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CASUAL CARPOOLING IN THE SAN FRANCISCO BAY AREA: UNDERSTANDING USER CHARACTERISTICS, BEHAVIORS, AND MOTIVATIONS

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ABSTRACT

Casual carpooling is an informal form of commuter ridesharing operating in Washington, D.C.; Houston, Texas; and San Francisco, California. In contrast to new forms of shared-use mobility, casual carpooling has been in existence for over 30 years and uses no information communication technology, and is entirely run informally by its users. Researchers have been fascinated by this phenomenon and have conducted studies in the past, but there remains a lack of up-to-date quantitative data. This study examines the motivations and behaviors of casual carpoolers in the San Francisco Bay Area to understand user characteristics and motivations. In Winter 2014, the authors observed and counted participants and vehicles at four casual carpooling locations, interviewed participants riding in carpooling vehicles (N=16), and conducted intercept surveys (N=503) at ten East Bay pickup locations. The results indicate that the motivations for casual carpooling participation include convenience, time savings, and monetary savings, while environmental and community-based motivations ranked low. Casual carpooling is an efficient transportation option for these commuters, while environmental sustainability benefits are a positive byproduct. Seventy-five percent of casual carpool users were previously public transit riders, and over 10% formerly drove alone. Logit modeling found that casual carpool role (i.e., always a rider or sometimes a driver), age, and employment status were key drivers in modal choice. Further research on a larger scale is needed to identify the elements needed for system replication in different areas.

KEYWORDS: casual carpooling, slugging, ridesharing, sharing economy, mode choice modeling, sociodemographics, user characteristics

INTRODUCTION

Casual carpooling is a user-run, informal form of ridesharing, which is formed with three or more commuters per vehicle. It provides participants' time and cost benefits through access to a high-occupancy vehicle (HOV) lane and often tolling discounts. Casual carpooling fits into the broader framework of the sharing economy, also known by other names, including the peer economy and collaborative consumption. The sharing economy is a popularized term for consumption focused on access to goods and services through borrowing and renting rather than owning them. What ties the sharing economy with casual carpooling is collaborative consumption of assets among peers – which can lower consumer costs and environmental impacts (Botsman and Rogers, 2010). Casual carpooling is a user-organized system of ridesharing at little to no cost—reducing both the driver and passenger burdens of car ownership. Moreover, because casual carpooling uses available vehicle occupancy, it decreases the number of automobiles travelling during peak travel periods, reducing congestion, greenhouse gas (GHG) emissions, and vehicle delays.

Casual carpooling is part of a wider spectrum of ride services that are rapidly emerging today, including long-distance ridematching; taxi and e-hail applications ("apps"); and app-based, on-demand ride services, also known as transportation network companies (TNCs) or ridesourcing. The authors also examine casual carpooling motivations, behaviors, and opinions to identify which of these motivations are critical to system success and how casual carpooling might be supported or enhanced. A major contribution of this research was the use of a custom-built mobile app to accurately capture wait times at different casual carpooling pickup locations. Previous studies only estimated passenger wait times and volumes from anecdotal evidence or counted by hand, leading to empirical gaps in the literature, while the mobile "Carma Carpool" app collected quantitative data.

This paper has five key sections. First, the authors present literature on prior research and describe where casual carpooling falls into the ride services spectrum; next, the data collection methodology is discussed. Third, the observational count data, interview findings, and intercept surveys are evaluated. In the final sections, findings and conclusions are discussed.

LITERATURE REVIEW

This section presents an overview of the history of casual carpooling and research into participant motivations and travel behavior, with a focus on the San Francisco Bay Area. The scope of this background remains within the United States, because casual carpooling does not exist elsewhere. The authors also examine several pilot projects, which attempted to replicate casual carpooling's flexibility and enhance it with technology or by supplementing public transit. The authors also discuss how this fits into a broader spectrum of ride services by comparing a number of features including cashless payment, average trip length, cost per kilometer/mile, and peer-to-peer ratings.

Casual Carpooling

Casual carpooling (also known as "slugging") is a user-run, informal type of *ad hoc* ridesharing (Chan and Shaheen, 2012). Impromptu carpools form with three or more commuters per vehicle: one driver and two or more passengers. These carpools form at park-and-ride facilities, public transit centers, or near public transit pickup points during the morning commute hours and take advantage of HOV lanes to get to a common employment center. Some carpools also form during the evening commute but typically on a smaller scale. Casual carpooling began during the 1970s and exists today in three United States (U.S.) metropolitan areas: Washington, D.C. and Northern Virginia; Houston, Texas; and the San Francisco Bay Area, California.

Casual carpooling began between communities north and east of the San Francisco Bay and downtown San Francisco due to public transit fare increases and service disruptions in the 1970s. Casual carpooling grew over the past 30 years due to a new HOV lane on Interstate 80, as well as a HOV/bus-only lane with no toll approaching the San Francisco-Oakland Bay Bridge. There are currently 23 pickup locations in the East Bay and North Bay. There are two dropoff locations in San Francisco, the main one at the intersection of Howard Street and Fremont Street, and a smaller one at Market Street and 9th Street. Until 2010, carpools of three or more paid no toll, but they now pay a discounted toll of US$2.50 in the westbound direction. There is no toll in the eastbound direction.

