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Contrasting Transportation Dynamics: A Comparative Analysis of Time Use, Vehicle Ownership and Emission Profiles in British Columbia's Urban Areas

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Introduction

Technological advancements and the COVID-19 pandemic have reshaped how individuals allocate time, with increased remote work, online shopping, and virtual services impacting travel behavior [1]. These shifts influence transit demand, infrastructure investments, and transportation policies. While tele activities present opportunities to reduce congestion and emissions, their overall impact on travel remains uncertain [2]. Traditional trip-based models, widely used in transportation planning, fail to capture the interdependencies between in-home, online, and out-of-home activities. Although activity-based models (ABMs) address some of these limitations, most still focus primarily on out-of-home activities [3]. We need to develop next generation travel demand model that accommodates the inter-dependency of online, and in- and out-of-home activities to accurately predict travel demand and be sensitive to emerging dynamic policies and strategies such as work-from-home. To do that we need to generate new data to provide evidence on the changes in behavior, quantify the interactions among decisions, and accurately forecast policy sensitive travel demand. Current travel surveys, such as the Transportation Tomorrow Survey (TTS), primarily collect cross-sectional trip data, limiting the ability to analyze behavioral changes over time [4]. However, to build an activity-based travel model, we need activity data. One of the major limitations of the existing activity time use surveys is to ignore how individuals spend time in the virtual space such as online shopping and food ordering which has been widely adopted in the recent times [5] . Another limitation of the existing surveys is their cross-sectional nature – meaning the collection of data for a particular time point. To address these gaps, a time-use survey was conducted in British Columbia, Canada, using a web-based tool (24-hour activity log) and a smartphone app (7-day data). The 24-hour activity log of the survey collected information about in-home, online and out-of-home activities. The survey also collected information about vehicle ownership and parking fees, electric vehicle (EV) charging, mobility tools and socio-demographic attributes. This study uses data from this time use survey to analyze how individuals allocate time to activities in the virtual and physical spaces, and their travel behavior, vehicle ownership, and travel-related carbon footprint. The study also compares behavior of residents of a larger metropolitan area (i.e., Metro Vancouver) with a smaller metropolitan area (i.e., Okanagan) in British Columbia, Canada.

Methodology

The core component of the BC ATUS web-survey is the 24-hour activity log, which collects information on all activities including out-of-home such as work at the work place, in-home such as work-from-home and online activities such as online shopping and virtual care (Fig. 1). For out-of-home activities, data for a total of 22 activity categories were collected which was 16 categories for the in-home/online activities. In the case of in-home/online activity categories, the broad idea was to mostly include the categories that has an out-of-home counterpart. For all types of activities, start-time, end-time and location information were collected. For out-of-home activities, travel mode, vehicle and transit used, and travel companion information were also collected. After cleaning and processing, the wave 1 of the survey yielded a sample of 1872 individuals (i.e., 1067 in Metro Vancouver and 767 in Okanagan) living in 1228 households. In the case of the smartphone app (7-day data), once participants completed the web survey, they were invited to use the smartphone app, which recorded travel data, including start and end time of a trip, GPS trajectories, travel modes, and trip purposes. At the end of each day, participants could review and confirm the accuracy of the collected data and manually input any missing details (Fig. 2). This smartphone app component collected 7 consecutive days of data from 143 individuals.

