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Review

The Social, Economic, and Environmental Impacts of Ridesourcing Services: A Literature Review

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Abstract: The proliferation of ridesourcing services has raised both hopes and concerns about their role in cities. The impacts of ridesourcing services are complex and multi-faceted. Through reviewing the literature, this study aims to identify the social, economic, and environmental impacts of these services and highlight opportunities and challenges that lay ahead of them for resolving issues related to urban transportation. According to the results, ridesourcing services offer safe modes of transport that provide convenient mobility options, improve transit availability in disadvantaged and remote areas, and respond to taxi demand fluctuations. They can create new job opportunities by employing new human resources that have not been used before, provide flexible working hours for drivers, and are more efficient than taxi cabs. These services provide other opportunities to extend or complement public transit, reduce car ownership and congestion, and minimize parking supply. However, they are criticized for unfair competition with traditional taxis, limited compliance with social legislation, and lack of affordability. They are not available in all places and exclude some vulnerable and socially disadvantaged groups. Labor rights are not secure in this industry, and driver income is not stable. Finally, there is also evidence showing that, in some cases, they contribute to the growth of VMT, energy use, greenhouse gas emissions, and congestion in cities.

Keywords: ridesourcing services; TNCs; on-demand services; sustainability; socio-economic impacts; environmental impacts

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1. Introduction

In recent years, a new generation of taxi services called on-demand ridesourcing has begun to emerge, changing the transportation landscape, and seen by some as a panacea to address some transport-related challenges facing society [1]. By applying an algorithm based on pickup and drop-off locations, transportation network companies (TNCs) match passengers who need a ride with self-employed drivers who tend to provide a trip in their privately owned cars [2]. TNCs have expanded their footprint into more cities and are now among the most prosperous and valuable global start-ups [3].

The proliferation of ridesourcing services has attracted considerable attention from scholars in various fields and it has been investigated from different points of view. Social research on ridesourcing has focused on themes such as equity and wellbeing [4,5], discrimination [6], tensions between traditional taxis and TNCs [7,8], safety and security [9,10], and employment rights [11]. Economic research has covered a diverse set of topics, including pricing [12,13], job creation and employment [14,15], competitions between TNCs [16], and efficiency [17].

Many studies have focused on some environmental implications such as vehicle miles traveled (VMT) [18,19], congestion and traffic [14,18,20], carbon emissions [21,22], energy consumption [23], and parking demand [24,25]. In addition to the aforementioned dimensions, some studies have focused on issues related to regulations [26–28]. Some others have endeavored to shed some light on technical and technological aspects, such as the introduction of autonomous and electric vehicles [29–31] and ridesourcing algorithms [32,33]. Nevertheless, the literature on this subject seems fragmented. There is also a limited understanding of the reported effects of on-demand ridesourcing services and the challenges and opportunities that these services present for the future of urban development.

Ridesourcing services have become prevalent in the developed and developing world, evolving from an early niche innovation to a socio-technological system that comprises a large portion of urban trips. In San Francisco, where ridesourcing was first carried out, these systems account for 15% of intercity trips and 20% of the city VMTs. Various studies have attempted to explore the positive and negative influences of this transportation innovation in cities. Since this transport breakthrough can help communities to address a range of social, economic, and environmental issues such as climate change, energy, segregation, and poverty, understanding its effects can provide adequate information to make efficient management and legislation decisions. Therefore, the importance of the topic, as well as the increasing number of papers published since the emergence of ridesourcing in 2012, make it timely to conduct a systematic literature review on the positive and negative impacts of these services on cities and societies.

Several studies, such as Jin et al. [34], Wang and Yang [35], Tirachini [36], have sought to synthesize the dispersed findings of previous ridesourcing studies. These reviews have mainly been on some key issues such as travel behaviors, demand and pricing, platform operational strategies, urban efficiency, substitution for and/or complementing other modes, and traffic externalities. However, all the social, economic, and environmental implications of this service were not thoroughly discussed by these review studies.

Against this background, this review study seeks to provide an overview of the impacts that ridesourcing services have on urban sustainability. The review investigates the effects in terms of social, economic, and environmental dimensions using the triple bottom line (TBL) approach. The justification for applying the TBL to review the impacts of ridesourcing services comes from the fact that these digital platforms have evolved from a niche innovation into a socio-technical system. TNC services make up a significant portion of street traffic. As a result, their contribution to air pollution, carbon emissions, taxi industry, and residents′ access to urban services and functions seems to be significant. TBL opens up possibilities to systematically review the impacts of ridesourcing services on the sustainability of cities. Ridesourcing services appear to have had both positive and negative impacts on the sustainability of urban regions worldwide. Accordingly, the objectives of this study are to systematically review the positive and negative contributions of ridesourcing services to social, economic, and environmental sustainability. The remainder of this paper is organized as follows. Section 2 discusses the methodological approach used to collect and review the literature. Section 3 provides a detailed discussion of how ridesourcing services have impacted cities in terms of social, economic, and environmental dimensions. A summary of significant positive and negative impacts, suggestions for future research, and recommendations to enhance the efficiency of these services comprise this paper′s final section.

2. Research Methods

By on-demand ridesourcing, we mean the services provided by TNCs that make it possible for individuals seeking a ride to use a smartphone app to find someone willing to provide transportation in their car [23,37]. To identify the related literature that should be reviewed, we conducted three literature search rounds in Web of Science and Google Scholar databases. We used the following search string that considers different variants of the ridesourcing services: TS = ("Transportation Network Companies" OR "real-time ridesharing" OR "real-time ride-sharing" OR "parataxis" OR "ride-hailing" OR "ridehailing" OR "on-demand rides" OR "Ridesourcing" OR "ride-sourcing"). Web of Science, a database for archiving peer-reviewed literature, was first used for the literature search. The initial search was conducted in September 2019 and returned 239 articles. The abstracts of these articles were reviewed to select studies that are focused explicitly on the social, economic, and environmental impacts of ridesourcing services. From the results of our search, we excluded those papers that concentrate on the other forms of on-demand services, such as ridesplitting, carpooling, vanpooling, micro-transit, traditional ridesharing, etc. At the end of this screening process, 109 articles were selected for detailed review and content analysis. Another round of the literature search was conducted in March 2020 to include newly published literature. At this stage, 25 more papers were added to the database. Finally, the third round of the literature search was conducted in December 2020. As a result of a careful search in Web of Science and Google Scholar databases, 55 more papers were added.