Several casual carpooling surveys have been conducted as early as the mid-1980s to approximate the number of casual carpooling participants. A 1985 survey estimated the number of daily Bay Area casual carpool participants at 3,000 (Beroldo, 1990). A 1987 update found that number grew to 5,000: 1,666 drivers and 3,333 passengers (Maltzman and Beroldo, 1987). Studies in the 1990s saw the average daily participants settle around 8,000 (Beroldo, 1990; Beroldo, 1999). However, these studies were conducted when carpools paid no toll. The

Metropolitan Transportation Commission (MTC) 511 Rideshare program estimated 6,700 participants in 2010, before the toll went into effect. A 2011 update estimated a 9% decrease in casual carpoolers after toll implementation, at 6,100 daily participants (MTC, 2011).

A smaller casual carpooling system for the evening commute was established after the 1997 Bay Area Rapid Transit (BART) strike, from downtown San Francisco to certain East Bay and North Bay locations. A 1998 survey observed only 187 evening carpools, much less than the 3,000 morning carpools (Beroldo, 1999). While evening carpooling is growing, casual carpooling in the Bay Area remains mainly a one-way morning trip phenomenon. Previous research has shown that evening trips are typically made by public transit for morning casual carpool passengers and by driving alone for drivers.

Travel Behavior and Social Norms

Not only did previous studies examine the volume of participants, but some also conducted surveys to understand their travel behavior. A 1987 study in the Bay Area incorporated a mail-back survey (N=562), which found the top two reasons for participating in casual carpooling were that it was cheaper and faster than other commuting modes. It further revealed that casual carpooling was only a morning phenomenon—less than 2% carpooled during the evening commute and over 70% took public transit home (Maltzman and Beroldo, 1997). The 1998 study update (N=725) found that drivers mainly casual carpooled to save time, while passengers casual carpooled to save money. Again, this survey discovered almost 85% of morning casual carpool passengers took public transit home, and over 70% of morning casual carpool drivers drove home alone (Beroldo, 1999).

Mote and Whitestone (2011) analyzed the sociology of slugging in Washington, D.C. through 12 interviews with drivers and riders. They assert that the social context of the region—urban life, demographics, and commute patterns—helped lead to the institutionalization and configuration of slugging in the region. Over time, the slugs developed a routine, leading to structure and greater perceived security. Thus, despite similarities to hitchhiking, structuration in the system, including social norms (e.g., never leaving a female slug alone at a pickup location), have allowed slugging to grow successfully.

Impact on Congestion and Associated Policy Issues

There have been conflicting estimations on the impacts on congestion and transit ridership due to casual carpooling. Beroldo (1990) estimated a range between 89 vehicles removed from the corridor and 565 added due to differing model assumptions and concluded that the Bay Bridge impact is unclear. The 1998 survey found casual carpooling added vehicles to the road. Based on this survey, between 500 and 650 automobiles would be removed from the road, if casual carpooling were not an option for drivers (Beroldo, 1999). The study noted this finding does not include other casual carpooling benefits, such as efficient HOV lane use and relief for crowded transit lines, so others may be encouraged to take public transit.

Concerns have arisen due to casual carpooling’s success and unclear impacts on congestion and modal split. Public transit agencies have been concerned that casual carpooling takes riders off bus and rail services, while taking up parking spaces at transit stations (Beroldo, 1990). Thus, research is needed to accurately determine the impact casual carpooling has on public transit systems and peak-period congestion, as well as the associated costs and environmental impacts.

Lessons Learned

Studies have identified the following casual carpooling success factors: 1) a time savings incentive for drivers; 2) monetary savings for passengers; 3) pickup locations near freeways, residences, parking, or public transit stops; 4) a common dropoff location; 5) reliable public transit for the return trip; and 6) an HOV requirement of three or more occupants (Beroldo, 1990; Reno et al., 1989). A 1999 study reemphasized the need to attract drivers to the system (Beroldo, 1999).

A recent analysis was conducted on casual carpooling in smaller cities. The Lawrence OnBoard ridesharing system (rebranded as CarmaHop in July 2014) is a carpooling system in Lawrence, Kansas, where potential passengers note their destination on a handheld whiteboard, which drivers observe on the road and may stop if desired. O'Brien and Dunning (2014) collected system ride data and rider surveys. They found over half of the riders waited less than five minutes for a ride. They found that an official-looking whiteboard and rider choice of pickup location were critical to quick ride matches. The Lawrence OnBoard system could prove a potential model for casual carpooling in smaller cities.

Enhanced Casual Carpooling

Despite its ubiquity today, technology has remained absent from casual carpooling. Studies have examined how to incorporate technology into casual carpooling, which Kelley (2007) called "enhanced casual carpooling." Several organized casual carpooling ideas have been proposed, but no formalized system exists on a full-scale today. Proposed enhanced casual carpooling systems include using radio frequency identification devices (RFIDs) as transponders for drivers, passengers, and vehicles.

Marin County, California attempted to enhance casual carpooling with a 16-month pilot study in 1979 and 1980. It was called the "Commuter Connection Ridesharing Demonstration Project in the Golden Gate Commute Corridor." It targeted two cities in Marin County, promoting it as a backup for bus services, which were at or near capacity. Over 1,400 members registered to participate, with designated meeting places located at major intersections at or near bus stops (Dorosin, 1981). System usage was not recorded daily, and it was only assessed by four surveys.

Summary

While past studies have cataloged the history, benefits, and lessons learned from casual carpooling, there is a lack of research into recent behavioral trends, wait times, and user motivations. Moreover, much of the literature documents casual carpooling studies conducted in the 1980s and 1990s, and much has changed since then (e.g., introduction of a toll for HOVs). This paper fills this gap through an observational study, qualitative interviews, and an intercept survey of casual carpoolers in the East Bay of the San Francisco Bay Area, along with an emissions analysis based on data collected for this study.

