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Abstract

This study analyses the status of online food delivery services (OFDS), which have seen a significant increase in use worldwide due to the pandemic, while presenting several negative externalities in economic, social, and environmental terms. The aim of the study is to highlight the results following the creation of a system of reusable packaging in the historical center of Bologna involving various restaurants for take-away and delivery food orders. In the first section of the study, different statistics are investigated regarding the incremental increase of OFDS, and some related negative externalities found in literature, the existing literature review, and some studies are highlighted to support the thesis. In the second section the status of European policies is briefly analyzed, which focus more on recycling rather than re-use actions, although conventional theory suggests that re-use is preferable to recycling. In the third part, eighteen of the main reusable packaging systems around the world are compared, highlighting the type of service, the type of material and several common characteristics. In the fourth and last part, the results of a survey involving 224 individuals living in the historic center of Bologna on the potential introduction of the service are presented. An analysis of economic sustainability through the Net Present Value and the calculation of the WACC is also provided and the potential benefits of introducing this service.

Keywords: reusable packaging, OFDS, online food delivery services, circular economy, DRS, take-away, food, food delivery, sustainable development, innovation, startup, green growth

Introduction

Online Food Delivery Services (OFDS) around the world have recently increased significantly, driven by various factors, including disruptive digitalization accelerated by the recent global crisis. This, among other consequences, is compounded by an increase in demand for food packaging that contributes to an increase in the consumption of primary resources. The most popular packaging is the disposable one, which since the Second World War has gradually replaced the existing realities of reuse, defining a linear economy based on convenience and immediate simplicity (Marsh et al., 2007). Traditional waste management, as it is currently and increasingly becoming widespread, focuses largely on recycling, which, although important and a segment of the life cycle of materials and products, is clearly not a panacea for waste problems. In recent years, there has been a push to focuson other circular economy strategies that could further avoid the consumption of energy and resources. Among these, the *Action Plan for the Circular Economy* which is part of

the *European Green Deal*, which states the legal proposals on waste and long-term sustainable achievements to stimulate the transition to a more circular economy in Europe (European Commission, 2019). The main key elements committed to this new action plan are the following:

- Target to recycle 75% of packaging waste by 2030.
- Reduce landfilling to a maximum of 10% of municipal waste by 2030.
- Promote material reuse.
- Encourage greener and easier-to-recycle products.

However, in 2019 the total volume of packaging waste generated in Europe was estimated at 79.3 million tons, an increase of 2.4% compared to 2018 (Eurostat, 2019), emphasizing how the role of single-use packaging is central, as is that of food packaging. The introduction of packaging reuse systems in the food delivery sector could be a partial solution to reduce the amount of waste and create a virtuous cycle (Gallego-Schmid et al., 2019). At local level, however, municipalities can support local authorities to develop and implementpilot reuse projects. Measures are needed to improve the business case for reusables, such as discouraging single-use containers. The project hypothesized and presented in this paper, called *Tondo*, fits into this context. This initiative concerns - through the creation of a network of restaurants in the historical center of Bologna - the implementation of a virtuous and convenient waste management system, according to the principle of re-use. Indeed, the usual disposable take away and delivery containers, normally provided by restaurants, will be replaced by reusable containers which can be reused up to 200 times, more sustainable and economical in their life cycle. An economic forecast will also be presented for the whole project, as the same project could be implemented in the future as a starting point for an innovative start-up or some other kind of local enterprise.
The research methodology focused on B2C instead of B2B because at the same time the literature is also based on B2B, meaning that B2C is a great source of pollution, and it was even more interesting to understand how to implement this kind of initiative at B2C level, whereas for B2B some solutions are already in place and are easier to implement.
The methodology followed in this research was the review of current literature, to provide the theoretical basis for the justification and development of the project, and the elaboration of data analysis, including through similar existing projects, with the aim of providing a financial plan and economic forecasts to ensure the economic viability of the project.

The context of OFDS

Online food delivery services (OFDS) are most often provided through apps, which allow the user to order food from a takeaway location, i.e., by picking it up in person, or to receive it directly at home via a *rider*, i.e., by delivery. The food can also be either ready-to-eat food or food that must be prepared specifically for the direct consumption. The online food delivery service can also be divided into two segments, depending on food management: restaurant-to-consumer delivery includes delivery of the order directly from the concerned restaurant, while the platform-to-consumer segment involves online delivery services that deliver orders from partner restaurants. The variety of digital platforms for food delivery has been rapidly increased in recent years worldwide. In the case of food delivery services, digital platforms serve as marketplaces that allow consumers to purchase food from local restaurants. These platforms based their business model on taking a percentage of the total purchase. In their turn, they provide restaurants the possibility to externalize the

distribution of food to the customer. The service works like this: once a purchase order is placed, the platform sends a notification to the riders who meet some criteria, such as geographical proximity and a good status on the platform. The first one who replies is allocated the service. The meal is then collected from the restaurant and there is a time limit to deliver the meal to the customer. The sooner the delivery is finalized, the sooner the rider is again available to accept new orders. While the riders are paid for each delivery, the platforms also charge the restaurant for a fee for the meal order. They also charge the customer for the delivery. In addition to this service, food delivery platforms offer a wide variety of functions, including providing consumers with a wide range of food choices, taking orders, and passing them on to the food producer, checking payment, arranging food delivery, and providing tracking services, giving feedback on restaurants through reviews, as well as an order guarantee and support service, and a strong discount policy. Sensor Tower Report (2021) assess that Europe Online Food Delivery Market is anticipated to be valued US$ 20.27 billion by 2026, growing with a 5.83% compound annual growth rate (CAGR) from 2020 to 2026. In this context, China alone accounts for around 37% of the total, followed by the US with just over 20% and Europe with 15%. However, the old continent shows the highest levels of growth at 9.5% per year, with countries such as France and Spain growing at a rate of over 10%. According to the report, in the first three quarters of 2019, European food app installs reached 117 million. By Q3 2020, Google Play and App Store downloads for these apps across Europe surpassed Q4 2019 by 4.5 million. According to these data, in 2020 *Uber Eats, Glovo, Delivery Club, Just Eat* and *Deliveroo* were the top five highest installed food delivery apps across Europe. There are several reasons for this exponential growth.

First, the reason that has simply accelerated this process rather than being the driving force is to be found in the COVID-19 pandemic. In this sense, on the one hand, delivery platforms have allowed restaurants to have an economic income despite the heavy restrictions that have seen the sector shut down for several months. On the other hand, customers who in a normal context would have consumed their food outside, found themselves in a lockdown situation, where ordering by delivery was a source of entertainment, as well to support the restaurant world in crisis. It should also be noted that during this period many delivery services lowered, or sometimes even removed, the service charges, which are the competence of the restaurant, to further facilitate the sector. According with Chang et al., (2020), in Taiwan the demand for online food delivery services during the pandemic grew, where sales and customers increased by 5.7% and 4.9%, respectively, for each new confirmed case of COVID-19. All this has been made possible by advances in technology, as highlighted by the McKinsey Report (2021), which shows that the massive spread of smartphones has contributed to the emergence of these services. About technological progress, tests on urban delivery by drones have already begun. Yaprak et al., (2021), point out the significant correlation between consumers' perceptions of benefit and risk, and attitudes and behavioral intentions towards drone delivery of online orders during pandemics, which would suggest that this type of delivery will also be enhanced in the future. In emerging countries, according to Xu (2017) and Xu et al., (2019) there may then be additional reasons that have made OFDS popular and can be found in facilitating convenient and fast delivery of food to customers' homes and providing restaurants with more opportunities to increase revenue without increasing restaurant seating capacity. There are multiple consumer value perspectives to consider, which have been the subject of various studies. Some perspectives regarding why consumers use OFDS apps are shown by Tandon et al., (2020). Schiopoiu et al., (2021) confirmed the values highlighted by Tandon et al., (2020) by carrying out a study in Romania. What is inferred is that from a service point of view, their results show that OFDSs should implement customer retention strategies, as the perceived risk of users to change the online food provider is high.

