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Review

Energy Consumption and Environmental Impact of E-Grocery: A Systematic Literature Review

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Abstract: E-grocery is fast growing worldwide and represents a relevant issue for city logistics. Although in almost all countries the percentage of food e-buyers was lower than those purchasing other commodity categories, due to the pandemic, they have increased significantly in the last two years, with consequences that are difficult to fathom and estimate. This phenomenon therefore deserves more attention, especially with respect to its environmental impact, mostly at the urban scale. This paper presents a systematic literature review (SLR) on how e-grocery impacts the environment through the CO_2 emissions generated and the equivalent energy consumption. The methodology used for the review follows a standard approach, with different combinations of keywords used for the search performed in SCOPUS and the Web of Science databases. Emissions and energy consumption assessments were performed for all of the papers considered. The results point to two different findings: some studies consider online grocery as an environmentally friendly channel, while others note that the energy consumption of this emerging channel is higher than alternative ones. This paper contributes by suggesting future research directions to be explored on the relationship between e-grocery and energy use and provides some reflections that are useful not only to e-grocers and logistics operators, but also to policy makers with an interest in developing sustainable urban plans and promoting less environmentally impacting distributions/configurations of grocery delivery systems within city logistics.

Keywords: e-grocery; energy consumption; environmental impact; city logistics; SLR

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1. Introduction

E-commerce is a fast-growing sector worldwide due to digitalization and new technologies that were experienced by all industries. E-grocery, i.e., buying and selling grocery products online, has known a significant increase since the declaration of COVID-19 as a pandemic [1]. Policy measures were taken to reduce the virus spread, including restrictions on the use of public space and physical distancing [2,3], which impacted people's activity and travel behaviour. There has been a shift from in-store shopping to online shopping [4] and people are less willing to shop in grocery stores when the virus is spreading at an increasing rate [5]. Some have changed their behaviour in response to the restrictive measures, while others are driven by the perception of their own safety [6]. Indeed, according to [7], online grocery shopping is one of the best ways to purchase everyday goods safely. However, the adoption of this shopping channel, even during the pandemic, remains conditioned by certain factors such as, for example: familiarity with the grocery online shopping and travel time to the store [8,9].

Challenges are high for retailers and the question of whether or not to adopt an online channel should no longer be raised. Critical resources such as sophisticated technology platform and strategic networks with competitors are one of the key factors for a successful implementation of a multichannel strategy [10]. In addition, communication strategy and logistic issues are also key drivers towards this digitalization [11], especially due to the high perishability of products in the grocery sector [12]. The omni-channel alternative, despite its wide adoption nowadays, is still difficult to operationalize for companies and is even considered by some researchers as a *utopia* to reach [12]. These difficulties are driven to companies by both the aforementioned internal factors and external ones such as consumer-related issues [12]. One should consider that understanding consumer behaviour is as important as other factors, if not the most important one. Consumer technology acceptance, perceived risk related to online transactions, and perceived difference in delivery time are among the drivers of e-grocery [13,14]. Other elements such as the preference for price, convenience and service are important motives behind the choice to shop online [15,16]. Retailers should also account for their responsible practices and ethical assortments to attract consumers [17].

Efforts to convert offline consumers to online shoppers and the increasing trend of e-grocery adoption imply several changes in mobility within cities. Incentives such as free delivery accelerate an increase in online orders [18], hence resulting in more delivery vehicles travelling a distance. The consequences are difficult to foresee without corporate actions that will help in quantifying the effect on the environment [19,20]. At first glance, one might assume that an increase in the number of deliveries and the traffic generated would thus have a negative impact on the environment. In reality, this consequence depends not only on the degree of efficiency of the delivery round but also on the net impact generated by the modal substitution between the old trip made by the buyer and the new trip—presumably in trip chaining—made by the courier [21,22]. From the public holders' perspective, an early integration of urban freight transport in city planning leads to a more sustainable transport in an urban environment [23]. Last-mile logistics consumes a huge percentage of the energy of the entire distribution channel, especially due to the high density in urbanised areas, which, in fact, stimulates new energy strategies [24], including various delivery alternatives aimed at substantially reducing fuel consumption and impact. In addition to low-emission vehicles [25], active travel could also be a "healthy" solution, using human energy for the last mile delivery [26] and cargo bikes [27]; crowd-shipping could also reduce the number of trips by substituting them for already planned ones [28]. There has also been an increase in other innovative solutions such as parcel lockers [29] or autonomous delivery robots that are not only considered as low carbon technologies but also offer contactless deliveries, which is important during the COVID-19 crisis [30]. In a grocery delivery context, one should not neglect the high energy consumption related to packaging [31] in estimating the whole impact of the online channel.

Despite the importance of assessing the environmental impact of e-grocery as an emerging channel, only a few studies have explored this issue. A quick search on the most known databases (the Web of Science, Scopus, and Google Scholar) also confirms this scarcity [32–37]. The scarcity of literature focusing specifically on the environmental impact of e-grocery is the main reason for the development of this paper. In fact, the present study is a systematic literature review on energy consumption in terms of CO_2 emissions in the e-grocery sector, and thus aims to highlight the environmental impact of e-grocery. The paper also offers a gap analysis and future research agenda to conduct fruitful analyses that deal with online grocery and its environmental impact.

The paper is structured in 4 sections. After this introduction, Section 2 briefly presents the methodology used for conducting the SLR, whose results are presented and discussed in Section 3. Section 4 concludes by providing policy implications and suggestions.

2. Methodology

This section illustrates in detail the process for searching and analysing the relevant contributions on the topic, which is well acknowledged as a "Systematic Literature Review" (SLR).

A systematic review can provide the synthesis of the state of knowledge in a field, from which future research priorities can be identified [38]. It is a well-structured process of systematically locating and collating all of the available information on an effect [39].

Several literature reviews have recently explored online grocery shopping [32–37] or agri-food [40–44] but only a few of them also addressed the sustainability issue as one of the aspects of the food and e-grocery whole sector [36,37,40].

In the present paper, authors conducted an SLR that addresses primary studies on the impact of e-grocery on energy consumption and related emissions. Reviews on the field of e-grocery are scarce and, to the authors' knowledge, this is the first SLR that focuses on the environmental impact of e-grocery.

The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) procedure [45] was adopted in conducting this review. A crucial step in conducting a high-quality literature review is the development of a protocol that defines the various *criteria* a paper will need to go through in order to be included in the review [46]. Hence, the present study defined a clear protocol, as recommended by [47], which is summarized in the following paragraph.

Defining the review goals and the research questions was the first step defined in the protocol. Accordingly, this study will try to answer the following 5 research questions:

Q1: How many studies that quantify the impact on the environment have been published on e-grocery until now?

Q2: What is/are the influencing factor/s of e-grocery on energy consumption and emissions that were confirmed by an important number of researches?

Q3: Do the studies confirm that e-grocery can be a more eco-friendly channel alternative to conventional grocery shopping?

Q4: What are the limitations of the currently published research?

Q5: What are the future research directions for guiding upcoming research in the development of this field?

In order to answer the previous research questions, the first search was conducted in the two well-recognized scientific databases "Web of Science" and "Scopus" that were chosen to ensure the high quality of the peer reviewed papers. The quality assessment of any included study is one of the most important steps in an SLR [47]. To this aim, the following search keywords were used, combined in different sets: E-grocery, online grocery, energy, emissions, environment, and sustainability. The next step was the definition of the inclusion/exclusion *criteria*. In more detail, only research papers in English that were published in scientific journals were included without restrictions on the date of publication or the study design. The database does not include any book chapters, conference papers, thesis, or research papers that were not subject to peer review. Research areas that are clearly not relevant to the study were also excluded, namely: medicine and dentistry; neuroscience, psychology, geography, agriculture and biological sciences, tourism, and computer science. The first selection was based on the inclusion/exclusion *criteria*. The second one was based on abstracts reading and the third one was based on whole paper reading. All the selection steps were done by at least two authors as recommended by the PRISMA procedure, in order to confirm the adequacy of the chosen papers. It is worth noting that snowballing was performed on the last selection of studies. A detailed methodology flowchart is represented in Figure 1. The first result is the scarcity of studies measuring a quantified environmental impact of online groceries channels, which responds to our first research question.