METHODOLOGY

Researchers conducted a study of casual carpoolers in the San Francisco Bay Area between November 2013 and January 2014. Data collection involved three modes: 1) observational counts of casual carpool participants to conduct quantitative analysis on wait times and passenger throughput; 2) in-vehicle qualitative interviews with participants to understand in-depth travel choices and guide subsequent surveys; and 3) intercept surveys with participants to understand travel choices among larger sample and provide the basis of the choice model.

Observation of Casual Carpool Participants

Researchers began by observing the casual carpooling system between November 18 and December 6, 2013 (excluding the Thanksgiving holiday) at four casual carpool pickup locations: 1) the North Berkeley BART station, 2) Park Avenue and Hampel Street, 3) Lakeshore in Oakland, and 4) the Richmond Parkway Transit Center. These locations were chosen to represent various conditions in the system: North Berkeley and Lakeshore represent dense, mixed-use urban neighborhoods served by public transit rail and buses. Hampel represents an inner suburban residential neighborhood. Richmond represents an outer suburban park-and-ride context. Over 20,000 passenger trips were recorded across the four sites and 13-day study period. There was no interaction between the researchers and casual carpoolers. The team collected observational data on the number of carpools formed, number of passenger trips, rider queue length, carpool arrival and departure times, wait time for both drivers and riders, vehicle queue length, and qualitative data on weather and any deviation from the status quo (e.g., Bay Area Rapid Transit (BART) District delays, an accident on the Bay Bridge). Data were collected through the smartphone app “Carpool Count,” designed by the company Carma Carpool for this research to enable digital counts and greater precision. This app was pretested in September 2013 and revised for the November/December research.

In-Vehicle Qualitative Interviews

Next, researchers conducted qualitative interviews with (N=16) casual carpooling participants between December 5 and December 10, 2013. The interviews were held during the casual carpool commute trip into San Francisco and began at three pickup locations: North Berkeley BART (N=9), Lakeshore (N=5), and Richmond (N=2). These three were chosen due to high rates of carpool formation observed during the previous research phase (and shown in Figure 1 below). With the informed consent of participants, the interviews took place in a carpooling vehicle. The researcher conducted a 15-minute interview, which began at the pickup location and ended at the dropoff location in San Francisco. Respondents received a US$5 gift card as an incentive. The driver was not involved in the interview. Interview questions focused on participant reasons for casual carpooling, typical travel time, how often casual carpooling is used, approximate final destination, afternoon travel patterns, any difficulties with the service, and basic demographics.

Intercept Surveys

Results from the qualitative interviews guided the development and deployment of an intercept survey of casual carpoolers. Pretesting of survey drafts resulted in the final instrument to be shortened to 22 questions. Researchers conducted the intercept survey between January 13 and January 17, 2014, surveying casual carpool passengers at ten East Bay pickup locations (including the four aforementioned locations and six additional sites to increase the sample size). Researchers randomly approached 709 persons to participate in the survey, with 503 responses collected (response rate of 70.9%). Researchers conducted the surveys while casual carpoolers waited in the queue for an available vehicle to arrive. Those who did not have time to complete a survey were given a link to an equivalent online survey, which they could complete at a later time. In-person responses totaled 317 (63%), while online replies totaled 186 (37%). In-person respondents were given a glass cleaning cloth as an incentive. Casual carpool drivers were not surveyed. Survey questions focused on participant reasons for casual carpooling, travel characteristics and behavior, system views, and basic demographics.

Study Limitations

This study focused on casual carpooling passenger perceptions and did not capture driver perspectives. This was in part due to safety concerns with interviewing drivers during a trip. The study also did not capture the direct views of commuters who do not use casual carpooling. Providing a small incentive for survey respondents could account for possible self-selection bias.

Due to study constraints, data were collected from a subset of casual carpooling pickup locations: four locations for observational data, three for in-vehicle interviews, and ten locations for intercept surveys. These locations include a mix of larger and smaller generators in terms of the number of casual carpools formed to represent a range of the locations in the greater Bay Area casual carpooling system. However, this subset cannot capture all facets of this complex system (e.g., farther locations, evening pickup locations). In this paper, the authors attempt to draw conclusions about Bay Area casual carpooling system based on the N=503 intercept survey. Nevertheless, a larger survey consisting of more of the 23 casual carpooling pickup locations would be needed to more accurately represent the entire system.

RESULTS AND DISCUSSION

In this section, the authors discuss the observational count data, in-vehicle interviews, and intercept survey findings.

Passenger Throughput, Wait Times, and Departure Times

The data from 13 days of counting using the "Carpool Count" mobile app show that the median of the four pickup locations (see top of Figure 1) recorded 361 commuters departing via casual carpooling each morning. The Carpool Count app also captured rider and driver wait times. At the North Berkeley pickup, the median rider wait time was 2.3 minutes, and the 95% percentile was 7 minutes. The median driver wait time was 0.2 minutes, and the 95% percentile was 5.3 minutes. Across the observed locations, median rider wait times were all below 2.5 minutes, and median driver wait times were two minutes or lower. When comparing these observed wait times to the stated wait times from the intercept survey (discussed below), participants perceived their wait to be longer than it is in actuality. Still, survey respondents stated 10 minutes was an acceptable period to wait for a carpool, much longer than the median wait time of 2.5 minutes across all observed locations.

