

## **Using Twitter to Investigate Responses to Street Reallocation during COVID-19: Findings from the U.S. and Canada**

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## **ABSTRACT**

The COVID-19 pandemic has challenged and encouraged local governments to reallocate street space. The chief purpose of new regimes of street management is to expand spaces for walking and bicycling, and to ease business interactions such as curbside pickup and dining while maintaining social distancing guidelines. We investigated how North Americans on Twitter viewed alternative uses and forms of street reallocation, specifically during the early months of the pandemic from April 1, 2020 to July 1, 2020. Relying on a crowdsourced dataset of government actions (Combs and Pardo 2021), we identified five areas of policy initiative that were broadly representative of government actions: cycling, walking, driving, business, and curbside. First, we identified a corpus of 292,108 geolocated tweets from the U.S. and Canada. Next, we used word vectors, built on this Twitter corpus, to generate similarity scores across the five areas of policy initiative for each tweet. Finally, we selected the top tweets that closely matched ideas contained in the areas of policy initiative, thus creating a finer corpus of 1,537 tweets. Using the five categories as guideposts, we conducted an inductive content analysis to understand opinions expressed on Twitter. Our analysis suggests that renewed use of the curb has opened up possibilities for reimaging this space. Particularly, business uses of the curb for dining and pick up zones have expanded widely, and there is more use of sidewalks; yet both spaces have limited capacity. Planners need to think of expanding these assets while reducing cost burdens for their alternative uses.

*Keywords:* COVID-19; Curb; Public commentary; Street; Twitter; Word vector

## 1. The COVID-19 Push: Re-imagining the public right-of-way?

The public right-of-way has been a contested space since the large-scale adoption of the automobile. Previously, pedestrians, bicycles, streetcars/trams, and animal drawn forms of conveyance shared the public right-of-way (Muller 2017). However, the arrival of the mass-produced automobile in the 1920s and its widespread adoption in the following decades challenged both the meaning and use of this space. The growing speed and volume of car traffic, over time, resulted in safety concerns and increased demands for efficient flow. New regulatory frameworks, often enshrined in engineering standards, created the sidewalk and the curb (Blomley 2010), and all uses that were deemed not to belong in the traffic lane were pushed to the edges. The multi-use, multi-modal street was divided into a roadway for vehicular traffic, and sidewalks for pedestrian use. The need to store the automobile led to the creation of parking standards, and the common solution was to move the idle vehicle to the curb (Shoup 2011). Thus, over time we have seen the car take over the public right-of-way, leaving designated slivers for other uses. From a design and practice standpoint, the roadway came to be dominated by moving or stationary automobiles.

This auto-dominance has not gone uncontested. By the early 1960s, traffic within urban areas, and its damage to social and built environments, was being problematized. This recognition was accompanied by calls for restrictions on car usage in cities and cautions that city authorities should not try to accommodate all future traffic demand (Buchanan 1963). By the late 1960s, public opposition to road projects, in particular freeway/motorway construction within cities, became increasingly widespread and was effective in stopping some plans (Langford 2012). From the 1970s, ideas such as Auto-Restricted Zones (ARZs), which sought to re-balance pedestrian and auto use in urban public spaces, were being trialed in American and European city centers (Gamble 1977; Herald and Alan Voorhees and Associates 1977). More recently, the automobile has seen pushback from other users of the public right-of-way (e.g., Marshall et al. 2016; Roe and Toocheck 2017; Sanders et al. 2020). Micromobility (Zou et al. 2020), entertainment (Sankalia 2014), public protests (Mitchell 2013; Németh and Carver 2017), and other alternative uses of the public right-of-way have confronted automobile-oriented standards, intensifying debate around the long-standing question of what this space ought to be.

The COVID-19 pandemic has upset the status quo around the meaning and consumption of the public right-of-way. With diminished vehicular traffic, and a need to find space for businesses and people to engage in the public realm, many cities have embarked on measures to re-imagine the public right-of-way, and in particular to expand the sidewalk and by extension the notion of a curb further into the roadway. NACTO and Bloomberg Philanthropies have made grants available to some US cities to encourage street transformation efforts during COVID-19 that focus on equitable health, transport, or food access (NACTO 2020). Combs and Pardo (2021), through crowdsourcing, have documented and analyzed street reallocation efforts due to COVID-19. Cities have indicated that most of these actions are temporary. Nonetheless, practitioners, advocates, and researchers are curious to see if these shifts in street management are efficient and might provide lessons for moving forward (Glaser and Krizek 2021).

Our motivation for this paper is to analyze opinions, using a large dataset collected via the social media platform Twitter, and gain insights about possible future redesign of the public street in the North American context. Our specific objective in this paper is to investigate public commentary on government policy in the first few months of COVID-19 when many cities changed how street space was allocated. In other words, we ask: what are people who are

tweeting saying about shifts in street reallocation during COVID-19?

Methodologically, this paper relies on machine learning techniques capable of mining textual information using an algorithm-based model (Pennington et al. 2014). Textual mining using machine-learning techniques has emerged as a method in transportation research (e.g., Biehl et al. 2018; Schweitzer 2014). Specifically, the use of geo-located tweets to connect public commentary to locations has gained attention in the academic literature (e.g., Ferster et al. 2021, Reynard and Shirgaokar 2019; Wu et al. 2017; Yazici et al. 2017). We relied on the dataset of policy actions (Combs and Pardo 2021) to identify five areas of policy initiative, namely, cycling, walking, driving, business, and curbside. For these five areas, we used word vectors to assign each tweet that was geolocated in North America a score between -1 and 1, which indicated the strength of the link between each tweet's content and ideas contained in the areas of policy initiative. We cut the corpus of geolocated tweets (N=292,108) down to a smaller set (n=1,537), and used the five areas of policy initiative as guideposts to conduct a deeper qualitative assessment.