Negative social externalities

A first insight is provided by Dong et al., (2021), which use an intercept analysis in Tianjin, China, to investigate the influence of external and internal regulations on food delivery and normal e-bike drivers, considering occupancy factors (time pressure). Their results suggest that not only the presence of traffic, but also personal norms negatively influence the frequency of aggressive driving behavior. This means that both external and internal regulations can effectively reduce the tendency of cyclists to drive aggressively. Considering these findings, some solutions are also proposed to mitigate the effect of time pressure, by limiting the maximum number of deliveries a rider can make. Food has also always been a vehicle for socialization and a way of interacting with other people. It is interesting to note that OFDS have made changes in people's habits in this respect too, i.e., in terms of socialization. Li et al., (2020) point out, according to the Research Centre for Network Economy and Knowledge Management of the University of Chinese Academy of Sciences, that at least 48 minutes of time is saved for every order placed. However, according to their findings, there are mixed results regarding the role of food in family sociability. According to Roh et al., (2019), Korean wives are reluctant to use OFDS and use it infrequently, as in their country's tradition the wife's job is to cook, and by using the service they are failing in their duty. On the contrary, in other countries such as China (Liu et al., 2019) and the UK clients would be happier to order food at home precisely so that they do not have to spend time cooking and thus use the time available for other collective activities (Meah et al., 2017). The same is demonstrated from another study (Liu et al., 2019) conducted in Guangzhou that involved people aged 18-35 who prefer to order once a week with OFDS to avoid spending their time cooking or buying the necessary food ingredients. The impact of OFDS on the diet-related behaviors and on the sedentary lifestyle are investigated respectively by Maimati et al., (2018) and Jang et al., (2019): a study of 1220 university students was conducted in Beijing and showed that eating with delivery is associated with poor medical attention, a preference for fatty and high-sugar foods, low activity, and of course obesity.

The social sphere, with a view to equal market conditions and fair territorial distribution, which in some cases could lead to certain areas being disadvantaged with consequences for people's health, as demonstrated by Keeble et al., (2021) is that of the emergence of so-called "*dark kitchens*" or "*ghost kitchens"* or *"cloud kitchens".* In this sense, the traditional restaurant, understood as a place that does not have delivery as an option, but where the option becomes to eat there, ceases to exist. Shared kitchens are then created between restaurants to reduce their overheads with OFDS providing the venue, supplies and marketing.

Finally, there is the question of riders' entitlements. In this sense, as pointed out by Sun et al., (2019), there is no doubt that OFDS have created many job opportunities, but debate remains about the actual quality of this type of work. Concerns have been voiced from many quarters about the poor working conditions (e.g. in cold, excessive heat, snow or rain) to which delivery workers are subjected, including the standardized nature of their work, their high workload the fact that they do not qualify as employees in their own right, the limited training that many receive, the risks they run to their personal safety during the food delivery process, the means of delivery that falls to them and not to the employer, pay that is not always fair, and the absence of employment insurance.

Negative economic externalities

Also, the financial sustainability of such OFDS in the long run is a topic of debate. This is pointed out in the McKinsey Report (2021), which stresses that the marketing costs of each platform, necessary for its advertising, are constantly increasing due to the large number of existing OFDS. One solution could be to do this through cross-platform

acquisition, whereby the cost should decrease.

Consolidation will also give the platforms enormous influence over which of the thousands of restaurants are seen by the customer, probably leading to further volume concentration at the top restaurants, whose own brands are well placed to compete in the digital markets. According to the Monte Carlo modelling developed by Alvarez-Palau et al., (2020) proves the necessary volume of OFDS orders required to make the system economically viable. The study was conducted in Barcelona, focusing only on the sources of income. The profit function is the following:

$$P(v, x, f) = I(v,x,f) - E(x,f)$$

Where *P* represents the profit of the digital platform firm, *I* represents its total income (calculated as the sum of revenue from restaurants and customers), *E* is the total expenses (calculated as the delivery cost plus the firm's fixed operating cost), *v = (v1,v2,...,vn)* is a vector containing the value of the n orders, *x = (x1, x2, ..., xn)* is a vector that represents the time distance between customer *i* and his selected restaurant. The revenues for OFDS generated by restaurants, on the other hand, can be identified through the following equation

$$I_R = \sum_{i=1}^{n} \omega . v_i$$

Income from the restaurant

$$I_C = \sum_{i=1}^{n} \alpha + \beta . \varkappa_i$$

Income from the consumer

- I_R represents the income received by the OFDS from the restaurant, and it is calculated as a fee or commission (ω) on the value of the meal.
- I_C is the total amount of income received by the OFDS from the customer according to the concept of single delivery, and it was calculated by the authors as a linear function of the time-based between the customer and the restaurant, $\varkappa_i$.

It already seems clear that this type of service can only work in certain urban contexts, i.e., where a minimum urban spatial extension is guaranteed. According to the authors, the sensitivity of the model to the restaurant tax is considerable, i.e., going from 30% to 20% would almost double the number of purchase orders needed for profitability. Conversely, going from 30% to 40% would only decrease the number of orders by a third. The scenario in which customer revenue is estimated as a value-based function shows that the economic profitability of the business model can decrease by up to 12.5%. Similarly, if we assume a scenario in which riders are full-time employees of these companies, a decrease in profitability of up to 30% is estimated.

According to McKinsey's Report (2020), they have traditionally measured their profits on three basic costs: food (usually 28 to 32 per cent of total costs), labor (another 28 to 32 per cent) and employment or real estate costs (22 to 29 per cent). Taking a holistic economic view of a restaurant, the business should run between 78 and 93 per cent, allowing a profit margin of between 7 and 22 per cent (franchised restaurants pay additional franchise fees to the company). Delivery orders were seen as an extra table for the restaurant, served by a driver instead of a waiter. Drivers were paid minimum wage by the restaurant and earned tips from customers, usually by delivering several orders at a time within a set distance. Overall, delivery was intended to improve a restaurant's revenue by increasing the use of its kitchen by a reasonable margin. In short, restaurants would be carefully offsetting delivery with other parts of the business to make a positive net

impact. A traditional restaurant should increase its total sales substantially to remain at the equivalent profit range as without OFDS. Restaurants that choose to continue to serve both dinner in and customers at home will need to adjust their prices to cover the additional costs of delivery. Those that encourage price consistency could increase overall menu prices to meet these charges, with dinner and delivery customers effectively subsidizing delivery. Alternatively, restaurants could create separate, more expensive delivery menus, as some have already done.

