University of Hertfordshire

MSc Project Report

Crowdsourcing for the last mile delivery: An approach for platform selection

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DECLARATION STATEMENT

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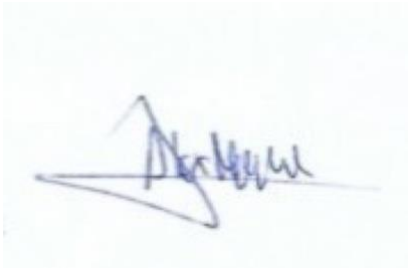

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ABSTRACT

Crowdsourcing appears to be a innovative trend that is growing in many sectors among urban areas. There is good reason to believe that it can be the solution to the growing issues arising from last mile logistics in crowded urban areas.

This paper analises the role of crowdsourcing in the last mile logistics field and presents the characteristics that differenciate the differnet types of platforms present today. In order to consolidate the presented concepts, a case study is performed. The objective is to define the characteristics of a crowdsorcing platform for last mile deliveries in a small city.

ACKNOWLEDGEMENTS

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GLOSSARY

Crowdsourcing: A business practice that outsources an activity to the crowd.

Commissioner: The person that orders a parcel shippment.

Last-Mile: Refered to the last step of a products supply chain; the transportation from the warehouse to the final customer.

e-Commerce: Commercial transactions conducted via de internet.

Crowd: Refered to the participants of a crowdsourcing platform. More concretely, the drivers that perform the deliveries.

CA: Customer Atributes. Used in the House of Quality method.

EC: Engineering Characteristics. Used in the House of Quality method.

1. INTRODUCTION

The developed world, more concretely, urban areas, have seen an unprecedented increase in the volume of parcel deliveries in the last few years. The widespread use of internet and social networks have caused the e-commerce sector to grow at the same time as the majority of the population are moving to big cities. Delivery vehicles are becoming more and more frequent, and consequently, many environmental and sustainability issues arise. Those issues will continue developing in the years to come and their impact will be more and more detrimental. In this sense, it is necessary to find innovative and effective solutions that contribute to a sustainable future for the last-mile logistics imposed by e-commerce sales. (Guo, et al., 2019)

This project aims to explore the role of crowdsourcing in the field of last mile deliveries. The objectives are to study the current state of the art in the field of crowdsourcing in last mile logistics and identifying the existing types of platforms and their characteristics. Furthermore, analyse the feasibility of implementing a crowdsourcing system for last mile logistics in the city of Mataró (Spain). To do so, a selection method will be used over the information obtained in the previous sections.

The paper is structured as follows. Section 2 introduces and defines the concepts of crowdsourcing and last mile logistics, as well as a brief review of the environmental impact of such systems. In Section 3, the different existing platforms and their characteristics are analysed in further detail, relevant literature regarding the topic is reviewed and summarised. In Section 4, the case study is presented. Next, in Section 5, the concepts presented in the previous sections are considered in order to perform a platform selection for the case study. The details of the platform are exposed, and the section concludes with a discussion about the benefits of implementing such a system. Finally, a conclusion is conducted in Section 6.

2. CROWDSOURCING IN THE LAST MILE DELIVERY. ANALYSIS

Before analysing how different crowdsourcing platforms operate in order to perform the last stage of the supply chain, it is important to define what the term crowdsourcing is. In addition, studying the importance of the last mile logistics is essential to understand why crowdsourcing is an interesting option to explore to overcome the present and future issues.

2.1 What is Crowdsourcing?

The term crowdsourcing was first presented by Jeff Howe in the journal Wired, in the article "The rise of crowdsourcing". In that article, Howe takes an etymological approach to the definition, combining the words *crowd* and *sourcing*, he defines it as 'a business practice that means literally to outsource an activity to the crowd'. (Howe, 2006)

Because of the many applications of crowdsourcing, authors have a different approach to define the term and disagree with that definition. (Folorunso & Mustapha, 2014) define it as "a methodology that lets humans process tasks which are difficult to implement in software". (Sutherlin, 2013) defines it as "the technological union of humans and software". Another definition for crowdsourcing is to be a web-based business model, which tries to solve problems with a distributed network of individuals.

Crowdsourcing has been successfully deployed in many domains. YouTube and Wikipedia are great examples of that. The second one defines itself as comprehensive online encyclopaedia, shows the collaborative nature of crowdsourcing. (Hong, et al., 2019)

The principle behind the idea of crowdsourcing solutions is that individuals are provide their under-utilised property in order to offer some value for the community. In exchange, both the individuals and the company that sets up the platform obtain value. Even though the concept of a sharing economy is been around for many years, technological improvements such as

internet, GPS and social media have made it possible for these models to grow in the last few years.

In the last decade, business models based in crowdsourcing models or “sharing economy” have emerged and had a great success. Companies like as Waze, Uber, Lime or Airbnb are great examples of how crowd-based solutions are already present in today’s world. The sharing economy is expected to have a global revenue of $335 billion by the year 2025.
(Alnaggar, et al., 2021)

2.2 What is Last mile Delivery?

In a product's transportation from the warehouse to the final customer, the "last mile" of delivery is defined as the final step of the process. — the stages before the package arrives at its final destination. This part of the product’s supply chain is considered to be the most inefficient from a cost, time and ecological point of view. Between 13% and 75% of the total delivery costs are associated to this last leg of the supply chain. (Buldeo-Rai, et al., 2018)

According to the United Nations (Anon., 2018) 74,4% of the European Union’s population lives in urban areas, and there is an upward trend regarding this figure. Cities are where most of the economic and social activity is concentrated, and together with this increase in population, many challenges regarding effective and efficient transportation arise.