## **2. The various uses of the curb and travel during COVID-19: A literature review**

### *2.1 The traffic and non-traffic uses of curb space*

Planners and researchers have talked about pricing for efficient resource allocation of parking (Alemi et al. 2018; Dey et al. 2016; Rivadeneyra et al. 2017), a use that typically dominates a large portion of the curb. Curb space, which cities have rarely managed effectively, is also in demand for delivery vehicles (Girón-Valderrama et al. 2019), bus services (Klein 2015; Klein 2016), and micromobility (Sanders et al. 2020; Zou et al. 2020), among other travel needs. Ride-hailing, however, may be shifting parking demand away from curb locations adjacent to businesses (Henao and Marshall 2019; Tirachini 2019), thus, potentially opening up capacity for other uses. In the autonomous vehicle future, curb space may indeed need to transform from a place for parked vehicles to a dynamic zone for pick-ups and drop-offs since vehicles may possibly be stored away from high-demand areas (Zhang and Guhathakurta 2017).

Urban Design offers lessons on how the curb may be repurposed (Cervero et al. 2017; Ehrenfeucht and Loukaitou-Sideris 2010; NACTO 2013; NACTO 2014), including to improve walkability (Adkins et al. 2012; Macdonald et al. 2018; Said et al. 2020) and velomobility (Duncan 2017; Forsyth and Krizek 2011). Much of the recent challenge to the vehicle-centric design of streets has been made possible through tactical urbanism (Campo 2016; Marshall et al. 2016), as well as other alternative uses of the curb such as food trucks (Ehrenfeucht 2017), or directly sitting on the curb or sidewalk (Sankalia 2014). These variegated efforts offer lessons on how to potentially repurpose the public right-of-way, especially in light of recent shifts in urban street management. During COVID-19, researchers have been building a deeper understanding of contemporary street use policies (Combs and Padro 2021), and finding that innovation and experimentation are increasing, although many of the changes to streets may be temporary (Glaser and Krizek 2021).

### *2.2 Travel during COVID-19*

Travel has been constrained during the COVID-19 pandemic largely due to the shelter-in-place orders affecting many jurisdictions (Praharaj et al. 2020). Roads saw a drop in traffic volumes

(Beck and Hensher 2020; Plumer and Popovich 2020) and transit agencies experienced reduced ridership (Basu and Ferreira 2021; Hu and Chen 2021; Teixeira and Lopes 2020; Wang and Noland 2021). A preference for traveling in non-shared modes became evident (Jabbari and MacKenzie 2020; Ozbilen et al. 2021a). However, impacts of public health policies were different across demographic groups. Low-income individuals and persons of color still needed to make essential trips (Goldbaum and Cook 2020; Kim and Kwan 2021; Lou et al. 2020).

Nevertheless, as time has passed there has been a rebound effect with more car-based commuting (Beck et al. 2020) and active transportation for leisure (Hu et al. 2021). There have also been location- and demographic-specific shifts with some places seeing increased outdoor activity among children (Mitra et al. 2020) or active travel as a means to be outdoors in suburbia (Tokey 2020). Public transit has remained critical, even with reduced services, for low-income communities and those in essential trades (Goldbaum and Cook 2020; Hu and Chen 2021). Additionally, lower preferences for returning to transit in the general population (Rauws and Lierop 2020), coupled with projected shifts to automobile commuting (Base and Ferreira 2021), and new policies for transit agencies to operationalize public health rules, seem to be on the horizon (Hörcher et al. 2021; Kanga and Eickemeyer 2021; Kumar et al. 2021). Scholars remain unsure of how transit may reemerge from the COVID-19 pandemic.

In contrast, walking and bicycling trips have increased, especially for high-income households who can telecommute as well as in locations with lower density (de Haas et al. 2020; Greenfield 2020; Ozbilen et al. 2021b; Teixeira and Lopes 2020; Zhang and Fricker 2021). Some individuals are indicating that they might keep engaging in active travel and other outdoor activities after the pandemic (de Haas et al. 2020). Bike-sharing, often supplied in high density locations, had experienced a substantial drop in use at the beginning of the pandemic but has rebounded as lockdowns have eased (Hu et al. 2021; Wang and Noland 2021).

In summary, as of the time of writing, evidence suggests that we are seeing less travel overall due to COVID-19, with transit being the most negatively impacted mode. Yet, there seems to be an uptick in travel by bicycling and walking in many locations, and a renewed interest in utilizing street space for non-automobile uses. More broadly, the dominant use of the curb for parking cars is increasingly being challenged by other uses such as just-in-time delivery services, micromobility devices, and pick-up/drop-off for ride-hail users. Moreover, urban designers have been reimagining the curb and sidewalk in new ways that have entered public discourse (NACTO 2013; NACTO 2014). The literature indicates that the time may be right during this pandemic to examine critically what the public right-of-way could be.

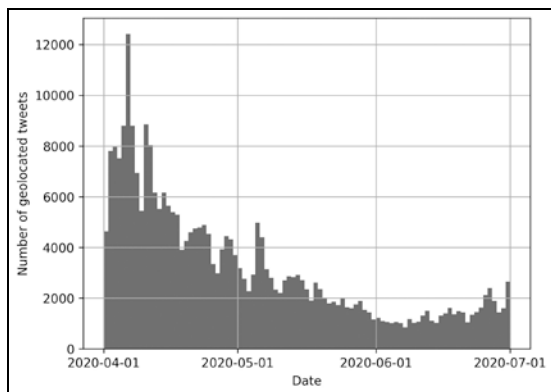
### **3. Data assembly and analytical approach**

#### *3.1 Twitter corpus: Assembly, strengths, and limitations*

We collected data for this research from Twitter using the free Application Programming Interface (API) (Twitter 2021). We wrote a Python script to search Twitter for the hashtags #COVID19, #coronavirus, or #socialdistancing, since our interest was to capture opinions about anything related to the pandemic at the early stage. We selected these hashtags after analyzing the most commonly used hashtags in the early days of COVID-19. This enabled us to gather wider commentary during the early months of the pandemic. For the current paper, we focus on a specific question related to street reallocation that can be explored using this pandemic Twitter dataset. Tweets were collected from March 18, 2020 to July 1, 2020. Due to an API limitation of