Negative environmental externalities

According to Li et al., (2020), one of the most pressing environmental concerns, evident from the dramatic increase in OFDS, is the huge volume of plastic waste generated and how to manage it. In 2020 the use of single-use food packaging increased in many parts of the world due to the COVID-19 pandemic, as many consumers believed that single-use packaging was safer and more hygienic; of course, the difference between safer and unsafe packaging lies in the way it is stored. Qiu et al., (2019) analyze how only 21.1% of 884 university students surveyed in Changchun, China in 2019 separated food and containers after consumption and 67.2% of them threw leftover food into containers. The study suggested that lack of awareness was the main reason for this, and only a small number of students (6.4%) clearly understood how to separate waste. To some extent, the lack of civic facilities (including the absence of recycling bins) contributes to this problem. Consumer behavior in the use and disposition phases of a product is a significant factor in the associated environmental effects of a product, with waste and landfill diversion recycling having the ability to contribute to significant emission reductions (Vasileva & Ivanova, 2014). According with Jang et al., (2020), in South Korea the analysis of material stream found that plastic consumption associated with food delivery in the form of bottles, cups and plastic bags, results in 600,000 tons of plastic disposed of each year. Consequently, it is essential that packaging and waste systems consider consumer behavior in their plans for environmentally efficient packaging. Packaging that is "easy to empty, easy to clean, easy to fold, easy to separate, easy to reseal, and availability of information on how to sort" facilitates proper sorting (Nemat et al., 2019). According to Changwichan et al., (2020) the use of food containers based on bioplastics is slowly gaining ground among restaurants. Bioplastics can be made from different materials; the common type is made from polylactic acid (PLA) which are derived from renewable sources such as crops. However, for material recycling and recovery, bioplastics need specialized temperature-controlled structures to facilitate biodegradation (Massardier-Nageotteetal et al., 2006). In the absence of these structures, bioplastics can also spend a long time to biodegrade, especially in landfills (Bàtori et al., 2018). A further obstacle which is reminded by White et al., (2020) to their broader uptake to be found in the price. Bioplastics may cost 2 to 5 times as much as conventional packaging materials, which may be attributable to the early stage of developing the bioplastics innovation landscape and the lack of dominant market players. In addition, a less obvious waste associated with online FD is the spent batteries of the electric bicycles of food delivery drivers and is highlighted by Li et al., (2020). Another negative externality highlighted in the literature is that of food waste which is often linked to the fact that OFDS set a 'minimum price' requirement which means that consumers pay more than necessary for food. A survey by China Food Saf. Mag. (2018) conducted in Changchun, China, showed that 90.1% of 884 university students surveyed left half of their food uneaten.

The correlation between food packaging and waste

The main negative externality related to the environment and OFDS is therefore to be found in the large amount of packaging that is required for food to be transported and then delivered and in this sense packaging in general (including

food packaging) plays a major role in generating urban waste. According to Marsh et al., (2007) the main roles of food packaging are: a) preserve food from external factors and damage; b) contain food; c) give consumers product information about ingredients and nutritional values; in this respect, traceability, convenience, and tamper evidence are secondary functions of increasing importance. The objective of food packaging is to preserve food in a convenient way that meets industry and consumer requirements, while keeping food safe and minimizing environmental impact. In 2018, the new Waste Framework Directive (2018/851) was adopted, amending Directive 2008/98/EC. The waste hierarchy has been strengthened as a priority applying principle in waste prevention and management regulation, and Member States should give priority to the options with the greatest environmental impact: prevention and preparing for reuse and recycling. In a further step, the targets for preparing for reuse and recycling of waste have been increased: by 2025, the amount of municipal waste prepared for reuse and recycling should be a minimum of 55% by weight, by 2030 this will increase to 60%, and by 2035 the target is to reach 65%.

Directive 2018/852 of 30 May 2018 amending Directive 94/62/EC on packaging and packaging waste sets out Article 5 specifically for "Reuse". The aim is to increase the share of reusable packaging available on the market, and to implement reuse systems that produce positive environmental impacts and do not compromise the hygiene and food safety of users. Member States are encouraged to introduce deposit-return systems, economic incentives, or the target of a minimum percentage of reusable packaging to be placed on the market.

Finally, the European Parliament and the European Council adopted Directive 2019/904 on reducing the impact of certain plastic products on the environment, usually known as the Single-Use Plastic (SUP) Directive, with Art. 4 and Art.5. Data provided by Eurostat estimates, in 2019 (most recent data available), packaging waste was estimated to be 177.4 kg per inhabitant in the EU. This quantity varied between 74.0 kg per inhabitant in Croatia and 228.0 kg per inhabitant in Ireland. Figure 1 shows how paper and cardboard (40.6%), plastic (19.4%), glass (19.2%), wood (15.6%) and metal (5.0%) are the most common types of packaging waste in the EU in 2019.

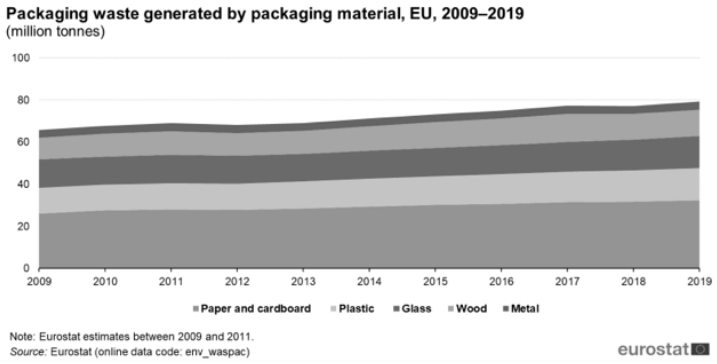


Figure 1: Packaging waste generated by packaging material, EU, 2009–2019 (million tons) Source: Eurostat

Other materials account for 0.3% of the total volume of packaging waste generated in 2019. This quantity varied between 74.0 kg per inhabitant in 2019, the total volume of packaging waste generated was estimated at 79.3 million tons, an increase of 2.4% compared to 2018. This is mainly due to the increase in glass packaging (+ 4.7% compared to 2018) and plastic (+ 3.6%). All other types of packaging also increased: wood packaging by 1.6 %, metal packaging by 1.5 % and paper and cardboard by 1.2 %. According with Marsh et al (2007) municipal administrations regarding municipal waste basically have these actions at their disposal, which can be summarized in recycling, combustion/incineration, and landfilling.

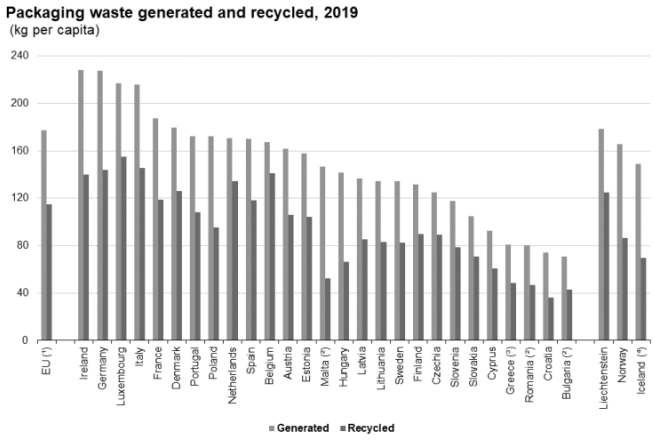


Figure 2: Comparison between waste generated and recycled per country in Europe in 2019. Source: Eurostat

