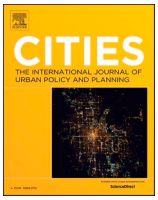
Cities 133 (2023) 104122

Contents lists available at ScienceDirect

Cities

journal homepage: www.elsevier.com/locate/cities



The impact of ridesourcing on equity and sustainability in North American cities: A systematic review of the literature

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ARTICLE INFO

Keywords:
Ride-hailing
Ridesourcing
Equity
Sustainability

ABSTRACT

Research on ridesourcing has grown exponentially in recent years. This study details the results of a systematic review of 161 publications on ridesourcing that explore environmental sustainability and equity in North American cities. We identify five main areas of research. First, ridesourcing is associated with two modal shifts: a decline of the taxi industry and a more complicated association with public transit ridership. Second, several studies have documented workers' rights and the challenges of contingent labor. Third, demographic studies show associations between ridesouring and affluent riders, and spatial analyses indicate that ridesourcing may exacerbate existing patterns of inequity in cities. Fourth, ridesourcing has dubious claims to improve environmental sustainability: it has only a small effect on vehicle ownership, but it increases emissions associated with deadheading, and pooled services do not reduce vehicle miles traveled. Fifth, ridesourcing companies also tend to oppose regulatory responses and sharing data with potential regulators. The review concludes with suggestions on areas for future research.

1. Introduction

Technological advancements have allowed for the growth and development of the sharing economy, which is based on renting and borrowing goods and services as opposed to owning them. An important element of the sharing economy, ridesourcing allows users to hail rides by using smartphone applications that link personal vehicle drivers with passengers who need rides. Ridesourcing remains largely an urban phenomenon, as transportation network companies (TNCs) have yet to make much headway in car-dependent areas like peripheral suburbs and rural areas. Nonetheless, during the last ten years, ridesourcing has become an integral mode of transport, and it has the potential to drastically change efficiency, environmental sustainability, and equity in urban transportation systems. For example, Conway et al. (2019) found that in the U.S., the for-hire vehicle market doubled between the years 2009 and 2017, owing its massive success to TNCs like Uber and Lyft. The Pew Research Center (2019) also found that in 2018, 36 % of U.S. adults had used ridesourcing in comparison with only 15 % of U.S. adults in 2015 (Pew Research Center, 2019).

Exploring the growth of ridesourcing is imperative given its connection to a range of problems that cities are facing: climate change and pollution; equity and accessibility issues; and uneven development leading to gentrification, displacement, and housing unaffordability. As such, researchers have begun to investigate the importance of ridesourcing in the context of both urban equity and environmental sustainability. Although data on ridesourcing trips has been somewhat limited, researchers have found creative ways to explore how ridesourcing contributes to patterns of inequality and to environmental externalities. This study builds on a previous review by Jin et al. (2018), who provided a categorization of past research and outlined a path for future research that explores the impact of ridesourcing on broad issues of urban development. At the time of that publication, there was a limited number of peer-reviewed studies on ridesourcing – especially those focusing on equity and sustainability. Since that time, research in this area has expanded.

The purpose of this study is to provide an overview of literature on ridesourcing in North American cities, as it pertains to both equity and sustainability, using the systematic literature review method. Given the increase in ridesourcing research and ridesourcing's impact on climate justice, it is imperative to categorize the ridesourcing literature and identify pathways for future research with respect to equity and environmental sustainability. Our systematic review revealed five major

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https://doi.org/10.1016/j.cities.2022.104122
Received 12 July 2021; Received in revised form 13 November 2022; Accepted 17 November 2022
Available online 7 December 2022

categories of articles that speak to these topics: modal shifts (including interactions with public transit and taxis), labor and workers' rights, demographics of users and spatial context (including both survey research and TNC service area analysis), sustainability, and regulation of TNCs. These articles are mostly empirical studies, but they also include discussion of potential policy solutions. The social and environmental context of ridesourcing relates to city development, which is tied to spatial scales such as regional and national context. To provide a more robust and focused discussion of major themes and potential policies, we limit the review geographically to research on ridesourcing in North American cities. Attention to the emerging issues of equity and environmental sustainability in this context can provide valuable information to researchers, policy makers, and advocates who are interested in tracking the continued growth of ridesourcing and its impact on various spheres of justice in North American urban areas, and issues identified in the literature for this world region are potentially applicable to other world regions.

The study is organized as follows. We first describe the methodology used to develop the systematic review and the thematic analysis and classification of articles. Next, we analyze the general results of the systematic review including major categories, publication years, and an overview of journals. In this section, we also provide detailed descriptions of each of the five major categories we identified as central to the conversation on sustainability and equity in relation to ridesourcing. Finally, we discuss areas of future research and the intersectional nature of these major topics as they pertain to urban equity and environmental sustainability.

2. Methodology

The design for this systematic literature review was based on the 'Preferred Reporting Items for Systematic Reviews and Meta-Analysis' (PRISMA) method (Moher et al., 2009) We used the PRISMA protocol to select articles for the systematic review if they met the following generic eligibility criteria: topic, language and/or country analyzed, and publication year. In stage one of the literature review, we began by conducting a database search for academic articles using Web of Science. We only searched for articles between 2011 and 2021, which corresponds with the growth of ridesourcing in North American cities. We conducted two inquires using the online search engine, one using the term "ridesourcing" or "ride sourcing" and one using the term "ride-hailing" or "ride-hailing." Although most academic transportation researchers use the term "ridesourcing" to describe the services offered by TNCs, "ride-hailing" has been a popular term in the press and social media (Jin et al., 2018). Our search was conducted in March 2022 and yielded a total of 2144 articles.

2.1. Screening process

Of the 2144 total records, 1557 were identified through the keyword search "ride sourcing" or "ridesourcing," and 587 records were identified through the keyword search "ridehailing" or "ride-hailing." Fig. 1 depicts the multi-stage screening process for article inclusion. The first stage eliminated duplicate records ($N = 87$), and the second stage excluded articles about ride-sourcing outside North America and articles that were off topic or outside the focus of this review ($N = 136$). The vast number of articles produced by the first search (1557 records) were out of context. The early process of elimination or inclusion involved reading the abstracts of each source. If the abstract did not provide enough information, we scanned introductions and conclusions for more information. The final stage involved screening the remaining articles to ensure that they were applicable. The citations within each article were scanned for articles that may have been missed in the initial Web of Science search. After this process, six sources were added into the review, yielding a total of 164 full text articles.

Articles come from a wide array of disciplines, although the largest representation comes from the social sciences and urban planning. However, disciplines were not excluded if the article specifically examined some facet of equity, environmental sustainability, or both, in the context of ridesourcing. For example, numerous articles on ridesourcing examine operational efficiency, evaluations of the business model of TNCs, or pricing techniques for TNCs. These articles were often

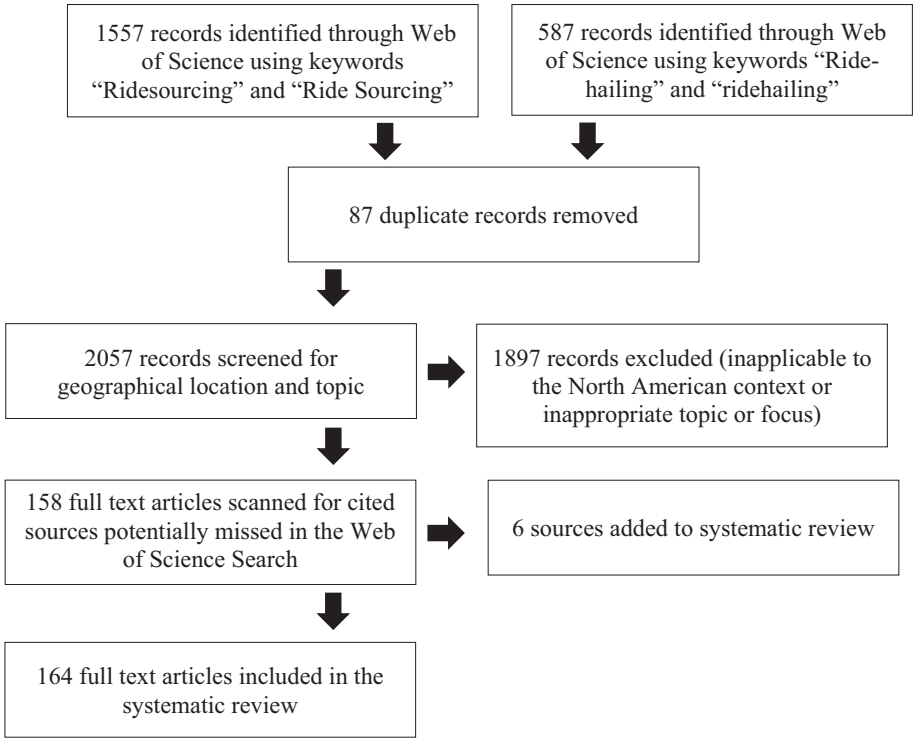

Fig. 1. Review and Screening Process.

excluded because they failed to mention urban equity or sustainability. Articles that proposed new ridesourcing services or apps were usually excluded as well. However, articles that proposed ideas for greening ridesourcing fleets were included. We also excluded articles that examine mobility sharing, without distinguishing between ridesourcing and other modes of shared mobility. All the articles come from either peer-reviewed journal articles of full-article conference proceedings.

