benefit people, the city and the environment when applying the shared economy concepts. The motivation was driven in the sense to answer the following questions:

- Is there a spare capacity in the urban traffic? How big is that?
- Can the concepts of sharing economy and crowd logistics be utilized to stimulate the usage of this existing spare capacity and serve as an opportunity to entrepreneurs?

The methodology used to answer those questions was based on the analysis of papers, published articles and research to confirm predefined concepts and arguments, the analysis of traffic data and numbers from the city of Porto and business cases. It will also suggest further new areas of knowledge to be discovered or explored.

### **1.3. Problem or opportunity?**

To answer this question, it will depend on the perspective and motivation of the viewer. One person can look at all the problems related to the logistics in city centres and try to find the root causes for such traffic. People can discuss how traffic jams increased due to the correspondent populational increase or the number of shipments via e-commerce (Urru et al., 2019), or because

of the size of the vehicles in urban areas (Urban Freight research Roadmap, European Road Transport Research Advisory Council (ERTRAC) & Alliance for Logistics Innovation through Collaboration in Europe (ALICE), 2014), point out the errors from public and private sectors during a certain period and may suggest a solution to solve it. However, others can look at a particular problematic situation, like urban freight, and find a solution by the simple attitude of observing the surrounding environment. That is the reason why it was hard to this researcher or any entrepreneur to classify spare capacity in transport as a problem, instead of an opportunity.

However, there is one thing that is common in most of the papers: the necessity to find a more sustainable solution to urban freight. The reader can find this need in all papers of this bibliography. Shared economy concepts brought a lot of new opportunities in the logistic industry by pointing to more sustainable urban logistics (Bin et al., 2020).

#### **1.4. Dissertation structure**

This dissertation is structured in a way that readers can understand how city transport networks can be better optimized by the usage of existing spare capacity in vehicles for cargo or goods transports to benefit cities on the urban freight and last-mile transports.

To understand how feasible this disruptive idea is and what solutions have been created in this regard, research on papers and articles associated with quantitative and qualitative research were made to obtain the necessary information for analysis.

The structure of this dissertation aims to explain the whole research process, gathered information and inputs from other authors and researchers, aligned with additional data collected from the Greater area of Porto city (Portugal) traffic, to validate if the idea of using the existing spare capacity in passenger or public city transport network for the transport of goods is feasible and the existence of any theoretical foundations.

Based on that, this dissertation is structured considering the following:

- Chapter 1: Contains the introduction to this dissertation and explains the context and motivations of the researcher as well as the main questions raised as objects of study.
- Chapter 2: It aims to evaluate what studies and researchers have been made regarding shared economy, crowd logistics and spare capacity. It explains how the

literature review was made, contains and provide an analysis of the main findings from the authors, same as the definition of the terms used in this dissertation.

- Chapter 3: Presents the methodology used and the data analysis of the survey created for this study combined with the information gathered from the traffic of vehicles, to measure how big is the existing spare capacity in a metropolitan area like Porto (Portugal).
- Chapter 4: Provides a review of the concepts found in the literature review and links them with the information gathered in chapter 3 to propose a crowd shipping business model. It also presents the environmental impacts of the spare capacity in the Porto District and proposes new areas of investigation and knowledge.
- Chapter 5: States the conclusion of this research.

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## **2. Literature review**

### **2.1. Introduction to the research**

The reason why this dissertation was created is to study how urban freight can be optimized and improved by the usage of existing city transport network with minimum or no impact on further investments, taking the existing spare capacity in urban freight as an opportunity to entrepreneurs who want to explore this “underused asset”, through a technological solution that combines the concepts of a collaborative platform and shared economy. It attempts to find innovative possible solutions for goods distribution in crowded city centers to help readers understand the advantages of using existing channels and networks to reduce the environmental impact on society.

The methodology used in this work is the analysis of other researchers and authors to check and confirm if the concepts of shared economy, spare capacity and crowd logistics can be combined. The main objective of this investigation is to present the challenges that the delivery of goods represents for cities today and to use the concepts already presented as solutions and entrepreneur opportunities to overcome these challenges.

Many questions were raised during the preparation of this dissertation, but the most important one was to understand if it is possible to take the advantage of an existing city network infrastructure or passenger flow to create a transport system to distribute and collect goods in city centers, or last-mile without changing but optimizing the network. To answer the numerous questions raised, it was analyzed some papers and articles related to this subject and the different opinions from researchers on how the existing city network capacity can be better optimized.

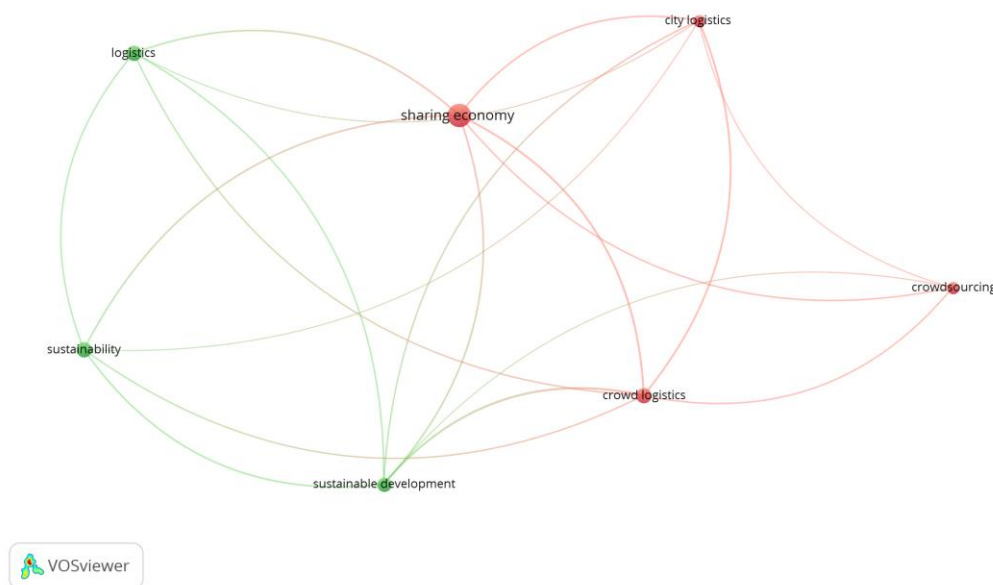
### **2.2. Literature review**

The identification and selection of articles to be included in the review followed a systematic process to compile an impartial assessment and an overview of the current state of knowledge. Considering the research proposal and problem statement, some keywords were identified that includes mainly: "spare capacity" OR "idle capacity", "shar\* economy" (so it includes, shared and sharing economy on the search), “urban freight” OR “crowd logistic\*” and “crowd shipping”.

Scopus database was used for this research, however and using the combination of all words selected as above, no results of papers or articles with such keywords combination were found. Based on that, it was necessary to split the research by:

- 1) "spare capacity" OR "idle capacity" AND "shar\* economy", where only 11 articles were found and 5 of them were selected based on the analysis made through the reading of the articles and relation with the purpose of this research.
- 2) "spare capacity" OR "idle capacity" AND "urban freight" OR "crowd logistic\*" where only 2 papers were found, but both were considered for the sake of this research.
- 3) "shar\* economy" AND ("urban freight" OR "crowd logistic") returned with 9 results, where 4 of them were selected for this research.
- 4) and last but not least, the keywords with more articles found were "shar\* economy" AND (crowd shipping OR crowd shipping OR crowd logistic\*) with 17 results, where 12 were selected considering the subjects of analysis of this paper and research.

By gathering and compiling the data from all the above research and by the usage of Bibliometrix and VOSviewer to present the results, it is possible to check the links between these concepts:



**Figure 1 - Keyword combination results from the Research**

Even considering that it is not the main focus of this research but as a result of the analysis of the content found from the previous search, some papers suggested making a further investigation about the utilization of the spare capacity in the public metro/underground network. Based on that, another search was made for papers and articles related to this area of study to complement

the analysis and check for concepts that would be valuable for the sake of this research. Thus, another literature review consists of filtering all papers and articles related to the underground urban freight network by the usage of “urban freight”; AND; “underground” OR “metro” keywords as filters on Scopus web-site. By reading the abstract as a reference of the 71 documents found, it was concluded that only 21 papers and articles are linked (but not entirely related) to the subject and purposes of this research. The overall conclusion based on these keyword combinations was that there are not many papers with relevant information or directly related to a deeper analysis on how the usage of spare capacity can be considered as a solution for urban freight.

After analyzing the documents found in both research, the literature review was limited to at least (but not limited to) 36 articles and papers in which they were considered the most relevant or the most related to the theme of this research and analysis, and therefore of greater relevance to this investigation.