The next stage was the extraction form design that will allow an accurate recording of information from the selected papers. The form includes standard items found in several guides [47,48] along with specific items germane to the present SLR, as shown in Figure 2.

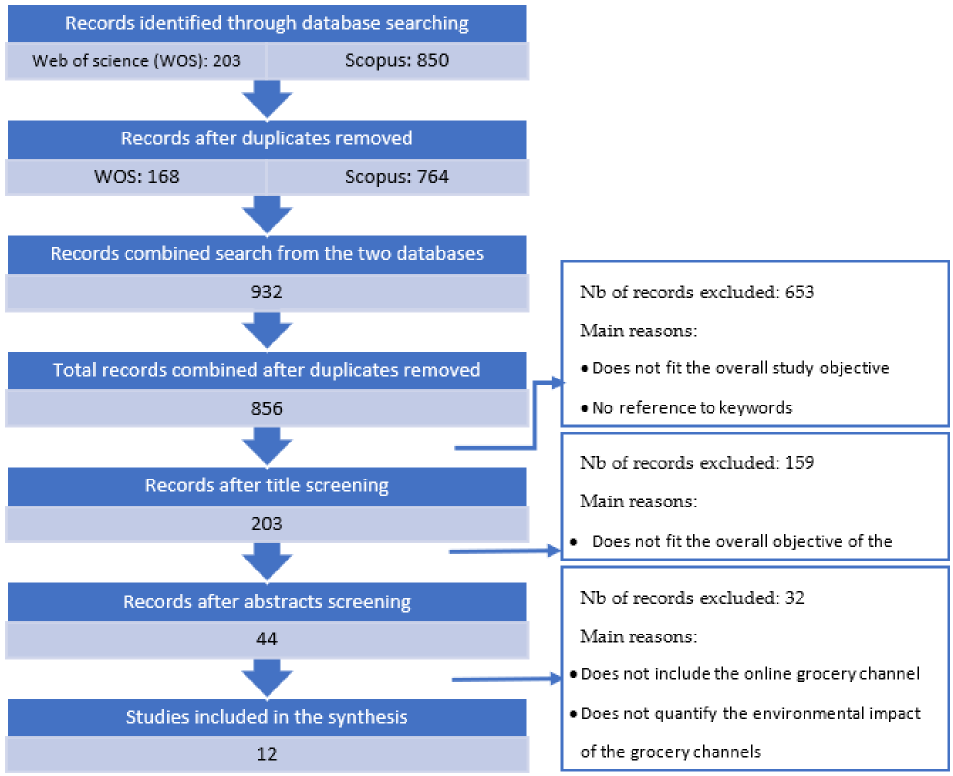

Figure 1. SLR methodology flowchart. Source: Adapted from PRISMA flowchart.

Figure 2. Data extraction form for the SLR. Source: Authors' elaboration.

Specific items are of paramount importance for studies that assess the environmental impact of e-grocery. The item "Actual size of demand/Fluctuation of demand" is crucial for measuring the energy consumption of online grocery. A sensitivity analysis of demand allows taking into consideration different scenarios and measuring the minimum/maximum impact e-grocery can have or not on the environment compared to other channels. Indeed, some unexpected factors such as the recent pandemic could have a great influence on demand, hence on related emissions. The fluctuation of demand is even important during the same crisis era. Consumers are more willing to shop online in periods of high COVID cases, while they are less willing to shop online in periods where the virus is spreading at a decreasing rate [5]. The second specific item, "Additional vs. Substitution demand", evaluates to what extent primary included studies are aware of the importance of the type of demand on emissions. A false identification of demand type leads to a biased estimation of emissions. Confusing the substitution demand with an additional one could lead to underestimating the demand and, consequently, the emissions. The third specific item deals with the "typology of products per channel" while the fourth one is about "shopping frequency". These two elements influence the travel behaviour of consumers when buying groceries. In fact, consumers benefit from online channels especially in buying heavy/bulky products, as it is perceived as one of the conveniences offered by this channel, hence increasing the online demand [49]. On the other hand, fresh produces online demand is low in some countries such as Germany and consumers were reluctant to shop for this product type via the online channel in a pre-pandemic era [11]. Consequently, consumers shifted their travel behaviour towards various channels that offer the opportunity to experience fresh produce quality, thus increasing the travelled distances and emissions. Similarly, perishable products induce more shopping frequency either via online or offline channels and leads to more energy consumption.

3. Results

The present section exposes the main results of this SLR divided in three sub-sections. The first one gives an overview of the number of papers per year and per country as well as of the main channels compared in terms of emissions by the selected papers. The second sub-section discusses the major models and analysis method used by each paper. It also discusses specific factors and the main results relative to each study. The third sub-section provides a summary of the effect of the estimates in terms of emissions and energy consumption to synthesize important findings associated with the environmental impact of e-grocery in its diverse forms.

3.1. Papers Per Year, Country, and Channel

The selected body of literature is focused on quantifying the impact of e-grocery on the environment. Despite not limiting the search on specific years of publication, the results of the selection include only very recent studies. Indeed, 75% of the selected studies are published in the last three years, which highlights the fact that the e-grocery topic is a very recent one and studies that are interested in its environmental impact are barely emergent. Figure 3 shows the distribution of papers per year. The online channel of grocery was discussed through various studies, some of them dating back to the 1990s. However, the recent pandemic has accelerated the trend of buying groceries online. Moreover, with the alarming statistics on global warming, pollution, and the degradation of natural resources, researchers yield more interest on the impact of emerging channels on the environment.

Note: Number of papers in 2022 represents only papers that were published in the first half of the year due to the time of the paper submission.

The online grocery channel was adopted almost worldwide. Shares of e-grocery markets are fragmented through countries with Asian ones as their leaders [50]. The UK is considered to have the third world-leading e-grocery market. It is also one of the countries most interested in e-grocery and its environmental impact according to the results (Figure 4). Three of the selected studies are from Germany despite the fact that it is a small market of online groceries and ranks low on an international scale [11,51]. However, environmental protection and Germany's commitment to it are of great importance [52,53]. Efforts to address greenhouse gas emissions are undertaken worldwide and the USA widely contributes to these actions [54], having well in mind that online grocery in this country is predicted to grab 20% of the total market by 2025 [55].

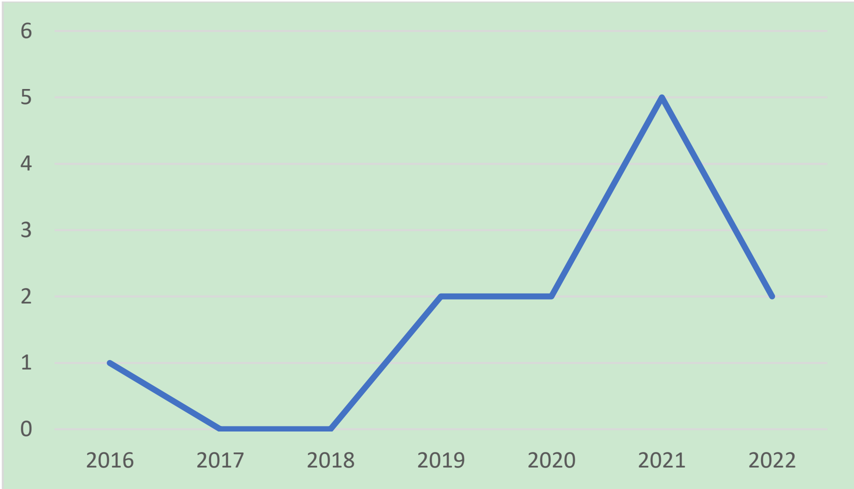

Figure 3. Number of papers per year.