Besides the increasing trend of urbanization, other factors also aggravate the situation. The people living in urban areas have more and more buying power, which results in more purchases, hence, creating more demand for deliveries. Furthermore, in the last decade, there has been an unprecedented growth in e-commerce, with even a stronger spike triggered by the COVID-19 pandemic and the subsequent lockdowns happening worldwide. Traffic in the e-commerce platform Amazon had an increase of 38,17% in Spain during 2020. Even after the pandemic, the industry is projected to grow at an annual rate of 5,16% for the next five years. Besides the growth of that market, expectations from the customer are every time more difficult to meet; as customers want shorter shipping times and more flexible delivery options.

The combination of these factors generates a complicated scenario for the future of last mile-logistics and there appears to be a clear need for innovation in that field. In order to overcome the challenges, some retailers are considering the integration of crowdsourcing in the last mile operations.

2.3 Crowdsourcing in Last Mile Deliveries

Crowdsourced last mile delivery, also known as crowdsourced logistics, is a fulfilment method that uses a network of non-professional, local couriers to deliver orders directly to customers. This practice is employed by both traditional retailers and new business models with the objective of maximizing the reach of their supply chain and cutting down costs. (DispatchTrack, 2020)

Crowdsourcing logistics is becoming popular among businesses. Large e-retailers such as Amazon or Walmart have implemented systems where independent drivers are hired to transport packages to its clients in order to offer same day deliveries, that would not be feasible using the traditional ways of transportation that operate with the companies own fleets. Moreover, many start-up companies that offer last mile solutions using crowdsourced services have been created in the last decade. Those companies mainly focus on the transportation of goods from retailers to customers, and have the goal of offering less expensive, more flexible and faster deliveries than traditional couriers.

A total of five stakeholders are directly linked with crowdsourcing in the last mile logistics:

- Commissioners. The ones that order the parcel shipment.
- Receivers. That receive the parcels. In some cases, commissioner and receiver can be the same.
- Platform providers. Can either be big companies or start-ups.
- Logistic service providers. They are providers that execute the transport service in a traditional way, in some cases, in the early stages of a platform, the operation relies on professional couriers that work for traditional logistic companies.

- Crowd. By definition, it is the key stakeholder in a crowdsourcing system, and its identity varies depending on the platform. For example, some platforms might rely on taxi drivers, regular clients of a particular shop, students, friends or co-workers, among others.

Regarding the crowd, a survey in the city of Alexandria, in the United States, shows that 72% of the participants would agree to deliver parcels to their friends. And another study conducted in Rome, concludes that 87% of students would act as a crowd in a crowdsourcing platform if the compensation is adequate. (Buldeo-Rai, et al., 2018)

2.4 Why Start Crowdsourcing Logistics?

Companies are using crowdsourcing for their last mile deliveries with the goal of supplying their customers more quickly. Businesses, no matter what size, can meet consumer demands for instant gratification while ensuring that packages are received by clients. In addition, crowdsourcing logistics minimizes failed deliveries.

One of the main advantages of crowdsourcing logistics in comparison to traditional delivery systems is that the companies don't own their delivery fleets and drivers, which supposes a much fewer cost in maintenance, insurance and management costs.

The benefits of this model are not limited to the companies, and favour the customers as well. It offers more flexibility over the delivery options and the possibility to select more accurate time slots, ensuring that the customer will be present in the moment of delivery, minimising failed receptions. It also provides greater visibility on the transportation process, both for the customer and the retailer, since GPS technology is used in order to continuously track the packages, giving real time updates on the delivery status.

2.5 Environmental Impact

In their paper about the environmental impact of crowd logistics, (Buldeo-Rai, et al., 2018) compere the effects of a crowd-based delivery method to traditional ways of transport. In their analysis, they came to the conclusion that the number of vehicle-kilometres in the activity is higher, as the crowd was taking trips dedicated only to perform the deliveries. Despite that fact, they came to the conclusion that the crowdsourcing scenario generates less climate change emissions, contributes to fewer air pollution and noise. These results can be explained by the fact that vans and bigger vehicles used by traditional courier companies are substituted by smaller cars in the crowd-sourcing scenario, the later generate significantly less harm to the environment than the first. However, their study concludes that crowd logistics as we know them today are more detrimental to the environment than they could be. Crowdsourcing has the potential to create a sustainable form of parcel deliveries if the crowd integrates deliveries in their existing trips. In this sense, the authors highlight that the platform has a critical role to play.

3 PLATFORM ANALYSIS

In their study, (Buldeo-Rai, et al., 2021) identify the segments of the population that are more interested in participating in crowdsourcing logistics and what services do they prefer. In the literature research, they identify three different types of services associated to crowdsourcing logistics:

- Transportation of goods: This focuses on the transportation and delivery of parcels, from a retail store or a warehouse, to the final customer. Many variations of this model can be implemented, by changing the mode of transportation (vehicle, bike, public transportation…) or the form of delivery (drop-off location, home delivery, automated lockers…).
- The second crowdsourcing service is an extension of the previous one, where the driver not only picks-up the parcel and delivers it, but also has to enter the store, search and collect the items that the customer orders.
- Crowdsourced warehousing: The crowd offers their own space, such as homes or offices, in order to store parcels temporarily, before those are collected by neighbours or drivers. This service is especially useful for parcel returns.