Based on the research results and considering the small number of articles and papers found, it can be considered that the relationship of themes and keywords in this research is still something to be explored with a wide field of application and opportunities.

These results may already confirm and suggest that the combination of all these topics can be seen also as an opportunity for entrepreneurs who want to combine those factors in a solution for the cities as a business opportunity. It was the first sign identified by this researcher that not only the simple combination of these keywords, but mostly the concept behind those words, is an area that is worthy to be explored.

### **2.3. Terms and Concepts**

Before moving forward with this dissertation, it is important to explain some concepts used in this dissertation.

#### **2.3.1. Urban Freight**

According to the study made by the European Commission in a partnership with the EXTR@Web consortium in Urban Freight Transport, “Urban freight transport and logistics operations are concerned with the activities of delivering and collecting goods in town and city centers. These activities are often referred to as ‘city logistics’ as they entail the processes of transportation, handling and storage of goods, the management of inventory, waste and returns as well as home

delivery services... Goods transport in cities represents from 10 to 18% of road traffic.”(Stantchev & Whiteing, 2006, p.04).

According to the information gathered by the Urban Freight research Roadmap made by the European Road Transport Research Advisory Council (ERTRAC) and the Alliance for Logistics Innovation through Collaboration in Europe (ALICE), in 2014, Urban Freight represented from 10 to 15% and an environmental impact for 25% of urban transport-related CO2 emissions and 30 to 50% of other transport-related pollutants (particulate matters (PM), Nitrogen Oxide (NOx). It also mentions that cities are not only the place of delivery of goods but also the place of shipments: outgoing freight represents 20 to 25% of truck-kilometers in urban areas, incoming freight 40 to 50%, and the rest originates from and is delivered within the city and also that 3 to 4% of urban land is dedicated to urban freight (ALICE, 2014).

The same research states that “urban freight is also characterized by a very significant informal sector, the so-called white vans, estimated in many countries to represent around 25-30% of urban deliveries. In Europe, urban freight is responsible for 25% of urban transport related CO2 emissions and 30 to 50% of other transport related pollutants (PM, NOx , etc.).”(ALICE, 2014, p.12)

### **2.3.2. Sharing Economy & Crowd logistics**

Bratianu (2018) describes the Sharing Economy as a result of disruptive “crazy ideas” that challenges the “old paradigms of business” that can converge into a new economic concept. According to Bratianu (2018), “the concept of sharing economy is a semantic construct aiming at synthesizing the theories and practices through which sharing becomes a source of an economic process. Sharing is a powerful concept with many meanings reflecting both tangible and intangible things and both economic and non-economic purposes.”

This concept is not new, but it will be considered in this work as a foundation for the possibility of making the most of the idle capacity already available in the vehicles' current journeys within cities. Considering that this concept can lead to many definition strategies, this dissertation would like to explore the adoption of this concept in a "stricter" way to make the most of underutilized physical assets to make money (Shaheen et al., 2017).

Considering that the concept of sharing economy involves the participation of society and therefore can be considered a social science, the direct involvement of people in this context,



associated with transport logistics and empowered by technology, can be defined by the concept of crowd logistics (CL) which is based on the possibility to the crowd to provide logistics services by the usage of the existing spare capacity (Rai et al., 2017).

### **2.3.3. Spare or idle capacity**

Spare capacity term is used in this dissertation to describe the unused space or capacity of a vehicle to carry or transport cargo with no prejudice of the user. This spare capacity can be found in all kinds of transport (Kin et al., 2018), but will be more explored and detailed within the passenger cars or light vehicles as a case study for this dissertation, without ignoring the potentials it may have in the public and other modes of transport.

The idea of measuring the spare capacity in this dissertation can be seen as an opportunity for individuals and entrepreneurs to make usage of an unutilized available asset. “The network spare capacity dimension is to quantify the network-wide residual capacity with an explicit consideration of travelers’ mode and route choice behaviors”. (Xu et al., 2015)

It’s the possibility of people being compensated by taking advantage of the excess capacity they have already, for freight transport as a more sustainable environmental solution.

## **2.4. Analysis**

It is estimated that freight transport is responsible for 30-40 % of vehicles on city roads (Kin et al., 2018). The problem is in the final part of the delivery and this aspect is related to the cost, the environmental and structural impact. In addition, this type of transport and vehicles cause greater intensity in city traffic, which needs a higher level of attention to the environmental impact caused by the usage of fossil fuels, increasing greenhouse gases, which are the biggest contributors to climate change.

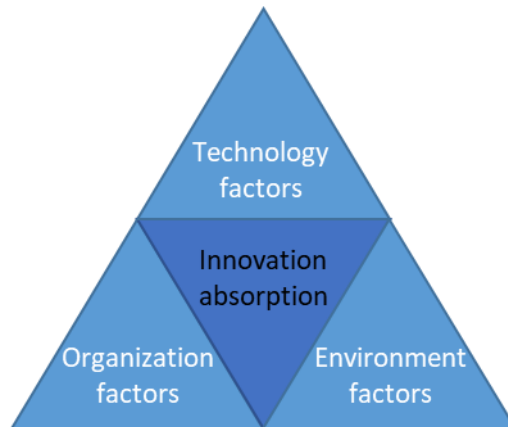
Optimizing the distribution of goods in cities is essential for the economic development of countries, especially emerging ones, with a growing population number, mainly in large urban centers (Singh & Gupta, 2020).

It was identified that the usage of the Crowd Logistic (CL) concepts, which is the possibility that individuals have to use their own (spare) capacities or better usage of the individual’s assets to share transportation services for others, is a concept that, if enabled by technology to streamline

communication within the stakeholders (who owns the cargo and the individual who is available to provide such service) can improve efficiency and sustainability in the way small parcels can be transported within cities. The benefits of applying this concept when empowered by technology are listed below (Szmelter-Jarosz & Rześny-Cieplińska, 2020):

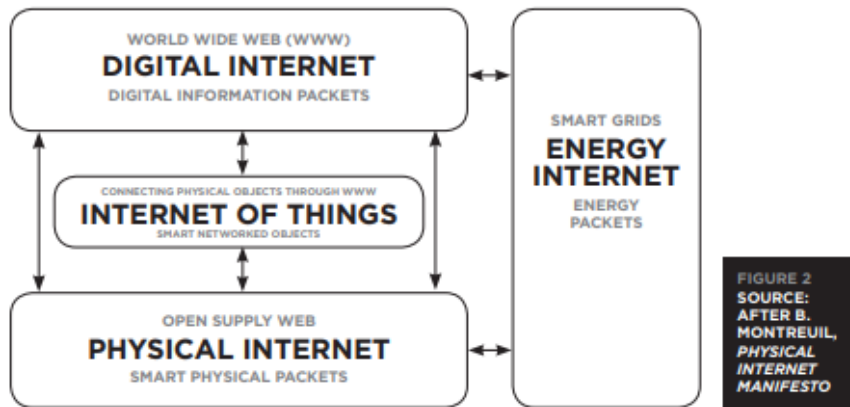
- For Consumers:
  - Reduced cost of mobility
  - Better access to service
- For authorities:
  - More safety
  - Reduction in emissions
- For society:
  - Less congestion and traffic
  - Less noise
  - Health benefits
  - Increased employment possibilities
- For CL solutions providers:
  - Less waste
  - Effective use of loading space
  - Extra capacity

The impact is positive in terms of new businesses adopting the CL based on these sharing economy concepts and benefits where new companies like Car2go (for car sharing), Craigslist (for book sharing), Airbnb (for space sharing) and the CL ones like Renren Express, JD-dada and Waze, which grew rapidly due to the growth of internet users where, retailers, crowd workers and crowdsourcing platforms are the main stakeholders of this innovation. Such innovation absorption is directly related to a “TOE” triad, which stands for: 1) Technology (to streamline communication and work within the stakeholders); 2) Organizational factors (to provide the necessary resources and structure) and; 3) the external Environment of logistics enterprises as shown below (Bin et al., 2020):



**Figure 2 - TOE theoretical model - Bin et al. (2020)**

Following the same path, Mckinnon & Bilski (2015) presents a physical internet concept which aims “to achieve this by applying the principles of the digital internet to logistics, harnessing spare capacity for economic and environmental benefit”. The idea is to create a physical distribution network through hubs, ensuring the delivery of the cargo and reducing the spare capacity on transport. They took the concept of an e-mail communication and brought the idea into the logistics environment to create a network framework based on a standardized, transparent, and integrated system:



**Figure 3 - Physical Internet Framework - Mckinnon & Bilski (2015)**

Mckinnon & Bilski (2015) were much more focused on the global distribution when suggested this framework, but it may be also used in the context of urban freight by working with parcel cargoes to circulate into the existing hubs in a way that these packets can absorb the spare capacity present the traffic journeys.