Data provided by Eurostat show total amounts of packaging waste generated and recycled are compiled from all packaging materials: glass, paper and cardboard, metal, plastic, wood, and others. Figure 2 shows an insight into the data reported by EU Member States and EEA/EFTA countries in 2019 on packaging generation and recycling per capita. There were 13 EU Member States with quantities of waste packaging generated exceeding 150 kg per inhabitant in 2019. The quantities of packaging waste generated among EU Member States in 2019 ranged from 74.0 kg per inhabitant in Croatia to 228.0 kg per inhabitant in Ireland, while the quantities of packaging waste recycled ranged from 36.2 kg per inhabitant in Croatia to 155.2 kg per inhabitant in Luxembourg. The simplified supply chains and logistical flows associated with single-use plastics have indeed favored the use of this alternative. However, they stated that reusable alternatives can be more easily implemented in a Business-to-Business (B2B) context than in a Business-to-Consumer (B2C) context, with individual consumers having to change their habits to integrate reverse logistics into their daily lives. Deposit Return Schemes (DRS) can further increase the success and efficiency of reusable packaging systems. These systems add a small fee to the cost of a beverage, which is then returned. The DRS are aimed at raising reuse and recycling return rates for specific packaging, such as beer bottles. At global level, according to estimates provided by Reloop, the median return rate of deposit systems for non-returnable beverage containers is 84%, with peaks as high as 97% in countries such as Germany that have long adopted such solutions. These types of systems have much higher recycling rates than other collection methods because contamination is reduced. DRS already exist in more than 40 countries, among them Europe, the United States, Canada, Australia, and Israel. In the last few years, several other jurisdictions, such as Victoria (Australia), Tasmania (Australia), Slovakia, Portugal, Turkey, Romania, Latvia, New Zeeland, and Scotland have approved legislation to implement DRS by 2023.

Newer European DRS programmed, such as the ones in Estonia (2005) and Lithuania (2016), give producers the choice of selling either reusable or single-use bottles as part of the same system. The implementation of DRS has been shown to enhance the impact of reusable packaging on environment and can be crucial for boosting reuse.

Main elements of reuse systems

DRS schemes, therefore, if applied on a local scale, can be applied to any type of packaging, including those for OFDS. So, if in the previous section we examined how the choice of material plays a key role, and to understand which one is the best, an LCA must be carried out considering the 16 indicators identified and their respective ecological

footprint. In addition to this there are cultural factors, which vary depending on the context in which the project is to be implemented. The implementation of reuse systems may face a few barriers, but it also offers numerous opportunities. First, the introduction of re-use systems creates new job opportunities. As Repp et al., (2021) point out based on data provided by the European Commission on new jobs related to the circular economy, employment in the EU could increase by 37% to 54/ 63 to 91, in re-use and recycling activities (Ereus). These new jobs would also involve acquiring new knowledge and skills, increasing the level of occupational competence and new career development in the community. The main barriers to reuse systems are those that make linear systems easy and convenient for every stakeholder in the value chain. First, single-use packaging is cheap because of low raw material prices, and the reason is that the externalities they are responsible for are not reflected in their price, such as the extended manufacturer's warranty (EPR). This makes it more difficult for reuse systems to prevail, as they have higher initial investments and operational costs (e.g., to buy reusable packaging, set up washing facilities, etc.). Reuse systems also address the challenge of changing the habits and behaviors of users, as they need to perform an additional step and return the packaging after it has been used - high levels of communication and awareness are needed. This can be a major obstacle if many non-standard systems are deployed, as users may find it challenging to deal with several systems. However, in addition to the undoubted environmental benefits demonstrated through the LCA of several previously reported studies, they also play an active role in the transition to a circular economy by lowering the costs of waste management and can be allies for municipalities in combating litter and degradation.

For companies using reusable packaging, this can not only promote cost savings, but can also be a source of profitability if the packaging goes through a high number of use cycles. In addition, companies using this type of packaging are perceived by users as more sustainable, which improves their image and can attract more users. Reusable packaging also offers a better user experience than single-use packaging, as it is of better quality and eliminates the need to dispose of the packaging. Economies of scale and centralized economies are also possible, which may include washing or recovering the packaging at a lower cost and time. Also, if the systems cannot achieve economy of scale, they may not be profitable. In the case of reusable packaging services, the DRS payment is only charged if the packaging is not returned, as the user must download the app and register their own payment method to use the service. If the packaging is returned within the timeframe (usually 14 days), there is no charge.

It should also be added that some services are not free of charge for the consumer, who must pay a small subscription. This solution, however, although it may represent additional income, is not recommended as it may discourage consumers even more than using a DRS. In brief, we can summarize all the elements as follow:

- Packaging design and its material: Regarding the material, it is necessary to make a specific LCA, considering the sixteen indices and the various endogenous and exogenous factors related to the context where the system is to be implemented. Apart from this, the packaging in question must have, if not superior characteristics to disposable packaging, at least the same. These characteristics are undoubtedly proof against leakage of liquids to be transported (better than single-use packaging if possible); a given number of standard sizes and shapes (not many) for as many foods as possible (e.g., soup, pizza, hamburgers); and easily washable, (i.e., with the least elaborate shapes) that is stackable and with sufficient air flow between the packages to avoid mold formation. Packages should also be heat resistant to allow heating and washing at high temperatures, have a separate universal lid (if one of the parts is lost or damaged it must be possible to restore it) and be sturdy. They should also be microwaveable and possibly thermal. In addition, the inclusion of an RFID tag would also be desirable

to be able to identify and classify each individual container by type, number of times it has been used, etc. Packaging should also be adapted for marketing and differentiation purposes, especially in the case of large chains and well-known brands. Standardized in format, packaging could be sorted during washing, grouped, and distributed according to brand. Reusable containers also need to respect national food safety laws and/or international regulations such as HACCP regarding food contact materials, and handling and storing of dirty containers, to be safe for food and beverage consumption. They must be made of materials proven not to release chemicals into the food, even with very hot food. Where possible, the use of recycled materials should be included, although material safety should be considered as the most important aspect.

- The packaging as a service model: Since restaurants are not inclined to take on additional fixed costs, especially in the absence of profit, the system should work on a per-user basis, i.e., you use a container, so you pay, otherwise you don't. This would also make the (often scarce) space in the kitchen more efficient. This would also make the (often scarce) space in the kitchen more efficient. This obviously lightens the load on the restaurant, but it also burdens the business of the reuse system, which cannot count on certain and constant revenues, and therefore if the service is not scaled up, there could be problems of financial solidity. On the other hand, another possible, but not very widespread, model is the periodic supply of a certain number of containers to the restaurant against payment of a kind of subscription. Alternatives with a fixed (low) fee and a variable fee based on the use of the containers are also widespread. In addition, the restaurant is guaranteed an advertising space and its own showcase within the app (if any, but indeed very widespread). In this sense, depending on the alternatives, the containers may or may not be owned by the entity managing the reuse system, rather than by the restaurant.

- Logistics and washing and HACCP regulation: Logistics play a key role in the project. In the case of closed spaces such as schools, campuses, offices, and sports facilities, and at events such as festivals, where consumption takes place on site, it may be easier to implement and manage these types of systems as they simplify return logistics and minimize the impact of transport. In the case of restaurants scattered around a city, it is better to set a day of the week for collection. If the collection is made in a city, it is best to use electric vehicles, or even better, cargo bikes, which are cheaper and have zero environmental impact. In addition to collection, it must be established whether the service, as well as delivering and collecting the packaging, also internalizes the washing activity. This can be either in-house or outsourced to an external partner. Furthermore, it can be either included in the service, done as an additional service, or left directly to the restaurant (easier choice). An app/website owned by the service provider can also be offered to display the network of partner companies and delivery points. Used containers should be collected to be washed as soon as possible to avoid mold, not to take up too much valuable space within the companies and to keep collection volumes low. The distance travelled to collect and clean containers should be minimized through intelligent logistics and planning systems.