To delve into the recent academic contributions about the impacts of ridesourcing services, the study applies the triple bottom line concept, which sets society, economy, and environment as three fundamental sustainability dimensions. A Microsoft Excel sheet was developed and related effects mentioned in each paper were noted. These notes were later used for developing the discussions presented in the following section. Based on Table 1, the main part of the evidence discussed in the review belongs to the three resourcing companies, Uber, Didi Chuxing, and Lyft. Note that this table does not include all operating companies across the world. Instead, only those discussed in the reviewed literature are listed here. To see a complete list, we refer the readers to Appendix A. Regarding the location, the majority of studies were conducted in the United States (N = 55.51%) and China (N = 10.19%), and the remaining studies were conducted in the United Kingdom (N = 3.3%), Canada (N = 2.2%), Australia (N = 1.1%), and the Netherlands (N = 1.1%). Moreover, about 22% of the studies did not concentrate on a particular geographic area and focused primarily on enhancing the efficiency of TNC platform through a proposed regulatory framework, matching algorithm, and pricing mechanism. The majority of studies were conducted in large cities and metropolitan areas, whereas the implications of ridesourcing services in towns and rural areas were less covered. This may be related to the fact that ridesourcing services are more prevalent in large cities and metropolitan areas compared with small towns and rural communities [38]. In terms of research design, 76% of studies were quantitative in nature compared to 24% that were qualitative.

Table 1. TNCs discussed and not discussed in the literature.

Part 1: TNCs for which Evidence Has Been Reported in the Literature							
Name	**Country**	**Year Launched**	**Area of Operation**	**Valuation (USD)**	**Number of Users**	**Rides per Day**	**NO. of Times Discussed**
Uber	USA UK Canada Colombia France	2011 2012 2012 2013 2012	600 cities in 65 countries	72 billion	75 million	15 million	34
Didi Chuxing	China	2012	400 Chinese cities and 6 countries	56 billion	550 million	30 million	14
Lyft	USA	2012	300 US cites, 2 Canadian	15 billion	23 million	1 million	10
RideAustin	USA	2016	Austin, Texas	- *	-	-	3
Grab	Thailand Myanmar	2013	Southeast Asia	11 billion	36 million	4 million	2
Sapphire (SAPP)	Iran	2014	More then 170 cities	1.7 billion	30 million		1

Source: Authors based on data provided by Deohans et al. [39]. *-means data is not available.

3. Discussions

This section is divided into several subsections that provide detailed discussions on qualitative and quantitative results. In line with the triple bottom line (TBL) approach that sets society, economy, and environment as three fundamental dimensions of sustainability [40], the impacts of ridesourcing services are presented in three major sections, namely, social, economic, and environmental. In each section, the results are also divided into positive and negative impacts. Positive impacts are explored first, followed by negative ones.

3.1. Social

3.1.1. Positive Social Impacts

Ridesourcing services have addressed many of the taxi industry's previous limitations, brought many positive changes, and considerably promoted the service quality [2,22]. It has been argued that TNCs have provided fast, flexible, and convenient mobility options for individuals seeking fast point-to-point services with short pick-up times while avoiding the difficulties of driving [1,41]. Tarabay and Abou-Zeid [42] show that the short pick-up waiting time and the speed of ridesourcing services are the main reason for between 66% and 72% of people to switch from traditional modes to ridesourcing services in Beirut, Lebanon. However, the research population is limited to university students, and it does not completely reflect the sociodemographic profile of Beirut society.

From spatial, temporal, and social perspectives, these services are also considered an opportunity to improve public transportation availability. From a spatial standpoint, these services can provide satisfactory mobility to poor and remote areas where public transport coverage is inadequate [4,43]. The study of Rayle, Dai, Chan, Cervero, and Shaheen [1] in San Francisco finds that ridesourcing can overcome some of the limitations that exist in mass transit, including trips to or from low-density areas. From the temporal perspective, ridesourcing services can potentially bridge the gaps between peak and non-peak hours, daytime and nighttime, weekends and weekdays, and rainy and sunny days in urban transit networks [44]. Adopting a dynamic pricing mechanism and motivating drivers to work harder during peak hours, TNCs have enhanced mobility and responded to taxi demand fluctuation, especially in the morning and evening peaks [37,45]. Ridesourcing is more readily accessible during late nights when transit is less available and waiting for it might feel unsafe [14,34,46]. Moreover, since mass transit cannot afford to provide service on weekends, ridesourcing can offer a viable option for many travelers, including low-income people and non-car owners [47]. This case is true for rainy hours when the need for door to door mobility services is increased [48]. Brodeur and Nield [49] show that rainy hours are associated with an 18%increase in the number of trips carried out by Lyft and Uber in New York City, indicating the demand for ridesourcing services is significantly correlated with increased rainfall. Ridesourcing services provide social equity benefits by providing increased access to transportation for older adults, particularly those that cannot drive [18]. They can also encourage a car-free lifestyle, reduce car ownership, and offer older adults more freedom of movement so they can rely less on friends or family to meet their needs for transportation [38,50,51].

When it comes to safety and security, TNC users and drivers enjoy a better feeling of safety compared to traditional taxi riders and drivers [34,52]. Indeed, the tracking and rating system embedded in ridesourcing services has increased the safety of both drivers and passengers. Based on Glöss et al. [52], surveys conducted in London and San Francisco showed that riders perceived an increased feeling of safety and reliability due to knowing some information about a driver before starting the trip and monitoring the real-time location of the car during the trip. They add that the registration of riders, ratings, and the online tracking of vehicles provided female drivers with a sense of control and security. Moreover, the digital payment system of ridesourcing services can also prevent drivers from being robbed or harmed [46].

The role of ridesourcing services in fighting against drunk driving is also worth pondering. In some cases, what prompts an individual to drive under the influence of alcohol is the insufficient number of taxis, especially at night, and their relatively high price [53]. Therefore, the convenience and flexibility of ridesourcing services may encourage many people to avoid drunk driving [20]. Several studies support this argument. For instance, supported by Uber, Mothers Against Drunk Driving (MADD) reports that the number of drunk drivers 30 years of age or younger has dropped in all U.S. cities where Uber operates [54]. This argument is also supported by independent studies of Rayle et al. [1] in San Francisco and Clewlow and Mishra [55] in major U.S. metropolitan areas, which show that avoiding drunk driving accounts for 21%, and 33% of people are choosing to substitute driving with ridesourcing services.

Evidence shows that, in some places, the entry of ridesourcing services has also been linked with a reduction in traffic collisions, injuries, and fatalities [53]. Based on U.S. county-level statistics from 2007 to 2015, Dills and Mulholland [56] have found a connection between Uber′s introduction in the U.S. and a reduction in fatal car collisions and violence. Kontou and McDonald [57] report that a 10% rise in the number of trips can contribute to a 12% reduction in traffic accidents and a 0.25% decrease in impaired driving. However, they do not find a significant relationship between the growth of ridesourcing services and road fatalities.