2.2. General results

The publication dates for the 164 articles included in this review reflect the rapidly growing interest in ridesourcing among researchers. One article was published in 2014, 2 in 2016, 6 in 2017, 14 in 2018, 29 in 2019, 50 in 2020, 51 in 2021, and 12 from January to March 2022. The 164 articles included in this study were published in 62 different journals. Although there is some diversity in the scope of the journals, including articles published in business and medical journals, the majority were in transportation, planning, urban studies and various social sciences. The top journals for ridesourcing publications are listed below in Table 1.

2.3. Thematic analysis

The thematic analysis of the literature sources followed standard methods in qualitative data analysis coding that begin with a priori categories but modify them in response to the new information (Braun & Clarke, 2006; King, 2004). Following template analysis, the a priori categories in this study were based on previous review articles and served as the starting point (Jin et al., 2018), but as more articles were reviewed, new categories were constructed, and some were merged. The categorization process led to a total of five final groups, with two of those groups having subgroups, a manageable number for a systematic literature review. We concluded our categorization when a further reduction would lead to vague categories that could not be meaningfully summarized.

The number of articles for each category are shown in Table 2. Table 3 provides a brief overview of the subtopics in each category. The first category of interest explores how ridesourcing creates modal shifts in urban transportation systems, with two subcategories: public transit and traditional taxis. The second category explores the labor practices of TNCs and the rights, and lack thereof, of TNC workers. The third category includes articles that assess the demographics of ridesourcing users and the spatial context in which ridesourcing occurs. This category has two sub-categories: research that uses survey methodology and research that uses service area analysis. The fourth category includes articles that address environmental sustainability, and the fifth category includes articles that explore current and potential regulation of TNCs.

Some articles are placed in multiple categories because of their interconnected nature. Table 4 provides information on these paired categories and includes the total number of articles within these shared topics. The top two combination categories are public transit/survey area analysis and public transit/survey of ridesourcing users. The categories of public transit/sustainability, survey of ridesourcing users/sustainability, and service area analysis/sustainability are all tied for third.

Table 1
Top journals for ridesourcing articles.

Top Ridesourcing Journals	Number of Articles
Transportation Research Record	26
Transportation Research Part A - Policy and Practice	14
Transportation	11
Transportation Research Part C - Emerging Technologies	11
Journal of Transport Geography	10
Transportation Research Part D - Transport and Environment	8
Transport Policy	5

Table 2
Results of the thematic analysis of ridesourcing articles.

Category	Number of Articles
Modal Shifts	
Taxi	24
Public Transit	49
Labor Rights	16
Demographics and Spatial Context	
Surveys of Ridesourcing Users	42
Service Area Analysis	31
Sustainability	33
Regulation of TNCs	16

Although we provide detailed information on these topics and their intersections in the second half of this review, we will provide a quick overview of some of the shared topics in each of these shared categories. Articles that share the topics of public transit and survey analysis of ridesourcing uses often rely on survey data to evaluate the demographics of ridesourcing users and how ridesourcing impacts their public transit usage. These articles are often included in the shared category of survey of ridesourcing users/sustainability because they provide some analysis or discussion on how the choice of ridesourcing over public transit impacts sustainability, or how sustainability factors into the decision-making of ridesourcing users.

The category of public transit/service area analysis provides a similar analysis but relies on aggregate statistics of service areas and often explores ridesourcing levels in relation to public transit coverage. Furthermore, articles within this category also contain the pairing of service area analysis/sustainability because they usually provide some discussion on how ridesourcing levels in the context of public transit networks and connectivity impact the sustainability of cities.

3. Results

The following section provides a more detailed analysis of the results from the systematic literature review. Specifically, we discuss each of the five major categories (and sub-categories) that emerged from the thematic analysis and provide a short and detailed overview of the main topics discussed within each category.

3.1. Modal shifts

There is a growing discussion in the ridesourcing literature on the potential of ridesourcing to create a modal shift away from major forms of transport traditionally used in urban areas such as personal vehicles, taxis, and public transportation. Although TNCs have touted the potential of ridesourcing to reduce private vehicle ownership (Zou & Cirillo, 2021), it is important to ask whether ridesourcing is replacing other modes of transportation, and if so, what are the major implications for this replacement. Researchers are interested in a broad set of questions such as under what conditions is ridesourcing causing a substitution for these other modes of transit, and why is this substitution occurring?[1]

3.1.1. Taxis

The modal shift from taxi service to ridesourcing is perhaps the most obvious given numerous articles in newspapers and media on the strained taxi industry. In cities across the world, taxi drivers have gone on strike to protest the proliferation of TNCs such as Uber and Lyft,

[1] Although the following subsections will focus exclusively on taxis and public transit, it should be noted that a few studies have also explored how ridesourcing impacts other modes of transit such as bikeshare and walking. For example, see Gerte et al. 2019, who demonstrate how bikeshare negatively influenced the demand of ridesourcing in NYC from 2015 to 2017.

Table 3
Major subtopics for emerging themes.

Category	Brief overview of subtopics in each category
Modal Shifts:	
Taxi	Explores the degree to which ridesourcing has impacted traditional taxi usage in urban areas and the implications for this modal shift (Anderson, 2014). Other potential topics include identifying reasons behind this modal shift (Brown & LaValle, 2020), labor rights for taxi drivers in the wake of increased ridesourcing (Baron, 2018), the impact of ridesourcing on taxi service areas (Kim, Baek, & Lee, 2018), and evaluations of varying equity concerns relating to taxis versus ridesourcing (Brown, 2019a,b; Pan et al., 2020). Typical methodologies: Surveys (including intercept surveys), Semi-structured interviews, market models, survey area analysis
Public Transit	Explores the degree to which ridesourcing has impacted public transit ridership in urban areas and the implications for this modal shift. Other potential topics include identifying a competition-complementarity relationship (Barajas & Brown, 2021; Deka & Fei, 2019) and reasons influencing substitution ridesourcing for public transit (Azimi et al., 2020), including characteristics of the build environment (Baker, 2020; Toman et al., 2020) Typical methodologies: Surveys (including intercept surveys), interviews, market models, survey area analysis
Labor Rights	Evaluates how TNCs have changed the nature of labor in cities (Malos et al., 2018; Mrvos, 2021), discrimination and customer abuse (Maffie, 2022), oppression and control of workers by TNCs (Mosseri, 2020), and inequity in driver pay (Bokanyi & Hannak, 2020; Henao & Marshall, 2019). Typical methodologies: Interviews, policy analysis
Demographics and spatial context	
Surveys of Ridesourcing Users	Surveys of ridesourcing users, which includes mass surveys such as the National Household Travel Survey (NHTS) (Mitra et al., 2019) or intercept surveys (Gehrke et al., 2019; Rayle et al., 2016). These articles frequently examine the demographics of ridesourcing users, including race/ethnicity, income, age, and employment (Gehrke, 2020; Sikder, 2019), as well as how ridesourcing impacts personal vehicle ownership (Shi & Sweet, 2020) Typical methodologies: Surveys (including intercept surveys), interviews
Service Area Analysis	Considers how ridesourcing levels vary across space with respect to socio-demographics (Brown, 2019a,b; Dias et al., 2019) and characteristics of the built environment (Ghaffar et al., 2020; Yu & Peng, 2019), including in the context of pooled ridesourcing (Dean and Kockelmann, 2021). Typical methodologies: Surveys (including intercept surveys), interviews, service area analysis (spatial area as the unit of analysis)
Sustainability	Studies of the sustainability impacts of ridesourcing, which often explore reductions in private car ownership (Zou & Cirillo, 2021) and externalities like air pollution and emissions (Wenzel et al., 2019) in the context of vehicle miles traveled and deadheading (Henao & Marshall, 2019; Ward et al., 2021). Typical methodologies: Surveys (including intercept surveys), interviews, service area analysis, analysis of individual rides
Regulation of TNCs	Analysis of the nature of TNCs and how they avoid regulation (Monahan, 2020), refuse to identify as transportation providers (Brail, 2017), and avoid city level ridesourcing regulation (Flores & Rayle, 2017). Typical methodologies: policy analysis, city level case studies

protested unfair policies at airports that benefit ridesourcing over taxis, and pushed for legislation to regulate TNCs. Research has identified ridesourcing as the primary competitor to taxis across all modes of transit (Anderson, 2014). In an intercept survey study of ridesourcing users in San Francisco, many respondents reported that they would have taken a taxi for the same trip had ridesourcing been unavailable (Rayle et al., 2016). Kim, Baek, & Lee (2018) use time-series regression modeling to examine factors that change the number of taxi trips. They found that Uber had crowded out taxis from central Manhattan, forcing taxis to respond by increasing their geographic coverage.