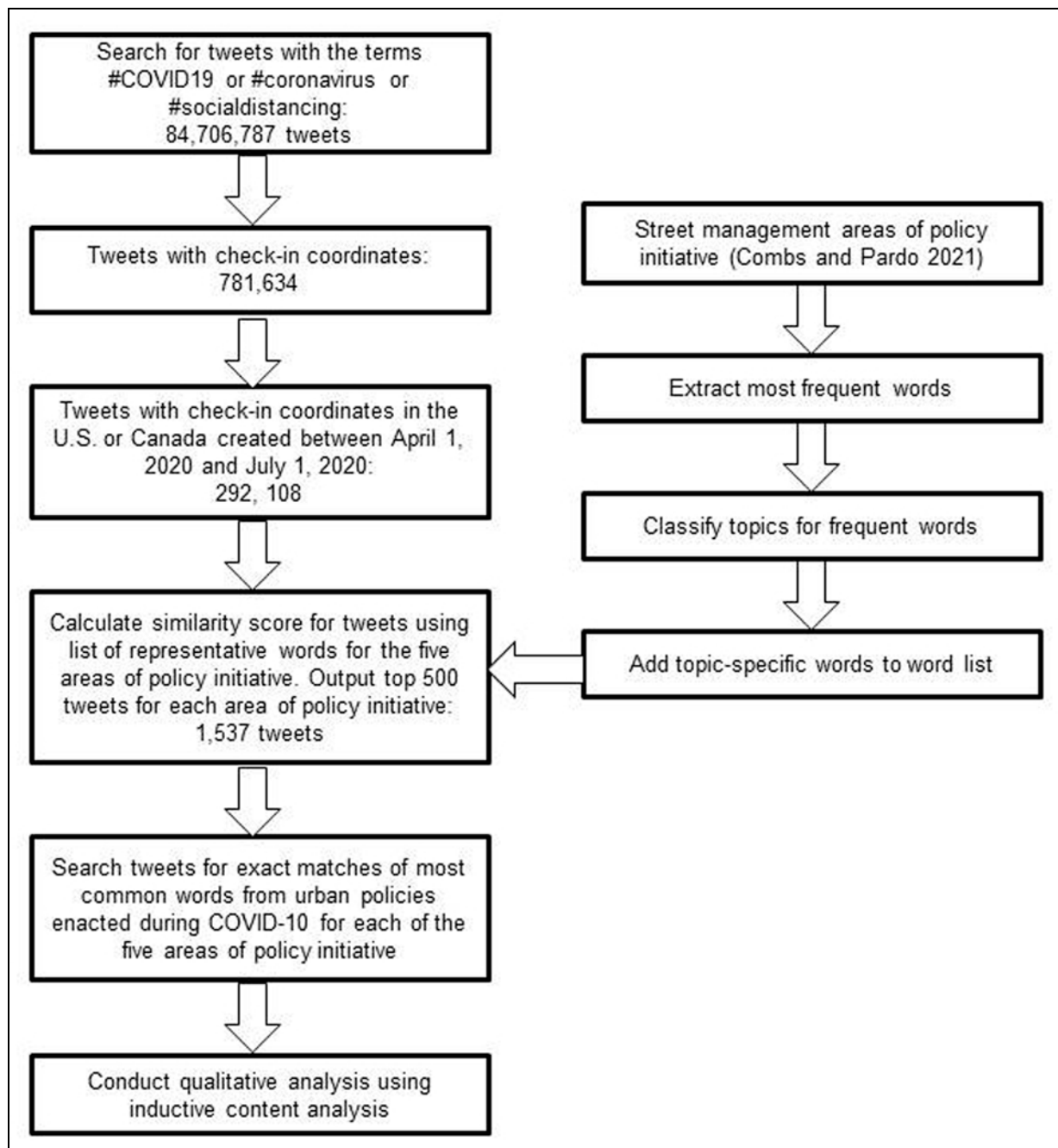
returning 72,000 tweets per hour (Twitter 2021) and the vast number of tweets sent out during the beginning of the pandemic, gaps exist in the database prior to April 1, 2020. Tweets sent out approximately 1.93 million tweets matching the search terms just on March 19, 2020, for example, assuming no missing tweets that day. Since Twitter allows 1.73 million tweets to be collected per day, more tweets were being created that day than could be collected. In addition, the number of tweets being collected overwhelmed our initial method of storage. Beginning April 1, 2020, tweets were stored in a postgresql database which enabled the algorithm to store and retrieve tweets more efficiently, and fill gaps in the collected tweets, in case collecting tweets was interrupted due to a network error. We took a conservative approach and restricted the date range for this paper to tweets collected from April 1, 2020 to July 1, 2020 (**Figure 1**). We then selected tweets which were geolocated. These geolocated tweets represent 0.92% of the total tweets collected.

There are multiple methods for geolocating a tweet (Graham et al. 2014) but there are three common techniques. First, a user can geotag the tweet, which embeds their current latitude and longitude, as read from their device's GPS or triangulated from how the device is connected to the Internet. Second, a user can check-in by selecting the location where they are when they create the tweet. For example, a user can check-in to a store, park, community, city, state/province, or country. The tweet is then embedded with the latitude and longitude coordinates of the smallest box that contains the entire check-in location. This is the location's bounding box. The final method of locating a tweet is by using natural language processing (NLP) to infer a location from the text contained in the tweet. For this analysis, we included tweets with user geotags or bounding boxes since this let us have confidence in placing tweets at specific locations in the U.S. or Canada. We did not rely on NLP methods because tweets may have words that indicate locations but can be from anywhere in the world. For example, "praying for New York #COVID19 #coronavirus" can be from someone who is not tweeting from New York, or indeed from within the U.S.



