COMMUTING CONNECTIONS: GENDER, CARPOOLING AND CYBERSPACE

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INTRODUCTION

The productivity and environmental costs of auto ownership and use for commuting and other activities appears to have reached staggering levels in both the US and Canada (*1*,*2*). Fuelled by the latest empirical evidence, and public reaction to the current state of the daily commute; policy makers, planners, and consumers are increasingly becoming interested in exploring alternative transport options for commuting. Canada's largest metropolitan region, the Greater Golden Horseshoe Area (GGHA), is no exception. The recent *Places to Grow Act* for the GGHA has identified critical metropolitan development and transport issues, and several policy and planning interventions designed to alleviate the congestion and poor air quality issues often linked to urban sprawl and auto-mobility (*3*).

Canadian national statistics suggest that there has been a dramatic rise in traffic and drivers (close to one million more since 1996) on Canadian roads during the last quarter century, that the majority of commuters use automobiles, and that Canadians are now travelling farther to work than ever before (*4*). It is evident that there is great *potential* for the application of alternative forms of transport (e.g., carpooling, cycling, ridesharing) to the journey to work.

Carpooling provides an alternative that is most similar to single occupancy vehicle use (SOV), and does not require significant capital investment because it relies on existing public infrastructure and private equipment. While the definition of carpooling varies within the literature, it is conceptualized in this paper as the *sharing of*

transportation to work or school in a private vehicle with other workers or students (5).

This paper examines the recent activities of the Smart Commute Association (SCA), a multi-stakeholder, alternative transport NGO based in the GTA. The SCA has been working to encourage carpooling primarily through the deployment of a web-based carpool formation tool called Carpool Zone. Smart Commute now operates as a program under Metrolinx, the regional transportation authority for the GGHA. Metrolinx is working toward improving the operation of all modes of transportation in the area (*6*). Central to the paper's key themes is an examination of gender differences in carpooling attitudes, context, and the identification of a potential mismatch between the commuting behaviours of females with paid employment and the capabilities of the Carpool Zone software. The two primary questions addressed in this paper are: (1) Does Carpool Zone perform equally well for both genders, and (2) Are there gender differences in attitudes and behaviours associated with carpooling and commuting. Following the introduction, the paper reviews the literature on carpooling, information technology and travel behaviour, and gender and commuting. Data and research methods are then discussed, followed by the presentation of research findings. Lastly, the paper discusses the implications of the findings for the ongoing development of Carpool Zone, and identifies future research directions.

BACKROUND

Gender and Commuting

For some time, researchers have studied gender differences in travel behaviour. Empirical research has often identified the shorter commuters of females, with some variation across two worker and single worker households (*7*). Equally important, and often cited as a causal mechanism for gender differences in commuting are issues pertaining to household responsibility and entrapment. The household responsibility hypothesis (HRH) suggests that females tend to commute less than males because they perform a larger share of childcare and domestic responsibilities (*8,9,10,11*). Activity patterns are related to the HRH as multiple worker households

incorporate family responsibilities with commuting, and activity decisions are largely based on the availability of services in space and time (*12*).

Entrapment theory suggests that females tend to be constrained to a smaller travel area due to household responsibility and the sort of employment opportunities available to females (*10,11*). Kwan (*13*) has examined the relationship between gender and accessibility, finding that females have lower levels of accessibility to opportunities than males. Tischer (*14*) and Kaufman (*15*) found that females are more likely than males to carpool, due to automobile use constraints. Other studies have identified "shades of gray" within existing theory, with some research challenging the empirical significance and policy relevance of the gender/commuting debate (*9,16,17,18*).

Carpool Formation, and Use

A significant portion of the literature discusses incentives for carpooling. The literature also identifies reasons for carpooling success and failure and the motivations for taking up the practice. Tischer et al. (*14*) along with others (*19,12,20*) found cost, safety, and alleviating congestion to be key factors in the carpool decision. Other studies have identified environmental awareness and poor transit service as key motivators for pursuing carpooling (*21*). The literature has also focused on government policies that aid or disrupt the practice of carpooling (*20*). With respect to personal characteristics, the literature points to the role of income, gender and educational attainment on carpooling choice (*15,22*). Regarding carpool formation, it is no surprise to discover that the size of the potential pool of matches correlates with carpool establishment (*23,15,24*).