Table 4
Information on paired categories.

Category combo	Number of articles shared
Modal shifts/demographics and spatial context	
Taxi/survey of ridesourcing users	3
Taxi/service area analysis	3
Public transit/survey of ridesourcing users	10
Public transit/service area analysis	13
Modal shifts/labor rights	
Taxi/labor rights	2
Modal shifts/sustainability	
Public transit/sustainability	8
Demographics/spatial context/sustainability	
Survey of ridesourcing users/sustainability	8
Service area analysis/sustainability	8
Modal shifts/regulation	
Taxi/regulation	2
Public transit/regulation	1
Labor/regulation	2
Regulation/sustainability	3

One reason for this modal shift relates to the ease of transaction costs and communication for ridesourcing in comparison to taxis. Ridesourcing presents users with mobility on demand (MOD), which differs from traditional taxis. Users can hail a ride directly from their phones, which reduces transaction times. In comparison, taxis can lack effective communication channels between drivers and riders. Acquiring a traditional taxi can require hailing one down in the street or calling a dispatcher. Not only does ridesourcing lower transaction times, but it also provides users with real time information on the location of their ride, which reduces uncertainty (Jin et al., 2018). In an audit study in Los Angeles on over 1600 ridesourced and taxi trips, Brown and LaValle (2020) explored variation in service quality between the two modes. For the same origin and destination areas, they found that ridesourcing users typically pay around 40 % less than taxi riders. Ridesourcing users waited less time to be picked up and were less likely to have their trips cancelled. However, taxi companies have responded to the popularity of ridesourcing by introducing their own mobile device apps (Shaheen & Cohen, 2018).

Researchers are also interested in issues of equity and accessibility, in terms of typical service areas of taxis and ridesourcing. In a study of ridesourcing in New York City (NYC), Pan et al. (2020) suggested that the equity of ridesourcing is higher than that of taxis because taxis tend to concentrate only in areas where demand is higher. Similarly, Atkinson-Palombo et al. (2019) explores variation in resourcing trips by neighborhood demographics and found that ridesourcing trips originating in the outer boroughs of NYC are typically in areas with low income and low car ownership. Conversely, Rafiq and McNally (2022) found that taxi users typically belonged to low-income and carless households, using the National Household Travel Survey (NHTS) to identify taxi-only riders as those who reported no use of app-based services for rides. Likewise, Brown (2019a,b) used an audit survey to explore discrimination in both ridesourcing and taxi trips and found that discrimination against Black taxi riders resulted in far higher rates of trip cancellation and longer wait times when compared to white riders. However, discrimination was drastically reduced for ridesourced trips. Nonetheless, racial disparities emerge when analyzing the cultural frames used in ad campaigns by companies like Uber for driver recruitment. In Winnipeg, whiteness underpinned the appeal of Uber, who used recruitment ads that often featured young, white drivers – but most of the taxi drivers in the city are immigrants who face daily racism (Gibbings & Taylor, 2019).

Even though taxis represent a small portion of urban travel, research has shown that the shift to ridesourcing has been quite disruptive for the industry (Rayle et al., 2016). Baron (2018) argued that taxi drivers, especially those who own their own medallions in places like Toronto, have an incentive to oppose TNCs. Taxi drivers often must undergo extensive training and certification processes that are often not required for ridesourcing drivers (Wang & Smart, 2020). Simply switching from driving a taxicab to working for a TNC is not feasible for all taxi drivers. Aside from the issue of repaying the investment in medallions, one barrier to entry is vehicle ownership, and taxi drivers often lease their vehicles. In a case study of a taxi worker cooperative in Philadelphia, Borowiak (2019) explored how TNCs have created disruptions for taxi cooperatives that sought to address the inadequacy of traditional taxis through a commitment to economic democracy, living wages, and outreach to underserved communities.

3.1.2. Public transit

The relationship between ridesourcing and public transit is less straightforward than between ridesourcing and taxis. Whereas taxis and ridesourcing can both involve rides in automobiles using unique and direct routes, public transit is a form of mass transport with fixed routes. Research in this area has focused on exploring a broad set of questions: does ridesourcing compete with or complement public transportation? Under what conditions does each type of relationship occur? Does the relationship vary by type of public transit? Far less research has investigated the significance of switching from public transit to ridesourcing, especially how this potential modal shift impacts both urban sustainability and equity.

Research seeking to assess either a competitive or complementary relationship often explores whether ridesourcing provides coverage to areas poorly served by public transit. This research area reveals that ridesourcing is widely used in areas with dense public transit networks. Early studies, such as the intercept study by Rayle et al. (2016), showed that a significant number of ridesourced trips begin and end near transit stations, but they failed to show interdependence between the two modes. Similarly, in a study using the NHTS, Deka and Fei (2019) found that people who live near both train and bus stops use ridesourcing more frequently. Barajas and Brown (2021) conducted a study of transit supply in Chicago and compared it to ridesourcing origins sand destination, finding that ridesourcing does not fill service gaps in areas poorly served by public transit (Barajas & Brown, 2021). In a study with similar methodology, Marquel (2020) found that ridesourcing is most prevalent in areas with high accessibility. Some researchers have also noted that ridesourcing is convenient for last-mile connections and could provide a significant boost to public transit (Mohiuddin, 2021; Schaller, 2021).

Studies have also explored how transportation ridership levels have changed with the introduction of ridesourcing. Boisjoly et al. (2019) use longitudinal multilevel modeling to explore variation in public transit ridership using data from 25 transit authorities in North America. They did not find that ridesourcing caused a major decline in public transit ridership across 25 North American cities; instead, they found that ridesourcing was associated with higher levels of transit usage. In an examination of transit usage data in major U.S. metropolitan areas, Hall et al. (2019) found that public transit ridership increased by an average of 5 % two years after Uber's entry into a city. Similarly, Nelson and Sadowsky (2019) found that while public transit usage increased in areas immediately following a TNC's entry into a city, the spike disappeared following the entry of a second TNC.

Other researchers have noted that the answer to the competition-complementarity question depends on the built environment of the service area (Toman et al., 2020; Baker, 2020; Schwieterman & Smith, 2018; Loa et al., 2021), the type of public transportation (Erhardt et al., 2022), and even conditions such as weather and service delays (Grahn et al., 2020; Hawkins & Habib, 2020). Erhardt et al. (2021) explored factors that influence public transit ridership patterns in San Francisco and found that between 2010 and 2015, ridesourcing was responsible for a net decline of about 10 % for bus usage, accounting for other factors such as service fee increases and population growth. However, the researchers did not find that ridesourcing had this effect on light rail ridership. In a study using similar methodology, Toman et al. (2020) identified a complex pattern in NYC: between 2015 and 2017, ridesourcing usage was associated with a decline in subway ridership at first, but the negative impact on subway ridership flattened over time. In a survey study, Hawkins and Habib (2020) found that public transit users in Toronto who switched to Uber after a service delay could do so in as little as 3 min, with 7 min being the average and 12 min being the longest wait time. Similarly, Liu et al. (2020) found that ridesourcing increased after subway disruptions in Toronto but noted that this pattern was not true for disadvantaged neighborhoods. In a study of ridesourcing in NYC, Jin et al. (2019) use service area analysis, finding that even though Uber competes with public transit in areas with good public transit coverage, it complements public transit late at night and in areas with insufficient public transit service.