**Figure 1** Distribution of geo-located tweets collected by date

The processing steps for the collected tweets were as follows: the tweets with bounding box coordinates were extracted from the postgresql database, the text of each tweet was cleaned, a list of representative words for each of the five areas of policy initiative was created, the similarity between the tweets and a list of representative words was calculated, a manual word search was conducted on a reduced tweet corpus, and the tweets were qualitatively analyzed using inductive content analysis to understand the opinions expressed. A flowchart of the major processing steps is presented in **Figure 2**.



**Figure 2 Decisions for identifying tweets for this research**

The text of the tweets was cleaned by removing URLs, Twitter usernames, and special characters, like & and RT:. Next, the text was tokenized by converting it to a list of individual words, converting all words to lowercase, and stripping out spaces. Stop words, which are short, common words (e.g., a, I, and) were also removed. An example is,

Original tweet: *Looking for local bookstores in Manhattan that may be doing curbside pickup -- anything out there? #midtownwest #supportsmallbusiness #COVID19*

Transformed information used in analysis: *looking local bookstores manhattan may curbside*

*pickup anything #midtownwest #supportsmallbusiness #covid19*

Although Twitter corpora have been used in transportation research (Ferster et al. 2021; Reynard and Shirgaokar 2019; Schweitzer 2014; Yazici et al. 2017), these data have strengths and limitations that need to be acknowledged. On the one hand, social media data are plentiful (often in the millions), distributed across large geographies, and oversample from the young and educated who are generally not active in other venues of formal public engagement. These data are relatively cost effective to collect, and using NLP methods, easy to analyze. On the other hand, social media is not widely used especially among subsections of the population that may be negatively impacted by social policies and disasters like pandemics. Features like geolocation are used by a small percentage of total users (Sloan and Morgan 2015), and privacy laws in various geographies may limit critical voices. Hence, based on the research topic and geography of interest, the analysis produced may not be generalizable to the population. Yet, such analysis can offer insights into public commentary from a large subsection of the population about a topic of interest.

### 3.2 Querying policy actions about street reallocation

To develop a thematic understanding of how cities reallocated street space, we relied on a crowdsourced dataset of changes in street management policies (Combs and Pardo 2021). Although their dataset had worldwide information, we focused on policy changes in the U.S. and Canada where the announcement date for the policy was in the same time frame as that of our tweet corpus i.e., April 1, 2020 to July 1, 2020. Further, of the total number of actions reported in the policy database, we focused only on the 144 actions related to curb management (**Table 1**).

**Table 1 Policy actions in the U.S. and Canada for street reallocation**

Policy action	Number of instances
Reallocated outer lane/curb space	43
Dedicated public space to outdoor dining/retail, Closed streets to motor vehicles	37
Dedicated public space to outdoor dining/retail	34
Dedicated public space to outdoor dining/retail, Reallocated outer lane/curb space	18
Other strategies: miscellaneous (impacts on curb)	5
Dedicated public space to outdoor dining/retail, Closed streets to motor vehicles, Reallocated outer lane/curb space	4
Closed streets to motor vehicles, Dedicated public space to outdoor dining/retail	2
Implemented shared streets, Dedicated public space to outdoor dining/retail	1

Relying on the more specific policy descriptions for these 144 actions, we ran a word cloud analysis to identify the focus of street reallocation in North America (**Figure 3**). We used an online tool (Steinbock 2021) and removed words such as COVID-19, and, the, etc., and then focused on the 100-most used words. We came up with five areas of policy initiative from this assessment: cycling, walking, driving, business, and curbside. We contend that these five areas capture specific policy ideas that constitute the rationale for reallocating street space. For example, words such as dining, outdoor, patio, restaurant, and seating are represented by the area

of policy initiative “business”. Though “driving” is not in the top-100 words (**Figure 3**), we included it since it speaks to the primary use of the public right-of-way.



**Figure 3** Word cloud of descriptions of street reallocation policies about the curb

### 3.3 Similarity scores for tweets linked to the areas of policy initiative

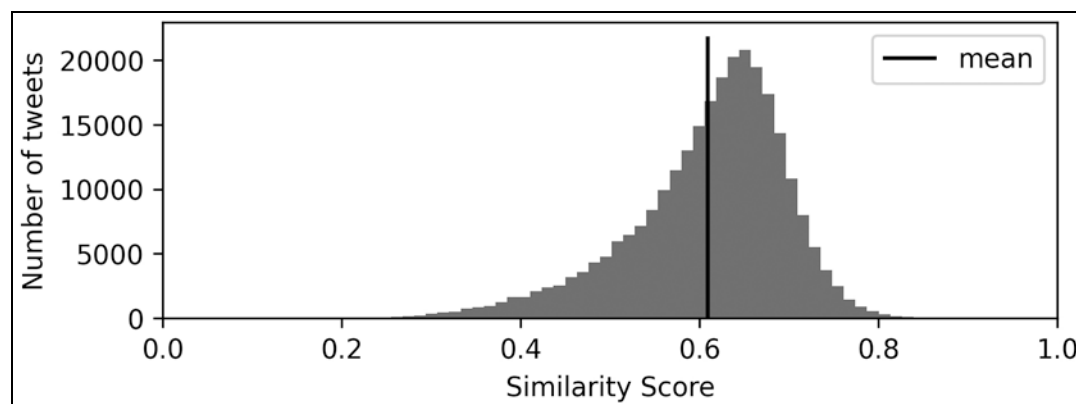
The cleaned tweets were scored using the word vectors algorithm (Word2Vec) from the gensim library (Řehůřek and Sojka 2010). The `n_similarity` algorithm takes two lists of words as its input and returns a value between -1 and +1. The more similar the two lists of words are, the closer the returned value is to +1. For this analysis, each tweet from the cleaned Twitter corpus represents one list of words and the second list consisted of representative words for each of the five areas of policy initiative. The most common words in the policy descriptions were analyzed and sorted into the list of words for each of the five areas of policy initiative (**Table 2**).