By conducting a survey to a representative sample for the population of Belgium, they recognize the behaviour and preferences of the population towards this type of platforms. Firstly, they identify that 67,7% of the customers prefer to receive their deliveries at home, followed by collection points and workplaces. When a home delivery is missed because the customer was not present, 47,4% prefer to pick-up the parcel in a collection point, in contrast to only 15,2% that prefers to get it redelivered at their own house.

3.1 Matching Mechanisms

In their research, (Alnaggar, et al., 2021) classify the different existent crowdsourced delivery platforms in two main categories; e-retailers and couriers. The former consists of existing big e-commerce companies that decide to implement this technology as an alternative to their

logistic operations. The latter are companies that are quickly growing in number and focus mainly on the transportation of goods between third parties.

This journal paper also approaches the way in which the crowdsourcing platforms match their drivers with the delivery requests. Four main patters are identified:

1. *Pure self-scheduling*. These systems do not require the drivers to indicate their availability beforehand. The drivers log into the app and wait for a delivery request to arrive. Once a request appears near the location of the driver, they have the option to accept or reject the offer. Platforms such as UberEats and Postmates use this matching technique in their operations.
2. *Hybrid and centralised scheduling*. In this case, a more centralised perspective is considered with the goal of reducing the divergence between supply and demand during the day. In this system, drivers have to indicate their availability in advance or pick work shifts, which can be posted up to a week in advance. This scheduling system is similar to a traditional delivery service, and it allows to have a better prediction of the capacity and the supply of the company's fleet. Companies like Amazon Flex use this kind of systems, and they pay their drivers a fixed amount, regardless of the delivery matches they complete during their shift. Some other platforms such as Deliv pay a fixed rate on top of a variable pay that depends on their deliveries.
3. *En-route matching*. This system is similar to the ones used in the problems of ride-sharing, that have the goal of matching drivers with passengers on their way, with the minimum deviation possible. For the case of freight transportation, the drivers indicate their upcoming origin and destination, and then are matched with delivery requests on their way.
4. *Bulletin-board type matching.* This system consists on posting the delivery requests and those being manually picked by the drivers if they match their preferences, without using an algorithm. DHL MyWays, Walmart Spark Delivery and UberFreight employ this kind of system.

Target market of platforms under different matching mechanisms.

Matching Mechanisms	Target Market				
	Individuals			Business	
	Courier service		From Local Businesses	Short haul	Long haul
	Short haul	Long haul			
Pure self-scheduling	✓		✓	✓	
Centralized scheduling				✓	
En-route matching	✓	✓		✓	✓
Bulletin-board matching	✓	✓		✓	✓

Figure 3.1. Target market of platforms under different matching patterns (Alnaggar, et al., 2021)

3.3. Compensation Schemes

Choosing the right compensation scheme is essential in order to ensure and maintain an appropriate supply of drivers and paying them accordingly to their effort. In the researched literature three main categories for those schemes are identified: (Alnaggar, et al., 2021)

1. *Hourly compensation*. It is mainly linked with centralised scheduling systems, allowing the drivers to secure their income during their working hours. The challenge about this type of compensation is to forecast the delivery needs and the necessary capacity in order to fulfil it. Platforms such as Amazon Flex use this way of compensation.

2. *Per-delivery compensation*. This is the most common and most used compensation technique. Drivers are paid for every completed delivery, and the amount they are compensated is calculated by an algorithm that considers factors such as the distance, the waiting time, the package volume and weight, the itinerary, parking, among others. Using this system, the drivers are not guaranteed to get paid even if they are available. They must complete a delivery to get compensated. The biggest challenges in this system are to ensure availability of drivers and maintain their loyalty to the platform. Drivers prefer to have a more predictable pay and are more likely to come back to the app if they had a good experience in the past.

3. *Shipper and driver determine the compensation*. In this systems, driver and shipper agree on a price for the service, and the platform keeps some commissions in exchange for making the match. This method is usually used in platforms that focus on long deliveries or bulky packages.

It is relevant to note that it is possible to do multiple deliveries per trip, meaning that the driver can carry multiple packages simultaneously and plan his trip in order to supply all the deliveries. That allows the platform to achieve economies of scale and can provide important cost savings, as well as more profits to the drivers, allowing the system to work more effectively in some cases.

3.4. Factors That Influence Crowd Participation

The crowd is the crucial stakeholder in the crowdsourcing system, hence, many of the challenges are related to the crowd. Maintaining a sufficient and constant participation is key in order to keep the platforms working and growing. (Huang, et al., 2020) take an interesting approach, they use the Push-Pull-Mooring (PPM) theory in order to identify the factors that influence the crowd's participative behaviour.

The authors make a series of hypotheses following the PPM theory:

Push factors refer to external factors that drive people towards working in crowdsourcing platforms. Having worked in in tedious, not flexible and not enjoyable jobs in the past, push people in favour of participating in a crowdsourcing platform.

Pull factors are those positive factors that attract the crowd to participate. In the paper, monetary rewards, low entry barriers for working as crowd and the relationship between monetary compensation and continued participation are three of the main factors that create a pull effect.

