

No Ticket to Ride: A Systematic Definition of Transit Insecurity

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16. Abstract The ability of persons and communities to reliably access transit is a pressing one that has not yet received significant attention in the literature on city planning, in public discourse, or in policy research. This scoping review focuses on factors that negatively impact a person or community's ability to have reliable access to transit; we call such persons and communities 'transit insecure'. Because of the lack of existing research in the area, the term lacks a widely accepted definition, scale, and metrics of assessment. To arrive at a definition and set of metrics, a systematic search was conducted in three electronic databases for studies pertaining to transit insecurity. Over 200 articles were initially identified and, after review and screening for relevance, a total of 15 articles were included in the analysis, ranging in publication date from 2005 to 2020. By analyzing common themes and concerns across these articles, four factors were found that affect transit insecurity: low income, long travel distance, long wait times, and limited accessibility.			
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1. Introduction

The concepts of food insecurity, job insecurity, and housing insecurity have entered the public lexicon and are now part of the identification and analysis of pressing contemporary social issues. By learning about what those insecurities entail, researchers and public discourse can also identify similar non-categorized concerns to those insecurities. It is widely acknowledged that recognizing and dealing with ethical problems is part of the professional responsibility of those engaged in human factors research. One such problem that we believe has not yet attracted enough attention is that of ‘transit insecurity’. This paper will define transit insecurity and examine common metrics to assess the extent to which persons and communities are transit insecure.

The first step to addressing a problem is to adequately define it. The consequences of achieving a consensus on such a definition could be wide-ranging on various professional fields, from policy and law to city planning. Lawmakers, for example, could make use of the definition to pass laws that address inequalities that result from people experiencing transit insecurity. Similarly, city planners could use an established definition to identify locations that need more transit and to prioritize work in communities where transit insecurity is widespread.

As a result of the analysis performed in this study, we define transit insecurity as: The inability to consistently access or afford a reliable transportation system leading to demonstrable negative impacts on a person or community. Persons and communities experiencing transit insecurity may directly perceive these negative effects, though they also may not. This analysis presents four primary factors that contribute to a person or community being transit insecure: (1) income level, (2) travel distance, (3) travel duration, and (4) accessibility.

Developing this list of metrics is important in addressing transit insecurity since the analysis and application of these metrics can reveal broader patterns of insecurity. Employing these metrics, we can examine the relationship between transit insecurity and access to resources such as jobs, food, healthcare, education, amongst others. The resulting analysis, in turn, can open a new realm for human factors researchers and many others, to come together and work on lessening the consequences of transit insecurity. This work is especially important when the notion of transit is widened beyond the use of personal transportation (e.g., cars and bicycles) to commercially available forms of individual transportation (e.g., public transit systems, taxi services, and more recent innovations such as ride hailing services); below we refer to this latter form of transit as ‘commercial transit’. Finally, we note that the definition of transit may also be expanded in future work to include systems designed for industrial and commercial purposes, such as rail and highway networks.