3.1.2. Negative Social Impacts

Previous studies have revealed that the access to, use of, and impact of ridesourcing services have been geographically and socially uneven. This has cast doubt on claims that ridesourcing services can provide an affordable mode of transportation and expand the access to public transit for less affluent people and those living in disadvantaged areas [2,4,34,58]. Geographically, ridesourcing services are used more in urban areas, mid-sized and large cities, and neighborhoods with high-density and mixed land uses [59–61].

Based on evidence from several U.S. cities, Tehran, and Cairo, there is a consensus among researchers that users of ridesourcing services tend to be disproportionately younger, college educated, and more affluent [31,60,62–64]. It is argued that not only are ridesourcing services more expensive than public transit, but their use relies on smartphones and credit cards, imposing financial barriers for low-income people [65–67]. In the U.S., Deka and Fei [68] found that the frequency of using ridesourcing services for people who have an income of over USD 150,000 is 62% more than people who have an income of less than USD 25,000, indicating a gap that exists between low-income and affluent people in using ridesourcing services. It can be postulated that the shift of affluent people from transit to ridesourcing can reduce public support for transit subsidies in the future. As low-income individuals are more reliant on transportation and cannot afford to use ridesourcing, their access to transport will be challenged [68]. This limitation is apparent during transit disruptions when low-income ethnic minorities are less likely to choose ridesourcing as an alternative for public transport for mandatory trips [69].

Several studies have argued that these services have so far failed to include physically disadvantaged people [8,33,70]. Under many laws, this group is generally eligible to use travel facilities and no travelers can be rejected on the grounds of disabilities [33]. TNCs have avoided responsibility to warrant non-discrimination and access for the disabled, arguing they are not transportation providers [3]. Besides, Mitra et al. [38] provide evidence from the U.S. suggesting that, due to physical difficulties and a lack of comfort and familiarity with technology, older adults may remain disconnected from the new transport technology.

While discrimination in traditional taxis and ridesharing services is a central preoccupation for public agencies, the ridesourcing industry has also not been immune [58,71]. The studies of E. Brown [71] in Los Angeles and Ge et al. [72] in Seattle and Boston confirm discrimination against African-American riders. It seems that the design of TNCs′ platform allows drivers and riders to learn mutual characteristics, opening up possibilities for discrimination from drivers to riders and vice versa [71,72].

There is also evidence suggesting that the geographic distribution of ridesourcing services is uneven as there have been differences in the availability of these services in urban and rural areas. According to a Pew Research Center survey, there is an adoption gap between urban and rural residents in the USA. Accordingly, 45% of Americans living in urban areas and 40% of suburban residents use a ridesourcing application, while this number is 19% for their rural counterparts [73]. Several studies suggest that ridesourcing is less readily available in small towns and areas with low population and road and pavement network density [38,68,74,75].

TNCs are also blamed for unfair competition with traditional taxis due to avoiding compliance with social legislation, tax regulation, basic wages, and other legal employment rights [5,76,77]. The growth of TNCs has exerted a very disruptive impact on traditional taxi services, contributing to a decrease in taxi ridership and driver income [78–80] and leading to social tensions between cab drivers and TNCs in many cities [5]. Nie [79] and Jiang and Zhang [8] show that the growth of ridesourcing services has been associated with a significant loss in the taxi ridership in Shenzhen and Beijing. In the same vein, Brodeur and Nield [81] have found that the number of taxi rides fell by 8% in three years from Uber′s introduction in New York. Based on recent evidence in the UK, 52% of cab firms consider Uber a severe or moderate threat and 79% believe that they should join together to effectively compete with Uber.

A group of scholars poses some questions regarding ridesourcing services′ positive role in safety and security. For example, Brazil and Kirk [82] show that the availability of ridesourcing services has no association with the number of traffic fatalities in the U.S. and concluded that one could not claim that TNCs have made American cities safer. They suggest several explanations for this. First, the number of ridesourcing users is relatively small compared to the total population of licensed drivers and drunk drivers. Second, ridesourcing services may substitute taxicabs and other public transit modes, but not as an alternative mode of travel for drunk driving. Therefore, ridesourcing riders may have been former users of taxis and public transportation and, as a result, the number of at-risk drivers on the road would not noticeably change. Third, as mentioned earlier, some social groups, including low-income, less educated, and older people, have remained largely disconnected from ridesourcing services. Therefore, they may be less likely to consider these services as a substitute for drunk driving. Finally, a portion of the population is not yet convinced that ridesourcing services can provide a safer ride when they are impaired by alcohol. Besides, many drunk drivers consider these services too costly, especially when considering the low likelihood of getting arrested for drinking and driving.

Moreover, whereas public transport agencies usually ensure that traditional taxi drivers have a commercial license and require them to obtain special permissions or training, TNCs have lower entry barriers and only check that drivers have a valid license [16,83]. Edelman and Geradin [70] point out that Uber does not comply with the law and its lower entry barriers may give rise to possible safety concerns. Training can prevent taxicabs from some risks that they would otherwise be unaware of, or by notifying them of preventive measures they might not otherwise follow. Additional risks may also impose drivers and passengers due to insurance. As Edelman and Geradin [70] and Malos, Lester, and Virick [84] suggest, in the U.S., Uber encourages drivers to hold personal insurance rather than a commercial one, overlooking the fact that ridesourcing drivers are more likely to have accidents due to driving more frequently, longer distances, with passengers, and often in unfamiliar and congested places while using smartphone applications. Berneking and his colleagues [10] make a similar argument, pointing out that TNCs employ drivers as "independent contractors," do not monitor their work hours and rest opportunities, or check them for medical issues that can reduce alertness. These cases have increased the number of fatigue-related accidents. They also added that working as a TNC driver is not a primary job for many individuals and they usually drive after hours of constant wakefulness or during darkness, both of which can raise the risk of drowsy-driving crashes.

3.2. Economic

3.2.1. Positive Economic Impacts

Past work suggests that ridesourcing services have positively impacted the taxi industry by tapping into a fresh reservoir of the workforce and shaking the foundation of obsolete structures, regulations, and policies that could have been the key cause of inefficiency [35,79]. Traditional taxis were regulated to charge static fares, leading to equal fares during peak and non-peak hours. Therefore, traditional taxi drivers preferred to drive during non-peak hours, contributing to a taxi supply shortage during peak hours. TNCs address this issue by introducing market-rate pricing, popularly known as "surge pricing." They encourage drivers to work harder during peak hours to gain more money, increasing taxi supply through surge pricing during peak times [37]. Moreover, by comparing the fares of ridesourcing services with traditional taxis, some scholars argue that TNCs have provided cheaper trips, made it possible for individuals to save costs (fuel and parking), and increased mode choices [65].