- Return incentives: To improve the return rate, a strong local network of accessible return points should be ensured so that it is easier for users to return containers. Automatic return machines or vending machines (e.g., *Tomra*) can improve the user-friendliness of the system, allowing users to return containers at their convenience, after closing time and avoiding queues. Or, as some services do, pick-up at home, or return of the container by the

rider carrying another OFD order. Of course, the need for users to return the packaging enhances the likelihood of a new order and can function as an opportunity to increase user fidelity to a restaurant that participates in this network.

- Marketing approaches: such as discounts, vouchers or rewards should not encourage unnecessary purchases, but instead promote appropriate repetitive use of the system. Furthermore, depending on the context, it should be planned whether to structure the service as a DRS or not, running the risk on the one hand of having a low uptake of the service, and on the other hand a low return rate. Gamification actions can also be considered to increase the re-delivery rate.

- The role of the customer: Users are part of the whole cycle, and as such return containers to a network of local drop-off points set up by the re-use service provider, either directly or indirectly. Apart from the return of the container, depending on the system implemented, some companies also require prewashing or even washing. In extension, reusable packaging will often provide a better food storage option than disposable packaging, so that users can keep and preserve leftovers for a longer time before returning the containers.

Reusable container systems for OFDS in the world

Eighteen of the existing OFDS reusable systems in the world were analyzed. These were categorized by name, by country, by business sector (whether only food or also beverages), packaging material, presence of a DRS, type of business (usage model as service, subscription, or mixed), presence of app and RFID, responsible for washing, drop-off point mechanism, to identify the ideal characteristics to start a similar project.

Name	*Field activity*	*Material*	*Type of business*	*App-RFID*	*Drs*	*Washing*	*Drop-off mechanism*	*Market area*
Vytal	Food	PPL	Use as a service	Yes	Yes	Restaurants	Restaurants	Germany
Bûmerang	Food	PPL	Use as a service	Yes	Yes	Restaurants	Restaurants	Spain (Barcelona)
Dispatch Goods	Food	Stainless-steel	Use as a service	No	Yes	Included	Restaurants; Door collection	USA (San Francisco)
Barepack	Food Beverage	Silicone	Use as a service	Yes	Yes	Restaurants	Restaurants; Door collection	France (Paris) Singapore
GoBox	Food	PPL	Subs and fee for restaurant	Yes	Yes	Included	Restaurants	USA (Portland)
reCIRCLE	Food Beverage	BPT and PPL	Use as a service	No	Yes	Restaurants	Restaurants	Switzerland

CupClub	Food Beverage	PPL	Use as a service	Yes	Yes	Restaurants	Restaurants	UK (London)
ReCup	Food Beverage	PPL	Use as a service	Yes	Yes	Restaurants	Restaurants	Germany
Deliverzero	Food	PPL	Use as a service	No	Yes	Restaurants	Restaurants	USA (New York)
Globelet	Beverage	PPL	Use as a service	Yes	Yes	Included	Events	New Zealand Australia. USA
Reusebol	Food	PPL	Subs for restaurants	Yes	Yes	Restaurants	Restaurants	Spain (Barcelona)
CanCan	Beverage	PPL	Subs for restaurants	Yes	Yes	Restaurants	Restaurants	UK (Bristol)
Cupkita	Beverage	Stainless-steel	Use as a service	Yes	Yes	Restaurants	Restaurants	Indonesia
AgainAgain	Food Beverage	Stainless-steel	Use as a service	Yes	Yes	Restaurants	Restaurants	New Zealand
Rebowl	Food	PPL	Use as a service	No	Yes	Restaurants	Restaurants	Germany
CauliBox	Food	PPL	Use as a service	Yes	Yes	Restaurants	Restaurants	UK (London)
Hui Zero Hawaii	Food	Stainless-Steel	Use as a service	Yes	Yes	Restaurants	Restaurants	Hawaii (USA)
GreentoGo	Food	PPL	Use as a service	Yes	Yes	Restaurants	Restaurants	UK (Durham)

Table 1: Comparison between eighteen reusable container system around the world

Out of the 18 services examined, there are many similarities. According to the analysis, the most used material is PPL, with 13 services choosing this material, followed by steel with four solutions, and only one opting for silicone. There is also a large presence of Apps and RFID, which facilitate better use and logistics of the containers. The predominant type of business is also confirmed to be that of use as a service, with some services (2) also opting to charge the user. Finally, most of the methods of container delivery are carried out at participating restaurants, with some exceptions (2) which also offer door collection. Washing is also outsourced to the restaurant, as it is easier to manage and less responsible (only 3 out of 18 services include washing).

Tondo Project

The reasons for considering the Tondo project in the historic center of Bologna are mainly to be found in a more advantageous analysis of the sample, logistical reasons aimed at recovering reusable packaging, and therefore a consequent reduction in costs and time, the high percentage of restaurants in the historic center, which has a higher percentage when compared to the semi-periphery, a higher number of customers due to the presence of several university faculties. In addition, the historical center has the typical characteristics of a medieval center, with the presence of squares and historical meeting points, which can be found in other towns of the same type.

Bologna and the context of the project

The city center is traditionally divided into four areas, Malpighi, Marconi, Galvani and Irnerio, whose inhabitants are respectively reported according to the data provided by the registry of the Municipality of Bologna for the year 2021.

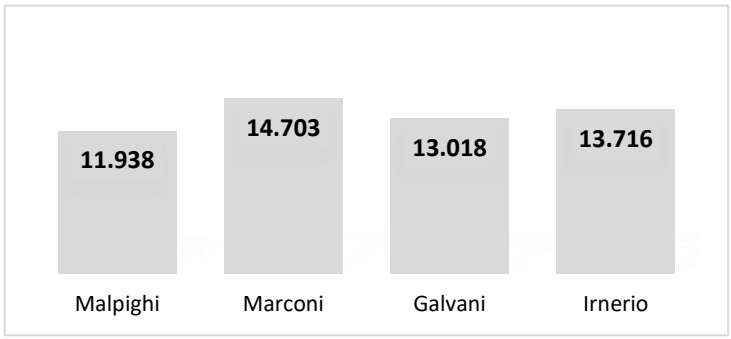
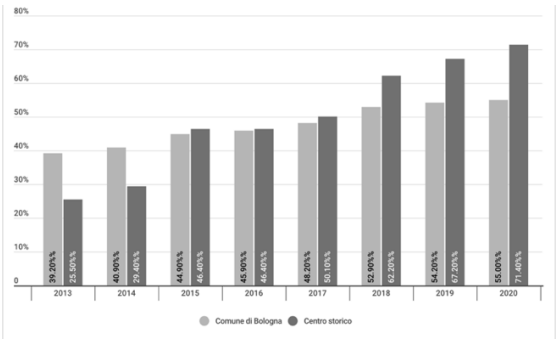
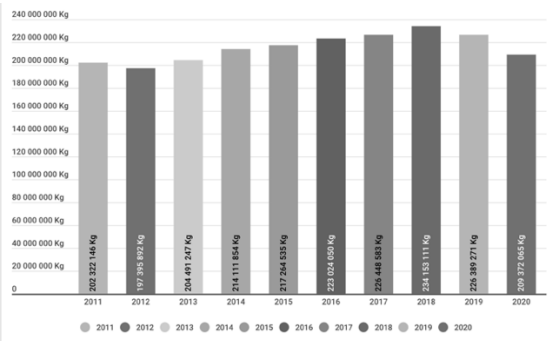


Figure 3: Resident population in the historic center of Bologna by traditional zone in 2020.