Survey research points to explanatory factors such as speed of service and convenience. Azimi et al. (2020) found that aside from concerns over time, users are attracted to exclusive rides. In a study of Washtenaw County, Michigan, Goodspeed et al. (2019) found that riders were more likely to choose ridesourcing over public transit because of time constraints and the convenience of receiving door-to-door service. Young et al. (2020) found that travel times and lengthy walks influenced rider choice in Toronto. However, because they also found that around 31 % of ridesourcing rides in the sample had wait times with a similar duration to public transit, wait times do not completely explain why users may choose ridesourcing over public transportation.

3.2. Labor

The business model set forth by TNCs, and gig economy companies in general, has changed the nature of labor in cities. TNCs often enter markets without obtaining regulatory approval and classify their drivers as “autonomous” workers as opposed to employees (Baron, 2018). This business model relies on contingent and outsourced workers and has become pervasive in the gig economy. Policy studies argue that by classifying drivers as independent workers, TNCs prevent drivers from falling under the protection of labor laws and deny them eligibility for benefits, vacations, unemployment, workers compensation, and overtime pay (Malos et al., 2018; Mrvos, 2021). Companies lower their overhead by shifting labor costs to the workers. They also allow customers to have a direct role in managing and evaluating the performance of drivers, which has been linked to customer abuse (Maffie, 2022). Fierce labor battles have been fought in cities and states over the status of TNC drivers, with labor advocates seeing little success (Brown, 2020). In 2020, during the height of the COVID-19 pandemic and accompanying financial crises when earnings of drivers plummeted, a California appeals court ruled that Uber and Lyft must reclassify their California drivers as employees (Katta et al., 2020).

Emerging research on ridesourcing workers has explored topics ranging from driver preferences and grievances, the health and safety of the drivers, and inequality in the distribution of diver income. In a discrete choice experiment, Hong et al. (2020) explored driver preferences including contract and platform design options. In general, the authors found that drivers value the flexibility of not having to commit to work hours. However, the authors also found that a driver's willingness to work for TNCs increased when provided with a minimum wage guarantee, benefits plans including retirement and health contributions, and a low auto-insurance deductible. Using ethnographic research methods in Boston, Mantymaki et al. (2019) explored how ridesourcing workers perceive their work and how the digital platform itself is shaping work relations. They found drivers value flexibility but that the power disparity between the drivers and the platform is a major source of dissatisfaction. The researchers introduced the concept of “algorithmic administrativity” to denote how TNCs use the platform's digital

properties to exercise control over the workers. Similarly, in an ethnographic study of drivers in NYC, Mosseri (2020) revealed how drivers feel oppressed by the constant monitoring by TNCs. The author argued that drivers must engage in uncompensated labor through "reputation auditing," which refers to how drivers must address inaccuracies within their company's record of them.

Other research explores driver preferences between regular ridesourcing and pooling. Services such as UberPool or Lyft Line offer lower cost options to riders by allowing multiple passengers to be added to a single ride with multiple pickup or drop-off locations. In a case study analysis of UberPool in a large Canadian city, Reid-Musson et al. (2020) found that drivers counter branded pooling as "Uber Poo" to express grievances about the program. Drivers argued that pooled rides combined challenges of both bus driving and taxi work by incorporating multiple passengers with multiple stops along a route that could change abruptly. Morris et al. (2020) surveyed 309 TNC drivers in cities across the U.S. and found that drivers are less satisfied with pooled trips compared to solo trips and that drivers believe that the compensation is unfair. Furthermore, this study found that drivers had to engage in more emotional labor because customers get frustrated when rides take longer.

Another area of labor-related research involves drivers' wages. Using multiple expense scenarios, Henao and Marshall (2019) conducted a study of the wages of Uber and Lyft drivers in the Denver region. They found that drivers usually earn an hourly wage between $5.72 and $10.46 per hour, which is lower than the state's minimum wage and lower than the $25–$35 per hour touted by companies. Often the claimed rate does not account for the financial burdens that have been placed on workers by TNCs, including driving expenses and vehicle maintenance. In a model based on empirical data from UberX in Boston, Bokanyi and Hannak (2020) found that even small changes in the parameters (such as location of drivers and passengers, layout of the city, traffic, etc.) created an unpredictable system that led to high income inequality. They argued that these incremental income differences could result in long-term wage gaps between drivers who perform similarly.

A final topic in labor-related research involves the broad analysis of the exploitative nature of on-demand work. In general, survey research has found that workers express a lack of control and a lack of autonomy in their self-employed work (Reid-Musson et al., 2020). In 2018, the American Academy of Sleep Medicine (AASM) took the position that fatigue and sleepiness are inherent safety risks in the ridesourcing industry. One reason is that drivers who are employed in a primary job work on their off hours. They may be driving after long periods of wakefulness and at night. Another factor is that because drivers are considered "independent contractors," they are not screened for medical problems that impact alertness. Malos et al. (2018) argued that corporate social responsibility should be a major factor in battles over the legal status of gig economy workers. Private companies are already required to cover social costs of doing business including worker compensation, family leave, and workplace accommodations.

3.3. Demographics and spatial context

Research that explores the demographic characteristics of ridesourcing users, either survey results or general demographic patterns, in service areas can generally be conceptualized as adopting a "mobility disparities" perspective. Researchers in this area have offered valuable information on the demographic patterns associated with unequal access to ridesourcing. In general, there are two broad categories in this area of the literature. The first category of studies uses survey methodology to evaluate the demographic characteristics of ridesourcing users, including their racial/ethnic identity, gender, income levels, etc. The second category often uses spatial methodology to explore associations between aggregated characteristics of a geographical area and ridesourcing usage or expansion.

3.3.1. Surveys of ridesourcing users

Survey research has consistently shown that ridesourcing users are more likely to be younger, white, well-educated, and wealthy in comparison to non-users (Clewlow & Mishra, 2017; Rayle et al., 2016; Sikder, 2019; Young & Farber, 2019). In their intercept survey in San Francisco, Rayle et al. (2016) found that the age distribution of riders skews younger, 84 % of riders had a bachelor's degree or higher, and households making below $30,000 were underrepresented among ridesourcing users. An intercept survey in the greater Boston region revealed that respondents tended to be young and white, but it did not reveal any significant differences in the income of users (Gehrke et al., 2019). A subsequent study of the greater Boston region conducted by Gehrke (2020) revealed that ridesourcing is favored by low-income respondents with limited vehicle access. However, it is unclear how many low-income respondents were also college students with access to other sources of monetary capital. In a survey spanning seven cities, Clewlow and Mishra (2017) found that ridesourcing users typically have a bachelor's or advanced degree and have incomes above $75,000. Sikder (2019) found that people who work full time and have flexible schedules are more likely to adopt ridescourcing and more frequently use it, compared to those not in the labor market and those employed part-time or with less flexible schedules. However, a 2018 travel survey in Toronto revealed that the second largest market for ridesourcing is among riders who are the most socio-economically vulnerable, with higher rates of unemployment and fewer cars per household (Shi & Sweet, 2020).

Survey research has also delved more deeply into various age categories including generational cohorts. For example, Alemi et al. (2018) explored what factors influence the adoption of ridesourcing in California for both millennials and Generation X. They found that respondents who have experience with transportation-related apps on smartphones and who have previously used taxi or carshare services are more likely to adopt ridesourcing. Also, those who frequently make long-distance business trips are more likely to adopt ridesourcing. With respect to older adults, Mitra et al. (2019) used data from the 2017 National Household Travel survey to explore demographic variations in ridesourcing adoption. Although prior research has shown that this age group is less likely to adopt ridesourcing, Mitra and colleagues found that younger seniors who live alone in urban areas, with higher levels of education and income, are more likely to adopt ridesourcing. They also found that ridesourcing levels are higher for older adults with a disability or medical condition that prevents them from traveling alone.

Other researchers have explored the demographic differences between regular and pooled rideshare users. In a study of ridesourcing in Dallas Fort-Worth, Lavieri and Bhat (2019) found that white users are more concerned about privacy than individuals of other races and ethnicities when it comes to using pooled rides. Spurlock et al. (2019) found that low-to-middle income riders are just as likely as those with higher incomes to have adopted pooled ridesharing in the San Francisco area.

Survey research has also uncovered demographic patterns in individual preferences between ride-hail and transit. Based on a survey of ridesourcing users in Philadelphia, Dong (2020) found that higher income respondents and those over 30 years of age are more likely to choose ridesourcing over public transportation. Respondents indicated that walk time to and from public transit played a significant part in their choices, expressing that in-vehicle travel time and wait time for either mode was less burdensome than walking. An in-vehicle intercept survey of ridesourcing passengers in the Greater Boston region revealed that ride sharing is more likely to replace public transit, walking, and cycling.