The appliance of a sustainable solution powered by the Crowd Logistics (CL) that is based on the usage of passenger's spare capacity, either when it comes to their vehicles or during the journey via public transportation, rely on the technology to support the business and communication but mainly on the willingness of the crowd worker. Bin et al. (2020), defines very precisely this concept by saying that "hiring idle crowd workers nearby conducive to solve the issues of insufficient distribution staff, scattered parcels and untimely delivery; and crowd workers provide delivery tools can reduce the capital investment of enterprises".

It was also identified that there are two main types of CL services (Sampaio et al., 2019):

- crowdsourced delivery (door-to-door and store-to-door), dedicated to freight deliveries
- cargo-hitching services—where the spare capacity of public transport is used for freight transportation.

As stated previously, the aim of this dissertation is precisely exploring the second type of CL service explained above which implicates either an evaluation of the spare capacity to enable but also to check the business availability that depends mostly on the willingness of the crowd worker, as the involvement of the crowd is essential and voluntary, therefore, and because there is no contractual connection, other factors may be needed to compensate users. For Rai et al. (2017), CL is 'an information connectivity enabled marketplace concept that matches supply and demand for logistics services with an undefined and external crowd that has free capacity with regards to time and/or space, participates on a voluntary basis and is compensated accordingly' (Rai et al., 2017).

This type of business has a fundamental pillar that is directly related to the combination of sharing economy umbrella effect concepts (Dreyer et al., 2017), where parties take advantages of "an economic system based on sharing underused assets or services, for free or for a fee", empowered by collaborative platforms that bring people together but focused on the commercial aspects of sharing (Carbone et al., 2018).

### **3. Methodology**

#### **3.1. Introduction**

Based on the literature review and research made, it was discovered that in fact, there is a spare capacity in urban transport that could be used to improve the distribution of goods in city centers. Besides, it was identified that there is a field of opportunities for companies and individuals to use this spare capacity in transport as means of conciliating the best practices of the shared economy, but also to obtain financial gain more sustainably and innovatively.

As this research aims to develop an initial conceptual approach to entrepreneurs to make usages of CL collaborative consumption, which (based on the research results), seems to be novel and unfamiliar, explanations can be derived from mere explorations. It was considered the theoretical framework, aligned with an entrepreneur's intuition and relied on the observation of specific instances (survey and statistics available) to seek generalizations. It adopted an exploratory qualitative research method, which was considered to be the more appropriate as CL and spare capacity in transport combined have not being deeply explored.

The methodology was based mainly on the analysis of papers and published articles to confirm predefined concepts and arguments, but also to investigate and suggest new areas of knowledge to be discovered or explored. To confirm the opportunity of exploring the spare capacity in current transport and traffic of vehicles, research was made to identify if people would be willing to transport small cargoes during their current and usual transport journeys within the city. The information gathered on the surveys were cross-checked with the data available from the Portuguese Mobility Reports from the Porto Metropolitan Area issued by the National Institute of Statistics (2018) to be used as a case study to validate data and for the proof of concepts.

#### **3.2. Survey: Would you please take this box there?**

The present research aims to find out how many people move daily within the greater city of Porto using any type of motorized transport but, willing to take, during their journeys or even outside those, some type of packaged goods and provide this service (either for free or for a fee). Another important aspect of this survey was to find out what is the idle or spare capacity in the vehicles used by the research participants which could be used in the transport of goods. This survey was answered online by 166 people of which 145 (87%) of the participants were from Porto District.

Considering that the District of Port is the selected area of analysis, this research will then consider the 145 responses only.

**Table 1 - Survey Results - Question: Where do you live?**

Where do you live?	#People	%
Porto District	145	87%
Minho Region	7	4%
Other country	5	3%
Lisbon District	4	2%
Beira Region	3	2%
Trás os Montes Region	1	1%
Baixo Alentejo & Algarve Region	1	1%
Total	166	

To reach the first objective of the research, several questions were asked, but the very first and main one was created to identify “What type of vehicle do people normally use for transport/displacement daily?”. The responses obtained were distributed as follows:

**Table 2 - Survey Results - Question: What type of vehicle do you normally use for transport/displacement daily?**

What type of vehicle do you normally use for transport/displacement daily?	#People	%
Light vehicle (own)	101	69,7%
Bus	16	11,0%
Metro	13	9,0%
Bicycle	7	4,8%
Walking / on foot	4	2,8%
Motorcycle	3	2,1%
Scooter, skateboard or similar	1	0,7%
Grand Total	145	

As presented in the above table, there were other minor alternatives of transport, such as scooter, skateboard and on foot, which received a tiny number of responses, however, it is observed by the responses indicated above that majority of inhabitants use their light vehicle, which will be the focus of the analysis of this research.

It was also important to identify the number of journeys the interviewers normally take per day. It was found out that the majority of people normally move from one place to another from one to two times a day (70%) followed by 2 to 4 times (25%). The distance in kilometers traveled on these routes and journeys may vary according to the following data:

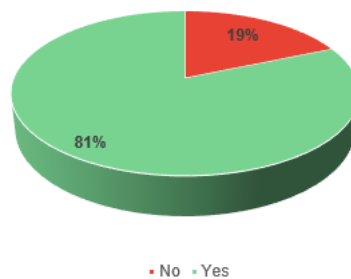
**Table 3 - Survey Results - Question: How far is your journey normally (km)?**

How far is your journey normally (km)?	#People	%
> 5 < 10	38	26,2%
> 3 < 5	36	24,8%
> 10 < 20	28	19,3%
> 20	24	16,6%
< 3	19	13,1%
<b>Grand Total</b>	<b>145</b>	

Above contains a high level of importance, since the more times the vehicle travels daily, the greater the potential for transporting goods. However, it is important to link this availability to the willingness of individuals to transport those goods.

Following the first objective of this research, they were initially asked if they would be willing to deliver a box or package outside the route of their usual trip but considering the high number of people who answered “maybe” (45%) and “no” (38%), it was needed to identify then if interviewees would then prefer to be paid to perform such a service. So, when asked if interviewees would deliver an order (e.g., box or package) with their vehicle underpayment condition, the responses became clearer as showed below:

Would you deliver any order (eg box or package) with your own vehicle if you were paid for this service?



**Figure 4 - Survey Results - People's willingness to deliver a cargo (graph)**

To be paid for the delivery service provided, participants answered the following question: “Would you deliver any order (e.g. box or package) with your vehicle if you were paid for this service?”. From the total of 145 interviewees, 118 (81.4%) participants answered “yes” and 27 (18.6%) answered “no”, therefore, the vast majority of survey participants answered that they would be willing to receive some remuneration to perform the service provided.

Although and based on the context of the survey, also considering the number of interviewees that would be willing to deliver even for free (29% for deliveries during the usual journeys and 6,2 for deliveries up to 5 km out of the normal routes) it’s understandable from the results obtained that the majority of the participants demonstrated interest in providing this type of service anyhow. Either motivated by any kind of compensation or not, both answers can be read by a demonstration of interest and worries of the citizens about the issue of urban mobility and environment.

To identify the willingness of the participants of this survey regarding the payment for the deliveries, two other questions were made:

- 1) The first question was made to identify how much a person is willing to receive for the deliveries to be made within their usual routes or journeys, with no need for deviation or change. The answers show that 42 (29%) of the participants would do this service for free and 29 (20%) for a payment less than €2.00 which indicates that 49% of the people interviewed would be able to deliver a cargo for less than €2.00 or even for free in case the delivery point is on the way of their current and usual journeys.

**Table 4 - Survey Results - People's willingness to receive for a delivery service during their current journey**

How much would you be willing to receive in order to deliver an order (box) DURING a trip that you normally take, without having to change your route?	#People	%
For free	42	29,0%
> €2,00 < €4,00	36	24,8%
< €2,00	29	20,0%
> €4,00 < €6,00	21	14,5%
> €6,00	17	11,7%
<b>Grand Total</b>	<b>145</b>	

- 2) The second question was made to identify how much the interviewer would be willing to receive to deliver an order (box or package) outside their current and normal route/journey (within 5 km). For those that would deliver a package within 5 km away from their usual journeys, it was analyzed the values they would be willing to charge to provide such a service. For those cases, it was presented a range of remuneration to be selected. The amounts range presented on the survey to be paid for those deliveries may vary from less than €2.00 (or even for free) up to an amount greater than €6.00. It was identified that the majority of the interviewers (100 participants or 69%) were willing to delivery those packages/boxes for more than €4.00, 31 (21.4%) for a fee from €2.00 to €4.00, 5 (3.4%) for less than €2 and 9 participants (6.2%) answered that they would do this service even for free as shown below:



Table 5 - Survey Results - People's willingness to receive for a delivery service outside their current journey (within 5km)

How much would you be willing to accept to receive to deliver an order (box) OUTSIDE your route/journey? (within 5km)	#People	%
> €6,00	53	36,6%
> €4,00 < €6,00	47	32,4%
> €2,00 < €4,00	31	21,4%
For free	9	6,2%
< €2,00	5	3,4%
<b>Grand Total</b>	<b>145</b>	

To achieve the second objective of the survey, which is to identify how much spare or idle capacity is present in the traffic of vehicles within the great Porto area, some other questions were also made to interviewees, such as: “What is the occupancy rate of your car boot?”.