Some research has looked into the behavioural processes that gives rise to carpooling. Ozanne et al. (*25*) applied the *Planned Action Behaviour* and the *Theory of Reasoned Action* to determine what drives carpooling and, like Horowitz et al. (*26*), found that attitudes are important. As a result, the research suggested that policy should focus on influencing attitudes. With respect to spatial factors, Teal (*23*) proposed that carpool users tend to travel further distances than SOV drivers and therefore the choice to carpool may also be location and destination driven. The temporal characteristics of work also have been shown to play a role (*24*). Tsao et al. (*27*) found that

the sacrifice of time and schedule flexibility is a significant deterrent to carpooling.

Information Technology (IT) and Travel Behaviour

The majority of the literature pertaining to IT and its role in commuting discusses teleworking and the extent to which IT can be used to overcome "the friction of distance" through a direct substitution of physical for "virtual" mobility (*28*). Interestingly, Resnick (*29*) suggested that the emergence of ride sharing has been closely associated with social conventions rather than technological innovation (*30*). Alternative views exist with, for example, Calvo et al. (*31*) arguing that information technology can play an important role in managing carpool dynamics (e.g., inform users of changes and delays in carpooling).

A few studies have examined the culture of use surrounding web-based ride-matching and carpooling. Hall and Qureshi (*32*) found that while matches can be achieved, the likelihood of success can be quite low (one in five at best). Haselkorn et al. (*33*) reported that while participants were excited about carpooling, the formation of matches was difficult. Another short-term ride match tool study found that as more users are registered, there is an increase in carpool formation (*34*). This evidence suggests that while a small carpool program may have little impact in the short run, with time and expansion of the "pool", its impact can increase (*34*).

DATA AND METHODS

The Carpool Zone project began in 2005. In the fall of 2007, two years after the launch of the service, Smart Commute conducted a web-based survey focused both on the assessment of Carpool Zone as well as respondent travel and personal behaviour. This research uses data for respondents from the Greater Golden Horseshoe Area (GGHA), who reported their gender as a survey response (n = 1144). There is a near equal representation of males (n = 562) and females (n = 582) in the sample. The Greater Golden Horseshoe Area has been selected as the study area because findings may be applied to inform the ongoing implementation of planning and policy strategies recently outlined in the provincial *Places to Grow* plan (*3*).

Smart Commute's survey included a series of questions designed to shed light on the motivations for commuter mode choice, and level of satisfaction and usage characteristics associated with the Carpool Zone application. Respondents were also asked for self-report commute times, and provided data on a number of individual and transport related characteristics. Potential respondents were contacted by e-mail by a representative of Smart Commute regarding survey participation. With respect to this research, the survey data are a secondary data source, Smart Commute was responsible for the development and implementation of the survey instrument.

This study is notably focused on a specialized population; individuals who have selected themselves into a database for the purpose of forming a carpool for the journey to work. This suggests that most respondents possess working knowledge and access to the required computing technology. This raises broader concerns around the equitable distribution of cost saving technologies and applications. That is, an initiative of this sort could benefit lower income households who typically spend a higher portion of their budgets on transportation than others, but might not have access to computing technologies.

The data has certain limitations with respect to demographic and spatial information. Income level, family status, education level, employment position and ethnicity are among the unknown variables of the sample. This limitation prevents complete analysis of certain theories discussed in the literature review. Due to institutional and programmatic constraints, destination data have not yet been made available to the research team. This gap in the geography of the respondent commutes makes it difficult to associate revealed behaviour in the sample with patterns of development at the work trip end, or to examine carpooling attitudes across the spectrum of possible commuting patterns (e.g., suburb-suburb, suburb-core, etc.).

Methodological Approach

Analysis of the survey is primarily exploratory, with the testing of several hypotheses concerning the relationship between gender and carpooling. The empirical analysis is subdivided into three parts and involves the application of graphical methods, and approaches for examining statistical difference across independent samples.