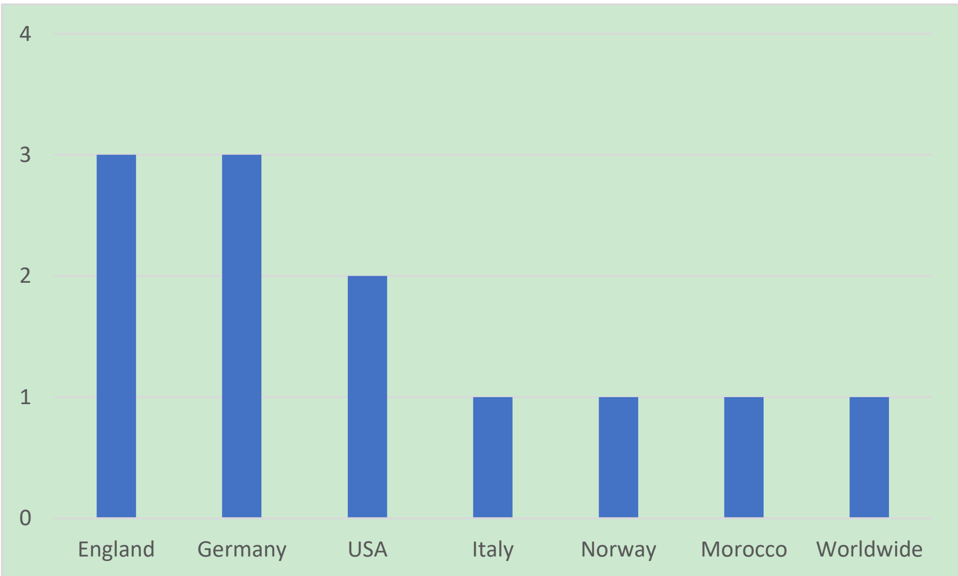

Figure 4. Number of papers per country.

While the offline channel of buying groceries consists of consumers travelling to the physical store of their choice, the online purchase of grocery, in contrast, could generate different delivery options. The studies selected by the present SLR exhibit different types of e-grocery and study their different impact in terms of emissions. Figure 5 shows the various online channels compared and analysed by primary studies. These different channels have different emissions; hence, the interest of analysing various online channels and comparing them to the offline one. Nevertheless, some studies focus on the basic form of the online channel [56] while others make a comparison within online channels only either between the conventional home delivery (HD) and the delivery to lockers [57], or between the HD and the pick-up [58]. These studies offer valuable results regarding online channels emissions and relative energy consumption. However, comparing emissions between the physical grocery retail type and the online one allows grocers to make a choice regarding the development of each form and their environmental implication. A new form of online grocery is to deliver the ingredients of recipes as a way to reduce food waste. The market for online recipe boxes has increased significantly over the past few years due to the convenience of HD and the quality of the produce [59]. These services deliver boxes of pre-portioned ingredients and corresponding recipes directly to consumers, although their energy consumption [60] has yet to be compared to other online/offline forms of grocery shopping.

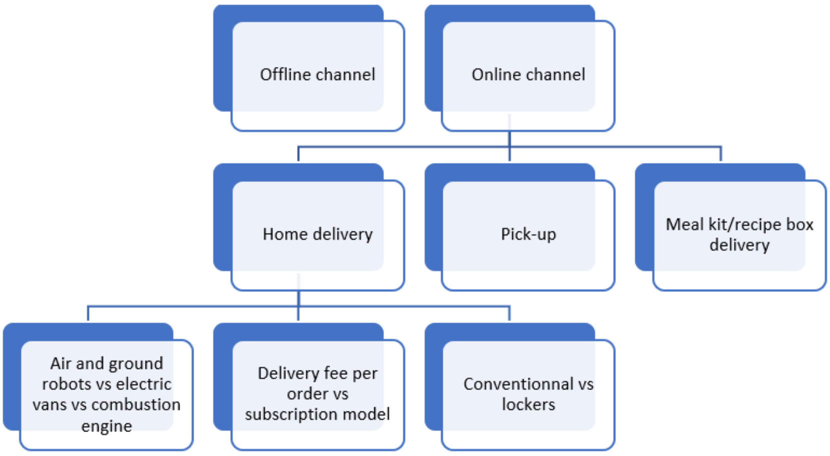

Figure 5. Online channels considered by primary studies.

3.2. Influencing Factors Per Paper

Research papers use a wide variety of methodologies when studying a specific phenomenon. Those that use similar methodologies to analyse the same problem can differ in the included attributes or factors that affect the outcome. To assess the environmental impact of e-grocery, a lot of factors can be taken into consideration and the studies can be conducted from different perspectives. To answer the second research question, the following synthesis illustrates the main influencing factors e-grocery deliveries have on both energy consumption and emissions. First, the share of online grocery vs. the offline one plays a role in the amount of generated emissions due to the travelled distances, mode of transport, energy waste, etc. The choice made by a consumer among the available alternatives to shop for their groceries depends on lots of attributes. Studies grounded on the Theory of Planned Behaviour (TPB) and the Technology Acceptance model (TAM) rely on factors such as social and personal norms, consumer attitude (which is evaluated based on perceived benefits), perceived costs/risks and positive/negative effects, and the dynamic factor of knowledge/experience [61]. An important body of literature considers price to be an important factor that drives the consumer purchase channel [17,62,63]. Product assortment can be a barrier towards the adoption of online channels [64,65]. The typology of products is one of the most influencing factors and product characteristics plays an important role across channels [66]. Heavy/bulky product categories attract more consumers to shop for them online because of the HD comfort and convenience [49,67], while fresh and sensory products, also referred to as "experience" goods, belong more to offline purchases [17,68]. Moreover, shopping frequency influences directly generated emissions either by HD, since it increases the number of deliveries, or by consumers travelling to stores, in case of offline purchases or, to a lesser extent, pick-up ones. Additionally, the substitution demand between online and offline channels is different from the additional one. Indeed, if online demand comes as a substitution to the offline one, it could only mean that the proportion of offline orders replaced by online ones will benefit from reduced emissions due to the delivery consolidation made by the couriers. On the other hand, if the demand is additional but is considered as a substitution one, the study may miss an important part of the travels that generate emissions and energy waste. Third, accounting for future demand, and comparing it to an actual one through a sensitivity analysis, provide valuable insights not only for grocers but also for urban planners. Grocers need decision support tools to better manage their channels' strategy and relative effects, but also to choose between the various modes of delivery to cope with the environmental regulations imposed by their governments. Urban planners aim at maintaining a manageable mobility that minimise its impact on the environment.

Table 1 represents to what extent selected papers take into account the pre-cited elements. The above-mentioned results indicate that the majority of the studies (more than 75% of the selected papers) do not take into account shopping frequency and products category, which are one of the key elements that have an influence on emissions. Moreover, 9 out of 12 papers consider the substitution effect between the offline demand and the online one, which can be a misleading path towards emissions estimations. Future research on the environmental assessment of online grocery should be careful when adopting such assumptions. A significant fact highlighted by the present SLR is that almost 60% of the studies, while providing results about the actual size of demand, conducted a sensitivity analysis that is meaningful regarding various factors. Indeed, special and different factors from the usual ones in the literature are considered by [69] who analyse scenarios while taking into account cooling during making deliveries in various air temperatures. New delivery technologies play a key role in future deliveries. While packaging was underestimated by some e-grocery research, Refs. [59,60] highlight the fact that it can be an important source of energy use that may classify the new meal kit/recipe boxes as energy intensive compared to conventional HD.

Table 1. Influencing factors.