Table 6 - Survey Results - Question: What is the occupancy rate of your car boot?

I don't have a vehicle	30	20,7%
It has space for carrying a small bag/pack - up to 5kg	14	9,7%
It has space to transport a box/small suitcase (approx. 55 x 35 x 25cm) - up to 10kg	19	13,1%
It has space to transport a medium box / suitcase (approx. 65 x 45 x 30cm) - up to 20kg	14	9,7%
It has space to transport a large box/suitcase (approx. 75 x 50 x 35cm) - up to 30kg	23	15,9%
it's always empty	45	31,0%
<b>Grand Total</b>	<b>145</b>	

It was identified that the 30 interviewees (20.7%) that informed that they don't have their own vehicle correspond to the number of people that use public transport (bus and metro) as informed on table 6, previously. From the remaining 79.3% of the interviewees that have their mean of transport (light vehicles) it's possible to check (when isolating the number of people who don't have a vehicle) that 45 of the people (39.1%) always travel within the cities with their car boot empty, 23 people (20%) with space enough for a large box of 0,13m<sup>3</sup> with maximum 30 kilos, 19 people (16.5%) with space enough for a small box of 0,05m<sup>3</sup> with maximum 10 kilos, 14 people (12.2%) with space enough for a medium box of 0,09m<sup>3</sup> with maximum 20 kilos and 14 people (12.2%) with space enough for a small pack of 5 kilos.

Table 7 - Survey Results - Question: What is the occupancy rate of your car trunk? Segregated by car owners

What is the occupancy rate of your car trunk?	#People	%
it's always empty	45	39,1%
It has space to transport a large box/suitcase (approx. 75 x 50 x 35cm) - up to 30kg	23	20,0%
It has space to transport a box/small suitcase (approx. 55 x 35 x 25cm) - up to 10kg	19	16,5%
It has space to transport a medium box / suitcase (approx. 65 x 45 x 30cm) - up to 20kg	14	12,2%
It has space for carrying a small bag/pack - up to 5kg	14	12,2%
<b>Grand Total</b>	<b>115</b>	

It would allow the researcher to predict that if considered the number of drivers with their car trunk empty plus the ones with space enough for a large box, it obtained a number of 59.1% of drivers capable of transporting, at least 0,13m<sup>3</sup> or 30 kilos per journey.

Another important aspect to be verified within the interviewees was the usage or adoption of a technology (in this case a mobile application for example) to enable them to check and select cargoes available to be delivered. To check that, cross-checked with the analysis of charging or not for this service, the following question was made: “If there was a mobile application capable of providing orders/cargoes to be delivered in your region, you...”; and the options given to this sentence were:

**Table 8 - Survey Results – The technology adoption rate**

<b>If there was an app capable of providing orders/cargoes to be delivered in your region, you...</b>	<b>#People</b>	<b>%</b>
would use if it received any value for delivery made	88	60,7%
wouldn't use	31	21,4%
I would use it for free as it costs me nothing to deliver during my journey	26	17,9%
<b>Grand Total</b>	<b>145</b>	

60,7% of the interviewees may use the application if they receive any amount in exchange, 17% would use it for free as a sight of demonstration that they could deliver the cargo anyhow, and 31% is the rejection rate of people that would not use the app at all. Based on these results, it's possible to conclude that at least 78.6% of users would use an application with the aim to provide this type of delivery service. A possible reason why 21.4% of people interviewed would not use this technology may rely on the fact that 20.7% of the same sample have no vehicle on their own (according to table 6).

Based on the analysis of the survey, it's possible to identify certain aspects of the sharing economy and social concern when part of the interviewees may deliver for free if the route is not different from their current journey and it's also possible to conclude that interviewees are willing to use the spare capacity in transport as a mean of optimizing transport of parcels and small cargoes as an alternative to increasing income if supported by peer-to-peer logistics application.

### **3.3. The transport in Porto District**

The analysis of transport in the District of Porto is used here as a case study to compare the results obtained in the survey with the public information available to measure the existing idle capacity in the metropolitan area of Porto.

### **3.3.1 Mobility at Porto Metropolitan Area**

According to the Statistic Portugal, when issued a Mobility survey in the Metropolitan Areas of Porto and Lisbon (2018) in cooperation with the Porto Metropolitan Council, it was noticed that there's a predominance, in the Porto Metropolitan area of 69% of car travels as the main mean of transport for the individuals, which corroborates the results of the research and analysis carried out for the scope of this dissertation, as shown in table 2, with a 69.7% vehicle usage rate. However, it seems that there is a change in the behavior of the individuals regarding the utilization of public transport in comparison with the movements by pedestrians (walking) or with public transport. In 2018, when data was collected and analyzed as a result of the mobility survey, public transport represented 11.1% of the journeys while 18.9% of the journeys were made by pedestrians or bicycle (this last one by 0.4%).

When analyzing the results of the survey in chapter 3.2 made in 2021, it's possible to check that public transport is the second main mean of transport utilized by the interviewers by 20% (11% by bus and 9% by metro) while 10.4% of the journeys were made by bicycle (4.8% - which is much higher than in 2017 with 0.4%) pedestrians (2.8%), motorcycle (2.8%) and scooter, skateboard or similar (0.7%). Possible reasons for these changes may be applied to the initiatives created by the Porto City Hall to promote and increase public transport but also, it is necessary to consider the implications of COVID-19 pandemic in how the behavior of individuals changed, regarding their journeys within the city, as from 2020. Further investigation on this topic is required.

Another interesting data found on the mobility survey was that the car's occupancy rate was 1.56 people. This information serves as an indicator that the idle capacity of the cars is quite high, given such a low occupancy rate.

In 2017, according to the same Mobility survey in the Metropolitan Areas of Porto and Lisbon, there were about 3.4 million trips per day (3 426 779 to be more precise) within the District of Porto. Most of those trips (71.0%) had origin and destination in the metropolitan area. If we consider that 50.7% were made by car (through the main driver), it means that at least 1.7 million (precisely 1.737.443) trips were made per day during this year with light vehicles by a single driver. The average number of trips/day per person stood at 2.72 in the Porto Metropolitan Area (AMP). This number corresponds to the results of the survey showed in the chapter 3.2 where 70% of the interviewers go out for trips within the District of Port from 1 to 2 times a day and 25% from 3 to 4 times/day.

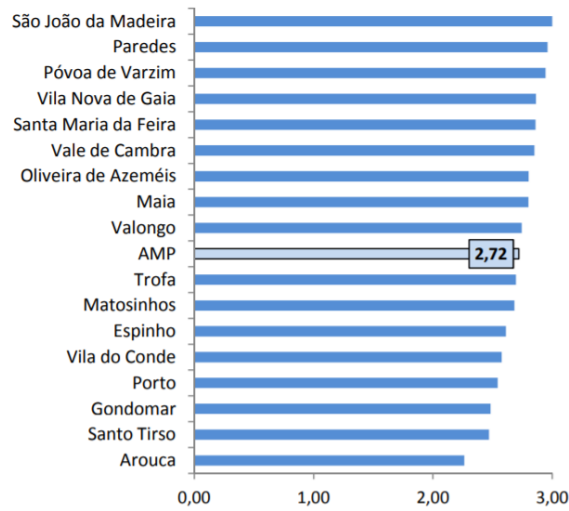


Figure 5 - Average amount of trips/day in the Porto Metropolitan Area (AMP)

Also, according to the Statistic Portugal (2018), the main reason people go out for these local trips are for work (30.3%) followed by shopping (18.5%) and their journeys may last 10.6 km each (average). When measuring only the trips to work, this average increases to 13.4 km. The research made for this dissertation shows that at least 51% of the people travel from 3 to 10 km per journey. It was identified that of the 1,718,021 inhabitants of the metropolitan area of Porto (AMP), 78.9% (1.355.519) of them travel at least once a day. To this number, it was assigned the term “mobile population”. During the business days, this average goes up to 82.9%. Here on the below graph, shows the AMP and percentage of the mobile population per city:

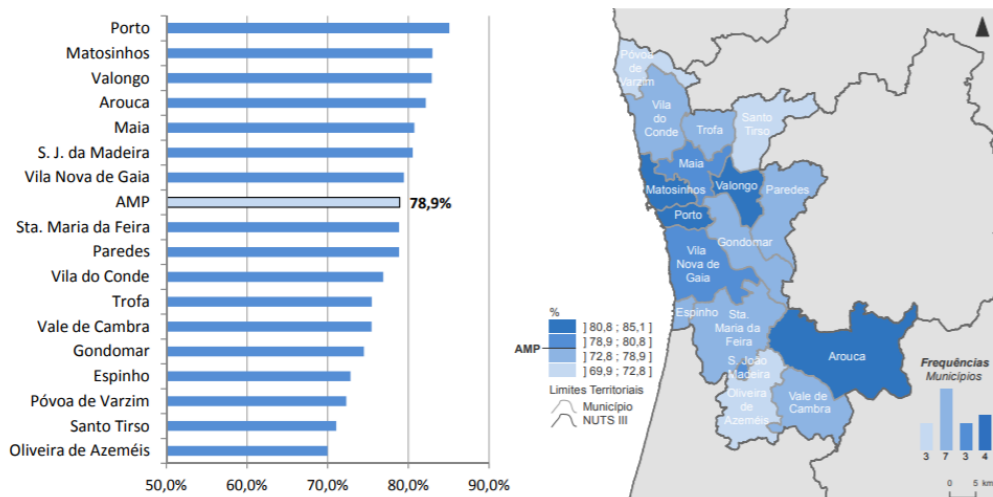


Figure 6 - Percentage of AMP mobile inhabitants/day

It was also identified in this report the density of daily journeys per city within the Porto District. Within the Porto Metropolitan area, there are 1 354 journeys per km<sup>2</sup>, but the number of journeys from other cities to Porto as a destination goes up to 12 300 journeys per km<sup>2</sup> (highlighted as blue in the below graph). Another indicator given is the number of inhabitants per km<sup>2</sup> (highlighted as grey) as a comparison between the number or density of the daily journeys with the number of inhabitants. It's possible to see for instance that in Porto City was found 5 170 inhabitants per km<sup>2</sup>.

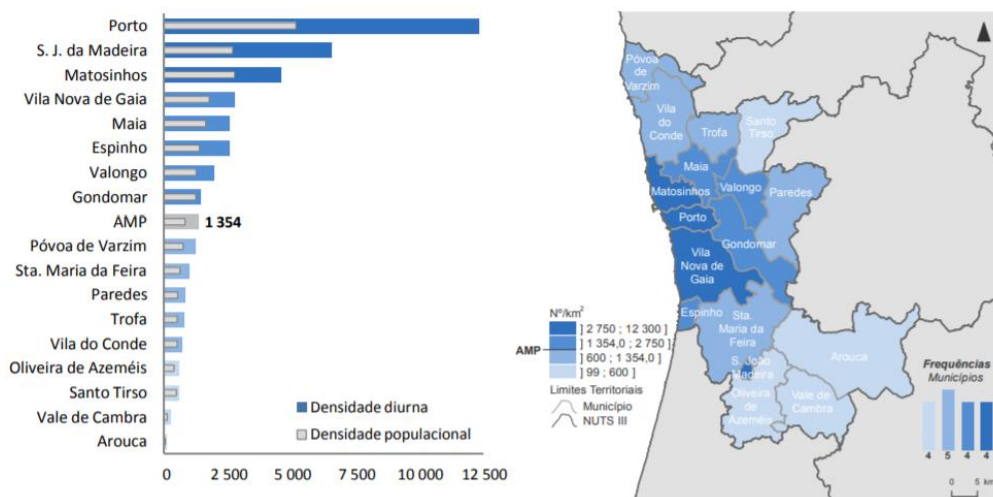


Figure 7 - Density of journeys per km<sup>2</sup>

Based on the results related to the fact that most of the interviewers would be willing to make the transport of parcels or small cargoes if financially compensated, it was also necessary to check what is the net income of the mobile population.

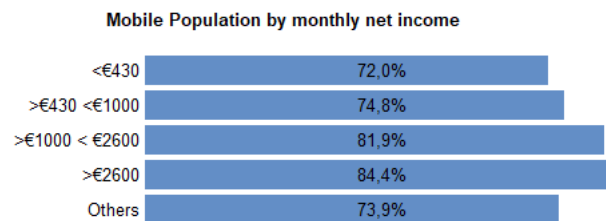
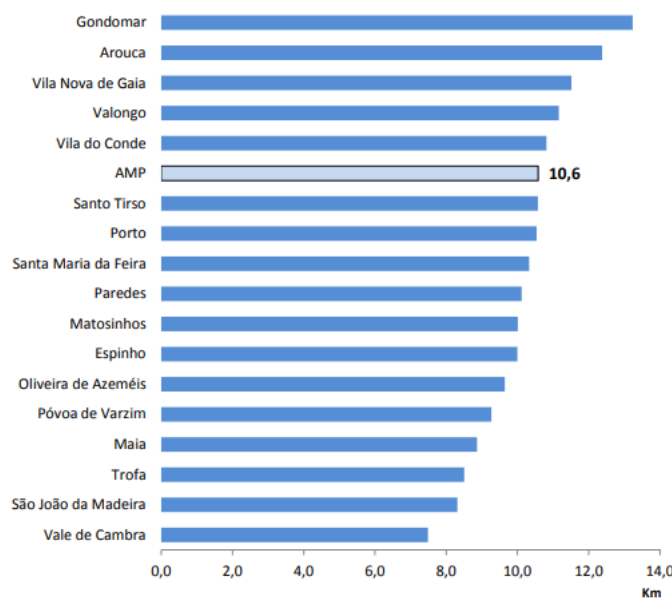


Figure 8 - Mobile population net income (monthly)

On the graph above, it is possible to see the mobility ratio per monthly net income and as shown, the portion of the population with higher mobility are the ones with net income higher than €1000 per month.

Another and very substantial factor to be analyzed is the average distance of the journeys. According to this same report, inhabitants of the Porto District (AMP) make an average trip distance of 10.6 km. This range may vary according to the reason/motivation of the trips. A journey to work as the main goal would take an average of 13.4 km while a trip to study may take 7.5 km.



**Figure 9 - Average journey distance (km)**

### **3.3.2 Number of vehicles transported within Porto**

According to the 2019 Portuguese Mobility and Transport Statistical yearbook, there are at least 786 transport companies with around 3 843 light vehicles registered (only) in Portugal. Regarding the heavy vehicles transport companies, these numbers increase up to 6 694 companies and 66 458 vehicles owned by these companies for heavy transport. It estimates that 32.4% of these companies and vehicles are in the North of Portugal which represents around 2 427 companies.

The density of the National Road Network for the Porto District is 0.38 (km/km<sup>2</sup>) of extension per area and 0.50 (km/thousand inhabitants) for the populational extension.

If we take the information related to the number of vehicles per day in the Greater Porto Area during 2019, we find an average daily traffic of 29 924 vehicles per day, which has a growth variation of 6.8%/year.

Based on the number of obligated vehicle inspection numbers from the 2019 Portuguese Mobility and Transport Statistical yearbook, it estimates that there's a total of at least 999 020 vehicles in Porto District where 767 115 are related to light passenger vehicles, 198 615 light vehicles for cargo transport and 18 288 heavy vehicles for cargo transport.

### 3.4. The size of the Spare Capacity of Porto District

To better measure the size of the spare capacity of the Porto District related to the transport made by people with their cars (as the object of study of this research), it is important to find out the number of journeys per Mode of Transport (MOT) utilized by the inhabitants of each city of Porto Metropolitan area. According to the Mobility survey in the Metropolitan Areas of Porto and Lisbon (Statistic Portugal, 2018) the numbers of journeys per day by the main means of transport used and by the city of residence are:

**Table 9 - Journeys/day by the main means of transport used and by the municipality of residence**

MOT Cities	Unit Numbers														
	TOTAL	Light vehicle - drivers	Light vehicle - passengers	motorcycle or moped	Taxi - passenger	Bus - public transport	Bus - School/Business	Train	Metro/Underground	Boat	Airplane	Walking	Bicycle	Others	
<b>AMP</b>	<b>3 426 779</b>	<b>1 737 443</b>	<b>580 205</b>	<b>46 161</b>	<b>6 027</b>	<b>232 647</b>	<b>47 910</b>	<b>27 173</b>	<b>67 707</b>	<b>x</b>	<b>1 466</b>	<b>633 024</b>	<b>15 098</b>	<b>31 898</b>	
Arouca	36 300	21 365	5 101	701	x	1 440	354	x	x	x	x	7 134	x	99	
Espinho	52 300	19 754	9 948	293 §	x	1 518	598	1 579	x	x	x	18 002	435 §	107	
Gondomar	286 444	147 185	46 586	1 624	715	36 562	6 575	1 094	3 192	x	412 §	41 209	205	1 084	
Maia	285 982	155 476	43 423	2 942	788	19 250	2 338	2 617	7 089	x	x	49 830	105 §	2 124	
Matosinhos	358 590	163 574	58 564	1 440	1 114	31 205	3 984	316	12 960	x	168	81 824	1 964	1 479	
Oliveira de Azeméis	122 114	85 334	16 942	2 222	x	881	998	427	x	x	47 §	12 191	1 907	1 000	
Paredes	188 528	98 588	38 072	2 668	x	6 952	4 418	5 231	530 §	x	x	26 613	1 473	3 667	
Porto	419 326	143 876	57 249	4 653	1 910	52 420	714	1 791	20 832	x	278	131 006	1 517	3 060	
Póvoa de Varzim	123 731	64 468	20 980	2 991	x	2 934	2 611	x	1 834	x	x	24 112	2 430	1 340	
Santa Maria da Feira	292 436	177 184	61 999	4 963	x	9 419	4 656	758	352	x	60 §	30 157	284 §	2 379	
Santo Tirso	113 552	68 389	18 235	913	x	4 137	2 493	1 759	x	x	x	15 962	535	907	
São João da Madeira	48 372	24 900	9 729	480 §	x	487	437	x	97 §	x	x	10 943	x	1 102	
Trofa	72 749	39 195	13 098	1 185	x	1 453	1 462	1 178	790	x	x	13 016	551	797	
Vale de Cambra	43 226	25 279	6 572	907	x	867	1 136	x	x	x	x	7 441	x	954	
Valongo	202 240	98 508	33 524	2 061	x	14 369	7 432	3 889	1 047	x	x	39 600	411 §	1 304	
Vila do Conde	145 673	77 341	23 608	4 558	x	2 811	3 028	x	3 289	x	x	28 279	1 299	1 202	
Vila Nova de Gaia	635 214	327 027	116 574	11 559	633	45 942	4 676	6 349	15 478	x	98	95 704	1 877	9 295	

Source: Inquérito à Mobilidade nas Áreas Metropolitanas do Porto e de Lisboa

Considering the results obtained on the survey presented on item 3.2, where it is possible to evaluate the willingness of drives to transport a small parcel/cargo in a trip (according to the four types of cargo weight and volume given), with the analysis made on the number of light passenger journeys per day in the Greater Porto Area (Statistic Portugal, 2018), it is possible to predict that

the minimum daily spare capacity of Porto District for light vehicles is approximate to what is expressed on below table:

**Table 10 - Average Spare Capacity in Porto District/day in weight (ton) and dimension (m3)**

Spare Capacity per Vehicle				Number of trips (daily)	Average Spare Capacity in Porto District/day (light vehicles)	
% People willingness/ cargo type	Dimensions (LWH) m	m3	kg		m3	Ton
59,1%	0,75*0,50*0,35	0,131	30	1 026 829	134 771	30 805
12,2%	0,65*0,45*0,30	0,088	20	211 968	18 600	4 239
16,5%	0,55*0,35*0,25	0,048	10	286 678	13 796	2 867
12,2%	0,30*0,15*0,40	0,018	5	211 968	3 815	1 060
<b>Total</b>	<b>100,0%</b>			<b>1 737 443</b>	<b>170 983</b>	<b>38 971</b>

The above analysis considered the willingness of people in percentage to carry a small parcel/cargo according to the range of weight and size provided on the survey. By making the ratio from the total number of trips within the Porto District for the capacity of weight and volume interviewers were willing to carry in their journeys, it was possible to estimate that at least 170 983 cubic meters (m3) or 38 971 tons of cargo can be transport by the usage of the light vehicles' spare capacity, per day, within the greater Porto area.

As a matter of comparison and to better understand the total daily spare capacity in Porto District it's possible to take, as a unit of measure, the average weight of 24ton and volume capacity of 80m3 of a standard truck to estimate in numbers, the amount of this spare capacity in Porto District. By using the average truck capacity in cubic meters and tons as unit of measure, it represents a potential reduction range between 1 623 and 2 137 of trucks circulating in the metropolitan area of Porto (depending on the cargo type and the correlation between wight and volume). If comparing to smaller trucks, like the ones used on the retail and last mile transport, these numbers would increase significantly.

If considered the daily traffic variation growth of 6.8%/year as informed by the Portuguese Mobility and Transport Statistical yearbook (IMT, 2019), the size of the Spare Capacity in Porto District would represent around 222 453m3 and 50 701ton per day in 2021.



## **4. Review of Background Concepts**

### **4.1. The Crowd Logistic business model**

One of the main challenges of innovating and creating a new business model comes with the need to create also a competitive advantage however, it's needed a portion of audacity and courage to be creative and not fall into the error of "reinventing the wheel" when it is necessary to innovate not only the products (or service) but the roots of the business model (Gassmann et al., 2013).

Based on the analysis of the literature and capacity available, reasoned by the analysis and observation of other researchers, but also grounded by the data analytics presented in this dissertation, it's reasonable to consider that the usage of an existing but unexplored spare capacity, existing in the current traffic of vehicles within the city centers, is a feasible solution for many cities who wants to reduce the environmental impact caused by the need for freight services on the last mile process.

The whole combination of the concepts of sharing economy and crowd logistics, when empowered by technology to enable the usage of spare capacity as an asset for entrepreneurs as an alternative for the urban freight, seems to be still a disruptive and innovative solution for the environmental and traffic jams issues of the urban city centers, as there's not so much content generated in this direction.

It's possible then to identify that a disruptive business model can be created out of the combination of such concepts when based on the fact that: 1) a technology can be developed to enable the connection of people and cargoes available; 2) there's an existing network and "available unexplored asset"; 3) it creates value for the user and society, 4) it generates revenue. So, if applying the business architecture proposed by Gassmann et al., based on the previous data and concepts presented, it's possible to answer the four questions below:

- Who's the target customer? Every driver who has access to technology, who cares about waste or wants to make the best usage of their assets, who is concerned about the environmental impact and is also looking for a way to earn some extra income.
- What can be offered to the customer or what values will the customer perceive? An application where they can find out what are the cargoes/parcels available to be delivered during their journey. Customers, by using this technology, can contribute to a better world,

reduce their transportation costs, get the return on invested capital from their assets and possibly get an alternative income.

- How is the value proposition created? Through the reduction of the environmental impact and the possibility of combining good actions with the provision of services
- How is profit created? By collecting a percentage of the minimum amount paid by companies that make the loads/parcels available to be transported by the users. When taking the examples of peer-to-peer (P2P) Delivery Services which has a variety of business models it is possible to identify many companies that apply a delivery fee with an additional % (e.g., Postmates that add 9% as a service fee) or a range of fee depending on the distances or time (e.g., Instacart, Shipbird) or a flat delivery fee (e.g., DoorDash) (Shaheen et al., 2017).



**Figure 10 - Business Model (Gassmann et al., 2013)**

The challenge but also the best way of implementing the crowd logistic is the combination of a robust technology with a business process reorganization, which is focused on understanding the internal and external needs, resources and environments and translate those requirements into a comprehensive technology. This is the reason why the TOE theory (figure 2) can provide a suitable framework for companies to check the factors that affect their willingness for implementing the crowd logistic (Bin et al., 2020).

Following what Bin et al. (2020) defend by presenting the TOE theory, it is possible to identify on this dissertation, the necessary resources to implement crowd logistics by analyzing the key factors presented below:

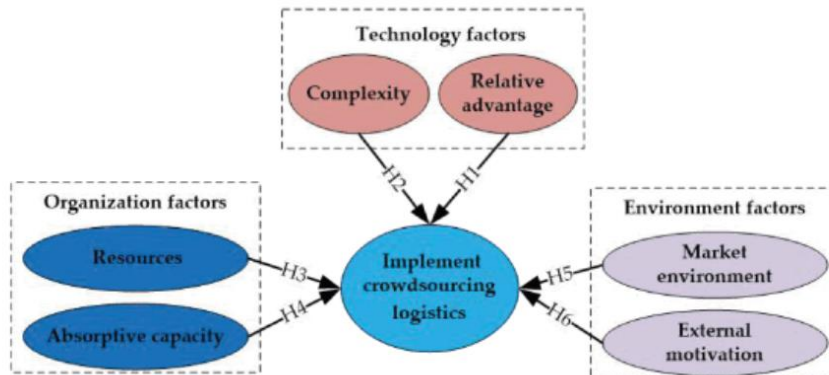


Figure 11 - The theoretical model proposed by Bin et al. (2020)

**Technology factors:**

Shaheen et al. (2017), when presenting the concepts of sharing mobility, confirms that new business models came up with a more innovative proposal empowered by the usage of internet-enabled smartphones, tablets or any other mobile device. Casprini et al., make a clear statement by saying that “the phenomena of the sharing economy and collaborative consumption have only been enabled by digital technologies” (Casprini et al., 2019).