3.3.2. Service area analysis

Literature that explores the demographic characteristics of ridesourcing areas has rapidly grown in recent years because data related to TNCs has been made publicly available. This research examines how ridesourcing adoption and usage varies across space from the perspective of socio-demographics and characteristics of the built environment.

Although survey research is important for uncovering the demographics of riders, this avenue of research helps us to better understand the spatial dynamics of ridesourcing on a much larger scale and connects demographic data with information on city infrastructure, density, transit usage, weather patterns, etc. For example, Yu and Peng (2019) used data from Ride Austin between 2016 and 2017 and found a strong relationship between ridesourcing demand and various characteristics of the built environment including land density. Similarly, in an analysis of Chicago, Ghaffar et al. (2020) found that ridesourcing demand is higher in areas with high employment density and higher land use diversity. In Toronto, Hasnine et al. (2021) found that the number of apartments is positively correlated with ridesourcing trip generation, but the number of single-detached homes has a negative correlation.

Results from this line of research are generally consistent with survey research that reports the demographics of ridesourcing users. In a study of Austin, Texas Dias et al. (2019) found that frequent users of Ride Austin, a local TNC, tend to be from areas with a high percentage of young whites with fewer children. In a study of NYC, Jin et al. (2019) found a negative correlation between the number of Uber pickups and percentage of racial minorities. Brown (2019a,b) found that white neighborhoods were positively associated with Lyft rides in Los Angeles, whereas majority Asian and Hispanic neighborhoods were associated with less service. However, the study did not find major differences in per capita trips between Black and white neighborhoods. Similarly, in a study of the spatial distribution of ridesourced trips in Chicago, Marquel (2020) did not find significant racial disparities in ridesourcing demand.

Research has also examined demographic differences in shared ridesourcing versus solo ridesourcing. Dean and Kockelmann (2021) provide evidence that census tracts in Chicago with a high share of people of color, young residents, unemployed persons, and low vehicle ownership exhibit a higher proportion of shared-ride trips. In a similar study of Chicago, Taiebat et al. (2022) found that shared ridership in areas that have lower incomes and a higher concentration of minorities is nearly double that of areas with higher incomes and fewer people of color. Their study also demonstrated that shared ridership declined over 52 % throughout 2019, a change that is likely attributable to the increase in per-mile costs of shared trips. In another study of Chicago, Soria and Stathopoulos (2021) also confirm that socio-economic disadvantage is positively correlated with ride-pooling and negatively correlated with solo rides. An increase in the price of shared ridesourcing likely impacts poor people of color the most, especially given lower ridesourcing usage among this demographic generally. Waiting time has also been identified as an indicator of equity in ridesourcing service areas. In a study of Austin, Yang et al. (2021) found that wait time is higher in areas with a high percentage of Hispanic/Latino and Black residents. However, they found the opposite relationship exists in areas with lower incomes.

3.4. Sustainability

Although transportation accessibility and mobility are essential components of equity in cities, the dominance of the car, whether through personal or TNC vehicles, produces externalities such as air pollution and greenhouse gas emissions. Researchers interested in understanding the relationship between ridesourcing and sustainability often focus on the potential external costs and benefits of this mode of transportation, such as solutions for emissions reduction for ridesourcing fleets or strategies to reduce the prevalence of ridesourcing altogether. Evaluations of externalities associated with ridesourcing often consider topics such as vehicle ownership, deadheading, vehicle miles traveled, air pollution, and traffic congestion.

TNCs have argued that ridesourcing can encourage a decline in personal vehicle ownership, but the research to date suggests that such declines are minimal (Zou & Cirillo, 2021). In a study across multiple urban areas in the U.S., Ward et al. (2019) found that controlling for other factors, on average TNC entry into an urban area is associated with only a 3 % decline in state per capita vehicle registration with no effect on vehicle miles traveled (VMT). Likewise, a survey conducted by Rayle et al. (2016) found that 90 % of respondents did not change their car ownership level after adopting ridesourcing. Wang et al. (2021) only found significant decreases in car ownership among frequent ridesourcing users. Anderson (2014) points out that ridesourcing could encourage private car ownership because many drivers use their income to subsidize car payments.

Even though ridesourcing has a minimal impact on car ownership, the replacement of rides from personal vehicles with ridesourcing could impact total VMT and energy use. Research has shown that ridesourcing fleets are generally more efficient than personal vehicles and that ridesourcing fleets have a higher percentage of hybrid-electric vehicles (Ward et al., 2021; Wenzel et al., 2019). Furthermore, ridesharing has the potential to vastly decrease VMT by eliminating the use of multiple vehicles on similar routes. Although ridesharing negatively impacts drivers (Reid-Musson et al., 2020), TNCs have been able to encourage pooled rides even while general carpooling between households in the absence of a digital platform has been declining.

However, research has consistently shown that pooled rides for ridesourcing do not necessarily reduce VMT. For example, in a study on pooled rides in Toronto between 2016 and 2017, Young et al. (2020) found that 14.8 % of ridesourced trips are pooled and that 51.7 % are successfully matched. They argue that unmatched trips are no better than traditional forms of ridesourcing and may be worse because the reduced cost could result in mode replacement (that is, shifting passengers away from more sustainable modes, such as public transit). In another study of pooled services and VMT, Schaller (2021) used Uber and Lyft data from 2014 to 2020 in Chicago, NYC, San Francisco, Boston, and the California suburbs. They found that pooled trips led to at least a doubling of VMT when compared to the user's previous mode of transit. These large increases were found to be the result of deadheading miles and users switching from public transit.

Deadheading often happens when drivers must drive long distances to pick up their next passenger after dropping off a prior passenger or when drivers are looking for passengers instead of parking and waiting. In a quasi-natural experiment in Denver, Colorado, Henao and Marshall (2019) estimated that 40.8 % of miles driven were deadheading miles. In a study of Austin, Texas, Wenzel et al. (2019) found that both commuting and between-ride deadheading account for 19 % and 26 % of ridesourcing VMT. Furthermore, this study demonstrates that the net effect of ridesourcing on energy use is 41–90 % increase when compared to pre-ridesourcing personal travel. Despite ridesourcing's marginal impact on VMT and energy use, research has shown that it does reduce overall air pollution (Ward et al., 2021). Bruchon et al. (2021) found that fleet electrification led to externality reductions ranging from 10 % in New York City to 22 % in Los Angeles.

Studies that explore the relationship between ridesourcing and sustainability often fail to critically evaluate the role of multiple externalities associated with ridesourcing. Ward et al. (2021) explicitly address this gap in the literature through simulating replacement of private vehicle travel with ridesourcing in six U.S. cities, providing a holistic evaluation of air pollution, greenhouse gas emissions, and traffic externality benefits and costs. This research shows that the combination of reducing “cold starts” and the use of newer, lower emitting ridesourcing vehicles reduces air pollution emissions by 50–60 %. However, it also finds that deadheading, congestion, crashes, and noise costs ultimately leads to a net increase in total externalities. What is more, when ridesourcing displaces public transportation, walking, or biking instead of personal vehicles, a threefold increase in externalities occurs. And even though pooled rides reduce overall externalities when displacing personal vehicles, the case is not true when pooled rides displace public transportation.

3.5. Regulation

Researchers are increasingly examining current and potential regulation of TNCs to combat the externalities associated with ridesourcing including congestion and pollution, safety and security of riders and drivers, unfair driver compensation and benefits, unequal competition with taxis and limousines, social inequity, and liability. When Uber first entered cities, it used a blitz approach by saturating urban markets before city-level regulators could create legislation that addressed labor rules, congestion, fees, or the number of permitted vehicles (Monahan, 2020). When Uber first launched, the company insisted that it was a technology firm that simply matched independently contracted drivers to riders and was not a ground transportation firm. Uber and other TNCs have changed their stance to argue that ridesourcing is a distinct sector, but they still deny their role as a transportation provider (Brail, 2017). TNCs have fought fierce battles against regulation and have lost some ground at times through city-wide bans and other restrictions such as fees per ride or caps on the vehicles permitted (Zhao et al., 2020). In turn, the responses of TNCs to regulation have differed across North America. For example, in response to fingerprinting requirements for drivers, both Uber and Lyft left Austin, but they remained in NYC when the same restrictions were put in place (Brail, 2017; Monahan, 2020; Beer et al., 2017).