**Table 2** Representative words focusing on areas of policy initiative

Cycling	Walking	Driving	Business	Curbside
bike	sidewalk	car	dining	bike
curbside	walking	parking	outdoor	curbside
cycling		space	patio	lane
sidewalk			restaurant	parking
			seating	patio
				restaurant

As an example, the distribution of the similarity scores for driving, which show how similar each tweet is to the representative list of words denoting driving, is shown in **Figure 4**. This figure shows that there is high similarity (>0.6) on average between our list of words representing notions of driving and the cleaned Twitter corpus.





**Figure 4** Distribution of driving similarity scores

The  $n$ \_similarity algorithm calculates the cosine difference between an aggregate of the two lists of words, one list being the words in a tweet and the other being a list of representative words (**Table 2**). The algorithm requires each word in the lists to be represented by a vector with direction and distance. There are two ways to obtain the vector representation of each word. One way is to use gensim algorithms to train a model based on the tweets in the corpus. The second way is to use a pre-built model. A model created from the corpus is more specific and may reveal concepts specific to that corpus. For example, in the model trained from the COVID-19 Twitter corpus, the vector representing social is most similar to the vector for words like physical, practicing, and many variants of distancing. Phrases like practice social distancing and physical distancing have been commonly used during the COVID-19 pandemic.

In a pre-built model, however, the vectors for each word usually represent their more general meaning. Specifically, in the pre-built model tested for this analysis, social is most similar to words like media, network, or popular. While a pre-built model may miss the close similarity between words in corpus-specific phrases, it may yield results that are more widely applicable to other research or corpora. This is because the pre-built model uses a wider vocabulary. Another advantage of using a pre-built model is that other researchers can use the pre-built model to reproduce results, thus encouraging replicability. For this analysis, we tested the Twitter pre-trained word vector model GloVe (Pennington et al. 2014). This model was created from two billion tweets and has a vocabulary of 1.2 million words. Despite the strengths of using a pre-built model, a model built from the collected tweets was used because it was more likely to reveal concepts specific to this COVID-19 corpus and our research objectives.

### *3.4 Qualitative analysis*

Word2Vec was a first-pass method for selecting the tweets which were most likely to contain text about the five areas of policy initiative. The top 500 tweets for each area of policy initiative were used to create a reduced corpus of tweets for the qualitative analysis. This dataset contained 1,537 tweets as there was high correlation between the tweets most likely to contain text about one or more of the five areas of policy initiative. The minimum Pearson's correlation coefficient between the five groups of tweets was 0.8. One additional step was used to find the most relevant tweets for the qualitative analysis. For each area of policy initiative, each tweet was searched for exact matches to key words. **Table 3** lists the keywords that were used. Socialdistancing was included as a single word as it tended to appear as a single word in a hashtag. The tweets with

the highest number of exact matches were read first and tweets with no exact matches were dropped from the analysis. For each area of policy initiative, at least 100 tweets were analyzed.

**Table 3 Keywords used to identify tweets focusing on areas of policy initiative**

Cycling	Walking	Driving	Business	Curbside
bike	pedestrian	car	dining	curb
cycle	run	drive	patio	curbside
cycling	socialdistancing	driving	pickup	patio
ride	walk	socialdistancing	restaurant	social
socialdistancing		suv	seat	socialdistancing
		traffic	socialdistancing	
		truck	table	
		vehicle	tent	

We treated the five areas of policy initiative as *a priori* categories for our qualitative analysis since they are external to the Twitter corpus, and were created deductively through a word cloud analysis of policy descriptions from the U.S. and Canada (Combs and Pardo 2021; see **Figure 3**). We conducted inductive content analysis *within* each of the five areas. We relied on the coding process using key words (**Table 3**), and without relying on any predetermined theories investigated what the tweets were revealing. The tweets reported in Tables 4-8 have been cleaned slightly for language only where necessary.

## 4. Findings about the five areas of policy initiative

### 4.1 Cycling

Cycling was overwhelmingly portrayed as an enjoyable form of mobility that allowed social distancing to be maintained during the pandemic. The types of cycle journeys described were primarily recreational, for both solo and group rides. Tweets emphasized the value of cycling as a way to explore scenery, exercise and connect with family and friends, while maintaining a safe distance from others (**Table 4**). Very few negative interactions with other modes (e.g., automobiles) were reported. Indeed, tweets that commented on the space available to cyclists tended to be positive, noting increased space due to either reduced vehicular traffic during the pandemic, or specific measures to ban cars from certain roads in order to support socially-distanced walking and riding (e.g., open street initiatives). Conversely, a smaller number of tweets mentioned the loss of space for cycling due to some cities closing parks and trails to the public in efforts to reduce COVID-19 transmission, which was said to have the unintended effect of concentrating people elsewhere, i.e., undermining social distancing. Relatively few tweets mentioned cycling in conjunction with commercial activity, such as visiting a cafe, bar or restaurant. The emphasis was on the quality of the cycling experience, paired with the imperative of social distancing.

**Table 4 Illustrative tweets about cycling**

Rode to Atlantic Blvd and back on my bike. Such a pretty day to ride a bike & easier to stay distant! #SocialDistancing
It's fun to bike with a friend during #lockdowns but still maintain #SocialDistancing.
Went on an 11 mile bike ride today in the gorgeous weather! So nice to get out and it was so much fun! #socialdistancing #gettingoutside #thanksgabe #quarantinedinvegas
Beautiful weather for a solo ride on some incredible roads! Very little traffic as well. I counted 6-7 cars that actually passed me! #socialdistancing #covid_19 #cycling #cyclistsofinstagram #outsideisfree
Pics of the last couple weeks of getting out a bit BUT still #socialdistancing Weird (and fun) to be able to bike downtown #Chicago with almost no traffic. #bikeride #sunnyskies
#covid19 #datenight Bike ride on the Southwest path and up State St followed by @graftmadison takeout dinner on the balcony. #downtowncondolife @ Downtown Madison
No Cars allowed in Stanley Park, more space to walk and bike for #socialdistancing @ English Bay
Enjoy #ActiveTO spaces this long weekend, close to #RiversideTO find closures of River from Gerrard to Bayview and Bayview from Rosedale Valley Rd to Mill St. Walk, bike, roll, while #socialdistancing :) thx @cityoftoronto
@LoriLightfoot fencing off the lakefront and parks is only making #socialdistancing harder. You're forcing everyone (runners, bikers and pedestrians) to use the same, more condensed sidewalks. NYC still has all the parks and paths open, fencing only makes it worse!
We need #OpenStreets to provide proper #SocialDistancing spacing for people to walk and cycle. Our sidewalks are too narrow. People are crowding the BeltLine because it is one of the few safe places for people, away from speeding vehicles.