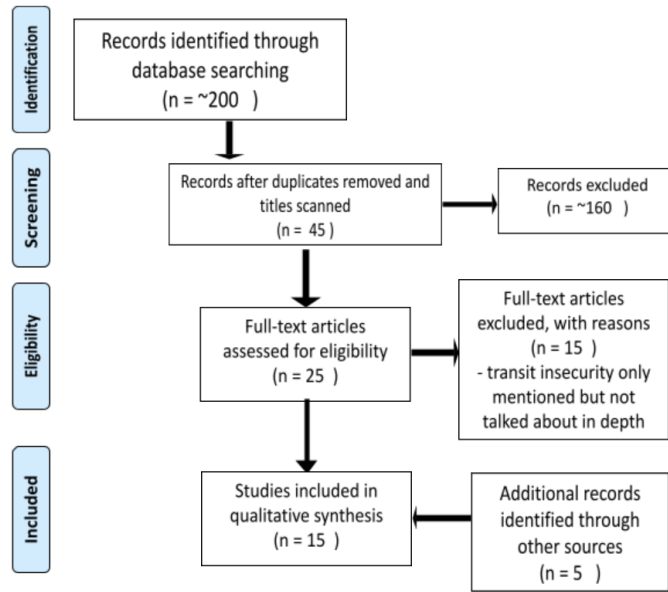
2. Method

In order to arrive at this paper's definition and metrics of transit insecurity, we performed a systematic review of literature on transportation. Based on the goal of identifying defining factors that impact transit security, the use of a scoping review was necessary to get a broad search of the relevant literature. The keywords used in the search for this review included: transit desert, transit insecurity, and transportation access. The term 'transit desert' was chosen for its close relationship to transit insecurity. Jiao and Dillivan (2013) define transit deserts qualitatively as "areas that fail to meet residents' travel demand due to insufficient transit service provision." Another way to define transit desert is to quantitatively compare transit accessibility (supply) to transit dependency (demand) (Aman & Smith-Colin, 2020). Since transit insecurity can be defined by both quantitative and qualitative studies, this review focused on mixed method studies.

2.1 Identification of Relevant Studies

The electronic databases utilized for this study were OneSearch (through the San José State University Library), Google Scholar, and ScienceDirect. For relevance, the articles were limited to the past four decades (1980-2020), and for practicality only articles written in English were considered. The syntax used in the search of databases was 'transit insecurity' OR 'transit desert' OR 'transportation access'. These initial search terms garnered a result of approximately 200 articles. After removing duplicates from different databases and scanning article titles, 45 distinct and relevant articles remained (SJSU Library: 35, Science Direct: 7, Google Scholar: 3). More than 50% of the articles were published in the last 5 years (2015-2020). Out of the 45 articles, 25 articles were found to be relevant from reading their abstracts. After reading the full papers, only 10 articles were included for consideration in this paper; 5 additional articles were added externally after studying the references of the initial 10 articles (Figure 1). The 15 selected articles include studies from China, Kenya, the United States, and Canada.

Figure 1. Systematic Review Process Flow Chart



3. Results

From these 15 articles, we distilled the factors affecting transit insecurity into four primary factors that contribute to a person or community being transit insecure: (1) income level (2) travel distance, (3) travel duration, and (4) accessibility.

3.1 Income Level

Unsurprisingly, several studies found transit insecurity to be more prevalent in lower income individuals or neighborhoods (Prayitno, 2017; Thomas et al., 2018; Cai et al, 2020). One of the reasons lower income individuals have a more difficult time accessing reliable transportation is that living in urban locations with better access to transportation is more expensive; persons with lower incomes tend to prioritize affordable housing over convenient transit access (Chen et al, 2020).

In a study focused on transit experiences in Toronto, Prayitno (2017) notes that “the rapid transit network is unevenly distributed across the city, which exacerbates social disparity issues between neighborhoods.” When living in suburban areas that are generally more affordable, transportation is limited to driving or using the comparatively restricted public transportation options. Individuals of lower income are less likely to be able to afford private vehicles, and so are highly dependent on public transit. Additionally, a separate study shows that a large population of lower income immigrants live in densely populated suburban neighborhoods in Toronto (Hulchanski, 2010). Though car use is a common form of transportation for some in the suburbs, “recent immigrants largely rely on [public] transit for most if not all of their commute” (Hulchanski, 2010). The lack of transit connectivity between the suburbs and urban Toronto presents a challenge for suburban residents whose jobs are located in urban areas (Prayitno, 2017). As a result, individuals with lower incomes often have to make long commutes to work.

A similar form of transit insecurity is identified in a Wuhan, China study where lower income populations also reside in suburban areas (Cai et al, 2020). Wuhan has many waterways that run through the city and requires transportation to get to the urban areas (i.e. walking is not an option), which makes many commuters public ‘transit dependent’. Public transit dependent commuters are individuals that rely on public transit for transportation to and from work or for everyday living activities such as grocery shopping. Jiao defines public transit dependent individuals as “people that are too young, too old, or too poor or who are physically unable to drive” (Jiao et al., 2013). Figure 2 demonstrates the correlation between lower income suburbs and the number of public transit dependent commuters in these areas, in contrast to their urban counterparts. Scarce public transportation in the suburbs has “forced low-income commuters to spend a larger share of their income and time on transportation” (Ahmed, Lu, & Ye, 2008). In part because they are forced to use commercial transit more often, individuals with lower incomes pay a larger percentage of their non-discretionary income for public transportation, stretching their already thin financial resources.