Researchers have also explored why local officials are conflicted over the regulation of TNCs. Mayor Bill Peduto of Pittsburgh famously said, "You can either put up red tape or roll out the red carpet. If you want to be a 21st century laboratory for technology, you put on the red carpet" (Kang, 2017). Flores and Rayle (2017) found that the former mayor of San Francisco shielded ridesourcing companies from local regulatory crackdowns by pushing regulation concerns to the state level, where ridesourcing had received a warmer welcome. In general, city level officials that prevent or regulate the operation of TNCs may be perceived as stunting employment and preventing wealth and investment from entering the city (Brail, 2017).

Monahan (2020) argued that the data monopolies maintained by TNCs can obfuscate the impacts of their services on urban areas including congestion; pollution; and the safety of pedestrians, cyclists, and other drivers. Furthermore, resistance to data sharing can interfere with city transit planners' ability to diagnose the structural needs of the city. Conversely, the failure to provide data to city governments could be viewed as interference with the city's ability to provide and maintain services that fall under the category of public goods. Monahan (2020) noted that this resistance to data sharing serves the goals of TNCs, which include prolonging monopoly status and delaying regulation to extract the maximum amount of capital. However, TNCs have access to city roadways and urban infrastructure, areas that have historically been viewed as part of the urban commons and where public needs should prevail.

More generally, Dunn (2020) argued that mobility platforms are not neutral technological solutions but are instead active players in city level politics and even actual sites where political engagement happens. In other words, beyond engaging with city and state governments over issues such as regulation, TNCs have the ability to digitally reproduce power and existing spatial inequalities in urban areas. Furthermore, the individualized nature of digital platform environments forces users to set individual goals and priorities as opposed to collective ones that are more prevalent in public transportation systems. Essentially, digital participation with space still has vast consequences for urban areas, but they are harder to visualize.

4. Discussion

This review identified five major categories of research that examines ridesourcing from the perspective of equity and/or sustainability. We will briefly summarize the main findings in each of these five categories. With respect to modal shifts, researchers have found that ridesourcing competes the most with taxi services (Anderson, 2014). This competition can cause damage to the livelihoods of taxi drivers (Borowiak, 2019) and force them to expand services to new territory (Kim, Baek, & Lee, 2018). However, researchers have found that unlike taxis, ride-hailing does not exclude low-income neighborhoods (Brown, 2019a,b). For the other main modal shift, public transportation, research has shown high ridesourcing levels in areas well served with public transportation (Barajas & Brown, 2021; Deka & Fei, 2019; Marquel, 2020; Rayle et al., 2016). Researchers debate whether the relationship with public transportation is complementary or competitive relationship. Those supporting the former hypothesis note how ridesourcing is convenient for last-mile transportation (Mohiuddin, 2021; Schaller, 2021).

Research on the labor dynamics of TNCs notes that classifying drivers as "autonomous" or contractual can deny workers significant benefits and protections under labor law (Malos et al., 2018; Mrvos, 2021). Workers take on significant labor costs compared to companies, and drivers face costumer abuse due to the power costumers have in performance evaluation (Maffie, 2022). On-demand work has been linked to workers feeling a lack of autonomy (Reid-Musson et al., 2020).

With respect to the topic of equity and access to transportation (or mobility disparities), both survey data and service area analysis have explored the demographic characteristics of ridesourcing users and the spatial context of ridesourcing in cities. Survey research has largely highlighted that ridesourcing reflects privilege (Clewlow & Mishra, 2017; Rayle et al., 2016), employment requirements (Alemi et al., 2018), and age (Mitra et al., 2019). Service area analysis has explored the spatial scales of ridesourcing and how they connect to demographic patterns and the built environment. In general, ridesourcing is connected to urban density and land-use diversity (Ghaffar et al., 2020; Yu & Peng, 2019). As with survey-based research, this work has found a connection between privilege and ridesourcing (Brown, 2019a,b; Dias et al., 2019), but some studies demonstrate a connection between various measures of disadvantage and ridesourcing (Dean and Kockelmann 2021; Jin et al., 2019).

On the issue of environmental sustainability, there is little evidence that ridesourcing has substantially taken cars off the road in a way that reduces emissions and air pollution (Clewlow & Mishra, 2017; Rayle et al., 2016). In fact, ridesourcing's potential to take riders away from more sustainable options, such as public transportation, biking, or walking, could have a negative impact on the sustainability of cities (Ward et al., 2021). Finally, with respect to policy and regulation, researchers have shown that ridesourcing companies have resisted local regulation and have even attempted to preempt it by influencing state-government policy (Brail, 2017).

5. Conclusion: future directions for ridesourcing literature

The transportation sector is central to urban life and mobility, and its historical entrenchment in equity battles continues today with the development of ridesourcing. Transit systems are at the forefront of current debates on equity and sustainability in North American cities, and ridesourcing has become part of that debate. Although many of the articles in this review move the current literature forward, we offer some guidance for next steps in the literature.

Regarding the impact of ridesourcing on public transportation, more research is needed on the equity and sustainability dimensions of the debate over the complementary versus competitive relationship. Results from service area analyses reveal that ridesourcing equity concerns are likely embedded within systems of structural (both physical and social) disadvantage. Although some work has examined socio-economic disadvantage in the context of high ridesourcing levels in transit-rich areas (Soria & Stathopoulos, 2021), debates on the complementary/competitive relationship have failed to consider equity and sustainability when defining the nature of a complementary relationship. A complementary relationship is often understood as the capacity of

ridesourcing to close gaps in public transit service, absent of the data from surveys and service area analyses that reveal disparities in ridesourcing users by class and race. High ridesourcing near public transportation could just be a reflection of class and race-based segregation in transportation type. Furthermore, research should explore the demographic characteristics of those using ridesourcing to get to their final destinations to better address which demographic categories are driving a potential complementary relationship.

Furthermore, studies using this first/last mile (or final destination) argument to justify a complementary relationship need to strengthen their methodological approaches by empirically assessing connectivity and availability of public transit at ridesourcing pickup and drop-off locations. If an entire ridesourcing trip could be replaced with public transportation, that would be a good indicator of competition. Survey research could address this issue by asking respondents if they use ridesourcing for last-mile connectivity to their final destinations and by analyzing responses from the perspective of potential demographic and spatial variation among those riders.

Widespread substitution for public transit could increase vehicle mileage traveled and city roadway congestion, both of which could impact a city's environmental sustainability. As such, researchers should also evaluate the extent to which ridesourcing provides an unsustainable solution to a problem that could be fixed with better public transportation policy. Put another way, is ridesourcing truly "complementary" when we include concerns of environmental sustainability? Similarly, research at the intersection of sustainability and ridesourcing must take a holistic approach that includes equity concerns, as opposed to evaluating single externalities. Although some articles explore whether the appearance of TNCs in a city impacts car ownership, few discuss the implications of the potential shift. Even though a reduction in car ownership is touted by TNCs themselves, there is little research showing how these modest decreases make any real impact on creating more sustainable urban spaces (see Ward et al., 2021 as an exception), and none truly address equity issues. Furthermore, there is little research on how modest decreases may be offset by ridesourcing's potential to take riders away from more sustainable options such as public transit.

Although many of the articles in this review explore more than one major topic related to ridesourcing, there is a need for more literature that addresses the *intersectional nature* of how TNCs impact both urban equity and sustainability in single studies. Many articles that examine the intersection of competition with public transit and demographic service analysis fail to address how competition with public transportation impacts environmental justice within a city. One way of strengthening this line of research could be to explore how competition could impact funding available to transit agencies, and this type of research could draw on transportation justice studies that have shown the benefits of public transit for communities of color and the working class (Bullard & Johnson, 1997). Future research could examine how contracts between local transit agencies and TNCs impact both urban equity and sustainability, and if such contracts are created, how cities can ensure that TNC laborers are treated fairly. Another potential topic is the analysis of other areas of equity beyond workers' rights, such as discrimination against riders or pricing out non-discretionary riders who rely on the amenities provided by transit agencies?

Increasingly, it is becoming clear that regulation of TNCs is imperative for ensuring that climate justice plays out on a local level. And it appears that the COVID-19 pandemic has influenced the potential for regulation of TNCs. Katta et al. (2020) argued that the pandemic has significantly destabilized the TNC business model by calling into question the ambiguous geographies of platform work that detach companies from actual people and places. Uber was forced to admit some responsibility for drivers' material conditions and the significant risks they undertook by driving during a global pandemic. This move solidified the notion that TNCs have always been able to assume some responsibility for their workers, pandemic or not. Regardless, TNCs have still failed to assume responsibility as transportation providers in urban areas, and this failure has allowed them to ignore how they influence environmental externalities and transportation equity in North American cities.