#### 4.2 Walking

Tweets about walking overwhelmingly focused on social distancing, encompassing positive experiences, but also concerns about the difficulties of maintaining 6 foot / 2 meter distances between people on sidewalks (**Table 5**). Positive walking experiences were described as those where social distancing was observed, in combination with a feature such as good weather or exposure to nature. However, complaints about other people not respecting social distancing, which detracted from the walking experience, were common. Many tweets referred to the complex, impromptu “negotiations” that occurred between pedestrians as they encountered each other and moved aside (or not) in order to maintain distance. The increased personal space required by social distancing rules was especially difficult to maintain in crowded areas, including commercial streets where outdoor dining effectively narrowed sidewalks. While a small number of tweets noted initiatives to close some traffic lanes to cars, the more common observation was of a lack of space for pedestrians, with some calls for additional closures / open street initiatives. The walking that was described was almost exclusively recreational, with no direct references to walking for commuting, and only a handful of mentions of walking to/from a place of business.

**Table 5 Illustrative tweets about walking**

<p>This morning Kalakaua was closed to vehicular traffic. Perfect for walking, running, biking, skateboarding and other activities. It all happens again the next 3 Sundays. Come out and enjoy Waikiki. #OpenStreetsSunday #ActWithCare #SaferAtHome #SocialDistancing</p>
<p>Positive interventions for #cabinfever Light up NYC #summerstreets. Extend sidewalk by blocking traffic on a street lane. Lanes are 10-12ft wide! Easy #socialdistancing with fewer cars on NYC aves. Let's block a few NYC lanes. @NYCMayor @NYC_DOT @NYTMetro</p>
<p>Some streets near us closed for walkers, runners, bikers, doggies, and humans this weekend. it was wonderful #socialdistancing #brooklyn #newyork #flatbush #justagirlandherdog @ Flatbush, Brooklyn</p>
<p>My neighborhood needs guidelines for which side of the street to run/walk on. It's chaos out there!!! Ran yesterday and came home frustrated from the number of times I had to cross the street or move into the road. #SocialDistancing</p>
<p>When you see someone walking towards you on your run, but there's also people across the street so you run back and forth the same stretch of sidewalk until you hit your move goal. #SocialDistancing #WednesdayVibes #NewNormal</p>
<p>If you're out on a walk, and someone else is walking towards you; what's the etiquette for moving 6 feet apart? Most sidewalks aren't wide enough. Does one of us move to the street? Can we walk on someone's yard? Who initiates the move? #SocialDistancing</p>
<p>Anyone feel like it's a game of chicken when walking on a sidewalk? Who's gonna yield and walk on the grass or the street to maintain #6feet? #SocialDistancing</p>
<p>#SocialDistancing hack If someone is walking toward you on the sidewalk, all things being equal, the person facing traffic should be the one to walk in the street. It's safer. If one person has a dog or a walker, sure, adjust.</p>
<p>This is how we get another #COVID19 spike. No social distancing. Tables on both sides of sidewalk, when the sidewalk isn't 12 feet wide - outside Vern's. How can people safely walk down that street? These businesses have turned it into a no-pedestrian zone.</p>
<p>#bucketlist Did my 3 mile walk of exercise yesterday by Crossing the #brooklynbridge It was hard #socialdistancing as it was a beautiful day and there were lots of people. I wore my mask though. @ Brooklyn Bridge</p>

### 4.3 Driving

Driving themed tweets were split into two groups: those that expressed satisfaction with driving and the opportunities it presented, and those that voiced concern about how mismanaged driving had become (**Table 6**). Some tweeters encouraged getting out since traffic was low, while others cautioned about stunt drivers or speeding cars, which had become more common due to the low-traffic streets. Driving served more purposes than just running errands or pleasure trips. Vehicles were used in new ways to attend funerals, participate in protests, and access COVID-19 testing. One tweeter noted that these trends were “car owner exclusive” and disadvantaged those who relied on other forms of mobility. It was evident that people were trying to lead reasonably engaging lives, and that driving played a role in this. Driving was used to access natural open spaces (trails, parks, etc.), with both governments and private citizens encouraging this behavior. Some residents near these open spaces complained that spillover parking was creating issues in their neighborhood. Other tweeters offered specific suggestions about how to redesign open

streets or shared streets. Cyclists, specifically, offered up that the reallocation of driving space during COVID-19 should become the norm with expanded space for bicycling and other uses.