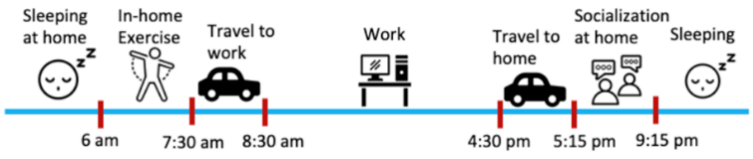

Fig. 1 Example activity log of a person

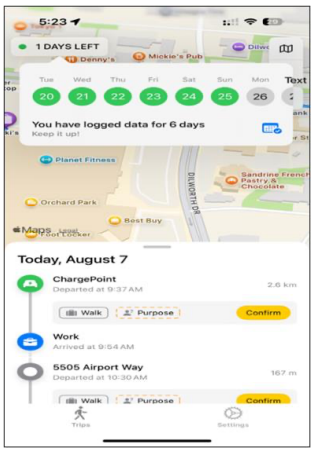

Fig. 2 Example Smartphone app data

Results

Daily life in Metro Vancouver and Okanagan is predominantly home-centered, with sleeping and in-home activities being the most common (Fig. 3 and 4). Workplace commuting is higher in Okanagan (43.42%) than in Metro Vancouver (43.46%), where remote work (29.43%) is more prevalent. Digital engagement, including online shopping and classes, is rising in both regions, reflecting a shift towards virtual alternatives and flexible work arrangements post-COVID.

Metro Vancouver has a diverse transportation mix, with 50% relying on personal vehicles, 21% using active modes, and 16.33% using public transit, reflecting strong urban infrastructure (Fig 5). In contrast, Okanagan is predominantly car-dependent (69.34%), with

lower active transportation (13.29%) and minimal public transit use (4.25%) (Fig 6). Alternative modes remain underutilized in both regions.

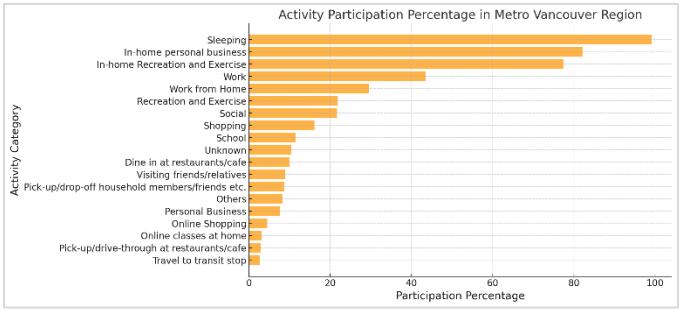

Fig. 3 Activity Participation in Metro Vancouver

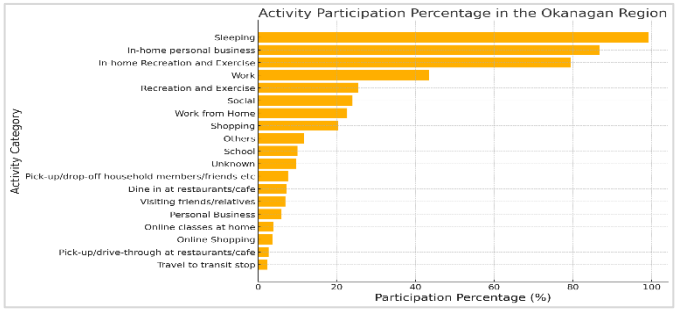

Fig. 4 Activity Participation in Okanagan

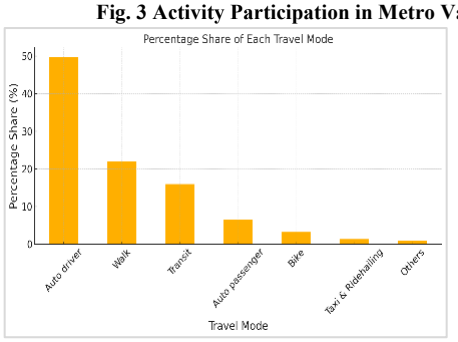

Fig. 5 Mode share in Metro Vancouver

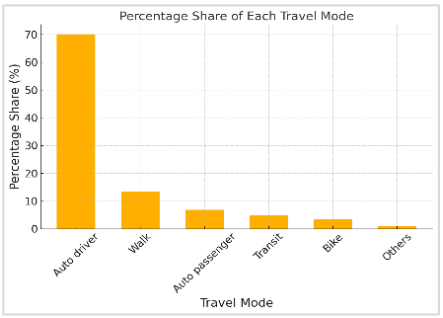

Fig. 6 Mode share in Okanagan

Metro Vancouver commuters travel the most (23.68 km/day), while remote workers cover significantly less (10.88 km/day), reducing overall travel needs (Fig 7). In Okanagan, commuters travel 21 km/day, while remote workers average 17.5 km/day (Fig 8). Hybrid workers, who split time between home and the workplace, travel even less at 12.5 km/day. These differences highlight how work arrangements impact travel behavior and distance.