TNCs have also provided job opportunities for individuals suffering from job loss or other career setbacks [80,85,86] by establishing an ecosystem for the immediate entry and involvement in the labor market as a freelancer or individual employer (45). Sui et al. [77] point out that Didi Chuxing has attracted a variety of regular car owners in addition to licensed taxis in China, and allows them to provide private trips in their own time. In a study funded by Uber, the Economic Development Research Group estimated that nearly a quarter (23%) of Uber drivers were unemployed before working as a ridesourcing driver [87]. Therefore, TNC riders are viewed as micro-entrepreneurs and a new generation of self-employed drivers who enjoy flexible working hours, appropriate work-life balance, and a family-friendly lifestyle [85,88].

There is also evidence regarding the positive role of ridesourcing services in the car industry. Evidence from China suggests that the initial entry of Didi Chuxing positively impacted new car sales [89]. However, it is not clear if this is a permanent effect. Similarly, Remy et al. [90] discuss that TNCs facilitate drivers′ access to car lenders and dealers and encourage purchasing new cars to join these platforms rather than reusing existing cars.

3.2.2. Negative Economic Impacts

Although ridesourcing services have created job opportunities for many people, there are concerns about unsecured labor rights, underemployment, and income instability. Labor rights are not secure in the ridesourcing industry and it may shift individuals away from secure employment to unsecured or footloose employment [50]. Moreover, the development of ridesourcing services has pushed many overqualified and educated people into underemployment. This can be due to few entry barriers, coupled with the attractiveness of operating with a technologically advanced platform [84]. Wages also fluctuate in this industry, threatening the income stability of drivers. While drivers cannot easily raise their salaries, TNCs can change their pricing system without seeking the views of drivers [34].

There is also some evidence suggesting that ridesourcing platforms have catered to wealthier people. Due to obstacles, including relatively high costs and the need for a credit card and smartphone, low-income individuals are less able to use ridesourcing [50,91]. Deka and Fei [68] show that the frequency of using ridesourcing services increases with increases in income above USD 50,000 in the U.S. They claimed that while ridesourcing services are cheaper than taxis, these trips tend to be substantially more costly than public transit fares. Notar et al. [92] made a similar argument regarding Uber and Grab drivers in Rangoon, Myanmar. They point out that whereas ridesourcing services have enabled highly skilled and educated people to find a job, people or drivers with fewer resources, such as less education, less literacy, and perhaps no cell phone, will not absorb in this market.

The disruptive impact of ridesourcing services on traditional taxis is reported in several studies [8,81,93]. Evidence in Beijing shows that ridesourcing services contributed to an 18.08% decline in the average passenger delivery trip number per day per taxi and a 19.29% drop in the average daily profit per taxi [8]. A similar point is made by Brodeur and Nield [81], who have found that, after entering Uber into New York City, a decline of around 8% in the number of taxi rides per hour was experienced.

Despite some evidence regarding the positive role of ridesourcing services on the car industry in China by Guo et al. (2018), other studies have yielded conflicting results. Ward et al. [94] showed that following the entry of ridesourcing services, the U.S. metropolitan areas experienced a 3% decrease in per-capita vehicle registrations without any impact on VMT.

3.3. Environmental

3.3.1. Positive Environmental Impacts

Given the considerable number of trips made by ridesourcing services, their role in energy consumption, greenhouse gas emissions, congestion, etc., is not negligible. Previous research shows that these taxis have both positive and negative effects on the environment. When it comes to the positive environmental effects of ridesourcing services, ridesourcing is assumed to be green or environmentally friendly since it can increase the use of pre-existing vehicles and reduce empty drives and idle distances [34].

Comparing the capacity utilization of TNC drivers with traditional taxis, ridesourcing services have a higher capacity utilization and productivity rate [8,95]. In comparing taxi and ridesourcing service quality in Los Angeles, Brown and Lavalle [96] notice that TNC users pay 40% lower fares and wait only one-fifth of the time relative to taxis. Nie [79] also shows that TNCs can increase the taxi capability usage rate in the off-peak times in Shenzhen, China. Similar results were obtained in the major U.S. metropolitan cities by Cramer and Krueger [97], who analyze the capacity utilization of UberX drivers based on time and miles. They found that UberX drivers have a 30% higher time utilization rate and a 50% higher miles utilization rate. They list four factors that may explain this difference. Firstly, TNC drivers make use of a technology that suits driver-passenger more effectively. Second, TNCs have a larger scale than taxi companies, which support faster matches. Third, regulations on traditional taxis are inefficient. Finally, the flexible labor supply model of TNCs and their dynamic pricing more closely match supply with demand throughout the day.

It has been argued that the integration of ridesourcing services and public transport can increase the efficiency of the transportation system by serving a niche demand that public transport does not generally serve well [1,74]. The positive impact of ridesourcing services on public transit is that they can extend or complement public transit [36]. When ridesourcing serves the routes and operates at the times that public transport does not serve well, it complements public transit. Ridesourcing can extend public transit by solving the first and last mile problem created by the fixed route and fixed schedule of public transit [1,20,98]. The results of the study of Zgheib et al. [98] show that the integration of ridesourcing and public transport can increase the overall market share of the Beirut BRT by 2%. They further explored that a 50% reduction in TNCs′ fares can lead to a 3.5% increase in the BRT market share in this city. However, it should be noticed that their model was simple and did not consider correlations across error components.

Moreover, individuals in lower-density urban areas typically suffer from a first and last mile problem due to the comparatively lower transit routes. The potential role that ridesourcing services can play in complementing and expanding public transit has prompted transit agencies and local governments to set up on-demand systems that include a multimodal, integrated, and connected transportation system [99,100]. For example, the U.S. Federal Transit Administration (FTA, Washington, DC, USA) Sandbox Program funded a range of pilot application-based on-demand projects to provide first/last mile connections to fixed route services [101]. In Canada, the Regional Municipality of Waterloo has launched similar pilot projects in Kitchener, Cambridge, and Waterloo to integrate transit fixed routes with ridesourcing services [102].

Some have speculated that the growth of ridesourcing services is an opportunity to reduce car ownership and automobile dependence [25,46]. Some evidence suggests that the entry of ridesourcing services is attributed to a decline in personal car dependence. For instance, after Uber and Lyft left Austin, Texas, Hampshire et al. [103] found that 45% of the TNCs′ users turned to personal cars and 8.9% of this group purchased an additional personal vehicle in response to the suspension. However, it seems that a part of the inclination to personal cars following the disruption may be justified by changes in travel behavior caused by Uber and Lyft operations in the past. The study is also based on the assumption that previous users of Uber and Lyft have switched to a mode of transport, while people may have switched to a mixed use of transport modes.