Descriptive and inferential techniques are applied to examine sample demographics, responses to Likert scale questions regarding Carpool Zone performance, and attitudes regarding the practice of carpooling. The Carpool Zone performance questions have been assessed using the Mann-Whitney U test – a non-parametric approach to statistically examine differences in the shape of male/female Likert variable distributions (median response is taken as the measure of central tendency). Gender differences in attitudes and travel behaviour (self-report commute time) have been analyzed using contingency analysis and t-tests (unequal variance is assumed).

FINDINGS

Performance of Carpool Zone

User satisfaction with Carpool Zone has been assessed by examining responses to a number of Likert scale (1: Poor to 5: Excellent) questions. The results suggest that respondents are generally very satisfied with Carpool Zone; however, there appears to be a need for a larger pool of matches. Males are typically more critical of the quality of carpools and technical Carpool Zone issues than females. Both males (Median = 4) and females (Median = 4) typically rate the software as being very good, with little statistical evidence of a gender difference in satisfaction (U = 122,657, p = 0.989)[1].

When probed regarding "Ease of use", i.e., overall user friendliness of Carpool Zone, both males and females felt the system was very good (U = 123,908, p = 0.639). There appears to also be broad and uniform satisfaction with the registration process with males (Median = 4) and females (Median = 4) typically assigning a high score to this aspect of system performance (U = 124,471, p = 0.889).

There is some evidence of concern regarding satisfaction with the number of carpool matches. This appears to be uniform across males (Median = 3) and females (Median = 3) (U = 101,859, p = 0.434). With respect to the relative ease of contacting matches, females and males responded in the same manner (Median = 4) (U =

[1] U denotes Mann-Whitney U, p denotes the p-value (required level of significance is at least 90%).

66,915, p = 0.352). The statistical evidence suggests there is no association between gender and overall satisfaction, ease of use, registration time, number of matches and ease in contacting matches (p > .10). Overall, the data indicate that most users are able to access and interact with the Carpool Zone software in a satisfactory manner.

Despite finding a broad level of satisfaction with Carpool Zone, gender differences have been detected for several key carpool formation and use variables. The strongest relationships with gender have been found for: carpool quality, technical support, privacy protection, email contact from Smart Commute, and match mapping (the aforementioned produce ordinal variables). At this early stage in Carpool Zone deployment, most respondents reported that they were unable to evaluate carpool quality. Nevertheless, for those respondents who have formed functioning carpools, males are less satisfied (Median = 3) than females (Median = 4) with carpool quality (U = 41,944, p = 0.008).

Evidence also exists to suggest that there is a statistically significant difference in male/female responses to the software's mapping capabilities (U = 92,204, p = 0.048) although both males and females report the same median response (Median = 4). Privacy protection is also rated highly by both males and females (Median = 4), however there exists a statistically significant gender difference (U = 104,352, p = .078). Lastly, females (Median = 4) are typically more satisfied with Smart Commute's technical support than males (Median = 3) (U = 42,309, p = .047).

Attitudes and Behaviour

This section reviews responses to questions focused on respondent attitudes and motivations concerning carpooling, the availability and accessibility of mobility resources, and time spent commuting. With the exception of commute time, all data were recorded as categorical responses. Alternatively, gender is associated with numerous key mobility and attitudinal variables including: current usage of the system, vehicle ownership, motivation for carpooling, ease in the assessment of suitable matches, replying to suggestions (requests to join a carpool), and current mode of commuting.

The data suggest that the primary motivation for carpooling, across males is to economize on daily transport costs. This is closely

followed by environmental concerns (Figure 1). Females, however, rate both cost and environmental motivations as equally important reasons for carpooling. Females also typically report having what can be interpreted as less auto-mobility than males. Females appear to drive less, and have poorer vehicle access than males. The statistical evidence suggests that there is a strong association between gender and motivations for carpooling ($\chi^2 = 22.31$, $p < .001$).