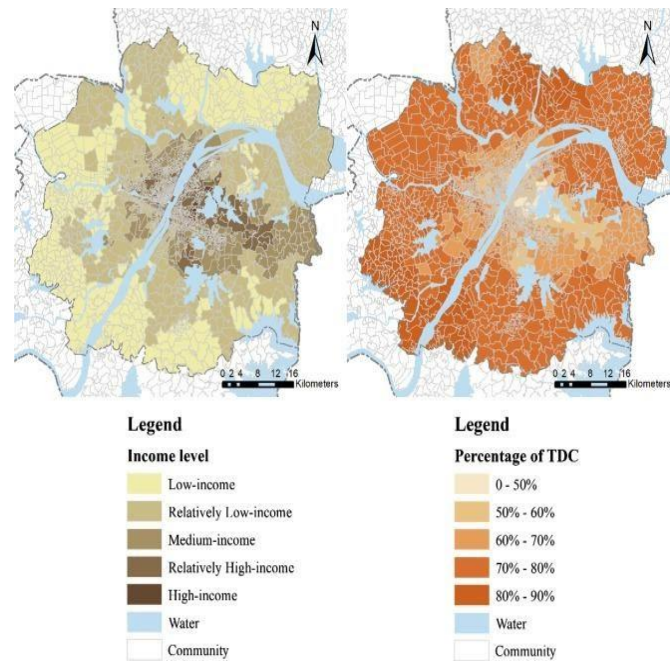
Areas that fail to meet residents' travel demands "due to insufficient [public] transit service provision" are defined as 'transit deserts' (Jiao & Dillivan, 2013). Cai argues that to reduce transit deserts and obstacles for lower income commuters and to increase transit equity, "it is necessary to... improve transport facilities in both central city areas and suburbs" (Cai et al, 2020). These improvements could increase transportation access for lower income transit-dependent commuters and thereby reduce transit insecurity in these communities.

3.2 Travel Distance & Travel Duration

Many studies suggest that long travel time and distances also contribute to persons or communities being transit insecure and exacerbate negative health outcomes (e.g., Thomas et al., 2018; Prayitno, 2017; Escamilla et al., 2019). In a specific case, Thomas et al's study (2018) analyzes transportation to health care facilities to determine whether transportation access had an impact on individuals with diabetes. Due to the long travel distances and wait times for public transportation, individuals with diabetes and no personal transportation often miss their appointments. As a consequence, individuals with diabetes had higher glycemic levels when they lacked transportation access and were not able to visit health care facilities for treatment. From this case, it is clear that travel distance, travel time, and access to transportation can have clear and deleterious effects on specific health outcomes.

Finally, several studies demonstrate the negative impacts that travel distance can have on an individual's likelihood to make use of health services. For example, a study done in Kenya found that women living in Nairobi's informal settlements reported long travel distance as a "reason for choosing to not give birth in a hospital but instead to give birth at home" (Escamilla et al., 2019). In contrast, for women living in neighboring urban settings, where transit is much quicker and more accessible, distance is "often not considered a deterrent" for accessing maternal health services (Escemilla et al., 2019). Distance was also found to negatively affect contraception use in Uganda (Cronin et al., 2017). This study found that travel distance was a primary reason for women discontinuing modern contraceptive use, whereas women residing closer to private clinics in urban Uganda were more likely to use modern contraception.

Figure 2. Spatial distributions of income (left) and public transit-dependent commuters (right). (Cai et al., 2020)



Contrary to the challenges of living in the suburbs, commuters who live in urban areas may have comparatively abundant transit options (Cai et al., 2020). As of 2017, around half the world's population live in urban areas, and this ratio is expected to increase to more than two-thirds of the world's population by 2050 (Sze, 2019). However, this increase in urban population may result in a large number of public transit dependent commuters in urban areas to compete for transit supply; as the demand for transit increases, so too will commuters' travel times if the provision of available transit does not also increase.