**Table 6 Illustrative tweets about driving**

@shawnmicallef We need a rethink in the suburbs too. After authorities closed the waterfront parking lots, cars are spilling over to the residential side streets as people drive in from far and wide in search of safe #SocialDistancing.
Take advantage of the empty roads and take your car out for a drive. Letting your car sit idle for too long can cause hefty repair bills. Driving it regularly can stop your battery from being drained. Just remember to stay in your car! #COVID19 #essentialbusiness
To my car driving friends: that 6' #SocialDistancing space during the pandemic is the same space you should give when passing a bike. Please remember as we start to reopen! @TheWarOnCars #BeSafe #SixFeetPlease
@gordperks @seanclarke81 Did you ask if there is risk for pedestrians walking in the street for #SocialDistancing when record numbers of drivers are stunt driving?
Sitting outside, @PhiladelphiaGov there seems to be a lot more cars driving up and down the @avenueofthearts people walking, jogging & cycling with #mask this weekend #staysafe keep on #SocialDistancing Exercise for Sanity's Sake #itsgoingtobeok
It's a great weekend to get outside and #hike on the @CoconinoNF. The Kelly trail system is about a 20-minute drive from Flagstaff and has miles and miles of low-traffic loops that are great for #SocialDistancing! @forestservice @DiscoverForest
It's a different kind of memorial for Clark Osojnicki, a victim of #COVID19. His widow hosting a "drive by" visitation. Steady stream of mourners are rolling thru the parking lot, waving & sending love thru their vehicle windows to respect social distancing/crowd size guidelines.
When out for essential travel, remember to drive within the speed limit. Less cars on the road does not mean drive faster. Maintain safe speeds and be extra cautious for the increase in pedestrians and cyclists. #Speeding #PedestrianSafety #CyclistSafety #COVID19 #MRHSSADD
I'm a bit on edge from the many car owner exclusive trends RE #COVID19 (i.e. Drive thru service requiring cars, car graduations). I get the intent behind these actions, but there's gotta be a better way to provide such services/activities without excluding those without cars.

#### 4.4 Business

Businesses used Twitter to advertise how they were adapting practices in lock step with state/provincial and local public health policies. In particular, many businesses tweeted (**Table 7**) about restaurant dining to communicate with potential customers about indoor and outdoor options, especially as alternatives to pick up/delivery. Comparatively few tweets were from other business types where patrons could walk in, follow public health guidelines, and leave after conducting their business in a short time. Restaurants came up with creative ways to follow public health guidelines, including expanding outdoor dining into the street (e.g., into bike lanes and parking lanes), using tents, and filling up seats with mannequins to enforce social distancing. Patrons commented on the experience of dining with social distancing rules, usually positively, although some tweets reported on crowding and non-compliance. Media outlets generated avenues for discussion, offered insights on what was working, and helped interpret shifts in public health regulations. In many tweets, references were made to state and local leaders, who were supporting opening businesses. Government support for outdoor dining was evident in waiving fees on patio conversions and allowing expansion of the dining area onto the curb, and even into the street in some locations.

**Table 7 Illustrative tweets about business**

@justindotnet @GovernorVA Starting Friday, June 12, 2020 Northern Virginia restaurants will be able to offer indoor dining at 50% capacity. Enjoy a nice dinner out! Fitness centers and gyms can open indoor areas at 30% capacity. Go workout! #COVID19
#onassignment #fox5news #coronavirus #nyc re-start Phase 2 - outdoor dining in the bike lane & parking lane so customers can socially distance. Some say it's a little crazy but restaurant owners say it's their only way.
@FullertonCA has closed parts of its Wilshire Bicycle Blvd so restaurants can have more room for outdoor dining amid #Coronavirus shutdowns. You'll hear some cyclist's response when you tune in to @KFIAM640 #OrangeCounty #BAAW #Fullerton
First time eating out in months. #fathersday #outdoordining #socialdistancing No one sitting at the sanitized tables near us. @ Iron Hill Brewery & Restaurant
#HappeningNow - announcing @HempsteadTown initiative to help jumpstart #restaurants on the road to recovery, by waiving fees and cutting red tape to allow for expanded outdoor dining permits once #COVID19 restrictions are lifted to re-open for dining.
The @InnatLittleWash, a Michelin Star restaurant in Washington, Virginia found its very own solution to enforce #SocialDistancing and still appear busy by using well-dressed mannequins seated at empty tables. #TheInnAtLittleWashington #restaurantstrong
#coronavirus #westpalmbeach #PalmBeach #SocialDistancing they are getting creative here in Palm Beach county by expanding usable serve(able) space for local restaurants, streets used for tents and tables, rather than cars, parking lots nearby. So far, so good
10 were cited at Uncle Tito's in Murrells Inlet for violating the state's order forcing restaurants & bars closed during the #coronavirus pandemic. Police went to the bar Friday night, finding people seated & standing throughout the bar area; patrons also had alcoholic beverages.
@epdevilla @JohnTory Physical Distancing isn't happening much on restaurant patios. Walk along the Danforth from Broadview to Pape and majority have not limited tables. Astoria one of the few limited tables. #CommonSense #SocialDistancing #Masks
As #coronavirus restrictions ease in Boston, many restaurants placed seating on the street, and the city is absolutely packed.

#### 4.5 Curbside

Most of the tweets were about promoting curbside activities, such as seated dining and pick up as a means of attracting patrons (**Table 8**). Curbside pickup mandated by many jurisdictions was often mentioned in tweets by businesses seeking to advertise and capitalize on such activity. Most abundant were dining locations, but there were also mentions of surfboards, bicycles, coffee, automotive services, nursery/gardening, books, pet grooming, and other businesses, all encouraging curbside pickup. Many businesses were asking for local support through ordering online followed by contactless drop off at customers' cars. Patio space was being leveraged as a feature to attract patrons. Some businesses were thinking about converting existing parking space into other uses including dining and pick up loops. One tweeter, however, was critical of this movement toward a pick-up culture arguing that it would compound automobile dependence. Private businesses were viewing outdoor areas surrounding their indoor footprint as opportunity space for expansion.