Authors	Article Title	Actual Size of Demand/Fluctuation of Demand	Additional vs. Substitution Demand	Typology of Products	Shopping Frequency	Other Influencing Factors
[56]	Sustainable by Design: Choice Architecture and the Carbon Footprint of Grocery Shopping	Demand not taken into account/No sensitivity analysis conducted	No comparison of online and offline	Not taken into consideration	Not taken into consideration	Moral goal priming/Bonus-malus carbon tax
[60]	Deliver Me from food waste: Model framework for comparing the energy use of meal-kit delivery and groceries	Actual size of demand/No sensitivity analysis conducted	Substitution demand	Not taken into consideration	Not taken into consideration	Packaging
[59]	Evaluating the carbon emissions of alternative food provision systems: A comparative analysis of recipe box and supermarket equivalents	Demand not taken into account/sensitivity analysis conducted regarding different values of food loss/waste for each ingredient and relevant packaging materials	Substitution demand	Not taken into consideration	Not taken into consideration	Cooking and packaging related emissions
[58]	Grocery Delivery or Customer Pickup-Influences on Energy Consumption and CO_2 Emissions in Munich	Study based on fluctuation of demand	Substitution demand	Not taken into consideration	Not taken into consideration	Combustion engine vs. electric vehicles
[69]	Cool but dirty food?—Estimating the impact of grocery home delivery on transport and CO_2 emissions including cooling	Study based on fluctuation of demand	Substitution demand	Not taken into consideration	Partially taken into consideration	Cooling while delivering groceries/Different air temperature
[70]	Carbon emissions reductions in last mile and grocery deliveries utilizing air and ground autonomous vehicles	Calculations based on approximation/Sensitivity analysis conducted regarding other factors	No specification	Not taken into consideration	Not taken into consideration	Delivery service area, Service area to depot distance, Time to deliver, Nb customers, Customer travelled distance
[71]	E-grocery: comparing the environmental impacts of the online and offline purchasing processes	Actual size of demand taken into account/Sensitivity analysis conducted regarding travelled distances and basket size	No specification	Not taken into consideration	Not taken into consideration	All phases: replenishment, pre-sale and sale, picking/assembly, delivery and post-sale.
[57]	Shortening the Last Mile in Urban Areas: Optimizing a Smart Logistics Concept for E-Grocery Operations	Actual size of demand taken into account/Sensitivity analysis conducted	Substitution demand	Three product types (frozen, refrigerated, and dry products) discussed	Not taken into consideration	Delivery by electric cargo bicycles (ECBs); Grocery lockers locations
[72]	Online Grocery Retail: Revenue Models and Environmental Impact	Actual size of demand taken into account/Sensitivity analysis regarding demand vs. CO_2 emissions was conducted	Partial substitution	Perishable products discussed	Taken into consideration	Subscription delivery model vs. per order one revenue model

Table 1. *Cont.*

Authors	Article Title	Actual Size of Demand/Fluctuation of Demand	Additional vs. Substitution Demand	Typology of Products	Shopping Frequency	Other Influencing Factors
[73]	Does e-grocery shopping reduce CO_2 emissions for working couples' travel in England?	Actual size of demand taken into account/No sensitivity analysis conducted	Substitution demand	Perishable products discussed	Taken into consideration	Gender
[74]	Bricks or clicks? Consumer channel choice and its transport and environmental implications for the grocery market in Norway	Actual size of demand taken into account/Sensitivity analysis conducted	Substitution demand	Not taken into consideration	Not taken into consideration	Product price, Service cost, Product range, Time window, Lead time, Travel time
[75]	E-grocery behavioural analysis for Sustainable Urban Logistics in Morocco	Actual size of demand taken into account/Sensitivity analysis conducted	Substitution demand	Not taken into consideration	Not taken into consideration	Product price, Service cost, Product range, Time window, Lead time, Travel time

3.3. Emissions and Energy Consumption

Getting an overall effect of a phenomenon as a result of an SLR is one of the target outcomes. However, when study designs are too diverse, alternatives to meta-analysis of the effect estimate are used. In the case of the present SLR, even Synthesis Without Meta-analysis (SWiM) methods, such as calculating the summary statistics of intervention effect estimates or combining *p*-values, are not useful [76,77]. Indeed, selected studies, in addition to the use of several different analysis techniques, compare different channels which makes them too heterogeneous to combine in a SWiM. Ref. [56] only study the online channel in its standard form of HD while Refs. [57,58] compare various online channels. The first one contrasts emissions from standard HD and those of pick-up from lockers or delivery from lockers using electric cargo bicycles (ECB); the second one compares HD with pick-up from physical stores. On the one hand, Ref. [60] assess the emissions of meal kit delivery in contrast to offline grocery shopping. On the other hand, Ref. [59] make a similar comparison but have added the emissions from online HD to the analysis. Other studies make the comparison of emissions between the offline channel and the various online ones differently. Thus, the heterogeneity of study design prompts a discussion of the overall effect of online grocery shopping channels without using a SWiM method.

Ref. [74] found that the total emissions, including the three compared channels emissions, is low for the scenario that offers free delivery. For this scenario, HD emissions are lower than those related to physical stores. This holds true since the market share of HD is about 25% compared to the physical store accounting for 65%, and Click&Pick for 10%. All the compared scenarios have large differences in terms of market shares. Hence, this study cannot offer a direct comparison between the channels for the same market share but rather allow to evaluate how different influencing factors impact the environment. The study conducted by [73] offers a direct comparison between online grocery emissions and offline ones. The results reveal that the reduction in the total CO_2 grocery shopping emissions for households using online grocery varies between 27% for households without a car and 38% for households with a car [73]. Ref. [73] highlights that the reduction is more important in urban areas than in rural ones. Those findings were confirmed by [71] who carried out an analysis of the logistics activities of online and offline channels. Online emissions are lower than offline ones with a highlight on the emissions of the replenishment phase that make the offline negative impact on the environment higher [71]. The savings in emissions are greater with the use of freight electric vehicles and could reach 85% [58]. Overall findings from the literature confirmed lower emissions from HD compared to the offline channel, except when accounting for food cooling during the delivery [69]. When food cooling is included, which is an important influencing factor not accounted for by most of the studies, the total CO_2 emissions are much higher in hot scenarios as refrigerator units increase fuel consumption and, thus, freight transport emissions are moderately higher, by factor two to five, as compared to driving [69].

New concepts are a part of the online grocery channel such as pick-up from lockers, delivery by ECB, delivery by drones and air and ground delivery robots. New research found that the use of lockers offers a great reduction in CO_2 emissions compared to HD, especially if it is used within an optimization approach of the locker's locations [57]. Overall, the new delivery technologies are proven to be more energy efficient than the combustion engine vehicles or offline shopping channel, with customers using standard combustion vehicles [70]. According to [70], a lot of factors such as service area, delivery time duration, or depot to service area distance, make each of the alternative delivery vehicles more energy efficient than the others in turn. However, pick-up can become more environmentally friendly when a customer is ordering a few items and driving a Tesla TM3 [70]. Results can be improved for HD if a subscription model is adopted instead of a payment of delivery fees for each order. In fact, emissions under the subscription model are lower than those under the per-order model [72]. The overall effect of the use of online channels shows a reduction in emissions and energy consumption compared to the offline channel. Thus, the various online channels should be encouraged to promote an environmentally friendly way of buying groceries. E-grocery players should only use different new technologies and channels to have a greater decrease in noxious gases.

3.4. Gaps Analysis and Future Research Agenda

Gaps identification and analysis are the most valuable outcomes of an SLR as it prepares the way towards the construction of the future research agenda. In the next subsections, the paper answers the two last research questions by, first, revealing the relevant gaps characterising the current literature and, based on that, proposing a future research agenda.

a. Gaps analysis

The major gaps highlighted by most of the quantitative research are the lack of data and the limited sample size. Among the twelve selected primary studies, only four of them rely on quantitative data to construct their main model. Indeed, Ref. [75] constructed a MultiNomial Logit (MNL) model based on the stated preferences survey and choice experiments. They also revealed the difficulty to obtain a large sample size and a lack of data regarding vehicle characteristics to better estimate related emissions. Ref. [74], who used a latent class model as their main analysis technique, also pointed at the small size of the sample and missing data regarding some of the parameters used in the model. Other studies also discussed missing data as their main limitation [60].