Some surveys measured the decline in car ownership due to the availability of ridesourcing services. Of the participants in the study of Henao and Marshall [47] in the Denver region, 13% reported that they own fewer vehicles due to the availability of ridesourcing services. They found that restaurants/bars, working trips to the CBD, airport, hotels, and event venues are the most popular locations that people prefer to substitute driving with ridesourcing. Lavieri et al. [47] indicate that 9% of respondents in their study in Austin, Texas, tend to dispose of one or more household cars due to the availability of ridesourcing services.

Ridesourcing services can open a window of opportunity for planners to minimize parking supply, create new land uses, and reduce overall vehicle miles traveled (VMT) [14,20,25]. For many people, parking is the main reason to substitute ridesourcing for personal driving [55]. TNCs can provide a mobility service to and from areas with low parking supply [104] because ridesourcing drivers never have to search for parking. Therefore, they can reduce overall VMT by eliminating wasteful driving, such as the search for parking at the end of trips [23,65]. Henao and Marshall [23] indicate that about 26% of TNC riders would have driven if these services did not exist and needed a parking spot in Denver.

The growth of ridesourcing services can also be a step forward in reducing congestion and energy use in cities [16,46,105]. Erhardt et al. [14], listed several mechanisms where ridesourcing services may reduce congestion. First, if TNCs shared trips based on a ridesplitting behavior, they would replace the trips that could otherwise be in a vehicle with fewer passengers. Second, travelers may use ridesourcing services to address first and last mile connections to regional transportation. As a result, TNCs may allow passengers to replace driving trips with transit. Finally, TNCs can discourage car ownership by offering an appealing alternative to driving. They can lead people to own fewer cars and shift to public transportation or active modes of transport.

Wenzel et al. [23] believe that ridesourcing services can decrease energy use in several ways. First, in the short term, sharing rides with strangers or polling is an opportunity to reduce VMT. It can significantly reduce miles of travel and the energy consumed in several vehicles with fewer occupants. Second, TNC drivers may ignore the initial increase in a more efficient car′s purchase price since the lower fuel costs may offset the cost in the medium run. Finally, in the long term, riders may retire their existing cars to avoid fixed costs for their mobility need and, as a result, may eliminate the trips they made with their vehicle beforehand. Jin et al. [4] further point out that if TNCs exclusively take advantage of electricity powered driverless cars, the prevalence of ridesourcing services could reduce energy use and urban pollution.

Overall, the confirmed positive impact of ridesourcing services is that they are more efficient than traditional taxis. In the reviewed literature, we identified several environmental opportunities, including increasing public transportation efficiency, reducing car ownership, minimizing parking supply, reducing congestion, and energy consumption. However, there is no evidence that these opportunities are yet exploited.

3.3.2. Negative Environmental Impacts

While the environmental merit of ridesharing is well documented [91,106], the environmental influence of ridesourcing is uncertain [107]. Theoretically, TNCs may reduce the overall VMT, congestion, energy consumption, and air pollution by increasing taxis and public transit efficiency. However, there is empirical evidence to reject this idea and characterize these services as detrimental to a city′s sustainable environment, as ridesourcing may add more idle cars to the road and attract some public transit users [1,22].

Some research, including Xu et al. [24], poses some doubts about the positive influence of ridesourcing on the public transportation system. It is argued that some passengers make ridesourcing trips which were previously carried out by transit. Some of the trips are also new trips that they might not have otherwise made without the availability of ridesourcing [108]. Based on evidence reported in Table 2, between 14 and 58% of ridesourcing trips are substituted with public transport trips. Clewlow and Mishra [55] have found that the introduction of TNCs is correlated with a 15% reduction in transit ridership in major U.S. cities. However, they argue that this effect is not the same for all forms of public transport, as public buses and light rail are more impacted, while heavy rail is benefiting from the new generation of taxi services. While it was initially expected that ridesourcing services would be an alternative to conventional taxis, Rayle et al. [1] have found that most ridesourcing trips in San Francisco are substituting for modes other than a taxi and are, therefore, outside the traditional taxi industry. Similarly, in Brazil, de Souza Silva et al. [76] suggest that 30% of riders would travel by public transport if these services were not available as an alternative.

Table 2. The results of studies on the impact of ridesourcing services on VMT/VKT, empty miles rate, transit substitution, walking or bicycling substitution, driving/carpool/taxi substitution.

.	Author(s)	City/Region	Period	Method	Impact	Target Population	Sample Size	Data Size	Direction [1]
VMT/VKT	[19]	Denver, Colorado	2016	Survey	+83.5%	Lyft/Uber drivers	416 rides	-	Negative
	[14]	San Francisco	2010–2016	Modeling-regression	+7%	San Francisco Bay Area residents	-	-	Negative
	[109]	Paris Region	2017	Survey	No effect	TNC users	1966	-	Non
Empty miles rate	[97]	5 US cities	2014–2015	Modeling	+36% to 45%	UberX drivers	-	-	Negative
	[23]	Austin Texas	June 2016 to April 2017	Modeling	+45%	RideAustin drivers	-	1.5 million rides	Negative
Car sale	[103]	Austin Texas	2016	Survey	+8.9%	Uber and/or Lyft users	1840	-	Positive
	[109]	Paris Region	2017	Survey	No effect	TNC users	1966	-	Non
New trip generation	[55]	7 major US cities	2014–2016	Survey	+22%	Urban residents	4094	-	Negative
	[1]	San Francisco	2014	Survey	+8%	TNC users	380	-	Negative
	[19]	Denver, Colorado	2016	Survey	+12%	Lyft/Uber drivers	416 rides	-	Negative
	[110]	California	2015	Survey	+8%	Residents of California	2400	1975	Negative
	[67]	Santiago, Chile	2017	Modeling	+3%	Uber users	1600	-	Negative
	[111]	Santiago, Chile	2017	survey	5.4%	Santiago residents	1500	-	Negative