This reliability of service has resulted in a high level of confidence among casual carpool riders and drivers that they will reach their destination in San Francisco quickly. With the exception of the Richmond pickup location, the highest passenger throughput occurs between 8:00am and 9:00am. The peak passenger throughput leaving Richmond begins at 7:00am and starts to decline at 8:30am. As the 32-km (20-mi) commute from Richmond takes longer than the 16-km (10-mi) commute from the Oakland and Berkeley locations, it is logical that the Richmond commuters would leave earlier on average.

Next, the authors superimposed rider and driver wait times, and passenger throughput for the four pickup locations observed. The bottom of Figure 1 shows the differing driver and passenger wait time peaks, implying there is room for improved efficiency and information dissemination in the system. For example, drivers arriving at Lakeshore between 6:45am and 7:15am are willing to wait up to 15 minutes to form a casual carpool, while driver wait times between 7:45am and 8:45am average just 1.5 minutes. Perhaps early drivers derive enough benefit from their time and cost savings from the HOV lane and the reduced carpool toll to warrant the extra waiting time or they are unaware of the dramatic decrease in waiting times later in the morning. Dissemination of this information to casual carpooling drivers and riders could shift behavior to increase carpool formation at the Lakeshore location.

Location	Total Passenger Trips	Total Carpools	Median Daily Passenger Trips	Median Daily Carpools
North Berkeley	8129	2700	653	220
Hampel	2264	751	184	63
Lakeshore	7711	2578	535	178
Richmond	3244	1142	310	106

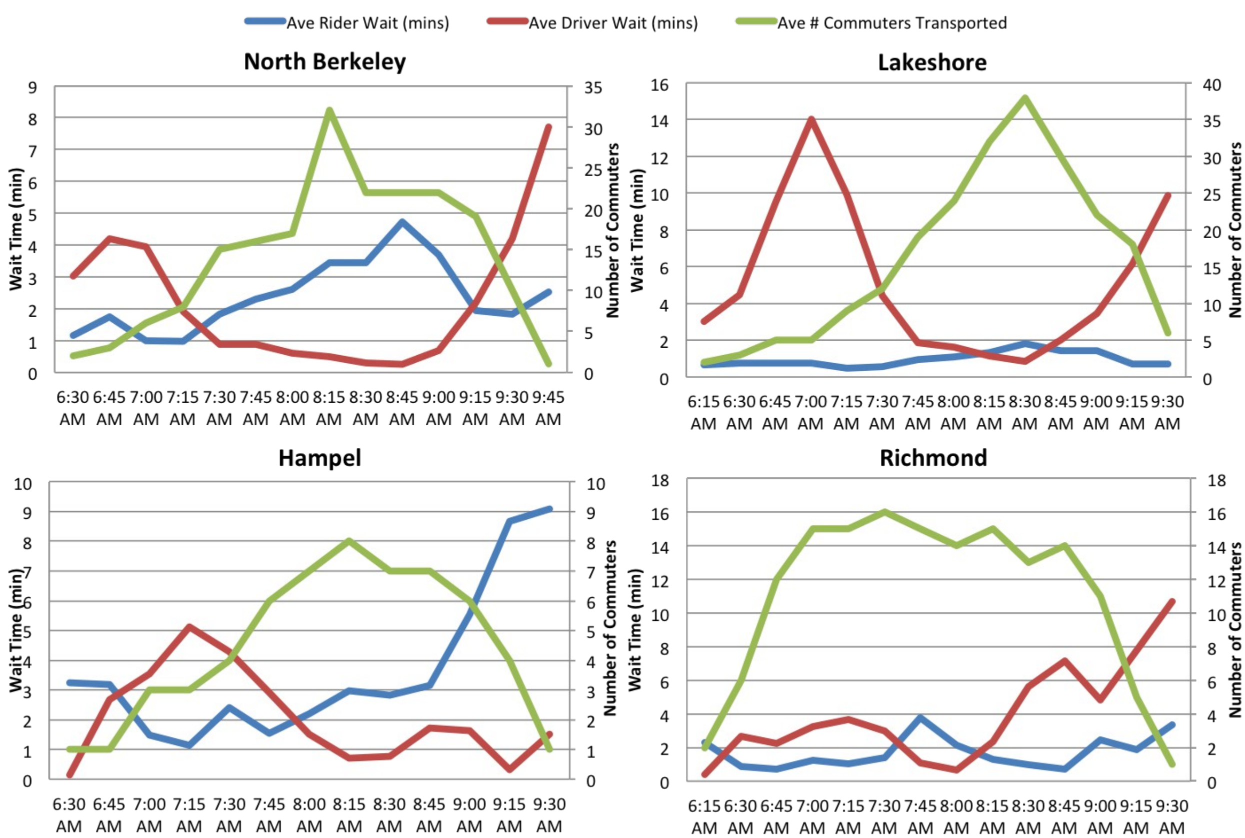

FIGURE 1 Count locations: key statistics, wait times, and volumes.

High passenger throughput and low wait times, particularly at Lakeshore 16 km (10 mi) from San Francisco, demonstrate a remarkable trend (see Figure 1). Its location next to Interstate 580 in a dense, mixed-use neighborhood may contribute to its efficiency, while the other three origins are located in less dense areas. This can complement other shared modes (e.g., carsharing and bikesharing—shared use of a fleet of cars or bikes), which have risen in popularity and effectiveness in recent years through ICT support and increased smartphone prevalence (for more on these modes see Shaheen et al., 2009; Shaheen and Cohen, 2013; Shaheen et al., 2013a; Shaheen et al., 2013b). Although it does not provide the pickup location flexibility provided by technological solutions, such as Carma Carpool and RideScout, casual carpooling's wait times are comparable to those of on-demand ride services (e.g., app-based taxis, TNCs/ridesourcing).