Limiting assumptions leads to several gaps in research, although one cannot find complete models that mimic exactly the reality and would have been complex to handle in both their resolution and application. Indeed, studies divide the model into sub-problems that are manageable when searching for solutions and reduce, hence, their complexity [57]. However, if some of the limiting assumptions were relaxed, models could have led to better solutions. Half of the analysed studies reveal several binding assumptions. In fact, Ref. [69] only consider that deliveries are point of sale based, which is not the usual case and does not consider any optimization in the delivery process. The same paper assumes some specific ambient temperatures and substitution rates that could not be the normal situation. On the contrary, Ref. [71] assume that deliveries and online orders in general are fulfilled by a dedicated warehouse. Neither the assumptions of [69], nor of [71], are the most widespread online strategies. Companies, specifically multichannel ones, use a combination of both strategies to cope with customer demand. The last-mentioned study discusses the partial variability of their data, which impacts the flexibility of the model application. Dividing the problem into sub-parts also influences its application and makes it, in the case of [57], only fitted to medium sized cities. Other limitations relate to the analysis of emissions for only a part of the supply chain [59], or to chained trips that are not taken into consideration [58]. Competition could generate additional cost for grocery companies if the customer is converted to the competitor store, whether online or offline. [72] accounts for this aspect by addressing the competition between online and offline grocers, however they did not study the competition among online grocers only.

Other limitations were detected during the analysis of the factors that are specific to studies that assess the environmental impact of e-grocery. The results showed that most of the papers do not consider shopping trips frequency. Shopping frequency is not only related to the customer's satisfaction [78] but influences the entire mobility within a city. Here, accounting for substitution is crucial. The analysis should consider whether the shift to online groceries produces additional demand, therefore increasing the shopping frequencies and consequently increasing mobility due to more delivery trips in addition to customers' trips to physical stores. In the case of substitution, the rate should be meticulously chosen or sensitivity analysis should be conducted for several substitution rate. It should be noted that precise forecasts of the replacement rate are hard to be made for the future, supporting the adoption of sensitivity analysis to gain knowledge on future trips volume and the related emissions.

b. Future research agenda

In the context of an SLR, the studies' limitations construct the path to follow for future research: an in-depth reading of the papers allowed for capturing future research propositions and suggesting other propositions to take into consideration to better assess the environmental impact of e-grocery. Figure 6 represents the future research agenda per study type. Studies are grouped by categories according to major studies and analysed by this SLR. The first group relate to "Quantitative studies" that use quantitative data to build their main model or analysis techniques. Since the outcomes of thess type of studies are based on the sample size, it should be big enough to be representative of the population. Main directives regard the acquisition of complete data either regarding attributes or consumers characteristics and behaviours. The second group is about "Optimization of grocery lockers" studies that focus on the optimization of grocery locker networks and assess their related emissions. Solutions for the optimising problems are mostly based on profit maximization as this is the objective of each company. However, in an environmental assessment context, resolving optimisation problems should also be based on emissions minimization. Researches aimed to improve the study conducted by [57], use a heuristic or metaheuristic approach for the proposed multi-echelon optimization model and refine the mathematical model. The third group assesses and compares the impact of the "meal kit/recipe box" on the environment with regards to other grocery channels. This new type of grocery purchase requires more packaging that can generate important emissions. Hence, accounting for packaging characteristics and household waste will provide better estimates of this channel energy use. Warehouse energy use is also important and should be considered in the analysis. The fourth group includes research that focus on the emissions of the "new grocery delivery technologies", including drones or unmanned aerial vehicles (UAVs), sidewalk autonomous delivery robots (SADRs), and road autonomous delivery robots (RADRs) [70]. Analysing in detail potential externalities and conflicts with pedestrians caused by SADR travel on sidewalks and evaluating the impact of these new vehicles and technologies on parking and kerb utilization, safety, and congestion are important aspects to consider for upcoming studies.

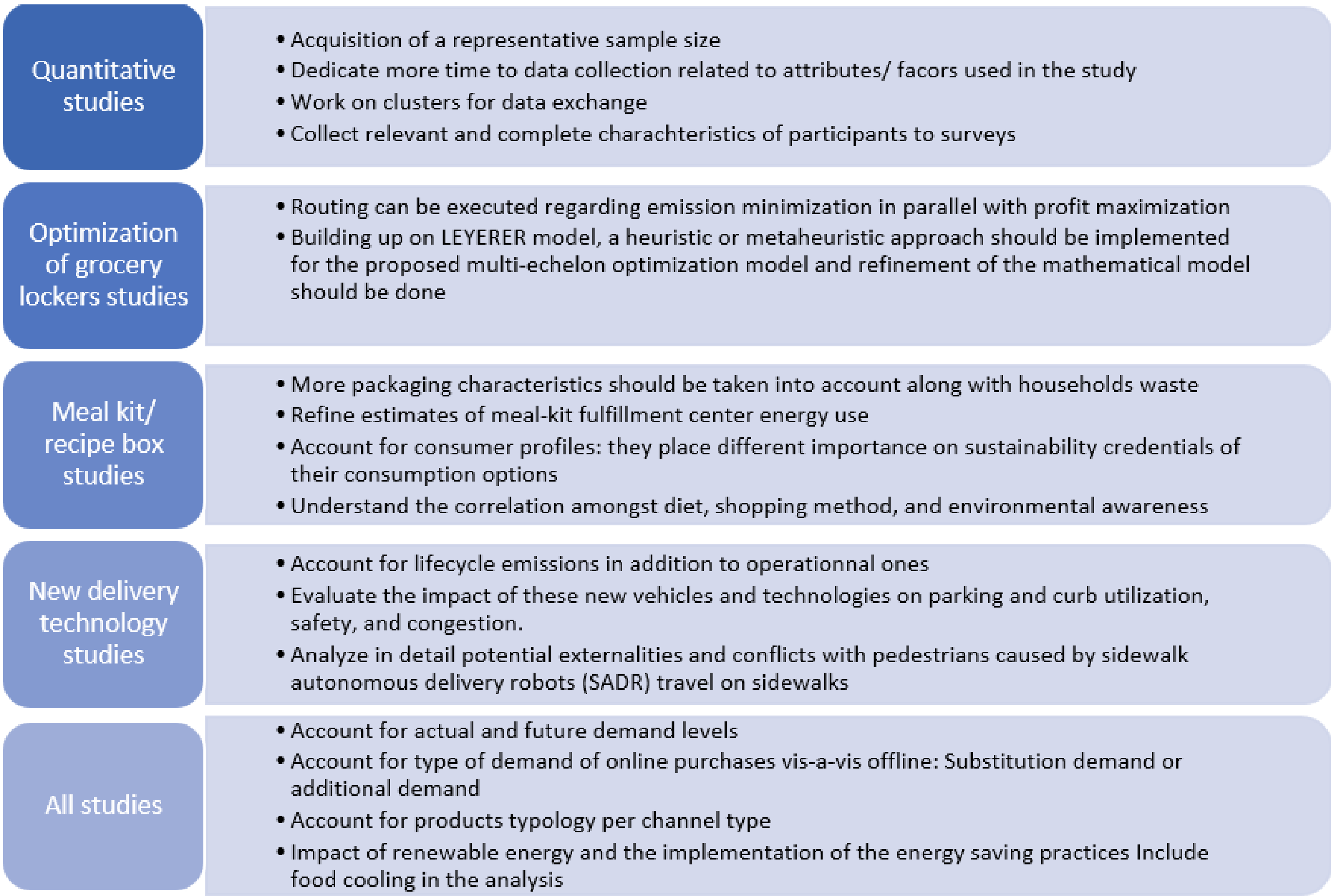

Figure 6. Future research agenda per study type.