Table 2. *Cont.*

.	Author(s)	City/Region	Period	Method	Impact	Target Population	Sample Size	Data Size	Direction [1]
Transit substitution	[55]	7 major US cities	2014–2016	Survey	15%	Urban residents	4094	-	Negative
	[1]	San Francisco	2014	Survey	33%	TNC users	380	-	Negative
	[19]	Denver, Colorado	2016	Survey	22.2%	Lyft/Uber drivers	416 rides	-	Negative
	[112]	7 US cities	2016	Survey	14%	Mobility users	4500	-	Negative
	[74]	New York	2009–2016	Regression model	58.54%	Taxi trips	1458	143,926	Negative
	[110]	California	2015	Survey	22%	Residents of California	2400	1975	Negative
	[76]	Brazilian cities	2017	Logistic regression model	30%	Brazilian Uber users	500	384	Negative
	[4]	New York	2014	Spatial cross-correlation	Mixed effects	Uber pickup records	-	74394 pickup records	Non
	[67]	Santiago, Chile	2017	Modeling	34%	Uber users	1600	-	Negative
	[111]	Santiago, Chile	2017	survey	37.6%	Santiago residents	1500	-	Negative
	[102]	Waterloo, Ontario, Canada	2018–2019	Descriptive analysis	74%	TNC rides	585	-	Negative
	[113]	Bogotá, Colombia	2019	Discrete Choice Models	33%	Uber trips	-	50,760 queries	Negative
	[114]	Chengdu, China	2016	Modeling	33%	DiDi trip data	-	181,172 trips	Negative
Transit extending or complement-ing	[66]	US cities	2017	Descriptive analysis	27%	National Household Travel Survey (NHTS)	-	-	Positive
Walking or bicycling substitution	[55]	7 major US cities	2014–2016	Survey	24%	Urban residents	4094	-	Negative
	[1]	San Francisco	2014	Survey	21.0%	TNC users	380	-	Negative
	[112]	7 US cities	2016	Survey	18%	Mobility users	4500	-	Negative
	[110]	California	2015	Survey	20%				Negative
	[19]	Denver, Colorado	2016	Survey	12%	Lyft/Uber drivers	416 rides	-	Negative
	[67]	Santiago, Chile	2017	Modeling	4%	Uber users	1600	-	Negative
	[102]	Waterloo, Ontario, Canada	2018–2019	Descriptive analysis	26%	TNC rides	585	-	Negative
	[64]	Tehran, Iran	2017	Chi-square test	19.7%	Urban residents	2377	-	Negative
	[64]	Cairo, Egypt	2017	Chi-square test	19.3%	Urban residents	2011	-	Negative
	[111]	Santiago, Chile	2017	survey	1.6%	Santiago residents	1500	-	Negative
Driving/ taxisubstitu-tion	[55]	7 major US cities	2014–2016	Survey	46%	Urban residents	4094	-	Positive
	[1]	San Francisco	2014	Survey	46%	TNC users	380	-	Positive
	[19]	Denver, Colorado	2016	Survey	52.1%	Lyft/Uber drivers	416 rides	-	Positive
	[112]	7 US cities	2016	Survey	42%	Mobility users	4500	-	Positive
	[103]	Austin Texas	2016	Survey	45%	Uber and/or Lyft users	1840	-	Positive
	[67]	Santiago, Chile	2017	Modeling	52%	Uber users	1600	-	Positive
	[113]	Bogotá, Colombia	2019	Discrete Choice Models	30%	Uber trips	-	50,760 queries	Positive
	[111]	Santiago, Chile	2017	survey	68%	Santiago residents	1500	-	Positive

Source: Authors. [1] By direction, we mean the overall impact of a finding on urban sustainability.

However, there are cases in which ridesourcing services both complement and compete with the public transit system [114]. For example, Jin et al. [4] show that ridesourcing services have contrasting impacts on public transport in New York, but their negative influence is more prevalent. They note that ridesourcing services compete with public transport in

Manhattan, where public transport coverage is too high. At the same time, it complements public transport at night and in areas with insufficient public transport services.

There have been optimistic views regarding the role of ridesourcing services in reducing wasteful driving and congestion in cities. However, some studies warn that the current ridesourcing system contributes to the growth of VMT in cities. For instance, Henao and Marshall [19] estimate that ridesourcing in the Denver region in the U.S., accounts for 83.5% more VMT compared to when it was not available. Schaller [115] focuses on the major American cities and reported that ridesourcing services put 2.8 VMT on the road compared to every mile of private car travel. It should be noted that the focus has been on large cities and there is a paucity of evidence about medium and small-sized cities. The literature suggests several reasons for this increase in VMT. First, a group of TNC drivers living outside major cities usually commute relatively long distances to begin and end their driving shift. Second, sharing ridesourcing trips is not yet popular and the trips have lower occupancy rates compared to ridesharing services [68]. Third, some TNC drivers do not park their car after a ride and select circulating while waiting to be matched with the next passenger. Forth, ridesourcing services induce new trips that would not be made if these services were not available [116]. Fifth, as a result of increasing the number of part-time drivers, TNCs may increase the average number of rides provided per driver or vehicle, which influences the overall VMT and traffic congestion in cities [23].

Regarding the first reason, Cramer and Krueger [97] calculate that the empty miles rate of Uber drivers in Seattle is about 45% and that it is about 36% for Los Angeles. However, Wenzel et al. [23] note that Cramer and Krueger failed to include the empty commuting miles at the beginning and end of shifts. Wenzel et al. [23] estimate that this commuting distance is about 19% of the total VMT for RideAustin drivers. Besides, they estimate that TNC drivers travel 21% longer distances to pick up passengers in Austin, Texas, and drive 55% more miles between the end of a trip and the next ride. There are three reasons why some TNC drivers opt to circulate rather than parking immediately after a ride: (1) TNC drivers often cannot quickly and accurately locate the waiting positions of riders. Therefore, cruising on the road helps them to find a new request in a shorter time [117]; (2) Drivers mainly search for riders based on their self-interest and experiences and, therefore, those uncoordinated searching strategies lead to longer idle driving [77]; and (3) In downtown, there are a restricted number of places for drivers to park. Therefore, vacant taxis can only cruise on roads while awaiting their next ride [24].

The negative implication of ridesourcing services on city congestion is well documented. Some studies show that TNCs have put more vehicles on the road and imposed extra traffic congestion, particularly in the city centers [5,14,74]. Erhardt et al. [14] and Castiglione et al. [118] show that ridesourcing services are the most robust determinant factor worsening congestion and travel time reliability, responsible for 51% of the rise in car time delays, 47% of the increase in vehicle miles travelled, and 55% of the drop in speeds in San Francisco from 2010 to 2016. Castiglione et al. [119] add that ridesourcing cars are clustered in the high density and most congested San Francisco areas, comprising 25% of vehicle trips during peak hours. A similar finding is reported by Schaller [120] for New York and by Nie [79] for Shenzhen, China. However, Nie notes that the impact is relatively mild. It seems that the continued growth in the number of TNC vehicles on congested streets can create increasing costs for businesses and customers and discourages cities from achieving sustainable mobility, economic, and environmental objectives [120].

The rapid development of ridesourcing services has also had some adverse impacts on greenhouse gas emissions and energy use. It is due to the absence of regulatory restrictions on ridesourcing vehicle emissions compared to taxicabs [34] and the fact that these services are being replaced by more efficient modes [23]. Moreover, some believe that the introduction of ridesourcing services has induced more travel [1] and increased overall new car sales [89]. Clewlow and Mishra [55] determine that 49–61% of ridesourcing trips in the major U.S. cities were either not made or made via sustainable modes, such as public transit and active travel modes. Wenzel et al. [23] calculate the net effect of ridesourcing services on energy use in Austin, Texas, and estimated that ridesourcing contributes to a 41% increase in energy use under a low energy assumption while increasing to 90% under a high energy assumption. Overall, Table 2 compares the results of studies on the impact of ridesourcing services on VMT/VKT, empty miles rate, transit substitution, walking or bicycling substitution, and driving/carpool/taxi substitution. This table summarizes the results of the quantitative studies and does not include the qualitative results mentioned in the text.