Mooring factors refer to the elements that obstruct or encourage workers to continue participating in the system. The factors analysed are trust between the crowd and the platform, and the costs of participating in the activity. The authors make the hypothesis that the higher

the trust, the stronger the crowd's intention to continue participating will be, and for the other factor, they suppose an inverse relationship between costs and willingness of participating.

To validate their hypothesis, a questionnaire is conducted with 45 workers from four different cities of the Hunan province in China. The results conclude that some of the factors considered in the hypothesis are more influential than others.

The following factors have a significant influence over the behaviour of the crowd: The enjoyment of the previous jobs, the trust between crowd and the platform, the monetary rewards, the entry barriers and the relationship between monetary compensation and continued participation.

However, the results show that some of the factors have no influence. Flexibility in previous jobs and costs associated with participation seem to be unrelated to the participants.
In conclusion, this study shows which are the factors that have stronger correlation with achieving crowd participation for a prolonged period of time. Moreover, it highlights the aspects in which crowd logistics platforms should focus on.

4. CASE STUDY. MATARÓ

This section details the characteristics of the case study. A brief presentation about the selected city is conducted, and the relevant features about its economy, retail, and demographic are explained in order to, in the following section, select the appropriate details for implementing a crowdsourcing platform for last mile deliveries.

4.1. City Profile

Mataró is a small city located in the Mediterranean coast, 30 kilometres north of Barcelona, in Catalonia, Spain. As of 2020, it had a population of almost 130,000 inhabitants. The city has historically been relevant from an economic point of view, attracting people from other near villages. Even though it is under the influence of the bigger city of Barcelona, Mataró is still influential in the retail sector, in fact, it is the fifth Catalan city with most shops per person, concretely, 14.31 per every one thousand people. (Periódico, 2017)

The city's population is evenly distributed along its area, so population density can be considered constant. (Mataró, 2019)

There are two main commercial areas in Mataró. The first one being in the city centre, and the second one being "Mataró Parc", a shopping mall located in the west of the city.

The city centre has an extension of 29 ha. and disposes of over a thousand shops. (Mataró, 2021) Traffic is restricted in most of the streets, and cars should pay in order to park in one of the three habilitated areas. That makes some potential customers decide to shop elsewhere, especially those who only want to visit one shop in particular, or only need to pick up a product they have ordered from the store. The resulting customers mostly people who park their cars and walk around the streets window shopping, but don't have the intention of buying any product in particular. That generates a lower profit from the stores and a worse in person shopping experience for the customers.

Mataró Parc is a shopping mall with 70.000 square meters of extension. There are more than 80 shops and 20 restaurants inside the facility. (Parc, 2021) It is estimated that around 15 million people visit the mall every single year. The mall offers free parking spaces for its clients. Being located next to the highway, its access is relatively easy for people coming from towns nearby, however, it is less convenient for the inhabitants of Mataró, that need to exit the city, a challenging task, especially in rush hours. However, the majority of its clients are people who live in the city of Mataró. Inside the mall there is a big supermarket, the clients that shop in the supermarket visit the mall more frequently than those who only shop in fashion stores or other retail. The fact that the mall has a big group of clients that visit the mall regularly and more frequently is beneficial when estimating the availability of crowd willing to participate in taking deliveries.

Figure 4.1. Map of Mataró indicating the two main commercial areas.

In the year 2016, in Mataró there were a total of 76,126 automobiles, 49,071 of which were cars (64%), followed by 15% of motorbikes, 7% mopeds 7% trucks and 6% vans. (DGT, 2015)

The population of the city is growing year by year, as can be seen in Figure 4.2, following the trends described in the introduction. In addition, the consumer habits are changing towards e-

commerce. Before COVID-19, 7 out of 10 people considered themselves regular users of online, after the lockdown, this number increased to 9 out of 10. (Capgròs, 2020). Despite this trend, only 24% of the shops in Mataró have online store, and 24,4% more are working on providing online service for their customers. There is a clear inequality between supply and demand in the local business, but at the same time, there is a clear opportunity to exploit an unsatisfied need for the customers: providing local shopping experiences with the benefits of an online platform.