Additional suggestions are related to all types of studies with the aim of evaluating energy use and the emissions of online grocery channels. One of these important suggestions for future research concerns the typology of products. It influences delivery freight vehicles chosen for this purpose and, consequently, emissions. In detail, bulky products with a high demand will need bigger vans, while fresh products will need more refrigerated vans. A grocery basket is generally constituted from both fast perishables (yogurts, meat, fish, vegetables, etc.) that need high refrigeration conditions and products that do not need these transportation types. Studies should account for the wasted energy that this last type of product do not need, but also the fact the basket is a variety of products needed to be delivered at the same time. Ref. [69] underlines that the substitution effect of other activities is not considered by studies in the field. This replacement of activities generates emissions that could be higher than travel trips to physical grocery stores. As we underline in the future research agenda, more characteristics of individuals' behaviour should be assessed to gain a realistic knowledge about an activities substitution effect [69].

4. Conclusions

The environmental impact and energy consumption of e-commerce and e-grocery are crucial points for the development of these activities.

More in detail, the paper contributes to the literature by: (1) quantifying the number of articles addressing/investigating the impact e-grocery has on the environment; (2) determining the influencing factors e-grocery deliveries have on both energy consumption and emissions; (3) confirming/rejecting the hypothesis that e-grocery represent an eco-friendly channel with respect to conventional grocery shopping; (4) clearly reporting all the limitations characterizing the current set of published papers; and (5) defining future research paths so to set future endeavours on the correct track for addressing critical/impacting/controversial issues.

The paper explores twelve primary studies dealing with online grocery emissions and energy consumption through an SLR using the PRISMA procedure. The SLR shows the paucity of papers that include and quantify the environmental analysis of online groceries. The analysed papers have a distinct study design and discuss different online channels in a comparative way, either between them or with the offline channel. It is worth noting that most of these studies were conducted in the last few years and mostly in countries where the online channel is highly developed, such as the UK, or in countries that give an importance to environmental issues, even if the online channel is moderately developed. Several factors impinge emissions related to the online grocery channel, such as consumer profiles and the demographic characteristics of individuals that are common to a lot of studies. Other factors such as delivery time, delivery fees, travelling distance, the packaging of meal kits (or recipe boxes), the location of grocery lockers, etc., showed a different energy consumption for diverse channels. However, important issues related to the demand sensitivity over time, shopping frequency, and substitution rate between the online and the offline channel are not always taken into account by the studies, although they can greatly influence the results. However, the main outcome revealed by the present SLR is that the adoption of the online channel, even in a partial way, leads to a decrease in noxious gases emissions and that this reduction can be important as new technologies and optimization models are used, which is in line with other recent reviews [36]. The gap analysis showed the major limitations of the papers analysed, such as the data limitations and the small sample size revealed by the quantitative studies. Other gaps refer to assumptions that help reducing model complexity but ignore some important aspects of the problem to be solved. A future agenda offers new paths for researchers who want to analyse the environmental externalities of online groceries.

As e-grocery is an emerging sector, there is a relatively low number of papers focusing on its environmental impacts. This might represent a limitation of the present paper. Future review papers on this topic could consider also working papers and conference papers to gain more insights into emissions and energy consumption related to online groceries. Additionally, the inability to perform a meta-analysis due to the heterogeneity of the selected studies, and thus to provide a quantitative measure of e-grocery impacts on the environment, represents another limitation.

The outcomes of this SLR are important and have several implications not only for researchers in the field, but also for urban policy makers at large. First, the scarcity of papers focusing on the quantification of the emissions of various online grocery channels and the evaluation of their relative energy consumption should urge researchers to work on the issue. Moreover, with the need for a reliable data and decision support tool, policy makers should encourage this type of research so to develop more sustainable urban mobility plans. Proving the eco-friendliness of online channels may push policy makers to support retailers in adopting these channels and to provide some incentives or tax reductions to stimulate consumers in steering their grocery purchasing behaviour towards sustainable choices. Second, the analysis of the influencing factors that might induce a change in consumers' behaviours, and consequently impact the amount of emissions, is valuable as it suggests new elements to be considered. Third, the results of the gaps analysis highlight important limitations in the current literature. Therefore, new research should focus on these themes to provide solutions in order to overcome the current limitations while producing robust models, analysis, and results.

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References

1. Tomoya Kawasaki, H.W.R.S. The use of e-commerce and the COVID-19 outbreak: A panel data analysis in Japan. *Transp. Policy* **2022**, *115*, 88–100. [CrossRef]
2. Honey-Rosés, J.; Anguelovski, I.; Chireh, V.K.; Daher, C.; Konijnendijk van den Bosch, C.; Litt, J.S.; Mawani, V.; McCall, M.K.; Orellana, A.; Oscilowicz, E.; et al. The impact of COVID-19 on public space: An early review of the emerging questions—Design, perceptions and inequities. *Cities Health* **2020**, *5*, S263–S279. [CrossRef]
3. Migliaccio, M.; Buono, A.; Maltese, I.; Migliaccio, M. The 2020 Italian Spring Lockdown: A Multidisciplinary Analysis over the Milan Urban Area. *World* **2021**, *2*, 391–414. [CrossRef]
4. Shamshiripour, A.; Rahimi, E.; Shabanpour, R.; Mohammadian, A. (Kouros) How is COVID-19 reshaping activity-travel behavior? Evidence from a comprehensive survey in Chicago. *Transp. Res. Interdiscip. Perspect.* **2020**, *7*, 100216. [CrossRef]
5. Grashuis, J.; Skevas, T.; Segovia, M.S. Grocery shopping preferences during the COVID-19 pandemic. *Sustainability* **2020**, *12*, 5369. [CrossRef]
6. Bhaduri, E.; Manoj, B.S.; Wadud, Z.; Goswami, A.K.; Choudhury, C.F. Modelling the effects of COVID-19 on travel mode choice behaviour in India. *Transp. Res. Interdiscip. Perspect.* **2020**, *8*, 100273. [CrossRef]
7. Friesen, C.A. Shopping for Food During COVID-19 Pandemic. *J. Nutr. Educ. Behav.* **2020**, *52*, 1082–1083. [CrossRef]
8. Alaimo, L.S.; Fiore, M.; Galati, A. How the COVID-19 pandemic is changing online food shopping human behaviour in Italy. *Sustainability* **2020**, *12*, 9596. [CrossRef]
9. Chen, J.; Zhang, Y.; Zhu, S.; Liu, L. Does covid-19 affect the behavior of buying fresh food? Evidence from Wuhan, China. *Int. J. Environ. Res. Public Health* **2021**, *18*, 4469. [CrossRef]
10. Agnihotri, A. Can Brick-and-Mortar Retailers Successfully Become Multichannel Retailers? *J. Mark. Channels* **2015**, *22*, 62–73. [CrossRef]
11. Piroth, P.; Rüger-Muck, E.; Bruwer, J. Digitalisation in grocery retailing in Germany: An exploratory study. *Int. Rev. Retail. Distrib. Consum. Res.* **2020**, *30*, 479–497. [CrossRef]
12. Hajdas, M.; Radomska, J.; Silva, S.C. The omni-channel approach: A utopia for companies? *J. Retail. Consum. Serv.* **2022**, *65*, 102131. [CrossRef]
13. Handayani, P.W.; Nurahmawati, R.A.; Pinem, A.A.; Azzahro, F. Switching Intention from Traditional to Online Groceries Using the Moderating Effect of Gender in Indonesia. *J. Food Prod. Mark.* **2020**, *26*, 425–439. [CrossRef]
14. Habib, S.; Hamadneh, N.N. Impact of perceived risk on consumers technology acceptance in online grocery adoption amid covid-19 pandemic. *Sustainability* **2021**, *13*, 10221. [CrossRef]
15. Haridasan, A.C.; Fernando, A.G. Online or in-store: Unravelling consumer's channel choice motives. *J. Res. Interact. Mark.* **2018**, *12*, 215–230. [CrossRef]
16. Frank, D.A.; Peschel, A.O. Sweetening the Deal: The Ingredients that Drive Consumer Adoption of Online Grocery Shopping. *J. Food Prod. Mark.* **2020**, *26*, 535–544. [CrossRef]
17. Cervellon, M.C.; Sylvie, J.; Ngobo, P.V. Shopping orientations as antecedents to channel choice in the French grocery multichannel landscape. *J. Retail. Consum. Serv.* **2015**, *27*, 31–51. [CrossRef]
18. Tsai, C.A.; Chang, C.W. Development of a Partial Shipping Fees Pricing Model to Influence Consumers' Purchase Intention under the COVID-19 Pandemic. *Energies* **2022**, *15*, 1846. [CrossRef]
19. Nowlan, A.; Fine, J.; O'connor, T.; Burget, S. Pollution accounting for corporate actions: Quantifying the air emissions and impacts of transportation system choices case study: Food freight and the grocery industry in los angeles. *Sustainability* **2021**, *13*, 10194. [CrossRef]
20. Marcucci, E.; Gatta, V.; Bråthen, S. E-groceries, digitalization and sustainability. *Res. Transp. Econ.* **2021**, *87*, 101097. [CrossRef]
21. Sernicola, F.; Maltese, I.; Gatta, V.; Iannaccone, G.; Marcucci, E. Impatto del lockdown sulla spesa degli italiani: Quale futuro per l'e-grocery? *Riv. Sci. della Soc. Ital. di Econ. Dei Trasp. E della Logist.* **2020**, *3*, 1–13. Available online: https://www.openstarts.units.it/handle/10077/32169 (accessed on 27 July 2022).
22. Bjørgen, A.; Bjerkan, K.Y.; Hjelkrem, O.A. E-groceries: Sustainable last mile distribution in city planning. *Res. Transp. Econ.* **2021**, *87*, 100805. [CrossRef]
23. Bjørgen, A.; Ryghaug, M. Integration of urban freight transport in city planning: Lesson learned. *Transp. Res. Part D Transp. Environ.* **2022**, *107*, 103310. [CrossRef]
24. Maltese, I.; Mariotti, I.; Boscacci, F. Smart City, Urban Performance and Energy. In *Smart Energy in the Smart City Urban Planning for a Sustainable Future*; Springer: Berlin/Heidelberg, Germany, 2016; pp. 25–42. ISBN 978-3-319-31157-9.