In-Vehicle Interviews (N=16)

The majority (81%) of respondents heard about casual carpooling through word-of-mouth from friends or colleagues. The respondents had been using casual carpooling for an average of five years, and use it on average 4.5 days per week. Before casual carpooling, 66% respondents used the bus (AC Transit Transbay) or BART to commute to San Francisco, and 75% stated that carpooling is faster than the equivalent public transit trip.

The most important reasons for casual carpooling reported were time (27%) and monetary savings (40%). The convenience of casual carpooling was also important, 10% of interviewees cited reasons of proximity to a casual carpool pick-up location or the higher frequency of cars in contrast to bus/BART. Environmental reasons or the sharing/community aspects of the service were each only stated once.

When asked for improvements to casual carpooling, four suggested the availability of a casual carpool ride back in the afternoon, and three wanted for a pickup at home. Only one interviewee stated that he/she would like real-time information, and only one mentioned a potential benefit from a connection to a social network, such as Facebook. Perceived safety issues were the primary reason why respondents' friends and family did not use casual carpooling. Ideas to reduce the fear for friends and family to use casual carpooling included taking a ride with them a few times (e.g., a mentor) or a safety awareness campaign.

Intercept Survey Analysis

Researchers distributed the intercept survey to lines of waiting riders. Thus, responses received provide information only on those who are riders or alternate between riding and driving. Table 1 shows the distribution of the responses (N=503) across ten pickup locations in the East Bay. This analysis includes five key sections: 1) descriptive statistics, 2) casual carpooling behaviors, 3) motivations for casual carpooling, 4) modal shift behavior, and 5) environmental impacts.

TABLE 1 Intercept Survey Responses and Demographics (N=503)

Pickup Location	City	Number of Survey Respondents
Claremont & College	Oakland	96
Claremont & Hudson	Oakland	18
El Cerrito del Norte BART	El Cerrito	35
Fruitvale & Montana	Oakland	23
Lakeshore	Oakland	72
North Berkeley BART	Berkeley	123
Oakland & Monte Vista	Oakland	22
Park & Hampel	Oakland	50
Richmond Parkway Transit Center	Richmond	27
Webster & Santa Clara	Alameda	37
	Total	**503**

2013 Household Income	*Count*	*%*	*Bay Area %*
Less than $10,000	2	1%	5%
$10,000 to $14,999	3	1%	4%
$15,000 to $24,999	3	1%	8%
$25,000 to $34,999	18	5%	7%
$35,000 to $49,999	33	9%	10%
$50,000 to $74,999	77	21%	15%
$75,000 to $99,999	61	16%	12%
$100,000 to $149,999	94	25%	18%
$150,000 to $199,999	41	11%	9%
$200,000 or more	38	10%	12%
(Decline to Respond)	133	--	--
Age	*Count*	*%*	*Bay Area %*
under 18	0	0%	22%
18-24	14	4%	9%
25-34	116	32%	15%
35-44	105	29%	15%
45-54	78	21%	15%
55-64	43	12%	12%
65 and over	10	3%	13%
(Decline to Respond)	137	--	--
Gender	*Count*	*%*	*Bay Area %*
Female	200	49%	50%
Male	212	51%	50%
(Decline to Respond)	91	--	--
Total	503		

Occupation	*Count*	*%*	
Full-time student	11	3%	
Part-time student	5	1%	
Employed full-time	354	89%	
Employed part-time	29	7%	
Stay-at-home parent	0	0%	
Retired	0	0%	
Unemployed, looking for work	0	0%	
Unemployed, not looking for work	0	0%	
Other	0	0%	
(Decline to Respond)	104	--	
Race	*Count*	*%*	*Bay Area %*
Asian/Pacific Islander	71	18%	24%
Black/African-American	34	9%	6%
Caucasian	261	65%	42%
Hispanic/Latino	27	7%	24%
Native American/Alaska Native	4	1%	0.3%
Other	2	1%	0.3%
(Decline to Respond)	104	--	--
Total	503		

Descriptive Statistics

The authors compared demographic and socioeconomic data from the participants to those of the San Francisco Bay Area (San Jose-San Francisco-Oakland Combined Statistical Area) (ACS, 2012). Table 1 presents key participant demographics. Annual household income was higher than that of the Bay Area, with almost half of the participant incomes were over US$100,000. The standard deviation of participant age (s=0.13) was much smaller than that of the Bay Area (s=0.0385), with most casual carpoolers between the ages of 25 and 55. This and the finding that 89% of respondents were employed full-time support the commuting nature of casual carpooling. Casual carpoolers tended to also be Caucasian (65% of the survey sample, as opposed to 42% of

Bay Area residents). Due to time constraints, education level was not asked in the survey.

Casual Carpooling Behaviors

As often noted (Beroldo, 1999; Minett, 2011; Oliphant, 2008), flexibility is an important motivation for casual carpoolers. An element of this flexibility is the option to choose, on a daily basis, whether to be a rider or driver; 44% of the riders surveyed had participated in casual carpooling as both a rider and a driver. This reveals that a large proportion of riders have taken advantage of this option at least once. Future research should investigate the frequency of role change (rider or driver) in casual carpooling.