Credit authorship contribution statement

Rachel G. McKane: Conceptualization, Methodology, Data Analysis, Writing.

David Hess: Conceptualization, Writing-Reviewing, Editing.

Funding

This project was partially supported by the U.S. National Science Foundation, OISE-1743772, Partnerships for International Science and Engineering (PIRE) Program: "Science of Design for Societal-Scale Cyber-Physical Systems." Any opinions, findings, conclusions, or recommendations expressed here do not necessarily reflect the views of the National Science Foundation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

References

Alemi, F, Circella, G, Handy, S, & Mokhtarian, P (2018). What influences travelers to use Uber? Exploring the factors affecting the adoption of on-demand ride services in California. *Travel Behavior and Society, 13*, 88–104.

Anderson, D. N. (2014). Not just a taxi? For-profit ridesharing, driver strategies, and VMT. *Transportation, 41*(5), 1099–1117.

Atkinson-Palombo, C., Varone, L., & Garrick, N. W. (2019). Understanding the surprising and oversized use of ridesourcing services in poor neighborhoods in NYC. *Transportation Research Record, 2673*(11), 185–194.

Azimi, G., Rahimi, A., Asgari, H., & Jin, X. (2020). Role of attitudes in transit and auto users' mode choice of ridesourcing. *Transportation Research Record, 2674*(11), 1–16.

Baker, D. M. (2020). Transportation Network Companies (TNCs) and public transit: Examining relationships between TNCs, transit ridership, and neighborhood qualities in San Francisco. *Case Studies on Transport Policy, 8*(4), 1233–1246.

Barajas, J. M., & Brown, A. (2021). Not minding the gap: Does ride-hailing serve transit deserts? *Journal of Transport Geography, 90*, Article 102918.

Baron, D. P. (2018). Disruptive entrepreneurship and dual purpose strategies: The case of Uber. *Strategy Science, 3*(2), 439–462.

Beer, R., Brakewood, C., & Viscardi, J. (2017). Qualitative Analysis of Ride-Hailing Regulations in Major American Cities. *Transportation Research Record: Journal of the Transportation Research Board, 2650*(1), 84–91.

Boisjoly, G., Grise, E., Maguire, M., Veillette, M. P., Deboosere, R., Berrebi, E., & El-Geneidy, A. (2019). Invest in the ride: A 14 year longitudinal analysis of the determinants of public transport ridership in 25 North American cities. *Transportation Research Part A, 116*, 434–445.

Bokanyi, E., & Hannak, A. (2020). Understanding inequalities in ride-hailing services through simulations. *Scientific Reports, 10*, 6500.

Borowiak, C. (2019). Poverty in transit: Uber, taxi coops, and the struggle over Philadelphia's transportation economy. *Antipode, 51*(4), 1079–1100.

Brail, S. (2017). Promoting innovation locally: Municipal regulation as barrier or boost? *Geography Compass, 11*(12), 1–22.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*, 77–101.

Brown, A. E. (2019a). Redefining car access: Ride-hail travel and use in Los Angeles. *Journal of the American Planning Association, 85*(2), 83–95.

Brown, A. E. (2019b). Prevalence and mechanisms of discrimination: Evidence from the ride-hail and taxi industries. *Journal of Planning Education and Research.*. https://doi.org/10.1177/0739456X19871687

Brown, A. E., & LaValle, W. (2020). Hailing a change: Comparing taxi and ridehail services in Los Angeles. *Transportation, 48*, 1007–1031.

Brown, R. C. (2020). Ride-hailing drivers as autonomous independent contractors: Let them bargain! *Washington International Law Journal, 29*(3), 522–574.

Bruchon, M. B., Michalek, J. J., & Azvedo, I. L. (2021). Effects of air emission externalities on optimal ridesourcing Fleet electrification and operations. *Environmental Science & Technology, 55*(5), 3188–3200.

Bullard, R., & Johnson, G. S. (1997). *Just transportation: Dismantling race and class barriers to mobility*. Gabriola, BC: New Society Publishers.

Clewlow, R. R., & Mishra, G. S. (2017). *Disruptive transportation: The adoption, utilization, and impacts of ride-hailing in the United States. Report UCD-ITSRR-17-07*. Institute of Transportation Studies, University of California, Davis.

Conway, M. W., Salon, D., & King, D. A. (2019). *Trends in taxi use and the advent of ridehailing, 1995-2017: Evidence from the US National Household Travel Survey*.

Dean and Kockelman, n.d.M.D. Dean K.M. Kockelman . Spatial variation in shared ride-hail trip demand and factors contributing to sharing: lessons from Chicago. Journal of Transportation Geography, 9, 102944.n.d.

Deka, D., & Fei, D. (2019). A comparison of the personal and neighborhood characteristics associated with ridesourcing, transit use, and driving with NHTS data. *Journal of Transport Geography, 76*, 24–33.

Dias, F. F., Lavieri, P. S., Kim, T., Bhat, C. R., & Pendyala, R. M. (2019). Fusing multiple sources of data to understand ride-hailing use. *Transportation Research Record, 2673*(6), 214–224.

Dong, X. (2020). Trade Uber for the bus? An investigation of individual willingness to use ride-hail versus transit. *Journal of the American Planning Association, 80*, 222–235.

Dunn, P. T. (2020). Participatory infrastructures: The politics of mobility platforms. *Urban Planning, 5*(4), 335–346.

Erhardt, G. D., Mucci, R. A., Cooper, D., Sana, B., Chen, M., & Castiglione, J. (2022). Do transportation network companies increase or decrease transit ridership? Empirical evidence from San Francisco. *Transportation, 49*, 313–342.

Flores, O., & Rayle, L. (2017). How cities use regulation for innovation: The case of Uber, Lyft and Sidecar in San Francisco. *Transportation Research Procedia, 25*, 3756–3768.

Gehrke, S. R. (2020). Uber service area expansion in three major American cities. *Journal of Transport Geography, 86*, Article 102752.

Gehrke, S. R., Felix, A., & Reardon, T. G. (2019). Substitution of ride-hailing services for more sustainable travel options in the Greater Boston region. *Transportation Research Record, 2673*(1), 438–446.

Ghaffar, A., Mitra, S., & Hyland, M. (2020). Modeling determinants of ridesourcing usage: A census tract-level analysis of Chicago. *Transportation Research Part C, 119*, Article 102769.

Gibbings, S. L., & Taylor, J. (2019). A desirable future: Uber as image-making in Winnipeg. *Communication Culture & Critique, 12*(4), 570–589.

Goodspeed, R., Xie, T., Dillahunt, T. R., & Lustig, J. (2019). An alternative to slow transit, drunk driving, and walking in bad weather: An exploratory study of ridesourcing mode choice and demand. *Journal of Transport Geography, 79*, Article 102481.

Grahn, R., Qian, S., Matthews, H. S., & Hendrickson, C. (2020). Are travelers substituting between transportation network companies (TNC) and public buses? A case study in Pittsburgh. *Transportation, 48*, 997–1005.

Hall, J. D., Palsson, C., & Price, J. (2019). Is Uber a substitute or complement for public transit? *Journal of Urban Economics, 108*, 36–50.

Hasnine, M. S., Hawkins, J., & Habib, K. N. (2021). Effects of built environment and weather on demands for transportation network companies. *Transportation Research Part A: Policy and Practice, 150*, 171–185.

Hawkins, J., & Habib, K. N. (2020). Finding the subway disruption regimes of switching subway to Uber in Toronto. *Transportation Research Record, 2674*(12), 303–311.

Henao, A., & Marshall, W. E. (2019). An analysis of the individual economics of ride-hailing drivers. *Transportation Research Part A, 130*, 440–451.

Hong, S. J., Bauer, J. M., Lee, K., & Granados, N. F. (2020). Drivers of supplier participation in ride-hailing platforms. *Journal of Management Information Systems, 37*(3), 602–630.

Jin, S., Kong, H., & Sui, D. (2019). Uber, public transit, and urban transportation equity: A case study in New York City. *The Professional Geographer*, 1–6.

Jin, S., Kong, H., Wu, R., & Sui, D. (2018). Ridesourcing, the sharing economy, and the future of cities. *Cities, 76*, 96–104.

Kang, C. (2017). *Pittsburgh welcomed Uber's driverless car experiment. Not anymore.* New York Times. https://www.nytimes.com/2017/05/21/technology/pittsburgh-uber s-driverless-car-experiment.html.

Katta, S., Badger, A., Graham, M., Howson, K., Ustek-Spilda, F., & Bertolini, A. (2020). (Dis)embeddedness and (de)commodification: COVID-19, Uber, and the unravelling logics of the gig economy. *Dialogues in Human Geography, 10*(2), 203–207.