3.3 Transit Accessibility

A fourth factor in assessing transit insecurity is the ability of persons and communities to access transit facilities. As Sze et al. states, “It is necessary that the design of the built environment be supportive and provide adequate access to essential urban and social resources, e.g. employment, education, medical, social welfare and recreation etc., for all...” (Sze et al., 2017). Several studies have shown that “all” has not always been inclusive of individuals with cognitive impairments and individuals with disabilities (Anderson et al., 2015; Sohlberg et al., 2005; Sze et al., 2017). Access to transportation is especially important for those who are transit-dependent. As Jiao confirms, “Transit-dependent populations mark an increasingly important demographic of people who often are marginalized from society and excluded from access to employment, retail, and overall participation in society” (Jiao et al., 2017).

Though access to transportation is essential for individuals with disabilities, it is often an unmet need. Specifically, the cognitively impaired “have a greater mobility challenge,” since most are not able to get a driver's license (Anderson et al., 2015). Sze et al. found that the average travel time for individuals with impaired mobility is 80% higher than those not recognized as having limitations (Sze et al., 2017). Due to these challenges, individuals with disabilities or cognitive impairments have a harder time taking care of their medical needs, running errands to manage their personal needs, and end up missing out on social gatherings and other activities (Sohlberg et al., 2005). In contrast, better access to public transportation has a positive correlation with an individual's social participation, and therefore a better quality of life. As mentioned in Sze et al.'s study, “Accessible transportation is one of the key components that supports the community integration of individuals with disabilities, with individuals with increased access to transportation reporting greater quality of life and lower levels of social isolation” (Sze et al., 2017). Sze et al., also note a similar dynamic with elderly individuals (Sze et al., 2017).

Importantly, accessibility is not only a challenge for individuals with disabilities and cognitive impairments. Studies also show that accessibility can be impacted by other factors such as infrastructure constraints or safety concerns. In many large cities in Kenya, Matatus (privately owned mid-size vehicles) are the most common transportation method. However, from a survey conducted with women entering/exiting health facilities, the researchers found that poorly constructed roads restrict Matatus from traveling to informal settlements. Therefore, individuals who want to access informal settlements are required to walk to their desired destination, and people who live in informal settlements are required to walk longer distances to have access to Matatus (Escamilla et al., 2019). Challenges with transportation access were also identified by a study in Toronto where participants cited accessibility concerns over safety due to the lack of direct path to transit stations (Prayitno et al., 2017). These various global studies confirm that the issue of accessibility is multifaceted, and may include infrastructure and transit coming into a community (‘inbound transit’) as well.

4. Discussion

From the articles analyzed, we were able to group the factors that influence transit insecurity. These four factors are: (1) income, (2) travel distance, (3) travel duration, and (4) accessibility (Table 1).

Low income was a factor for transit insecurity because individuals either did not have the means to afford private vehicles, hence were dependent on public transportation, or they could not reliably afford public transportation. Additionally, affordability of housing pushed some individuals to move out to the suburbs, where public transportation is may be less available. Similarly, long travel distance and long wait times were factors of transit insecurity caused by a lack of transportation supply, also known as transit deserts. In these scenarios, suburban residents are required to travel a longer distance to access public transport. Yet, if individuals live close to public transportation (likely in urban neighborhoods), they face the challenge of greater demand, thus greater competition for transit supply and longer wait times for commuters. Limitations on the accessibility of transit are a particularly impactful way in which one might be transit insecure because they can compound with other ways in which persons can be marginalized, such as physical disabilities or cognitive impairments. The accessibility of transit can also be affected by safety concerns, infrastructure constraints, and a lack of direct path to and from public transport.

Table 1. Initially identified transit insecurity factors

Item	Factors*	Paradigm Studies
1.	Income Level	Prayitno, 2017; Thomas et al., 2018; Cai et al, 2020
2.	Travel Distance	Prayitno, 2017; Thomas et al., 2018; Escamilla et al., 2019
3.	Travel Duration	Escamilla et al., 2019
4.	Accessibility	Sohlberg et al., 2005; Anderson et al., 2015; Jiao et al., 2017; Sze et al., 2017

* Other factors are important and will be uncovered as researchers continue to investigate transit insecurity

Transit insecurity is important to analyze and understand due to its possible links with food insecurity and job insecurity. When transportation options are limited, a community's access to food and job opportunities are also hindered. In addition, calculating travel times, and budgeting for transportation expenses could add to the stress of being transit insecure by increasing mental load.