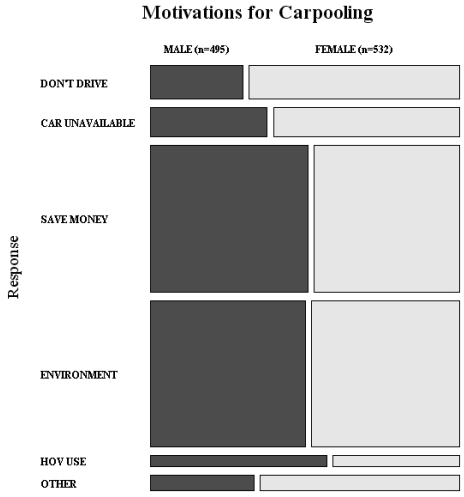

Figure 1. Respondents' motivations for carpooling. The height of each "row" displays the total number of responses in each category, while the width of each cell displays the response distribution by gender.

When respondents were asked how often they use Carpool Zone, most reported that they were either waiting for initial matches or had started carpooling with matches. Males typically indicated they were waiting for better matches, while females appear to have more difficulty finding initial matches. Gender differences of this sort are likely informative for planning purposes, and there is statistical evidence of an association between gender and the usage of the

software (χ^2 = 12.54, p = 0.083). Curiously, most respondents have indicated not having received any carpool suggestions, i.e., requests to carpool. There is strong statistical evidence of an association between gender and carpool requests (χ^2 = 15.59, p = 0.003). This is an important finding because the carpool formation process obviously relies on interaction between registered users. When probed further as to why they have not replied, respondents did not give any reason (e.g., selecting the "not applicable" response) or indicated that they are waiting for better matches. More often, males cite waiting for a better match, while females responded not applicable, but there is little evidence of a statistical association between gender and reasons for not replying (χ^2 = 11.53, p = 0.241).

With respect to vehicle ownership and use, 78% of respondents report owning a vehicle, with fewer females having auto ownership than males. There is a statistically significant association between gender and vehicle ownership (χ^2 = 26.25, p < .001). Regarding commuting mode, the largest share of respondents reported "drive alone", followed by transit and then carpooling. Males appear to be more likely to drive alone, participate in a carpool or cycle when compared with females. Female respondents were also more likely to get dropped off, or act as passengers in carpools. There is strong statistical evidence of a relationship between gender and commuter mode choice (χ^2 = 39.24, p < .001).

Respondents were also asked to provide an estimate of their commute time (Figure 2). Based on evidence from the literature, the expectation is that, at the scale of the entire sample, females will typically have shorter commutes than males. The average male commute was found to be 42 minutes, while females typically commute 38 minutes (t = 2.36, p < .05)[2]. The data also suggest that there is a larger share of males with longer commutes (commutes ≥ 100 minutes) than females in this sample. The coincidence in the commute time distributions, particularly at the lower and upper tails, suggests that at the disaggregate scale there are similarities in male in female commuting.

[2]Welch's unequal variance t-test was applied. The result is further substantiated by exploring the difference of medians across the male (40 min.) and female (35 min.) commuters (U = 120,990, p<.001).

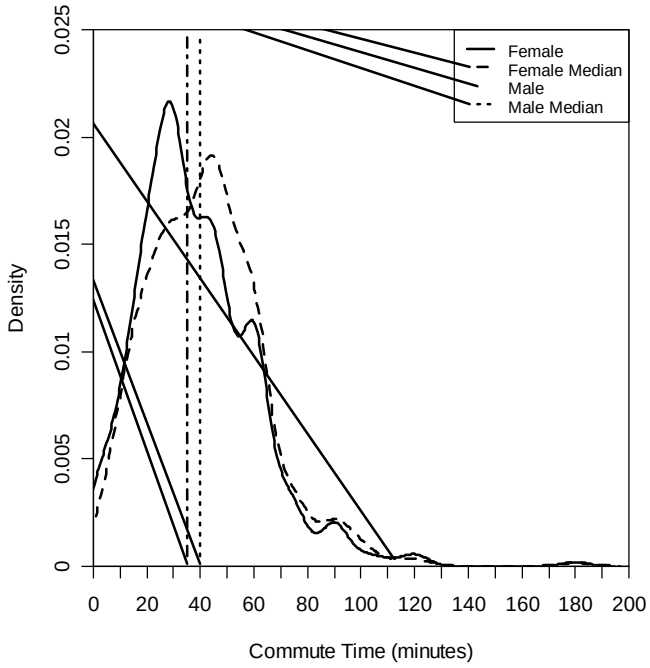

Figure 2. Self-report commute time distributions.