25. Patella, S.M.; Grazieschi, G.; Gatta, V.; Marcucci, E.; Carrese, S. The adoption of green vehicles in last mile logistics: A systematic review. *Sustainability* **2021**, *13*, 6. [CrossRef]
26. Maltese, I.; Gatta, V.; Marcucci, E. Active Travel in Sustainable Urban Mobility Plans. An Italian overview. *Res. Transp. Bus. Manag.* **2021**, *40*, 100621. [CrossRef]
27. Arnold, F.; Cardenas, I.; Sörensen, K.; Dewulf, W. Simulation of B2C e-commerce distribution in Antwerp using cargo bikes and delivery points. *Eur. Transp. Res. Rev.* **2018**, *10*, 2. [CrossRef]
28. Gatta, V.; Marcucci, E.; Nigro, M.; Patella, S.M.; Serafini, S. Public transport-based crowdshipping for sustainable city logistics: Assessing economic and environmental impacts. *Sustainability* **2019**, *11*, 145. [CrossRef]
29. Milewski, D.; Milewska, B. The energy efficiency of the last mile in the E-commerce distribution in the context the COVID-19 pandemic. *Energies* **2021**, *14*, 7836. [CrossRef]
30. Pani, A.; Mishra, S.; Golias, M.; Figliozzi, M. Evaluating Public Acceptance of Autonomous Delivery Robots During COVID-19 Pandemic. *Transp. Res. Part D Transp. Environ.* **2020**, *89*, 102600. [CrossRef]
31. Kochańska, E.; Łukasik, R.M.; Dzikuć, M. New circular challenges in the development of take-away food packaging in the covid-19 period. *Energies* **2021**, *14*, 4705. [CrossRef]
32. Baldev Sandhu, E.A.; Hanus, G. A Systematic Review on Consumer's Behaviour for Online Grocery Shopping. *Irjet* **2016**, *8*, 639–644.
33. Annadate, P.; Mude, G. Online Grocery Industry in India: Identifying Key Themes and Future Directions through a Literature Review. *IIM Kozhikode* **2020**, *4*, 1–4.
34. Prabowo, H. Online Grocery Shopping Adoption: A Systematic Literature Review. In Proceedings of the 2020 International Conference on Information Management and Technology (ICIMTech), Bandung, Indonesia, 13–14 August 2020; pp. 40–45.
35. Hänninen, M.; Kwan, S.K.; Mitronen, L. From the store to omnichannel retail: Looking back over three decades of research. *Int. Rev. Retail. Distrib. Consum. Res.* **2021**, *31*, 1–35. [CrossRef]
36. Lagorio, A.; Pinto, R. Food and grocery retail logistics issues: A systematic literature review. *Res. Transp. Econ.* **2021**, *87*, 100841. [CrossRef]
37. Martín, J.C.; Pagliara, F.; Román, C. The research topics on e-grocery: Trends and existing gaps. *Sustainability* **2019**, *11*, 321. [CrossRef]
38. Page, M.J.; McKenzie, J.E.; Bossuyt, P.M.; Boutron, I.; Hoffmann, T.C.; Mulrow, C.D.; Shamseer, L.; Tetzlaff, J.M.; Akl, E.A.; Brennan, S.E.; et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ* **2021**, *372*, 89. [CrossRef]
39. Davis, J.; Mengersen, K.; Bennett, S.; Mazerolle, L. Viewing systematic reviews and meta-analysis in social research through different lenses. *Springerplus* **2014**, *3*, 511. [CrossRef]
40. Zeng, Y.; Jia, F.; Wan, L.; Guo, H. E-commerce in agri-food sector: A systematic literature review. *Int. Food Agribus. Manag. Rev.* **2017**, *20*, 439–459. [CrossRef]
41. Apostolopoulos, N.; Ratten, V.; Petropoulos, D.; Liargovas, P.; Anastasopoulou, E. Agri-food sector and entrepreneurship during the COVID-19 crisis: A systematic literature review and research agenda. *Strateg. Chang.* **2021**, *30*, 159–167. [CrossRef]
42. Barth, H.; Ulvenblad, P.O.; Ulvenblad, P. Towards a conceptual framework of sustainable business model innovation in the agri-food sector: A systematic literature review. *Sustainability* **2017**, *9*, 1620. [CrossRef]
43. Michel-Villarreal, R.; Hingley, M.; Canavari, M.; Bregoli, I. Sustainability in Alternative Food Networks: A systematic literature review. *Sustainability* **2019**, *11*, 859. [CrossRef]
44. Shroff, A.; Shah, B.J.; Gajjar, H. Online food delivery research: A systematic literature review. *Int. J. Contemp. Hosp. Manag.* **2022**, *34*, 2852–2883. [CrossRef]
45. Page, M.J.; Moher, D.; Bossuyt, P.M.; Boutron, I.; Hoffmann, T.C.; Mulrow, C.D.; Shamseer, L.; Tetzlaff, J.M.; Akl, E.A.; Brennan, S.E.; et al. PRISMA 2020 explanation and elaboration: Updated guidance and exemplars for reporting systematic reviews. *BMJ* **2021**, *372*, n160. [CrossRef]
46. Okoli, C. A guide to conducting a standalone systematic literature review. *Commun. Assoc. Inf. Syst.* **2015**, *37*, 879–910. [CrossRef]
47. Kitchenham, B.; Charters, S. *Guidelines for Performing Systematic Literature Reviews in Software Engineering*; EBSE Technical Report EBSE-2007-01, 2007. Available online: https://www.elsevier.com/__data/promis_misc/525444systematicreviewsguide.pdf (accessed on 27 July 2022).
48. Bandara, W.; Furtmueller, E.; Gorbacheva, E.; Miskon, S.; Beekhuyzen, J. Achieving rigor in literature reviews: Insights from qualitative data analysis and tool-support. *Commun. Assoc. Inf. Syst.* **2015**, *37*, 154–204. [CrossRef]
49. Campo, K.; Breugelmans, E. Buying Groceries in Brick and Click Stores: Category Allocation Decisions and the Moderating Effect of Online Buying Experience. *J. Interact. Mark.* **2015**, *31*, 63–78. [CrossRef]
50. Roger, S. Global E-Commerce Grocery Market Has Grown 15% to 48bn. *Kantar World Panel*. 2016. Available online: https://www.kantarworldpanel.com/global/News/Global-e-commerce-grocery-market-has-grown-15-to-48bn (accessed on 27 July 2022).
51. Seitz, C.; Pokrivčák, J.; Tóth, M.; Plevný, M. Online grocery retailing in Germany: An explorative analysis. *J. Bus. Econ. Manag.* **2017**, *18*, 1243–1263. [CrossRef]
52. National Climate Policy. National Climate Policy. 2017. Available online: https://www.bmuv.de/en/topics/climate-adaptation/climate-protection/national-climate-policy#:~{}:text=Germanyhassetitselfambitioustargetsforreducingemissions%2Cfor,to95percentby2050 (accessed on 27 July 2022).