Despite the changeable behaviors associated with casual carpooling (e.g., varying departure times, role changes between rider and driver), participants find the system reliable and able to transport them to their destination on time. A traveler with low confidence in a transport system may add a time buffer to allow for the possibility the trip will take longer than planned. Interestingly, when asked when their casual carpooling trip began, only 5% of respondents began their trip prior to 7:00am, 32% between 7:00am and 8:00am, and the majority (63%) travel after 8:00am, suggesting that a significant number of commuters do not add this time buffer to their travel. Although the number of casual carpool departures can be seen to reduce dramatically after 9:00am, it is of note that some casual carpoolers continue to take advantage of the HOV lane and reduced bridge toll for carpools, which are both available until 10:00am on weekdays. The top of Figure 2 below shows the distribution of morning commute start times.

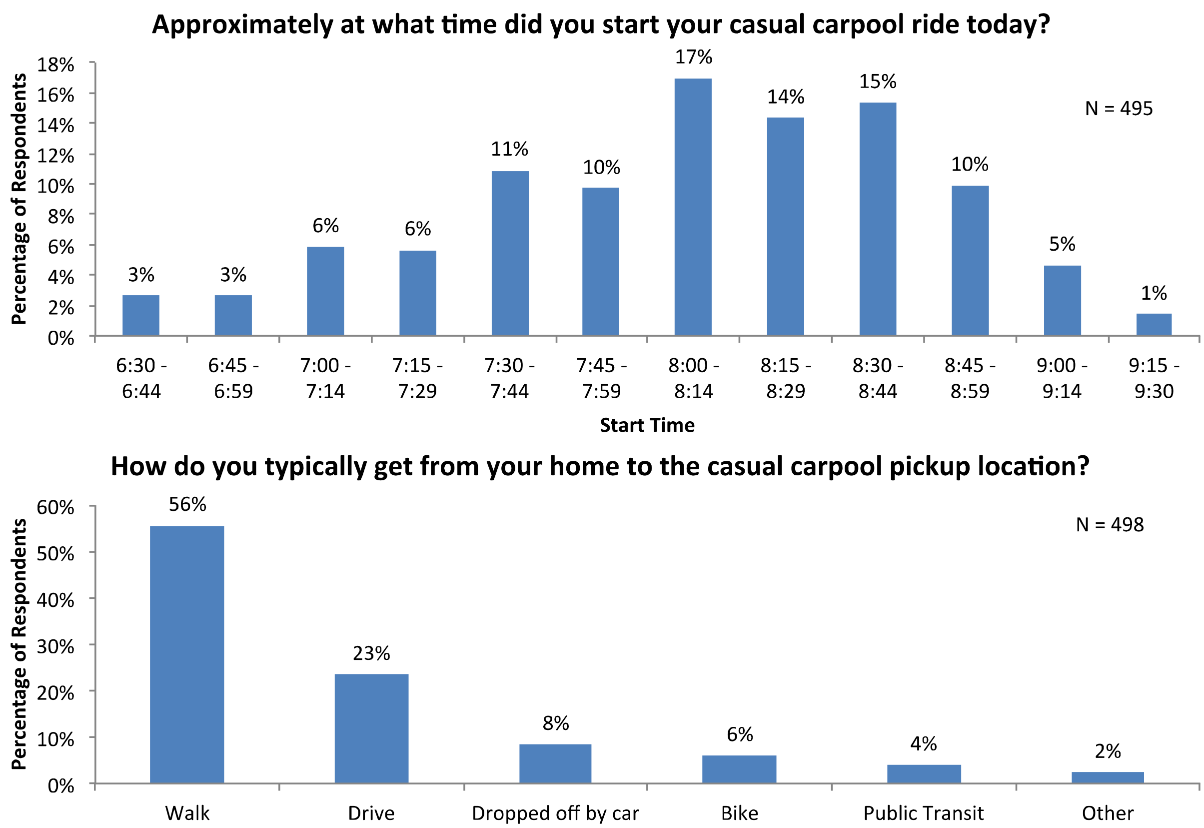

FIGURE 2 Morning commute start time and access mode.

When asked about wait times, 61% of casual carpoolers stated they had never waited longer than 15 minutes for a ride, and 29% have never waited longer than 10 minutes. The survey also suggested there was a reasonable level of satisfaction with the wait time for rides, as the largest proportion (36%) responded that up to 10 minutes is a reasonable amount of time to wait in the casual carpool line.

As cited in earlier research (Murray and Chase, 2012; MTC, 2010), the majority of casual carpoolers were previously public transit users. In this study, 75% were formerly transit users: 54% of respondents were previously BART riders and 22% traveled by bus before. Thirteen percent of riders drove alone before beginning to casual carpool; thus, these vehicles were taken off the road and out of morning peak-period congestion as a direct result of casual carpooling.

The majority of casual carpoolers surveyed lived within walking distance of their pickup location; 56% noted they arrived by foot (see the bottom of Figure 2). Of the 23 total morning casual carpool pickup locations, only four (Fairfield, Vallejo, Hercules, Richmond) are not located in densely populated, walkable neighborhoods. In Washington D.C., access to park-and-rides as pickup locations is considered as vital to slugging success (Oliphant, 2008). While this can be explained in a variety of ways, including the difference in commute length, it is interesting to note that casual carpooling can adapt to suit the needs of the local built environment.