Kim, K., Baek, C., & Lee, J. D. (2018). Creative destruction of the sharing economy in action: The case of Uber. *Transportation Research Part A: Policy and Practice, 110*, 118–127.

King, N. (2004). Using templates in the thematic analysis of text. In C. Cassell, & G. Symon (Eds.), *Essential guide to qualitative methods in organizational research* (pp. 257–270). London, UK: Sage.

Lavieri, A. S., & Bhat, C. R. (2019). Investigating objective and subjective factors influencing the adoption, frequency, and characteristics of ride-hailing trips. *Transportation Research Part C, 105*, 100–125.

Liu, R., Palm, M., Shalaby, A., & Farber, S. (2020). A social equity lens on bus bridging and ride-hailing responses to unplanned subway disruptions. *Journal of Transport Geography, 88*, Article 102870.

Loa, P., Hossain, S., Yicong, L., & Habib, K. N. (2021). How have ride-sourcing users adapted to a wave of the COVID-19 pandemic? Evidence from a survey-based study of the Greater Toronto Area. *Transportation Letters, 13*(5–6), 404–413.

Maffie, M. D. (2022). Becoming a pirate: Independence as an alternative to exit in the gig economy. *British Journal of Industrial Relations, 0*(0), 1–21. https://doi.org/10.1111/bjir.12668

Malos, S., Lester, G. V., & Virick, M. (2018). Uber drivers and employment status in the gig economy should corporate social responsibility tip the scales? *Employee Responsibilities and Rights Journal, 30*, 239–251.

Mantymaki, M., Baiyere, A., & Najmul Islam, A. K. M. (2019). Digital platforms and the changing nature of physical work: Insights from ride-hailing. *International Journal of Information Management, 49*, 452–460.

Marquel, O. (2020). Spatial distribution of ride-hailing trip demand and its association with walkability and neighborhood characteristics. *Cities, 106*, Article 102926.

Mitra, S. K., Bae, Y., & Ritchie, S. G. (2019). Use of ride-hailing services among older adults in the United States. *Transportation Research Record, 2673*(3), 700–710.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & Prisma Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine, 6*(7), e1000097.

Mohiuddin, H. (2021). Planning for the first and last mile: A review of practices at selected transit agencies in the United States. *Sustainability, 13*(4), 2222.

Monahan, T. (2020). Monopolizing mobilities: The data politics of ride-hailing platforms in US cities. *Thematics and Informatics, 55*, Article 101436.

Morris, E. A., Zhou, Y., Brown, A. E., Khan, S. M., Derochers, J. L., Campbell, H., Pratt, A. N., & Chowdhury, M. (2020). Are drivers cool with pool? Driver attitudes towards the shared TNC services UberPool and Lyft Shared. *Transport Policy, 94*, Article 1230138.

Mosseri, S. (2020). *Being watched and being seen: Negotiating visibility in the NYC ride-hail circuit*. New Media & Society.

Mrvos, D. (2021). Illusioned and alienated: Can gig workers organize collectively. *Communication Capitalism & Critique, 19*, 262–276.

Nelson, E., & Sadowsky, N. (2019). Estimating the impact of ride-hailing app company entry on public transportation use in major US urban areas. *The B.E. Journal ofEconomic Analysis & Policy, 19*(1), 1–21.

Pan, R. B., Yang, H. T., Xie, K., & Wen, Y. (2020). Exploring the equity of traditional and ride-hailing taxi services during peak hours. *Transportation Research Record, 2674*(9), 266–278.

Pew Research Center. (2019). More Americans are using ride-hailing apps. https://www.pewresearch.org/fact-tank/2019/01/04/more-americans-are-using-ride-hailing-apps/.

Rafiq, R., & McNally, M. G. (2022). An exploratory analysis of alternative travel behaviors of ride-hailing users. *Transportation*. https://doi.org/10.1007/s11116-021-10254-9

Rayle, L., Dai, D., Chan, N., Cervero, R., & Shaheen, S. (2016). Just a better taxi? A survey-based comparison of taxis, transit, and ridesourcing services in San Francisco. *Transport Policy, 45*, 168–178.

Reid-Musson, E., MacEachen, E., & Bartel, E. (2020). 'Don't take a poo!': Worker misbehaviour in on-demand ride-hail carpooling. *New Technology, Work, and Employment, 35*(2), 145–161.

Schaller, B. (2021). Can sharing a ride make for less traffic? Evidence from Uber and Lyft and implications for cities. *Transport Policy, 102*, 1–10.

Schwieterman, J., & Smith, C. S. (2018). Sharing the ride: A paired-trip analysis of UberPool abd Chicago Transit Authority services in Chicago, Illinois. *Research in Transportation Economics, 71*(c), 9–16.

Shaheen, S., & Cohen, A. (2018). Shared ride services in North America: Definitions, impacts, and the future of pooling. *Transport Reviews, 39*(4), 427–442.

Shi, H. Y., & Sweet, M. N. (2020). Who uses ride-hailing? Policy implications and evidence from the Greater Toronto and Hamilton Area. *The Canadian Geography, 65*(2), 197–214.

Sikder, S. (2019). Who uses ride-hailing services in the United States? *Transportation Research Record, 2673*(12), 40–54.

Soria, J., & Stathopoulos, A. (2021). Investigating socio-spatial differences between solo ridehailing and pooled rides in diverse communities. *Journal of Transport Geography, 95*, Article 103148.

Spurlock, C. A., Sears, J., Wong-Parodi, G., Walker, V., Jin, L., Taylor, M., Duvall, A., Gopal, A., & Todd, A. (2019). Describing the users: Understanding adoption of and interest in shared, electrified, and automated transportation in the San Francisco Bay Area. *Transportation Research Part D, 71*, 283–301.

Taiebat, M., Aimini, E., & Xu, M. (2022). Sharing behavior in ride-hailing trips: A machine learning approach. *Transportation Research Part D, 103*, Article 103166.

Toman, P., Zhang, J. Y., Ravishanker, N., & Konduri, K. C. (2020). Dynamic predictive models for ridesourcing services in New York City using daily compositional data. *Transportation Research Part C, 121*, Article 102833.

Wang, S., & Smart, M. (2020). The disruptive effect of ride souring services on for-hire vehicle drivers' income and employment. *Transport Policy, 89*, 12–23.

Wang, Y., Moudon, A. V., & Shen, Q. (2021). How does ride-hailing influence individual model choice? An examination using longitudinal trip data from the Seattle region. *Transportation Research Record, 2676*(2), 621–633.

Ward, J. W., Michalek, J. J., Azevedo, I. L., Samaras, C., & Ferreira, P. (2019). Effects of on-demand ridesourcing on vehicle ownership, fuel consumption, vehicle miles traveled, and emissions per capita in US states. *Transportation Research Record Part C, 108*, 289–301.

Ward, J. W., Michalek, J. J., Samaras, C., Azevedo, I. L., Henao, A., Rames, C., & Wenzel, T. (2021). The impact of Uber and Lyft on vehicle ownership, fuel economy, and transit across U.S.cities. *iScience, 24*(1), Article 101933.

Wenzel, T., Rames, C., Kontou, E., & Henao, A. (2019). Travel and energy implications of ridesourcing service in Austin, Texas. *Transportation Research Part D, 70*, 18–34.

Yang, H., Liang, Y., & Yang, L. (2021). Equitable? Exploring ridesourcing waiting time and its determinants. *Transportation Research Part D, 93*, Article 102774.

Young, M., Allen, J., & Farber, S. (2020). Measuring when Uber behaves as a substitute or supplement to transit: An examination of travel-time differences in Toronto. *Journal of Transport Geography, 82*, Article 102629.

Young, M., & Farber, S. (2019). The who, why, and when of Uber and other ride-hailing trips: An examination of a large sample household travel survey. *Transportation Research Part A, 119*, 383–392.

Yu, H. T., & Peng, Z. R. (2019). Exploring the spatial variation of ridesourcing demand and its relationship to built environment and socioeconomic factors with the

geographically weighted Poisson regression. *Journal of Transportation Geography, 75*, 147–163.
Zhao, J. Z., Fonseca, C., & Zeerak, R. (2020). Regulating TNCs: Should Uber and Lyft set their own rules? *Transportation Research Record, 129*, 193–225.
Zou, Z., & Cirillo, C. (2021). Does ridesourcing impact driving decisions: A survey weighted regression analysis. *Transportation Research Part A, 146*, 1–12.