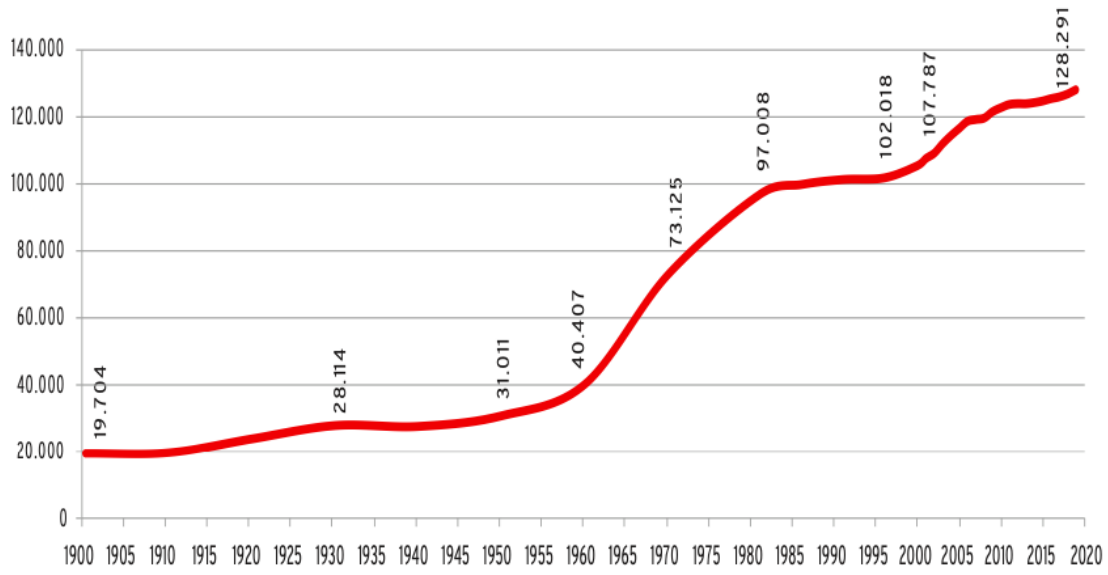

Figure 4.2. Mataró's population evolution (Mataró, 2019)

From the business perspective, many believe that it is urgent and necessary to take action and transform their business models in order to adapt to the new customer trends and continue being profitable. This transformation consists on innovating the way on which their activity is done. Participating in a crowdsourcing platform seems a good decision to take in this situation. It will allow the business to expand to further customer segments, increase their revenue and diversify their clients, while maintaining their original business model.

4.2. Customer Profile

In order to determine the profile of both the potential clients and the potential drivers that would participate in the platform, it is necessary to identify the characteristics of those participants.

Due to the fact that the service is app-based and relying on mobile phone connections, crowdsourcing platforms attract younger segments of the population. Moreover, sharing services are more accepted amongst younger generations, as well as people with higher levels of education. (Punel & Stathopoulos, 2017)

In a survey conducted with the objective to identify the friendship levels required to create a crowdsourced delivery network using friends and acquaintances, (Devari, et al., 2017) survey men and women, mainly from 25 to 75 years old from different income levels. The results show that 60% of the participants would agree to deliver packages with no monetary compensation. Surprisingly, 30% of the other respondents would only agree to participate if the reward was higher than $5. It seems clear than the polarised nature of the answers is due to the fact that the system considered in the study is to make deliveries for friends. In a system where the deliveries are conducted between strangers, the participants would likely demand a significant monetary compensation.

The survey also studies how much time are the drivers disposed to spend in order to perform a delivery. The results show that more than 80% of the participants would agree to spend up to 15 minutes in order to complete one delivery.

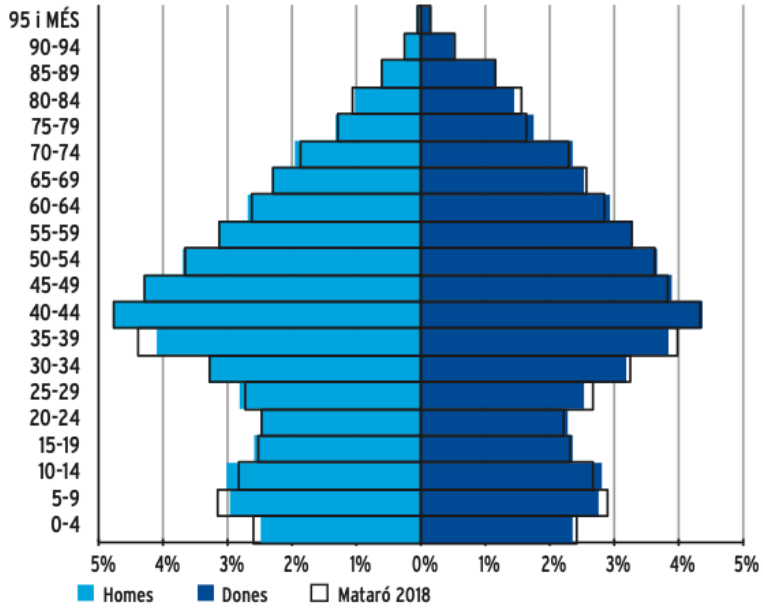

Figure 4.3. Population pyramid (Mataró, 2019)

By taking a look at the population pyramid of Mataró, it is clear that there is a big market opportunity to successfully implement a crowdsourcing platform. Approximately 70% of the population is between 25 and 75 years old, hence, they are fit to participate as crowd. (Devari, et al., 2017)

4.3. Current Platforms

In the last few years, more and more crowdsourcing and sharing platforms have been starting to operate in Mataró. Most of them are food delivery platforms, that were previously located in other bigger cities such as Barcelona, and decided to start offering its services to drivers and customers in the surrounding smaller cities like Mataró. In another field, ride-sharing platforms such as BlaBlaCar have also been in service for a few years, offering the chance to take profit from the under-utilised capacity of the vehicles during commuting to work in Barcelona or taking long distance trips.