The return trip for casual carpoolers has been noted as a point of contention in the past between this grassroots system and public transit operators. According to Maltzman (1987), casual carpooling caused AC Transit ridership and revenue losses and created a scheduling problem due to larger afternoon loads (*4*). The evening commute appears similar today based on the intercept survey: 46% returning via BART, 40% on bus, and only 6% by carpooling. However, this may not be by choice, it is more likely due to the lack of driver incentives and logistical challenges associated with pickups on the return commute. While only a small percentage (6%) of morning casual carpool riders surveyed take this option home in the evening, an evening casual carpool trip was the most frequently selected system improvement. There is no toll on the Bay Bridge in the eastbound direction, eliminating their time and monetary incentives to pick up riders. Only drivers traveling to farther destinations (e.g., Vallejo, Fairfield) achieve time savings in the HOV lane on Interstate 80 and a reduced carpooling toll on the Carquinez Bridge (US$2.50 vs. US$5.00) on their return commute.

Negative casual carpooling experiences reported in the survey varied. While the majority of respondents noted they had a negative experience casual carpooling, these were minor and included bad odors in vehicles, rude drivers, or long wait times. The frequency of such experiences was not reported by respondents, however.

Previous research has provided insights into how casual carpooling functions and examined changes in volumes over time and ridership impacts due to specific events, such as the introduction of a toll for carpools on the Bay Bridge (Beroldo, 1985; Maltzman and Beroldo, 1987; MTC, 2011; Chan and Shaheen, 2012). However, little research exists on casual carpooler demographics, why individuals start casual carpooling, perceived participant benefits, and how it could be improved. Understanding these motivations is an important for expanding casual carpooling.

Casual Carpooling Motivations

This study's survey data indicate the most important reasons for casual carpooling are convenience and monetary and time savings, which supports findings from Beroldo (1999). Survey responses specifically mentioned monetary savings compared to BART/bus (33%), convenience (20%), and time saving over BART/bus (15%). While the survey did not provide "comfort" as an option, 4% of respondents (55% of the entries in the "Other" section) mentioned either comfort advantages over BART, the benefit of always having a seat, or not having to travel through the Transbay Tube (BART's subterranean tunnel connecting San Francisco and Oakland), which operates near capacity during peak commute. While comfort has rarely been cited as an advantage of casual carpooling in previous literature, flexibility is a commonly associated benefit (Zmud, 2013). However, equal percentages (4%) cited flexibility and comfort as the most important reason for casual carpooling.

From these results, it is interesting to note that the motivations of casual carpoolers are similar to those of the broader sharing economy. According to Botsman and Rogers (2010), those who participate in collaborative consumption are *not* motivated by pure selflessness. For the most part, they believe in the principles of capitalist markets and self-interest; sustainability is often an unintended consequence of this behavior. Indeed, this was previously discussed by Marcoux (2009) who states that people challenge the often unquestioned and romanticized notion of sharing as "ennobling, humanizing or of greater moral worth" and reveal that participation is a self-serving, utilitarian decision, rather an altruistic one (*20*). This also appears to be the case in casual carpooling: monetary savings, personal time benefits, and convenience are the motivating factors for participation. Interestingly, only 1% of respondents cited social reasons as their motivation for choosing casual carpooling.

Modal Shift Behavior

The data show there are two main channels through which users learn about casual carpooling: word of mouth (71%) and street visibility (18%). Given the relatively small online resources dedicated to casual carpooling in the San Francisco Bay Area (MTC, 2014; 511.org, 2014; SF Casual Carpool, 2014), this is not surprising.

In the intercept survey, casual carpoolers were asked their opinion on the best way to introduce new people to the system. In line with the FHWA focus group results (2013), which revealed that hearing about casual carpooling does not in itself spark participation, and safety remains a top concern, 47% responded that the best way to introduce people they knew to casual carpooling would be to go with them; 19% believed a safety campaign would be the best method; and 15% thought an online community would have the greatest effect. These responses reflect fear of the unknown. Interestingly, 45% of respondents stated they felt completely safe the first time they used casual carpooling versus only 18% who expressed any safety concerns. Future research should investigate whether or not an online system, an online community enabling individuals to leave passenger and driver ratings, or a greater amount of information would alter opinions. Perhaps an online community showing the new user's connections to different casual carpoolers on social media could bridge this gap just as effectively. Other companies in the sharing economy, such as Airbnb, have used similar methods successfully (Airbnb, 2014). Although the current casual carpooling system is highly effective and efficient, efforts to replicate it in the past have failed (Dorosin, 1981; Kirshner, 2014). Future research should examine the potential impact of technology and online social connections for casual carpooling further (e.g., rating systems), as these elements could be powerful tools for replication and expansion.

Choice Model

From the survey dataset, a multinomial logit (MNL) model was developed using the Bierlaire

Optimization toolbox for GEV Model Estimation (BIOGEME) 2.2 modeling software package (Bierlaire, 2003). The logit model considered three alternatives in the choice set: 1) public transit (BART or bus), 2) casual carpooling, and 3) driving alone. This simplified choice set was established because the majority (89%) of survey respondents reported that their travel mode prior to casual carpooling was either by public transit or driving alone. The respondent attributes that were tested included: age; gender; education level; ethnicity; income level; employment status; and casual carpooling role (i.e., "only a rider" or "sometimes a driver"). The alternative specific attributes tested included: public transit headway (i.e., the average headway of the closest bus/rail to the pick-up location); estimated travel cost; and typical travel time.