53. Climate and Energy. Climate and Energy. 2022. Available online: https://www.tatsachen-ueber-deutschland.de/en/climate-and-energy (accessed on 27 July 2022).
54. Wygonik, E.; Goodchild, A. Evaluating the Efficacy of Shared-use Vehicles for Reducing Greenhouse Gas Emissions: A U.S. Case Study of Grocery Delivery. *J. Transp. Res. Forum* **2012**, *51*, 111–126. [CrossRef]
55. Daniels, J. Online Grocery Sales Set to Surge, Grabbing 20 Percent of Market by 2025. 2017. Available online: https://www.cnbc.com/2017/01/30/online-grocery-sales-set-surge-grabbing-20-percent-of-market-by-2025.html (accessed on 27 July 2022).
56. Panzone, L.A.; Ulph, A.; Hilton, D.; Gortemaker, I.; Tajudeen, I.A. Sustainable by Design: Choice Architecture and the Carbon Footprint of Grocery Shopping. *J. Public Policy Mark.* **2021**, *40*, 463–486. [CrossRef]
57. Leyerer, M.; Sonneberg, M.O.; Heumann, M.; Breitner, M.H. Shortening the last mile in urban areas: Optimizing a smart logistics concept for e-grocery operations. *Smart Cities* **2020**, *3*, 585–603. [CrossRef]
58. Hardi, L.; Wagner, U. Grocery delivery or customer pickup-influences on energy consumption and CO2 emissions in Munich. *Sustainability* **2019**, *11*, 641. [CrossRef]
59. Wang, X.; Zhang, S.; Schneider, N. Evaluating the carbon emissions of alternative food provision systems: A comparative analysis of recipe box and supermarket equivalents. *Technol. Forecast. Soc. Chang.* **2021**, *173*, 121099. [CrossRef]
60. Gee, I.M.; Davidson, F.T.; Speetles, B.L.; Webber, M.E. Deliver Me from food waste: Model framework for comparing the energy use of meal-kit delivery and groceries. *J. Clean. Prod.* **2019**, *236*, 117587. [CrossRef]
61. Brand, C.; Schwanen, T.; Anable, J. ' Online Omnivores ' or ' Willing but struggling ' ? Identifying online grocery shopping behavior segments using attitude theory. *J. Retail. Consum. Serv.* **2020**, *57*, 102195. [CrossRef]
62. Blitstein, J.L.; Frentz, F.; Jilcott Pitts, S.B. A Mixed-method Examination of Reported Benefits of Online Grocery Shopping in the United States and Germany: Is Health a Factor? *J. Food Prod. Mark.* **2020**, *26*, 212–224. [CrossRef]
63. Gatta, V.; Marcucci, E.; Maltese, I.; Iannaccone, G.; Fan, J. E-groceries: A channel choice analysis in shanghai. *Sustainability* **2021**, *13*, 3625. [CrossRef]
64. De Magalhães, D.J.A.V. Analysis of critical factors affecting the final decision-making for online grocery shopping. *Res. Transp. Econ.* **2021**, *87*, 101088. [CrossRef]
65. Maltese, I.; Le Pira, M.; Marcucci, E.; Gatta, V.; Evangelinos, C. Grocery or @grocery: A stated preference investigation in Rome and Milan. *Res. Transp. Econ.* **2021**, *87*, 101096. [CrossRef]
66. Chu, J.; Arce-Urriza, M.; Cebollada-Calvo, J.J.; Chintagunta, P.K. An Empirical Analysis of Shopping Behavior Across Online and Offline Channels for Grocery Products: The Moderating Effects of Household and Product Characteristics. *J. Interact. Mark.* **2010**, *24*, 251–268. [CrossRef]
67. Campo, K.; Lamey, L.; Breugelmans, E.; Melis, K. Going Online for Groceries: Drivers of Category-Level Share of Wallet Expansion. *J. Retail.* **2020**, *97*, 154–172. [CrossRef]
68. Chintagunta, P.K.; Chu, J.; Cebollada, J. Quantifying transaction costs in online/off-line grocery channel choice. *Mark. Sci.* **2012**, *31*, 96–114. [CrossRef]
69. Heldt, B.; Matteis, T.; von Schmidt, A.; Heinrichs, M. Cool but dirty food?—Estimating the impact of grocery home delivery on transport and CO2 emissions including cooling. *Res. Transp. Econ.* **2021**, *87*, 100763. [CrossRef]
70. Figliozzi, M.A. Carbon emissions reductions in last mile and grocery deliveries utilizing air and ground autonomous vehicles. *Transp. Res. Part D Transp. Environ.* **2020**, *85*, 102443. [CrossRef]
71. Siragusa, C.; Tumino, A. E-grocery: Comparing the environmental impacts of the online and offline purchasing processes. *Int. J. Logist. Res. Appl.* **2021**, *25*, 1164–1190. [CrossRef]
72. Belavina, E.; Girotra, K.; Kabra, A. Online grocery retail: Revenue models and environmental impact. *Manag. Sci.* **2017**, *63*, 1781–1799. [CrossRef]
73. Motte-Baumvol, B.; Chevallier, L.B.; Bonin, O. Does e-grocery shopping reduce CO2 emissions for working couples' travel in England? *Int. J. Sustain. Transp.* **2022**, 1–12. [CrossRef]
74. Marcucci, E.; Gatta, V.; Le Pira, M.; Chao, T.; Li, S. Bricks or clicks? Consumer channel choice and its transport and environmental implications for the grocery market in Norway. *Cities* **2021**, *110*, 103046. [CrossRef]
75. Aziz, S.; Gatta, V.; Marcucci, E.; Benmoussa, R.; Irhirane, E.H. E-grocery behavioural analysis for Sustainable Urban Logistics in Morocco. *Int. J. Transp. Econ.* **2022**, *XLIX*, 9–32.
76. Campbell, M.; McKenzie, J.E.; Sowden, A.; Katikireddi, S.V.; Brennan, S.E.; Ellis, S.; Hartmann-Boyce, J.; Ryan, R.; Shepperd, S.; Thomas, J.; et al. Synthesis without meta-analysis (SWiM) in systematic reviews: Reporting guideline. *BMJ* **2020**, *368*, l6890. [CrossRef]
77. McKenzie, J.E.; Brennan, S.E. Chapter 12: Synthesizing and Presenting Findings Using Other Methods. *Cochrane Handbook*. 2022. Available online: https://training.cochrane.org/handbook/current/chapter-12 (accessed on 27 July 2022).
78. Mortimer, G.; Mortimer, G.; Fazal, S.; Andrews, L.; Martin, J.; Mortimer, G.; Fazal, S.; Andrews, L.; Martin, J. Online grocery shopping: The impact of shopping frequency on perceived risk. *Int. Rev. Retail. Distrib. Consum. Res.* **2016**, *26*, 202–223. [CrossRef]