As far as the economy is concerned, Bologna has an important network of mechanical, electronic and food industries and many craft enterprises. The metropolitan city hosts proportionally the highest number of enterprises per inhabitants in Italy. Regarding waste collection, there are different methods, depending on the area.



Graph 2: Difference between separate collection in the historic center and in the municipality of Bologna (Comune di Bologna)



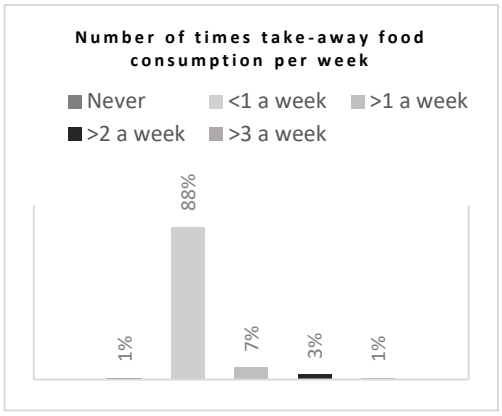
Graph 3: Production of urban waste per year 2011-2020. (Comune di Bologna)

As a result of the innovations introduced in recent years, both in the suburban area and in the historic center, at the end of December 2020 the percentage of separate waste collection achieved in Bologna reached 55%, compared to 39% in 2013. The radical transformation of the waste collection system in the historic center, with the launch of small underground collection islands for organic waste, glass and cans and door-to-door collection of paper, plastic, and undifferentiated waste, has made a significant contribution to the increase in separate waste collection. The change in the collection system, which began in 2015 and ended in March 2018, has increased the collection rate from 22% to over 60%.

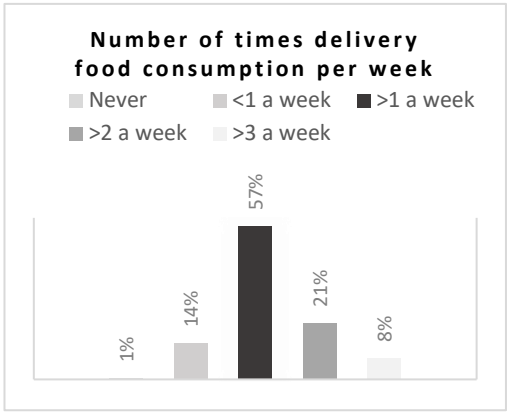
The survey results for the historic center

To obtain practical feedback on the feasibility of the project, through a direct relationship with the citizens, it was created and then distributed a short survey to a wide range of people. After identifying the potential criticalities of the project, referring to a system of established habits, which make practicality and simplicity the main point, the purpose of the questionnaire was precisely to have feedback from the people involved.

A total of 243 people living in Bologna took part in the survey, but only 224 of them were selected as living in the center of Bologna. Although this was not the initial target, it was a good starting point, which provided the possibility for an initial analysis, which could then be taken up again later and extended to citizens living outside the historic center. The survey, which is available in the appendix, was structured in three parts. In the first part the aim was to get an overview of the generalities of the citizens, in the second part what their reaction would be to the introduction of a project like Tondo. In the first part the aim was to have a framework of the respondents' age, their profession, where they live, and how long they have been in Bologna. In the second part, the aim was to outline the habits of the participating citizens regarding their consumption of take-away and delivery food, and their preferences in this regard, to understand which types of restaurants to involve in the project. In the third and last part of the survey, a brief description of the project and what it consists of was given, asking the citizens directly for their opinion, and trying to understand how sensitive they are to the issue of sustainability in the field of waste. The 83% of the participants are under 39 years old, only 9,4% are between 40 and 49 years old and the remaining part, corresponding to 7,6% of the sample is over 50 years old. 75% of the sample belonged to the student category (not better specified, if they belonged to compulsory school, university, or post-graduate studies), the 8.3% belonged to the category of self-employed, less than 12.7% to employees, but more than 4% to the category of not working. The dominant percentage on the start of residence in Bologna is 88% of the participants, followed by 7% who have resided in Bologna for a period between 3 and 4 years, 3% for a period between 1 and 2 years, and 2% who have resided there for less than a year. Within the historical center, the percentage of residents in the various areas and participants in the survey is basically equally distributed. One per cent of respondents stated that they had never personally gone to the premises to collect take-away food, 78% did so less than once a week, 7% at least once a week, while 3% said they did so more than once a week and 1% more than three times in a 7-day period.



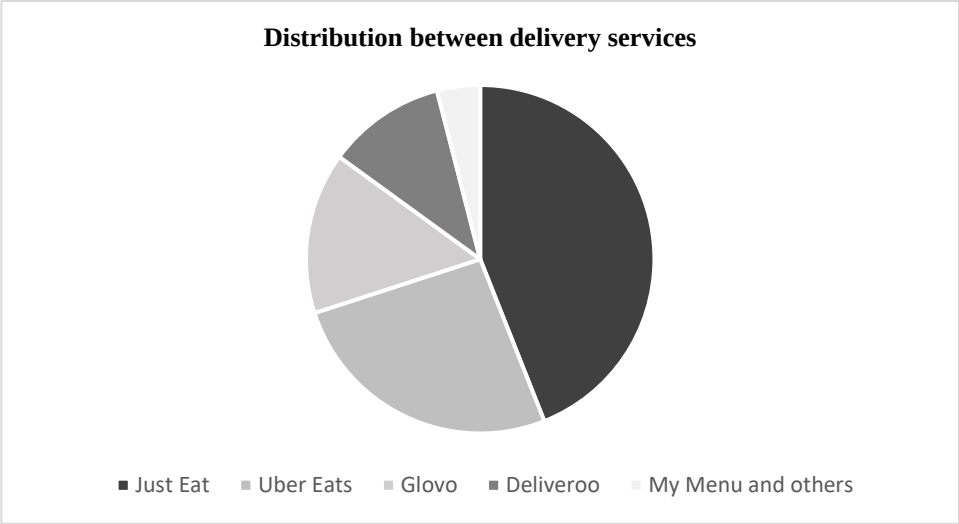
Graph 4: number of times take-away food consumption per week



Graph 5: *number of times delivery food consumption per week*

There are different numbers regarding the habit of consuming food ordered by delivery. 0.5% said they had never used a delivery service, 13.5% used the service less than once a week, 57% at least once a week, while 21% and 8% respectively ordered food by delivery at least twice a week or even three times a week.

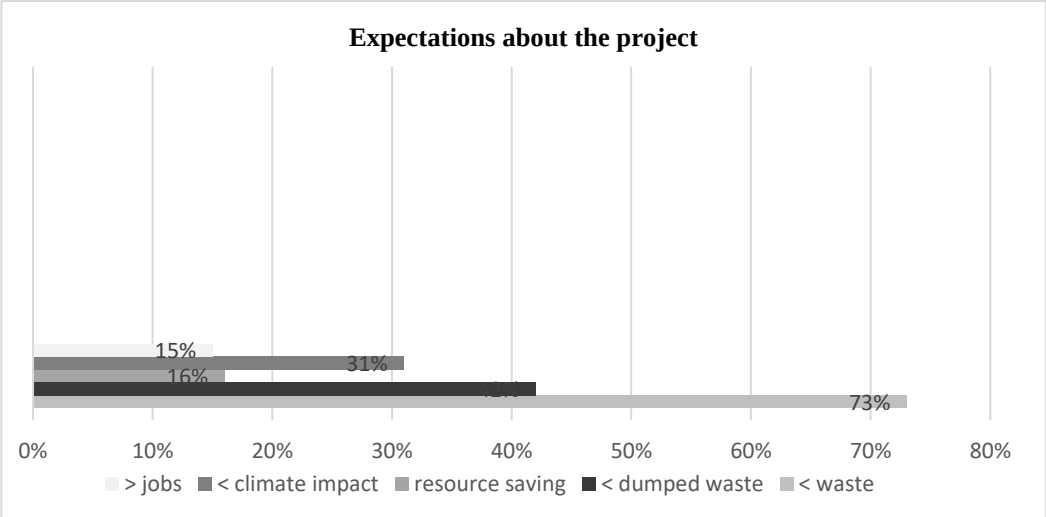
Regarding the delivery platforms most used, which have recently also introduced the possibility of ordering takeaway, but without telephone contact, 44% of respondents use the Just Eat service, 26% Uber Eats, 15% Glovo, 11% Deliveroo, 4% My Menu, and the remainder other modes.