DISCUSSION

This study reveals a number of important findings involving attitudes toward carpooling, travel behaviour within a specialized commuter population, and the "gendering" of mobility. Overall, while respondents appear to be satisfied with the Carpool Zone software, gender differences in motivations and behaviours have been detected. Positive reviews by males and females regarding satisfaction with the Carpool Zone "software" is somewhat tempered by the lack of satisfaction around carpool quality (e.g., a primarily male concern) and matching. In other words, while the software appears to be technically sound and easy to use, the travel demand management

goals are not necessarily being realized, at this early stage, with the same degree of success.

With respect to the leveraging of IT to enhance the efficiency of passenger transport, other research suggests that while theoretically workable, IT mediated carpool formation faces several challenges, including the striking of functional agreements between users (*32*). Notably, IT mediated carpooling has worked elsewhere with, for example, Calvo (*31*) reporting successful implementation in the European context. While data in this study are somewhat limited, and while Carpool Zone is still in its early days, it is perhaps useful to consider the impact of place-based differences in societal "norms" and attitudes regarding the sharing of mobility resources; the historic development of cities and regions; and prevailing geographies of travel behaviour on the successful implementation of tools like Carpool Zone.

The evidence suggests stronger gender differences with respect to attitudes and behaviours when compared with gender-based assessment of Carpool Zone performance. Behavioural findings reflect commute mode choice and carpool decision making and attitudes that are consistent with the literature. Teal (*23*) reported that factors such as commute length, cost, and automobile availability are more often affecting carpool decisions than individual characteristics. There is little mentioned in the literature, however, about environmental concerns affecting the choice to carpool. The findings here suggest that the environmental motivation is nearly as strong as cost ($). This sort of motivational parity could be indicative of a shift in societal values, driven by "popular" movements advocating for increased environmental stewardship.

With respect to gender and mobility, the results suggest that females are more often passengers in carpools than males, have less access to automobiles than males, and are more likely to use transit. Overall, and similar to studies by Tischer (*14*) and Kaufman (*15*), females appear to have less mobility potential than males, with females citing not driving, and not having access to vehicle as reasons for carpooling. These findings support Kwan's (*13*) observation that females have less mobility, a factor which also limits accessibility to spatial opportunities. Perhaps carpooling presents an opportunity for females with poor access to mobility resources to close the so-called

mobility gap. Lastly, while other research suggests that female commuting patterns are not wholly influenced by household responsibilities (*9*), and that females typically travel longer distances than males (*35*), this study suggests that females with an interest in carpooling typically travel shorter distances than males.

CONCLUSIONS

This study focused on evaluating the performance of Carpool Zone, a web-based carpool formation application, and examined gender differences in software satisfaction, attitudes toward carpooling, and travel behaviour. While Carpool Zone users were satisfied with the software, minor differences emerged when the user population was segmented by gender. The evidence also suggests that a key aspect to facilitating carpool formation is, not surprisingly, successfully growing a database that can accommodate various permutations and combinations of user characteristics. With respect to mobility and travel behaviour, the evidence suggests that females appear to initiate the carpool formation process to overcome what can arguably be described as a mobility deficit when compared with males.

Several important recommendations for future research have also been identified. Key demographic and geographic variables (e.g., destination geocodes) have not been released for both technical and programme related reasons. These issues are largely beyond the control of the researcher, and recommendations have been made concerning broadening the range of personal and geographic data gathered through the satisfaction survey. Lastly, given the information that is provided in the survey, it would be instructive to model the carpool formation process to tease out those factors that are most important to achieving successful carpool formation.

To conclude, ridesharing and carpooling has been singled out as one of the most difficult forms of mode choice to achieve (*12*). Nevertheless, carpooling initiatives have met with varied levels of success and represent one approach to using the transportation system in a creative way to achieve economic and environmental policy goals. Smart Commute's Carpool Zone represents an innovative attempt to leverage the power of the Internet to improve performance within the passenger transportation system.

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