Minimizing transit insecurity not only has substantial benefits for individuals or communities, but also for the economic activity of a particular region. A study on the effect of transportation

accessibility on business activities established that “significant association exists between transportation supply and business activity in a given area” (Targa et al., 2005). The accessibility (enhanced by transit) of a location increases the resources available to residents of an area and increases the attractiveness of the location to individuals from neighboring areas along with new businesses.

4.1 Limitations

The goal of this paper is to draw attention to the issue of transit insecurity, to establish a conceptual framework to evaluate existing research on transit, and to provide a useful name for a breadth of issues that can be used to further research and policy moving forward. Naming and clearly defining a problem can serve as a banner around which to organize future research, which in turn can foster communication and collaboration between researchers, as well as between researchers and the communities where their research is conducted. Moreover, identifying and naming a problem helps to coordinate efforts to address it, which might include provision of public resources, private philanthropy, or market-based approaches. Finally, establishing a definition can provide the conceptual tools to assist in further policy discussions, activism, and forwarding the issue in public discourse.

There are many areas for further research, and expansion of the factors that may contribute to a person or community being transit insecure. For example, research on transit accessibility mostly discusses cognitive and physical impairments, but we note socio-cultural impacts as well, and the notion that not all groups feel equally comfortable on public transit; this kind of perceived insecurity is presently understudied. Another aspect of transit insecurity is that of “incoming” services, goods, and other resources. Unreliable access to transit systems, including highway and commercial rail networks, can impede the delivery of medical supplies, as well as the ease with which businesses, governmental resources, and others can enter a community. The four factors identified in Table 1 are therefore not intended to be an exhaustive list, and the authors are eager for others to join in adding to this list by identifying further factors that may contribute to persons or communities being transit insecure.

4.2 Technological Interventions

There are several potential solutions to different aspects of transit insecurity. Some obvious suggestions include lowering the public transportation costs, and increasing its supply, especially outside of urban areas. In addition, with the advancement of technology, some authors argue that “it is essential to enhance the availability of geospatial information of accessible facilities for pre-trip planning and real time navigation, to improve travel time reliability” (Sze et al., 2017). Especially for individuals with disabilities and cognitive impairments, it is suggested that use of a personal navigation device would be beneficial (Sohlberg et al., 2005; Anderson et al., 2015). A personal navigation device can provide information about one’s trip times, destination, and the transportation vehicle’s location on the road. The device can also guide the individual by sending

real-time notifications about when to get off the vehicle, or if the destination has already passed. In Sohlberg et al.'s study on community navigation in individuals with cognitive impairments (2005), bus drivers suggested that “personal devices could link to the GPS system on the bus without calling undue attention to the user by scanning the rider’s fare card,” which would help make bus rides more accessible. Similarly, Anderson et al. present the potential of smart-phone based applications to improve transportation access (2015). The goal for such smart-phone applications is to “deliver location specific and real-time cues” in order to allow individuals with cognitive impairments to “safely and effectively utilize public transportation” (Anderson et al., 2015). Some suggestions to achieve this goal include “remote system management” and “real-time monitoring” by taking advantage of the capabilities of smart-phones (Anderson et al., 2015). However, socio-technical and connected system approaches also bring software safety concerns, amongst other kinds of concern. Burns et al. (2018) describes this technological system as a Cyber-Physical System approach, and argue that, as more advanced technology is integrated into it, adhering to safety standards becomes even more important.

4.3 Future Work

Metrics of transit insecurity are highly context dependent; access to commercial transit, reliable roads, or vehicle repair facilities could be different factors that impact transit insecurity in different communities. Future work should expand our understanding of factors that lead to transit insecurity and metrics to quantify their severity. Similarly, there are numerous areas where the consequences of transit insecurity are under-explored. Future work on examining the impacts of transit insecurity on community and individual health, financial wellbeing, and overall wellness in the short term as well as longitudinally is needed. Intergenerational impacts of transit insecurity have not been reported using the same language proposed here; we hope that enlarging the umbrella with the term ‘transit insecurity’ will help shed light on these problems and assist in proposing and studying solutions to transit insecurity.

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