**Table 8 Illustrative tweets about curbside**

Left the house for curbside pickup from @dinechartier today. I popped the hatch, they plunked the bags in the back, no contact, we were very far apart, easy peasy. Many #yegfood places now have this option, it's easy to #SupportLocal. #SocialDistancing #TheirDoughnutsRock #yeg
Day 78 of being home... Wills Family Dinner from La Paz Mexican Restaurant. I called at 4:40pm, then @mdub71, Liem, and I picked it up curbside at 5:05pm. #eatlocal #socialdistancing #covid_19 @ La Paz Mexican
Although our store front is open, for those not feeling comfortable coming in, you can take advantage of our curbside pickup! #GearUpAtGearUp #ShopLocal #CrazyTimes #Coronavirus #Covid19 #SocialDistancing #curbsidepickup
Our doors are locked. We are closed to walk-in traffic. We are taking phone-in and on-line orders for contactless delivery or contactless curbside pickup. Tuesday to Saturday 10-5 Please stay safe! #wewillgetthroughthis #RegalFlorist #socialdistancing #Easter #EasterDecor
@OpportunCity I see the very same in my suburban community: longer than ever line-ups at drive thrus and curbside pickup lanes. Without healthy and safe mobility alternatives, #SocialDistancing could make life in the burbs even more car dependent...
Brunch in the times of a pandemic. Eating takeout on the curb of an empty church parking lot. #SocialDistancing #wewearmasksinpublic #keepingyousafe #keepingussafe #COVID19
Our projected patio open day is May 25th everyone! We will be open for curbside, carry out, and delivery through the weekend. Thanks everybody! #restaurant #brunch #ddd #broadripple #3sisters #indianapolis #covid19 #cafe #breakfastindy #breakfast #supportlocalbusiness #vegan
We've heard your requests and are proud to announce that we will be open 7 days a week at noon! 3000 sq feet patio space. #SocialDistancing #abbeer #beergardens #foothillsofalberta #hardknox4life #yycbeer #yycpatios @AvenueMagazine
Curbside pickup has been a great solution for many restaurants. @KowloonSaugus looks to create car hop in parking lot to expedite pickup amidst #coronavirus dining room closure.
Social distancing solutions 101: 1. Drive to parking lot near Starbucks 2. Park cars 6 feet from each other and roll down windows 3. Get coffee and talk for two hours #socialdistancing #friendship #beentoolong

## 5. Competition for space on the sidewalk, curb, and street: A discussion

COVID-19 has indirectly prompted a re-evaluation of the significance of curb space, highlighting that there are many competing uses of the curb beyond parking. There has been recognition that the curb is valuable for walking, cycling, outdoor dining, and as a space for conducting business, for example, as a pick up location. Evidence suggests that the curbside, at least in urban centers in North America, is gradually reemerging in the public imagination as a mixed use space, especially as a result of uses such as dining.

Our analysis indicates that people were experiencing urban spaces anew due to public health regulations, facilitated by changes in street management. Individuals reported a positive change in the quality of life due to the availability of outdoor space for walking, bicycling, and socializing. Bicyclists, in particular, observed that the opening up of space was making it more joyful to ride.

Restaurants and hospitality venues more generally are the business type that most require and value outdoor space. Public health guidelines required all businesses to modify their use of indoor space to maintain social distancing, and in response food-serving locations increased use of outdoor space. These businesses realized that they had to expand outwards, and were advertising their expanded seating, including on the sidewalk and curb. In some locations, businesses were encouraged by the removal of red tape to enable extending seating capacity. Business owners were thinking of using any space they had access to, including parking lots and curb parking.

During the pandemic, space (adequate space, space separating people) has been utterly critical in the context of social distancing. Our analysis indicates that space was limited in the public right-of-way for every use other than the automobile. This was made more apparent due to the increase in demand for the slivers of non-automobile street space. Specifically, walking and cycling increased in importance as forms of recreation during the pandemic due to the lack of other options, thus, contributing to increased demand for space for these activities. Many pedestrians observed that it was hard to follow social distancing guidelines on existing sidewalks. As businesses expanded into the sidewalk and curb, it became more difficult for individuals, including those in mobility devices such as wheelchairs, to move along sidewalks while maintaining suitable distances.

Driving gained in importance in part because it facilitated access to recreational activities situated farther away from home locations. Driving also increased access to new forms of activity made necessary by the pandemic such as testing/vaccinating, drive-by funerals, and curbside pickup. Yet, there were concerns expressed about how going down this track would leave those without cars at a disadvantage. Some tweeters observed that the experience of the city was automobile dominated, since access to everything from food to pet grooming was based on driving. Additionally, safety was on people's minds because speeding vehicles in low traffic were reported on streets.

## **6. Policy implications and concluding thoughts**

During the COVID-19 pandemic, non-automobile users of urban streets experienced safety while walking and bicycling, perhaps for the first time on streets that are normally busy with traffic. In some ways, the era of automobile-restricted zones (ARZs) was revisited (Gamble 1977; Herald and Alan Voorhees and Associates 1977). This shift in the uses of the curbside, brought on by public health concerns, is a change from the auto-centric values attached to this space. This change in policy and practice, although seemingly temporary (Glaser and Krizek 2021), is an indication that, under pressure, established practices built on strongly held beliefs *can* change (Langford 2012). Curbside space has become an important feature for businesses indicating that, if supported through minimal regulation, there exists potential to change urban curb uses. Parking space has been reimagined by different demands on business which suggests that, with incentives, it may be possible to change parking assets into other short-term/seasonal/time constrained uses. Business owners, who have traditionally argued against travel demand management policies, may be open to a reallocation of the curbside away from free parking in light of the pandemic experience.

This paper adds to the existing array of methods to study opinions about public policies (e.g., Tønnesen 2020), using geolocated social media content. Such low-cost techniques can help researchers and practitioners examine views about public policies, especially when there are few public sources of data available (Butrina et al. 2020). Specifically, social media such as Twitter can be a venue for community feedback, in a limited but meaningful way. The early days of the pandemic showed that traditional media such as local television stations became interested in covering aspects of street reallocation. Cities might consider leveraging such information assets if they decide to embark on innovative street reallocation agendas.

Our work here does not touch on some uses of the curb, such as freight movement and delivery services. The COVID-19 Twitter corpus did not have content on these subject areas, which is most likely a function of how we operationalized this research. Additionally, most



individuals do not experience issues of logistics movement in the same manner as business owners or building managers do. Competition for delivery space was also likely lower during the pandemic since providers could often use vehicle lanes to park given the low volume of traffic. Similarly, our work did not result in insights on how micromobility growth, especially as we emerge from the pandemic, could create even more competition for urban curb space. Lastly, our work does not address how less space for the movement of vehicles might negatively impact traffic flow in the urban network. Future efforts should focus on these aspects of curb management specifically.

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