- **Glovo**: Glovo is a Barcelona based start-up founded in 2015. It offers on-demand purchases, pickups and deliveries for a wide variety of products. The platform pays the drivers in a unique way. The huge difference from other platforms lies in Glovo's

organizational formula, the only one in the industry that assigns a score to the rider. As orders are concentrated on weekend nights, delivery drivers try to work at those hours. To avoid them, Glovo divides the week into blocks and the delivery drivers choose which one they work in. Those with higher scores (the scale goes from 1 to 100) choose earlier, up to a maximum of 56 hours per week. Drivers gain around 11 or 12 € per hour, even though on weekends, they can earn up to 15 or 16 €. (Glovo, 2021)

- **Uber Eats**: This platform functions in a different manner than Glovo, drives do not work in blocks. They can select deliveries individually. Despite that, the platform constantly sends incentives to their drivers in order to maintain their loyalty. Incentives can be, for example, receiving an extra compensation when the driver completes a certain number of deliveries in a certain time period. Even though the platform does not publish how much their drivers earn, it is estimated that they make around 9 € per hour.
- **Deliveroo**: Similar to Uber Eats, drivers from this platform can decide when and where to work, gaining compensation per every delivery. As a result, they earn around 10€ per hour. Drivers of these kind of platforms are more interested to work in peak hours, as the demand is higher, therefore, the compensation is better.
- **Just Eat**: This platform of food-deliveries pays their workers under a part-time contract, something different from the previous ones. Thus, the drivers receive a fixed salary, insurance, and social security membership regardless the number of deliveries they perform. (Lara, 2020)

Glovo, Uber Eats and Deliveroo only require a few conditions for new drivers to start working for them. The requirements are: To have an own vehicle (car, motorbike or bicycle), have the right to work in Spain, register as self-employed and have a smartphone with certain minimum software requirements. (Uber, 2021) (JustEat, 2021) (Glovo, 2021) (Deliveroo, 2021)

Other competitors in the field of last mile logistics are companies that don't use sharing or crowd-based technologies. These can be companies like Amazon or grocery stores, that employ their own drivers for delivering products, or directly traditional transportation companies such as Correos, GLS or DHL. In addition, some small local shops offer at home delivery

service for their customers, in that case, the trips are done walking or by the private vehicles of the shop workers.

5. PLATFORM SELECTION FOR THE CASE STUDY

Once all the theoretical framework is defined and the case study and its main characteristics is presented, in the following sections, a selection method will be followed in order to obtain the characteristics that the customers and other stakeholders desire for the platform to be implemented.

5.1. Stakeholders Wants and Needs

A crowdsourcing platform integrates many different stakeholders, all of them have different needs and wants. In this section, we identify the importance of the different features of the platform for the different stakeholders, that had been presented in Section 2.3. The different factors include the ones that influence the participation of crowd into a crowdsourcing system, presented in Section 3.4.

It is important to note that some of the characteristics are not relevant for all the stakeholders, while other have varying relevance. A part from that, some other features are important for more than one stakeholder, but their preferences are opposed, in that case it is clear that there exists a trade-off between stakeholders. For example, receivers prefer to have a high level of flexibility on their delivery options, while platform providers prefer to plan and schedule their operations in order to have more certainty in their operations quality.

	Commissioners/ Receivers	**Platform providers**	**Logistic service providers**	**Crowd**
Service flexibility	High (Flexible)	High (Planned)	Low (Planned)	Low (Flexible)
Price	Cheap	Cheap	Expensive	Expensive
Service Quality	High	High	-	Low
Customer Engagement	High	High	-	-
Enjoyment of the previous jobs.	-	-	-	High
Trust between crowd and the platform	-	High	-	High
Monetary rewards	-	High	-	High
Entry barriers	-	Low	High	Low
Relationship between monetary compensation and continued participation.	-	High	-	High

Table 5.1. Relevance of the demanded quality for the system stakeholders

5.2. Selection Methodology: House of Quality

In order to select the appropriate features for the platform, in this section, the method of House of Quality will be conducted. House of Quality is a basic design tool of the management approach known as quality function deployment (QFD), which originated in the year 1972 at Mitsubishi's Kobe shipyard site, in Japan. Since then, many companies such as HP, General Motors or Ford use this method for designing their products. (John R. Hauser, 1988)

When constructing the House of Quality, in the left side there are the customer attributes (CAs), that determine what do the customer want from our platform. In the opposite side of the house, there is a list of competitive platforms in comparison to ours. This section allows to identify opportunities for improvement. The top of the house answers the question "How can the product be changed?" by listing engineering characteristics (ECs).