It’s possible to see already the examples of many new businesses created from the same concepts of sharing economy and crowd logistics (e.g., Lyft, Uber, car2go, Bridj, etc) where online social networking platforms and global positioning system (GPS) play an important role, enabled by mobile technology. (Shaheen et al., 2017).

It’s important to note that Crowd Logistics is directly related to the physical internet. The reason is that “technology enables passengers to use the capacity in their vehicle more efficiently, by carrying parcels for others” (Rai et al., 2017). It plays an important role as the technological infrastructure is the main pillar to enable the coordination of the demand and supply for logistic services same as serving as infrastructure to connect cargo flow, information and finance. (Rai et al., 2017).

When bringing the concept of physical internet, which is defined by the integration of the physical with digital and operational interconnectivity, supported by a system that is driven by technological, infrastructural and business innovation (Montreuil et al., 2013), it’s possible to assume that such technology foundation framework below fits the technology factor mentioned by Bin et al. (2020).

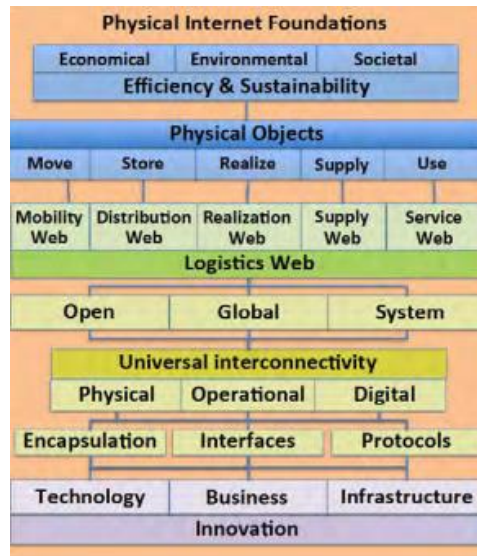


Figure 12 - Physical Internet Foundations Framework (Montreuil et al., 2013)

So, the technology may be the most tangible external factor that enables the creation, acceleration and adoption of the sharing economy and crowd logistics (consequently). The combination of mobile and GPS enabled devices, online payment platforms and social networks empower the crowd logistics concepts to make better usage of people’s assets in a virtual marketplace that makes sharing economy possible (Nadler, 2014).

**Organization factors:**

Apart from the technological infrastructure already covered on the previous topic, which is fundamental for this type of business, it was dedicated a whole detailed session on this thesis to analyze and evaluate the spare capacity present in the Porto District area as a baseline to present in numbers, the potential of using an idle and unutilized spare capacity, already available in the transport network of the cities, as the main possible asset and resource for the creation of a crowd logistic business. Besides, the “crowd is the database of people willing to execute the logistics tasks” (Rai et al., 2017). That’s the reason why checking the willingness of people to perform the deliveries in urban centers are crucial to the success of the business and it’s possible to assume that at least 81.4% of the inhabitants of the Porto District area is willing to contribute to that.

One of the closest successful business cases to the one presented and proposed in this dissertation is the one from BlaBlaCar. At the initial stage, they remained dependent on the own resources of the founders, the well known FFF (fools, family and friend’s funds initial investments), but as long

as their business model proved to be consistent, they became attracted by VC firms and investors. At the same time, BlaBlaCar achieved a complimentary resource by the sharing functional building block of social media to extend its customer base and create a loyal community. It was by reaching out and expanding the boundaries of their community and network through the sharing of experience and stories with their users, that BlaBlaCar increased the business itself (e.g., number of seats, destinations, time availability, etc.), besides, another key factor of success was the partnerships BlaBlaCar created with insurance companies and companies related to their sector. It was considered a value generator to their final customers, who could trust and rely on their services (Casprini et al., 2019).

Another way to expand the resources of crowd logistics companies is to work in cooperation with retailers. The “click-and-mortar businesses” that work with physical and digital stores can be a great ally, as they can make their stores available as warehouses so that the crowd can be the delivery solution (Rai et al., 2017).

In short, the success of the Crowd Logistics business depends on attracting a sufficiently large number of participants (Taylor, 2015) willing to make their assets available to be used in a crowd logistic business.

### **Environmental Factor:**

Even considering that Bin et al. (2020) focused on the market environment as a driver for companies to adhere to the implementation of crowd logistic businesses, based on influence factors found like absorptive capacity and relative advantage, this researcher would like to use the concepts of sharing economy already explained, as an external influencer on society's behavior regarding the adoption and consumption of peer-to-peer crowd logistics services.

It is a fact that the market demand dictates the rules of the business, in the same way that the behavior of customers shapes a product or service. Considering the general concern of people to look for eco-friendly companies with their products or services and the awareness that society's behavior interferes with the environment, there are much more people today looking for environmentally friendly solutions. Thus, consciously or not, the concept of sharing economy ends up being widespread and the demand for this type of services becomes increasingly greater. The behavior and values of the users define the customer choices for peer-to-peer business models (Demailly & Novel, 2014).

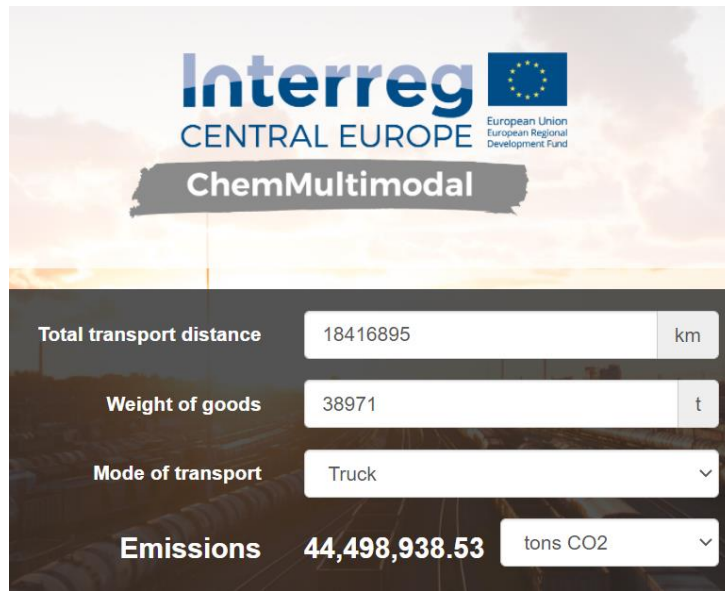
Following the theoretical model proposed by Bin et al. (2020)., this researcher classifies the empirical concern for the environment as the main external motivator in choosing crowd logistics services. The survey created for this thesis shows that at least 29% of the interviewers were willing to deliver a cargo, during the usual journeys, even for free (6.2 for deliveries up to 5 km out of the normal routes). It can indicate the concern of interviewers to do something good. Further investigations may be necessary to identify if it is related to the concern with the environmental impact or if it is based on their values, sense of well-being or purpose in doing something good for society.

#### **4.2 Review on the Environmental Impact**

Environmental impact is an external motivational factor for a crowd logistic business and movement. Measuring the environmental impact by providing people with the numbers that support the statement that the usage of spare capacity can reduce the CO<sub>2</sub> emission in urban areas (as an example) can be one of the additional values and benefits for people perceive to apply and support a crowd logistics business/solution.

Considering the average distance per journey within the Porto District of 10.6 km (figure 9) by the number of trips (1 737 443 as per table 9) it is possible to estimate that light vehicles travel on average 18 416 895 km per day. If taken this total average distance by the number of Tons that could be transport by the usage of the spare capacity of 38 971ton (table 10), it is possible to calculate an average of 717 724 815 045 tkm (tonne-kilometre (tkm) is unit of measurement used to measure the quantity and traffic of transportation used in transportation statistics).

Assuming an average CO<sub>2</sub> performance for road transport of 62g/tkm according to the Interreg Central Europe CO<sub>2</sub> Calculator (Cichosz et al., 2018), it is possible to estimate that if spare capacity in light vehicle transport within Porto District could be used for cargo transport, it would represent an environmental impact saving of approximately 44 498 938tons of CO<sub>2</sub> emission every day (Cichosz, M., Nowicka, K., & Pluta-Zaremba, A. TOOLBOX ELEMENT: CO<sub>2</sub> CALCULATOR. Available at: <https://ifsl50.mb.uni-magdeburg.de/chemmultimodal/>);



**Figure 13 - Environment impact of the Porto District Spare Capacity (CO2)**

Based on the concept of making the best usage of peoples' assets (in this case vehicles) so as picking and delivering a cargo that fits the current journey of drivers, it is possible to conclude, in addition to the impact of CO2 emissions, that transport by light vehicles within the Porto District through the use of its spare capacity is feasible when comparing these numbers to a unit of measurement that correlates with city traffic (for example, trucks). It is possible to assume that the current daily volume and weight (38 971 ton and 170 983m<sup>3</sup>), corresponds to a number of 1 623 daily trucks, that could be optimized and thus, reduce traffic and travel times.