Graph 6: Distribution between delivery services

The survey also analyzed the type of cuisine preferred by the participants to identify the implementation of containers that best suit these preferences. This resulted in heterogeneous preferences, with 42%, a relative majority, ordering pizza, 11% of participants usually ordering hamburgers, 5% Japanese, 8% Chinese food, 6% Kebab and the like, 3% poke, 3% Greek, 7% Italian, 2% and 1% vegetarian and vegan, 7% Korean, Indian, etc., respectively, and the remaining 5% indicating other. In terms of orders, 44% order for themselves, 27% for their family, 4% for their flat mates, 3% for their colleagues, and the remaining 22% order for their partner.

The third section then briefly outlined the project and surveyed the potential perception of users and their degree of sensitivity to sustainability issues. From the sample analyzed it emerges that no individual declares that sustainability is "not very important" in their lives, on a scale where 1 indicates "not at all" and 5 "absolutely", with 5%, 17%, 57% and 21% respectively giving a score of 2, 3, 4 and 5 to the importance of sustainability in their lives. In addition, 93% of the sample stated that they correctly sort disposable containers once they have been used, with only 23% of the sample stating that they had heard of reusable packaging systems. An interesting picture emerges from the final questions of the survey. 73% of the sample surveyed said they would be prepared to use a system like Tondo. If, in addition, it was guaranteed that the containers could also be collected at home, the percentage interested in the service would increase by 11 percentage points to 84% of the sample surveyed. Finally, the citizens were asked about their expectations following the possible introduction of a system like Tondo, with the respective percentages shown in the graph below. Citizens, overall, would like to see a decrease in waste (73%) and abandoned waste (42%), savings in resources (16%), a decrease in climate impact (31%) and the creation of new jobs (15%).



Graph 7: Expectations about the project

The responses provided partly confirmed what was expected, and partly provided the possibility of channeling the project's efforts in one direction rather than another. However, based on the results, the citizenship would be interested in the introduction of such a service.

How it works

Customer chooses the restaurant he wants to order from within the restaurant section, through the app which was developed and that is already available from the stores, depending on the favorite cuisine. In the case of a simple take-away order, all the customers must do is go to the restaurant in person and order the food, showing his Qr Code to the restaurant, which will scan it. From that moment on, you will then have 7/14 days to return the borrowed container to one of the restaurants participating in the service. The restaurants participating in the service are also always visible on the map. The service is completely free of charge for the end customer, who simply enjoy his meal. Only if the packaging is not returned in time will the customer be charged a small commission from their credit card, to cover the non-delivery, but this commission will always be returned in exchange for the packaging. After careful analysis, consideration was also given to the possibility of a scheduled home collection once a week, either by Tondo itself, or in conjunction with a regular delivery service. This could lead to greater take-up of the project. For restaurants, all they must do is to download the app and then register for the service. Once they have downloaded the app, they must log in with the credentials provided by Tondo, and then scan the Qr Code of the customers who take or return the packaging for take away. For delivery, on the other hand, enter the code that the customer has copied into the notes of the delivery service in the appropriate section, and then hand the food in the container to the deliveryman for the drop-off, as is normally done. Once they have received the dirty packaging, all they must do is wash it in the dishwasher so that it is ready to be used again. Each participating restaurant also has a duty to accept containers from other restaurants. Once a week, or when necessary, Tondo will restock the restaurants' containers. This is because Tondo will know how many and which containers the restaurants and customers have in their possession via the existing management system. After a thorough analysis the chosen containers are produced by Mepal, are available in three sizes (500 ml, 750 ml, 1250 ml) and according to Gallego Schmidt et al., (2018) who makes a comparison between packaging materials, are made of polypropylene. In addition, a SWOT analysis was carried out following the introduction of this service, as follows:

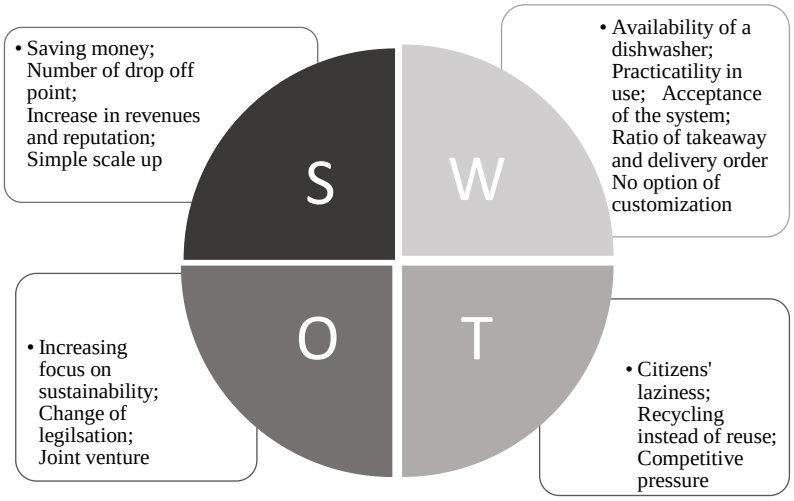


Figure 4: Representation of the SWOT analysis

Economic forecast

To estimate the costs of the hypothetical project, the Net Present Value was calculated. It consists in calculating the net present value of a series of future cash flows by discounting them based on the rate of return (WACC). The *Internal Rate of Return (IRR)* is also calculated to represent the percentage of return on the investment, i.e., the value that sets the NPV at zero. Revenues and expenditures were assumed on a precautionary basis and based on the list prices of the individual items. Data shown in Table 4 (Annex) was calculated basing on the usage and return rates of similar services already existing in Europe, as well as the number of participating restaurants. Under the number of 30 restaurants, or with an allocation limited to 30 containers per week per restaurant, no profit is generated. A note must be made about the containers. As can be seen in the table showing revenues and costs, the cost of containers is the highest, with an average cost of €4.8. It should be stressed, as has already been done, that the choice of Mepal containers is entirely indicative, based on the standards of other similar services, and on LCAs that would see these as environmentally convenient containers. Ideally, as mentioned above, a local container would be created at an even lower cost. This would cut costs further and increase revenue, with an average cost of € 4.8, the container, according to the product characteristics, can be used between 200 and 300 times, already being more sustainable than a similar disposable container in terms of characteristics after 6 uses. The number of containers was decided since, on average, a restaurant needs to place at least 20 delivery orders per day, totaling 140 per week and around 1.000 per month to generate profits. According to this, from an economic point of view, considering a price of the service for restaurants equal to € 0.25 (a price equal/lower than the disposable alternatives), after only 19 uses there would be a return of the investment, after 200 uses a single container could generate revenues for € 50.00, therefore 10 times more than its cost.