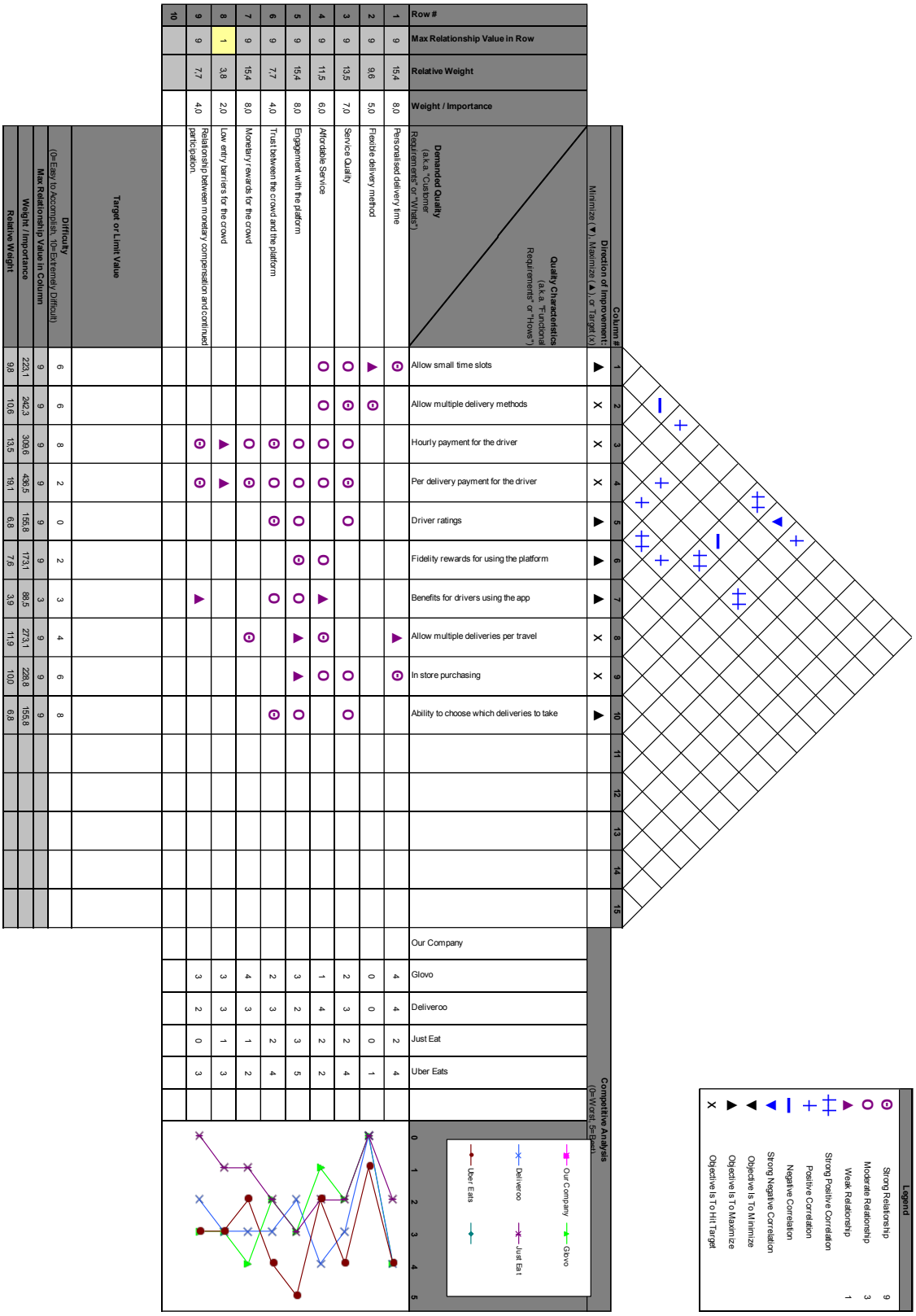

Figure 5.1. House of Quality

Completing the house of quality allows us to identify which ECs are more relevant for satisfying the stakeholders needs, especially the customers and the crowd. The bottom rows indicate the relative importance of every EC. In the following table, we can see the ECs classified by its relative importance, and in consequence, what we decide to implement for the studied platform.

	Engineering Characteristics	Weight	Decision
X	Per delivery payment for the driver	19,1	Chosen per-delivery as it aligns with the characteristics of the crowd in that case scenario.
X	Hourly payment for the driver	13,5	
X	Allow multiple deliveries per travel	11,9	Drivers can deliver multiple packages in the same route.
X	Allow multiple delivery methods	10,6	Customers can choose between different delivery methods: At home delivery, at a neighbour's place, or in a pick-up point, such as a local store.
X	In store purchasing	10	Not include it, as it effects negatively the other customer preferences.
+	Allow small time slots	9,8	The method indicates that it is a relevant feature, so it giving a 2h time slot can be adequate.
+	Fidelity rewards for using the platform	7,6	It is a good way to create customer and crowd engagement.
+	Driver ratings	6,8	It is a simple task to implement into the system, so it is completely good to implement.
+	Ability to choose which deliveries to take	6,8	It implies a big challenge and threat to the success for the platform quality (In case one order does not get served). Hence, the decision is to give priority to fulfil older requests.
+	Benefits for drivers using the app	3,9	Not relevant, so it is not priority.

Table 5.1. Decisions on the platform based on the most relevant ECs.

The right-hand side of the house of quality shows how four different competitors in the sector perform in providing answers to the customer needs. It is clear that the different alternatives follow a trend, obtaining similar scores in some CAs, while in other cases, the scores are scattered. If we take a close look to the Figure 5.1, we identify that there is a great opportunity in fulfilling the need of offering a *Flexible delivery method*, as none of the rivals succeed in this field. In other CAs, such as *Engagement with the platform* and *Personalised delivery times*, we can observe that the competitors have a strong score. This means that is necessary to at least score as much as the competence in those areas to not fall behind.