The VMT is defined as the number of miles traveled by vehicles in a given area over a certain time period [121]. The positive effect of ridesourcing services on VMT has negative implications for urban sustainability, as it contributes to increased fuel consumption, carbon emissions, and air and noise pollution [122]. The empty miles refer to the miles traveled by taxi without a passenger to find a new ride. It contributes to overall VMT and can increase traffic congestion [23]. The next factor is car sales, defined as the number of cars sold in a given area over a specific period. An increase in new car sales can benefit the economy [89]. New trip generation is another factor contributing to traffic and air pollution. It refers to the number of ridesourcing trips that would not have been generated if ridesourcing services were unavailable [55]. Transit substitution is defined as the number of ridesourcing trips that are substituted for public transit [1]. It directly increases the number of cars on the roads, contributing to traffic congestion and fuel consumption, thus increasing carbon emissions. Similarly, walking or cycling substitution is defined as the number of ridesourcing trips that are substituted for walking or cycling ones. On the contrary, driving or taxi substitution has a positive effect on environmental sustainability. It refers to the number of ridesourcing trips that are substituted for driving or taxi trips [110]. Finally, transit extending or complementing trips are defined as those that provide connectivity to or from public transportation stations and those serve routes and operate at times when public transportation is unavailable. It supports public transit and positively contributes to climate change mitigation and adaptation efforts.

4. Summary and Conclusions

Ridesourcing services have found their place in many cities around the world. Since the advent of this new transportation technology, there have been hopes and fears for their role in societies and it has been a popular topic for both public opinion and planning research. Based on evidence from the literature, we attempted to identify the major impacts of ridesourcing services on various urban sectors and understand critical factors that should be considered in planning for these services in the future. We presented the results in the three sections, social, economic, and environmental. Both positive and negative impacts are reported for each section. Significant positive and negative implications of ridesourcing services and possible lessons and recommendations for sustainable planning of this transportation mode are presented in Table 3. This table represents significant challenges that ridesourcing services have so far encountered and need to be addressed. On the other hand, it highlights opportunities and possibilities that planners and policymakers should take full advantage of.

While there is a consensus among researchers about some impacts, there are conflicting results about some cases that need to be explored further in future research. For instance, Jiang and Zhang [8] believe that older adults in Beijing are disconnected from ridesourcing services due to physical challenges and lack of convenience and familiarity with technologies. However, Mitra et al. [38] suggested that this transportation mode gives more freedom of mobility to older adults in the United States. They can depend less on friends or relatives to meet their transportation needs. Future studies can explore how ridesourcing can influence the mobility and wellbeing of older adults. Besides, Table 2 showed significant discrepancies about the reported influence of ridesourcing services on factors like VMT, car sales, and substitution rates. These differences might be related to the different geographic contexts of the studies, local regulations on the services, or their varied analytical methods. Perspective studies can compare the cities and identify how some factors, such as culture, urban form, and regulation, can be discrepancies. They can also compare the efficiency of analytical methods used to calculate VMT, car sales, and substitution rates.

Table 3. Summary of major positive and negative impacts discussed in the literature.

Social	**Positive Impacts**
	Convenient mobility options Decreasing drunk driving Improving the availability of public transportation in poor and remote areas Bridge the gaps that exist between peak and non-peak hours, daytime and nighttime, weekends and weekdays, rainy and sunny days in urban transit networks Responding to taxi demand fluctuations Increasing access to transportation for older adults Improving safety for both drivers and passengers Preventing drivers from being robbed or harmed
	Negative Impacts
	Uneven access to these services Excluding physically disadvantaged people Excluding people with low literacy Less readily available in small towns and low-density areas The vulnerability of socially disadvantaged groups to discrimination Unfair competition with traditional taxis Social tensions between cab drivers and TNCs Increasing accidents Avoiding compliance with social legislation, tax regulation, basic wages, and other legal employment rights
Economic	**Positive Impacts**
	Tapping into a fresh reservoir of the workforce Increasing the efficiency Saving costs Creating job opportunities Providing flexible working hours, appropriate work-life balance, and a family-friendly lifestyle for drivers Increasing new car sales Addressing taxi supply shortage during peak hours Increasing mode choices
	Negative Impacts
	Unsecured labor rights Pushing many overqualified and educated people into underemployment Income instability of drivers More costly than public transit fares Decline in the car industry Disruptive impact on traditional taxis Relying on smartphones and credit card to use Expensive for low-income people
Environmental	**Positive Impacts**
	Having higher capacity utilization than traditional taxis Extending or complementing public transit Solving the first and last mile problem created by the fixed route and fixed schedule of public transit Reducing car ownership and automobile dependence Minimizing parking supply Reducing congestion
	Negative Impacts
	Attracting some public transit users Substituting public transport Contributing to the growth of VMT in cities Adding more idle cars to the road Worsening congestion and travel time reliability Increasing greenhouse gas emissions Increasing energy use

An area of uncertainty is the impact of the dominance of ridesourcing services on the car industry. While the results of Guo et al. (2018) showed that the initial entry of Didi Chuxing positively impacted new car sales in China, Ward et al. [94] found a negative impact in the U.S. metropolitan areas. Therefore, it is recommended to continue research on the influence of ridesourcing services on the car industry. Finally, several studies have identified many opportunities in ridesourcing for reducing the overall VMT, energy use, and congestion in a city [14,23,65]. However, the literature offers evidence that the current ridesourcing system is contributing to the growth of VMT. This indicates the potential for ridesourcing to reduce VMT, energy use, and congestion is not entirely exploited yet, and it has increased wasteful driving and resulted in energy use and congestion in cities [23,77,97,117]. Identifying transition pathways towards a green or environmentally friendly ridesourcing system is a promising avenue for future research. There has also been some confusion about the contribution of ridesourcing services to decreasing drunk driving. Contrary to Greenwood and Wattal [53], Rayle et al. [1], and Clewlow and Mishra [55], who point out that the availability of ridesourcing services has an association with a reduction in drunk driving, Brazil and Kirk [82] believe that TNCs have not made American cities safer. As a result, while ridesourcing services offer many opportunities in this regard, future studies should take a number of barriers into account that may change the way these services affect drunk driving.