The model estimation found several respondent attributes irrelevant (i.e., statistically insignificant at the 10-percent level) to their mode choice. These included education level, ethnicity, gender, income level, trip origin, and trip start time. However, age and casual carpooling role (i.e., "only a rider" or "sometimes a driver") were statistically significant at the 10-percent confidence interval. Employment status was nearly, but not quite not statistically significant. But because it was close, it was retained in the model. The final utility functions were defined as:

$$U_{PT}=\beta_{age}AGE+\beta_{role}ROLE+\beta_{emp}EMP+\beta_{hway}HWAY_{PT}+\beta_{cost}COST_{PT}+\beta_{TT}TT_{PT}$$

$$U_{CC}=ASC_{CC}+\beta_{age}AGE+\beta_{role}ROLE+\beta_{emp}EMP+\beta_{cost}COST_{CC}+\beta_{TT}TT_{CC}$$

$$U_{DA}=ASC_{DA}+\beta_{cost}COST_{DA}+\beta_{TT}TT_{DA}$$

where *U* is utility, β is the coefficient, *PT* is public transit, *CC* is casual carpool, *DA* is drive alone. Moreover, *role* denotes casual carpooling role, *emp* is employment status, *hway* is headway, and *TT* is travel time. Note that the sociodemographic variables—casual carpool role, age, and occupation—are only included in two of the utility equations, because they do not vary across alternatives, and are thus estimated in a way to capture differences in utility. Similarly, one alternative-specific constant is removed to capture differences in utility due to factors unobserved in the model. Table 2 shows the estimated parameter results.

Table 2 Multinomial Logit Model of Morning Trip Mode Choice

Parameter	Coefficient	*t*-Statistic
Age	-0.0167	-1.76
Casual carpool role	-1.12	-3.65
Employment status	0.214	1.49
Transit headway	-0.0758	-4.22
Travel cost	-0.709	-3.68
Travel time	1.05	6.15
Number of observations		938
Log likelihood		-150.613
Likelihood ratio test		1407.017
Adjusted ρ^2		0.814

The parameters' coefficients exhibit reasonable magnitudes and signs with respect to the utility equations. The utility equations were established such that a negative coefficient for the sociodemographic variables meant that a rise in the attribute (which was age in this case) increased the probability of driving alone with increasing value of the parameter. The largest contributing factor to modal choice appears to be respondent role in casual carpooling. This was a binary variable (0 or 1), that was assigned a value of 1 if the person was a driver. The model coefficient indicates that participating as a driver in the casual carpooling system (the higher value) increases the possibility of also driving alone. This makes sense, given existing possession of a car and its associated convenience. Participant age played a smaller role in the model: increasing age increases the probability of driving alone. Although not as statistically significant, employment status was observed to impact modal choice. Full-time employment (the lower value on the scale) increased the probability of using casual carpooling or public transit. This demonstrates the commuter aspect of these mode choices and their importance as modal choices during peak-period travel.

The magnitudes and signs of the alternative attributes—public transit headway, travel cost, and travel time—provide interesting insights. Naturally, both lower headways and costs led to higher utility. Interestingly, the coefficient of travel time is positive, suggesting that higher travel times provide higher utility. It can be noted that many of these respondents are already engaged in long commutes, crossing the San Francisco Bay via bridge or a subterranean tunnel. As travel times increase, the value of speed declines, while the value of rest/comfort increases. Thus, for commuters with long-distance drives, alternatives with longer travel times can seem favorable, since choices are made toward modes that have this rest component (e.g., a seat on the train or in the vehicle). Further research should investigate the relationship between travel time and comfort in travel choice.

Although it appears that not many parameters are included in the model, it is important to note that the adjusted ρ^2 was 0.814—thus, the model goodness-of-fit is high. Finally, note that responses left blank were accounted in the model, considered distinct from other choices.

RECOMMENDATIONS AND CONCLUSIONS

Through this multi-stage research study, the authors documented observational data of casual carpooling operations; traveler demographics, behaviors and motivations; and associated emission savings. Casual carpoolers tended to be high-income earners, employed full-time, between the ages of 25 and 55, and Caucasian. Casual carpooling average wait times were more efficient in contrast to alternative travel modes (bus/BART) with median wait times less than 2.5 minutes for riders and 2 minutes for drivers during peak commute times. Interview and survey results showed the majority of participants learn about casual carpooling by word-of-mouth and value the advantages of time and cost savings and the comfort it provides over their alternative commute modes of BART and bus. Three-fourths were formerly public transit riders. Over 60% travel after 8:00am, suggesting participants find the system reliable to transport them to their destination on time, without needing to factor in a time buffer. Environmental benefits are a positive byproduct of the system, but they are not as highly regarded among participants. Logit modeling found that casual carpool role, age, and employment status were key drivers in modal choice. Participants to be largely content with the system in its current form, but believe that public perception of the safety of casual carpooling would need to be reversed if the community were to grow.

The authors believe future research is needed on casual carpooling. This research should investigate methods for recruiting, incentivizing, and surveying casual carpooling drivers and non-casual carpoolers. Survey instruments could examine the potential impact of technology and online social connections and rating systems for casual carpoolers and document any sense of pride among casual carpoolers. Expansion of observational data could measure the volumes of casual carpool participants at all 23 locations in the Bay Area and determine system-wide impacts of casual carpooling on public transit, peak-period congestion, and carbon emissions. Finally, researchers could test the impact of providing real-time wait-time information to casual carpoolers in increasing participation and improving efficiency.

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