5.3. Characteristics of the Selected Platform

Performing the House of Quality Analysis allows to identify which are the most important needs for the stakeholders, and which features should the platform adopt in order to satisfy those needs. Here are the conclusions taken from the analysis:

- The platform will run on a mobile application. This app will be free to download and it will also be free to register into the platform. In there, clients will have the possibility to make an order, track their parcel, and rate the service after the delivery is conducted. On the other side, the crowd will be able to use the app to receive delivery requests, accept or decline those, and get instructions for the best route to take in order to collect and complete the accepted deliveries.
- There will be two collection points for the parcels: the city centre and Mataró Parc. In the city centre, drivers will need to pick up the items from the store, which in a few cases can be in a pedestrian street, which can make the delivery slower. It is important to anticipate that some problems can happen regarding this topic. In Mataró Parc, instead, the delivery point will be centralised in an accessible area for the drivers. Bear in mind that the system will not allow in store purchasing, so the stores are the responsible to prepare the packages that will later be picked up by the drivers.
- The selected matching method "*Pure self-scheduling"*, as stated in Section 3.1, this system does not require the drivers to indicate their availability beforehand. The drivers use a mobile app to receive delivery requests and select whether they do or do not want to accept it.
- Given the nature of the system, we can expect two different types of crowd to participate in the system, professional and occasional drivers:
    - Professional: Those are people who will participate in the system by performing deliveries with the goal of obtaining monetary reward from it. It is possible that different users will work in different schedules, more or less hours, depending on their availability and willingness.
    - Occasional drivers: Those are people that are shopping in one of the considered areas, and they decide to take a small detour in their way home in

order to perform a delivery and get rewarded in exchange. Even though they obtain monetary reward, that is not the main reason why they participate in the system. The reasons are more associated with being part of the community, helping neighbours, obtaining rewards in the platform, or taking environmental conscience.

- The chosen compensation scheme is "*Per delivery compensation".* As exposed in Section 3.2, this method allows drivers to get rewarded per every delivery. Thus, not only professionals will be able to participate into the platform, and it will allow more casual users to integrate into the platform, creating a sense of community. Furthermore, the nature of this payment method incentivises drivers to perform as many deliveries as possible as quickly as possible, resulting in more rewards for them, and also, faster and more efficient service for the customers.
- The platform will allow drivers to carry multiple parcels at the same time. This allows for a much more efficient and sustainable system; hence the crowd can make use of the capacity of their vehicles. Moreover, the routes can be optimised by the platform app in order to deliver all parcels in time while minimising the delivery time.
- Three different delivery methods will be available. At home delivery, delivering the parcel to a neighbour's place, or pick-up points will be the three alternatives that the customers will be able to chose from.
- When a delivery request is not selected by any driver, or there are no drivers available to complete the task, the platform will pay a traditional logistic provider to perform the delivery. The platform should maintain a close relationship with one courier company, such as Correos, in order to coordinate the operations and negotiate a fair price for the service.

5.4. Discussion

The analysis conducted in the previous section allows us to define the characteristics of the system to be implemented in the case study in particular. The key elements of the platform are to achieve and maintain sufficient crowd participation. Incentives are essential for the crowd to choose out platform instead of other competitors. Our platform will try to create attachment with the participants and the drivers by rewarding their loyalty.

Another important feature of the platform is allowing the customers to select between different delivery methods. This yields a competitive advantage over the current platforms that operate in the city, and can be one of the main focuses when presenting the platform to the public. Moreover, being able to control the delivery time and track the parcel location at any given moment gives the customer a perception of quality in the service, that reduces the fear of ordering products online and not being home for collecting the parcel.

The environmental impact of the platform is slightly more complex to predict, as it depends strongly of the nature of the crowd that participates in the system. If the crowd is conformed mainly by Professional drivers, as described in Section 5.3, the trips made by those drivers will be exclusively dedicated to perform the deliveries and the environmental impact will be similar or higher than traditional delivery services. If otherwise, Occasional drivers are the majority, most deliveries will be done using already planned trips, in other words, taking advantage of the under-utilised resources of the crowd. In that case, the environmental impact would be drastically reduced.

Furthermore, the implementation of such a platform is essential for dynamizing the activity in the local shops in the city centre, which have been losing clients and are being forced to close in the last years due to the changes in behaviour of their clients. Joining this crowdsourcing platform as a key stakeholder will allow them to reach to many more customers, change their old-fashioned image and adapt to the rapidly changing demands of the market. Moreover, the fact of offering local products will be a distinctive feature of the platform, which will have the

ability to attract a certain customer profile that does not use similar platforms. In conclusion, the incorporation of local commerce in the platform results in a positive effect for the platform, its customers and the stores themselves.

Finally, by generating crowd participation and interaction between users, crowd and the platform, it is expected to create a sense of community between neighbours. In the last decade, digitalisation has caused communities to lose contact and relationship, however, crowdsourcing has the potential to bring those communities back together.

6. CONCLUSIONS

In this report, we established a conceptual framework regarding the current state of crowdsourcing platforms for last mile logistics in urban areas. By reviewing relevant literature, we identify how different platforms adapt to different requirements, what are their features and how they affect the stakeholders. Further in the report, we perform a selection for the characteristics of a crowdsourcing platform to be implemented in the Spanish city of Mataró. With that analysis, we take a more practical perspective to the concepts developed in the first half of the report.

In relation to the objectives, we derive the following conclusions:

The integration of crowdsourcing has great potential for improving last mile deliveries from an environmental and economic point of view, even though as of today, it might not be sustainable in some cases.

Characteristics such as compensation schemes or matching mechanisms have a significant effect on the system performance.

A selection method can be used to determine which features are required for implementing a new crowdsourcing system for las mile logistics.

6.1. Further Development

The project has limitations regarding the case study. Even though the system main idea is drawn, we lack numerical data that would allow us to determine what parameters are really relevant. Conducting surveys to the crowd and simulating the case study would provide a better estimation of the quantitative parameters to take into account.

Further research can focus on developing the theoretical framework by including other relevant topics, such as pricing, marketing and sociology.

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