It can also support the reduction of inefficient vehicle movements, like empty running trucks or vans, by splitting the deliveries that can be carried out by any person in the network as there's no need for trucks to return to distribution centers (Kin et al., 2018), positively effecting the circulation of vehicles in the cities.

It's also important to mention that the size and weight of the goods, so as the combination of the journeys with cargo route is determinant to assume the potential of environmental impact reduction on pollution and traffic jams. However, it is not an overwhelming barrier as still, there is a high demand for small parcels and cargoes to be delivered. The reason why it cannot be considered *the* solution is that there are many other influential factors to this business model, but it can, for sure, support the logistics system to deal with on-demand economy opportunities (Gatta

et al., 2019). This administration has to be very well orchestrated between the distributors/drivers and the distribution centers in a very efficient way (Kin et al., 2018).

### **4.3. Discussion and further investigation**

#### **Public Transport**

The analysis, made on the content of those papers, shows that changing a network originally designed and developed to carry passengers alone to also accommodate cargoes does not seem so easy and simple to achieve.

Numerous attempts have already been made to optimize the rail and land networks in unsuccessful urban centers (Robinson & Mortimer, 2004). Some attempts were related to the creation of tunnels and pipes which according to Wanjie Hu, “it is undeniable that the high cost, long construction period, and high risk of underground projects are serious obstacles to underground logistics system (ULS) development. Reducing the construction cost is critical to improving the uptake of ULS” (Dong et al., 2018, p.01), so can't be possible to say that just as there are many benefits to metro/underground transportation, we can also identify numerous implications and impacts that such change can have. There's no doubt about the benefits of an ULS which can not only improve the capacity and efficiency of urban logistics, but also have great environmental and social benefits, such as the reduction of the number of ground trucks and thus the reduction of exhaust emissions which is a common concern in the research. The costs would be the complex underground engineering project, which requires huge construction investment where its freight capacity and network scale are the first aspects to be considered but also necessary to establish a quantitative evaluation model to analyze the real impact of the scale of ULS network on urban development (Dong et al., 2019). However, and based on the results obtained in Vienna, “Claimed environmental benefits did not materially influence commercial decisions” (Robinson & Mortimer, 2004, p.05). Blainey (2016) also suggest a deep investigation on the capacity utilization of the rail system as a way to identify locations and time when a spare network is available to be better used or improved with no need for investment nor additional infrastructure.

In addition to the possible costs and structures required for the expansion and adaptation of this network, it's possible to highlight a constraint in the flow of people and cargo simultaneously, the priorities between passenger and freight transport, cooperation between parties that may also be



competitors and the implementation of capable technology to manage and automate this chain. Research from Sapporo in Japan reveals that at least 43% of the population believes that there would be much confusion bringing freight along with passenger transport, but (in the same proportion) recognizes that this would bring a reduction in congestion of land transportation. About 58% of respondents believe that one way to mitigate the problem of freight and passenger traffic would be to separate a wagon/car specifically for freight, while about 74% believe that a renewal of subway stations is needed to support this operation (Kikuta et al., 2012). Mazzarino & Rubini (2019) states that mixing cargo and passengers has a significant environmental, economic and social impact in low urbanized and remote urban areas where public transport receive more incentives from the public sector. It represents a significant change in the operations, policymaking and theoretical approaches to urban mobility where, in most cases, should pass through a review on the regulatory and legislative systems (at all levels). They alert to the fact that “cargo and passengers transport systems are considered as separated entities since they are regulated by different authorities, rules and guidelines” (Mazzarino & Rubini, 2019).

When it comes to the investment and the possibilities around the Underground Logistic System (ULS), it's undeniable the advantages, benefits and how a city metro network can contribute economically and environmentally to a city. So, it suggests that governments should look into this subject and establish relevant policies to create a joint strategy (possibly with 3rd party logistic partners) on this new multimodal logistic system. Considering that investments will depend on the total transportation and logistics figures, preponderant Gross Domestic Product (GDP) growth depends on the investments in the structure and logistics network creation. Dong (2019) explains that Underground Logistic System (ULS) investment depends on the total transportation and logistics investment of the city.

There is no solid conclusion or content found on the papers and articles in analysis related to the private sector participation or investments regarding the developments or improvements on the metro network for cargo distribution. Most of the papers consider that it is a subject to be treated by the public sector or state, also, there's no mention of the other way around, meaning, private sector initiatives with public partnerships.

### **Risk**

Among this research and considering all the inputs received, it became inevitable not to consider the risks related to a business model where “any” person can transport cargo with their vehicles

for spare capacity utilization. The main question in this regard is “who is responsible for any damages, loss, theft of cargoes during a crowd logistics transport?”

Transparency and trust mechanisms combined have been seeing as an alternative to mitigate risks in crowd logistics. A rigorous selection process (either for users and cargo providers as a “prescreening of the crowd”), same as the security of personal and cargo data (same for the messaging system) and also the security of online payments can be used to monitor and control risks of this business (Rai et al., 2017). Rześny-Cieplińska & Szmelter-Jarosz (2019) make a clear statement by saying that “the risks such a social (unsuitable society, labor risk) as well as quality (unequally service quality) and sustainability (the rebound effect can higher the emissions) aspects are hard to ignore”.

Jointly with the statements and opinion of other researchers, this author classifies at least 5 ways of mitigating the CL risks that can be used for further investigation: 1) the appliance of an insurance fee: need to see the impact on the business, liability and trust of the users; 2) making clear statements about the risk responsibilities on the policies; 3) the possibility to instruct and train drivers on how to handle the cargoes; 4) the standardization and the redefinition of the design of the package type to be used on this kind of transport (mainly carried out by the users or loaded into car boots); 5) by segregating the service to less risky cargo movements; etc.

### **Partner’s willingness**

As this study was focused on the spare capacity of the crowd vehicles and the willingness of people to do such transport but not so much on the requestors for this type of service, the willingness of the cargo owner was not taken into analysis. It is unknown if companies or distribution centers that have the cargo available is willing to make usage of such services and in some cases, even split the cargo into small parcels to enable drivers to perform the service. However, the emergence of ecologically correct companies is increasingly frequent, to meet the demands of a market that is increasingly aware of environmental impacts.

## **5. Conclusions**

New industries emerge when entrepreneurs manage to mobilize resources in response to perceived opportunities (Aldrich & Fiol, 1994). Based on this statement, this study sought to deepen the knowledge about the spare capacity of light vehicles' traffic in the District of Porto as an entrepreneur opportunity. However, it is necessary to mention that in the conception of this idea, this researcher could not have imagined the size of this opportunity, nor this idleness.

By evaluating the result of the responses obtained through the questionnaire created, as well as the analysis of data, studies and articles related to crowd logistics, it became even more evident that today's social context is looking for solutions and companies to minimize the environmental impacts. Such a search is intrinsically and directly related to the concepts and values of the shared economy.

Nonetheless, the combination of shared economy concepts in the context of crowd logistics, when considered as the basis of a business model that aims to explore an idle and generally unnoticed installed capacity in an existing and usual traffic network, proved to be a novel and disruptive business model when analyzed more deeply in this study.

It is evident in this study, the need for investment in a robust technological structure that allows connectivity between companies (that make their cargo available for delivery) and the crowd available to perform the logistic services. A reliable mobile technology platform that enables cargo and driver's traceability becomes the fundamental basis of this type of business which seeks to have as the main assets the people/crowd, spare capacity and availability of vehicles, as well as the entire technological structure that integrates the stakeholders of this type of business.

Seen from an entrepreneurial perspective, while validating these concepts with other authors and case studies that also address the benefits of shared economy applied to crowd logistics, in addition to the findings, facts and numbers available of the spare capacity in Porto District, complemented by the society's will in actively contributing with its resources, it is possible to conclude that there is a vast field of possibilities when it comes to the creation of a sustainable business model based on these foundations.

This study revealed that this idle capacity is gigantic and untapped. If empowered by a technological platform that enables to fill this idle capacity through connectivity between people and cargo, the reduction of the CO<sub>2</sub> levels, as well as the traffic in cities, become preponderant factors and a high

business value-added for a generation increasingly concerned about the environment and environmental impact. In fact, crowd logistics are only sustainable when they can maintain a high level of economic, environmental and social performance and connectivity. Thus, it will be possible to ensure a better future for future generations. (Montreuil et al., 2013).

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