Significant recommendations can be made to enhance the efficiency of ridesourcing services. First, TNCs are often considered independent contractors and drivers are driver-partners. They have had less obligation to drivers and the community, operating independently and outside the government [28]. Although the drivers enjoy the flexible working schedule and independence, it provides opportunities for TNCs to avoid existing considerations designed to protect laborers and to sacrifice the advantages that come with employee status [11,123]. In a situation where workers are self-employed and employers exert a minimum control on their employees, TNCs refuse responsibility to third party victims for losses caused by accidents, sexual violence, and other damages arising in the external environment [84]. As a result, revisions to laws to make TNCs more committed to the drivers and the public are needed. More supervision using technical means of monitoring and big data models is also necessary to ensure that they function within a proper regulatory framework. Second, some technical deficiencies need to be resolved by TNCs. For instance, Xu et al. [124] estimated that 40% of ridesourcing requests go unfulfilled in Beijing in 2015. These demand failures are significant losses in terms of the transaction value and losing passenger loyalty [16,124,125]. The matching algorithms of ridesourcing platforms are also far from perfect and do not assign the closest driver to a passenger, leading to additional delays [9,79]. Moreover, due to the road environment′s difficulty, traffic, and fluctuating weather conditions, ridesourcing apps cannot always decide the best route. [117]. Therefore, more advanced matching and routing algorithms to improve the function of the platforms are recommended. Some TNCs, including DiDi Chuxing, have also suggested a pickup point method that can significantly enhance the matching between the rider and the driver. Third, this innovative transportation technology can open up new opportunities to promote multimodal lifestyles and reduce revenue losses by replacing unprofitable transit lines with ridesourcing services in places with limited transit demand [4,46]. Therefore, the cost of transit extending trips is recommended to be reduced, and they should be developed in areas with insufficient public transit. In the meantime, the operation of TNCs should be limited in areas where there is appropriate coverage of public transit, as they can lead to an increased VMT and traffic congestion. It seems that the concept of Mobility-as-a-Service (MaaS), by combining the payment methods of ridesourcing and transit, can comprehensively pursue this goal. Forth, the lack of effective regulation on the emissions of ridesourcing services relative to taxicabs is of concern [34]. It is proposed that tighter regulations should be put in place to restrict ridesourcing vehicle emissions, as has been the case with conventional taxis. Fifth, the review found that the development of ridesourcing services in many cities has contributed to increased VMT, energy use, and congestion. TNCs and public agencies can adopt policies that facilitate shared ride services.

While it was attempted to provide a synthesis of available evidence about the social, economic, and environmental impacts of ridesourcing services, this review and its findings have several limitations. First, while the implications of ridesourcing services have been extensively investigated in academic journals, dissertations, reports, and newspaper articles, this study did not review all types of documents. It systematically reviewed published peer-reviewed papers and the reports that were more relevant to the topic. Second, shared ridesourcing services and user typology were the parts of the literature that are not discussed in this review. This was due to the extensive literature on these two topics and the total word number limitation. Besides, the issues are very well reviewed by prior systematic reviews, such as Tirachini (2020). Therefore, the study attempted to focus on areas that have not received due attention. Finally, providing more information regarding the methods of the reviewed studies could help clarify the variations in the reported findings presented in Table 2. However, many of the studies lacked key details such as research strategy, modeling approach, target population, and data volume.

Besides the limitations, this review suggests some research gaps in current studies.

- According to Table 1, the reported evidence related to ridesourcing services is restricted to a small number of TNCs and in limited countries. For instance, Uber operates in 65 countries worldwide, while the evidence of its operation is reported only in the United States, the UK, Canada, France, and Colombia. Moreover, lesser known TNCs are operating worldwide (such as Snapp in Iran, Ola Cabs in India, and Easy Taxi in Brazil), which have received limited attention in previous research.
- While a large proportion of the papers published about ridesourcing services is focused on the United States and China, the literature failed to include many countries, especially those located in the Global South. For example, while several studies have investigated discrimination from TNC drivers to riders and vice versa in the U.S., the problem is rarely investigated in other countries. Therefore, the development of ridesourcing in other countries should be taken into account in prospective studies to provide an international perspective on the perception of the impacts of ridesourcing services.
- It should further be noted that the majority of studies conducted in the United States and China are also focused on exceptional cities, such as Austin, San Francisco, New York, Chandu, Beijing, and Shanghai.
- While TNCs operate in small and medium-sized communities, prior research has focused principally on large cities and metropolitan areas.
- Although scholars have paid a significant emphasis on the impacts of ridesourcing services, some aspects have remained somewhat obscure. For example, mode substitution patterns and the VMT of ridesourcing services are extensively empirically investigated, while there is limited evidence for the impact of these services on energy consumption and air pollution.

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Appendix A. Operating TNCs across the World

Name	Area of Operation
99	Brazil
ARRO	New York City, Boston, Miami, and Houston
Arro	United Kingdom and United States
Bahamas Ride	United States Minor Outlying Islands
BiTaksi	Turkey
Bolt	40 countries in Europe, Africa, Western Asia, and Latin America
Bounce	United States
Bridj	United States
Bubbl	United States
Cab Hound	United States
Cabify	12 countries and more than 90 cities across Latin and South America
Caocao Zhuanche	China
Care Ride	United States
Careem	15 countries in the Middle East, Africa, and South Asia
Carma	Ireland, Norway, and United States
Carmel	More than 70 countries
CURB	United States.
Easy Taxi	420 cities across 30 countries
Eva	Canada
ExecuTesla	United States
Fare	United States
Fasten	United States
Flywheel	United States
Free Now	EU and United States
Gett	UK, Israel, and Russia
GoCatch	Australia
Gojek	Southeast Asia
Hailo	Ireland, Singapore, Spain, and United Kingdom
HopSkipDrive	United States
InstaRyde	Canada
Jayride	Australia, Ireland, New Zealand, United Kingdom, and United States.
Jeeny	Saudi Arabia
Jozibear 24/7	South Africa
Jrney	South Africa
Juno	United States
Kango	United States
Kid Car	United States
Limos.com	United States
Little Cab	Kenya
Mondo Ride	Kenya, Tanzania, and Uganda
ReachNow	United States
RideBoom	Australia
RideYellow	United States
RipeRides	Canada
See Jane Go	United States
Shebah	Australia
Shofer	Australia
SocialDrv	United States
Stroll Guam	Guam
Summon	United States
SuperShuttle	Canada, France, Mexico, Netherlands, Sweden, United Kingdom, and United States
Talixo	Oman
TappCar	Canada
TAPSI	Iran
TotalRide	United States
VIA	Chicago, New York, and Washington
WINGZ	United States.
Yandex Taxi	Finland and Russia
Yango	Armenia, Belarus, Estonia, Finland, Georgia, Ghana, Israel, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Romania, Serbia, and Uzbekistan
Yidao Yongche	China
Yoweby	Canada
Zoomy	New Zealand

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