To ease, the revenues were calculated by considering only those from the use of the service, and not by charging revenues for the non-delivery of any containers, the same for costs. Although it would be more economically advantageous for as little packaging to be returned as possible (thus increasing revenue) this would not be within the scope of the project. About expenditures, the costs for advertising and publicizing the service have been assumed to be equal to the reported amount. This was done for several reasons. First, to encourage a conscious use of advertising, which should not be done

through leaflets and brochures, but only through digital means. The same were the considerations for the cargo bike, which would make passers-by aware of the service during its operation. Finally, the other OFDS are not used to advertising themselves except through online ads or TV spots. In addition, an income of an average of € 25.00 per month per restaurant was assumed for advertising via the app, with specific banners and alerts, in accordance with market rates. Advertising by and in cooperation with the municipal administration and other local authorities would also be conceivable. In the data shown in Table 5 it was also assumed that the service would no longer be limited to the city center (as was assumed for the first years) but would also cover the rest of the city such as the peripheral areas, to widen the pool of participating restaurants.

As regards the calculation of the WACC (Weighted Average Cost of Capital), see Table 4 (Annex) no initial debts are assumed and therefore it can be set equal to 0. Consequently, the WACC is equal to the CAPM (Capital Asset Pricing Model). The CAPM is calculated considering a β coefficient (a factor characterizing the Waste Management sector) of 1.02 for environmental and waste activities, a free-risk rate of 0.5%, and a hypothetical expected market return of 10%. The CAPM equation gives a result of 10.16%, equal to the WACC. Thanks to this value it was possible to quantify the NPV of the project and to verify its economic feasibility. The NPV of the project was €174.800,00. The project could, therefore, also achieve profitable results over time, with the possibility of reinvesting and extending the service to other cities as well.

Conclusions

The central role of OFDS has demonstrated the opportunities of this growing sector, but also its limitations and potential economic, social and, not least, environmental problems. It is therefore necessary to regulate this type of service the soon as possible, considering all the potential consequences of inaction: increasing social inequality, worsening health conditions, potential exploitation of workers, new urban settings linked to 'dark kitchens', changes in daily social life, increasing urban waste linked to food packaging, to name but a few. OFDS have been able to respond promptly at a time of global crisis, helping the catering sector and providing a way of escaping from reality for many people. In addition, market potential is being developed that was hitherto only hypothesized, but that must be responsibly addressed in terms of the future and the global challenges that await us. In this sense, the correlation between the increase in food packaging and urban rubbish was highlighted, together with the challenges that the EU and the whole world has set for itself in terms of recycling.

Recycling, in fact, seems to be the preferred option for most countries, which have invested large amounts of public money. In this sense, the role of packaging has gradually evolved over time, until it has become something extremely innovative and complex, no longer a mere object to contain food, but a vehicle for a message, which can also be one of sustainability. When choosing which material to use, it is also essential to make a real comparison between the different alternatives available on the market, starting with a careful LCA and end-of-life analysis.

It would also be necessary to rethink single-use packaging so that its price also reflects the costs of disposal, recycling, or incineration. It is also useful to understand which type of market we want to address when implementing a reuse service, whether B2B or B2C, since as we have seen there are significant and fundamental differences between the two. Cases of virtuous re-use in the world do in fact exist, and they are tangible and manifold. Ways to create local jobs, to involve communities and citizens, to improve one's own locality and consequently the whole world. However, to develop

an effective re-use service, attention must be paid to many aspects, such as the design of the packaging and its material, the introduction of a business centered on the "service model" - you pay for what you use - in order not to add more costs to restaurants and to disincentivize them. It is therefore necessary to think and formulate reverse logistics, considering distances, and therefore HACCP compliance, and therefore washing. Washing can be included in the service, optional, or compulsory for the restaurant itself. In this case, based on the 18 packaging reuse services analyzed around the world, it seems to be the most suitable and widespread choice, as it is simpler, safer, and more economically advantageous. To this it is necessary and possible to add a policy centered on DRS, a phenomenon that is quite widespread among the samples examined, which is carried out through the creation of an app and a small sum that is charged to the customer in case of non-delivery of the container. It is precisely the customer who must be incentivized to return, through multiple drop-off points, and possibly home collection, discounts and vouchers, gamification. In this the customer must be considered as central. OFDS services could benefit in terms of reputation if they decide to cooperate with these re-use services and could thus readily respond to some of their negative environmental externalities.
The aim of this research, besides taking stock of the OFDS sector, was to study the feasibility of the Tondo project within the historical center of Bologna. Since the market analysis and the literature, an attempt was made to create a service that had all these functions and was able to respond in a concrete manner to the city context. In this sense, a prototype App was also developed, already available and functioning, to further underline the feasibility of the project.
The project's feasibility was judged positive by the citizens, according to the survey conducted, in which 224 residents of the historic center took part. In response to this, 73% of those surveyed would be willing to try the service, a percentage that would rise to 84% if home collection of containers were also envisaged. The survey is obviously only a starting point, but it still represents a small sentiment and a small indicator of the city. The various elements required for the investment to operate the service were then outlined, and an economic analysis was carried out using NPV criteria with WACC and IRR. The analysis was positive, and such an investment would not only have environmental benefits but also economic ones. Under the conditions indicated, it would guarantee an NPV of € 174.800,00. About the choice of container and costs, it was emphasized that these represent the largest percentage of incidence, and therefore the ideal solution would be to use a cheaper solution, built ad hoc according to the preferences of restaurants, and at local level. This would make it necessary to expand the project outside the historic center to include the suburbs, and therefore also other cities, generating economies of scale and reducing the amount of waste generated responding positively to the waste hierarchy.

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Annex

IRR	128.22%
NPV	€ 174.800,00

Table 2: value of IRR and NPV

Table 3: value of factors

Factor	*UoM*	*Tot*
Free risk	%	0,5%
β		1,02
Expected return	%	10%
CAPM	%	10.1
WACC	%	10.1

		Years					
DATA	UoM	0	1	2	3	4	5
Revenue per container	€		0,25	0,25	0,25	0,25	0,25
Rate of return	%		80%	85%	90%	95%	97%
Non-return rate	%		20%	15%	10%	5%	3%
Food containers per restaurant	n		30	30	45	60	70
Total container scan/week	n		300	900	2025	4200	7000
Total container scan/month	n		1200	3600	8100	16800	28000
Total restaurants	n		10	30	45	70	100

Table 4: Data used for calculation

Table 5: Total cash flows

REVENUES	*0*	*1*	*2*	*3*	*4*	*5*
Tot container revenues		3600.00	10.800	24.300,00	50.400,00	84.000,00
Total advertising revenue		3000,00	9.000,00	13.500,00	21.000,00	30.000,00
Total revenues		6.600,00	19.800,00	37.800,00	71.400.00	114.000,00
OUTCOMES						
Tot Cost/container	1.440,00	2.880,00	5.400,00	10.440,00	13.440,00	17.000
Cargo bike	2.500,00					
Poster stand	50,00	90,00	75,00	125,00	150,00	200,00
Amministrative exp.		5.000,00	5.000,00	5.000,00	5.000,00	5.000,00
App	2.500,00					
Tot cash flow		(1.370,00)	9.325,00	22.235,00	52.810,00	91.800
Tot investment	6.490,00					
Tot cash flow discounted at IRR	-6.490,00	-600,29	1790,35	1870,55	1946,67	1482,73