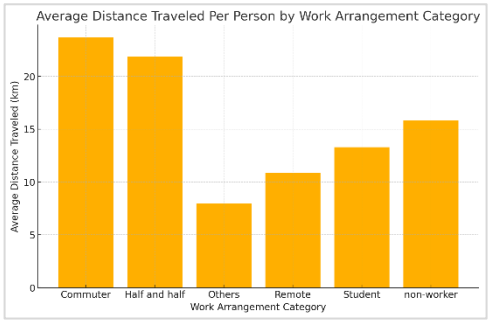

Fig. 7 Distance traveled per person in Metro Vancouver

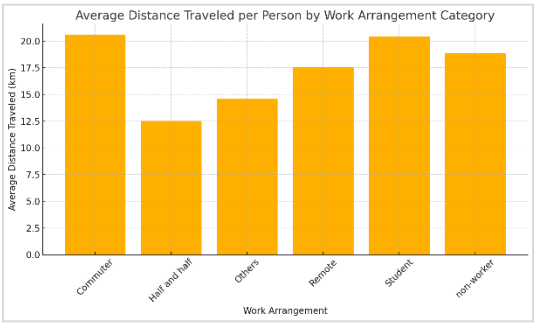

Fig. 8 Distance traveled per person in Okanagan

Greenhouse Gas (GHG) emissions were calculated based on the average distance traveled per person across different modes of transportation. In Metro Vancouver, commuters exhibit the highest emissions due to their reliance on personal vehicles and longer travel distances, averaging 4 kg CO2 per day (Fig. 9). Remote workers have significantly lower emissions, averaging 1.62 kg CO2 per day, reflecting their shorter travel distances and greater use of low-emission modes like walking and biking. In Okanagan, GHG emissions per person vary significantly by work arrangement, with commuters having the highest average emissions at 4 kg of CO2 per person (Fig. 10). In contrast, remote workers produce lower emissions, averaging 3.44 kg per person, reflecting the reduced need for daily travel. Non-workers and students, despite not commuting daily, show higher emissions due to their varied travel patterns.

In Metro Vancouver, 17.7% of households are car-free, relying on transit, walking, or cycling. The majority (50.1%) own one vehicle, followed by 26.0% with two vehicles, 5.1% with three, and less than 1.0% with four or more. The prevalence of zero- and one-vehicle households (67.8%) reflects strong transit and mobility options. In Okanagan, vehicle ownership patterns differ from Metro Vancouver, with a lower proportion of car-free households and a higher share of multi-vehicle ownership (Fig. 12). The majority (46%) of households own one vehicle, followed closely by 39% with two vehicles, indicating a strong reliance on private transportation. In contrast, only a small percentage of households (around 8%) are car-free, suggesting limited alternative mobility options such as public transit, walking, or cycling. These results suggest that transportation policies in the Okanagan should focus on improving transit accessibility and supporting active transportation to reduce car dependency.

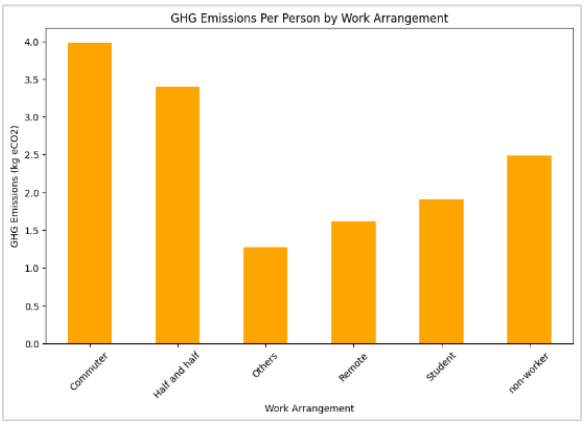

Fig. 9 GHG emissions in Metro Vancouver

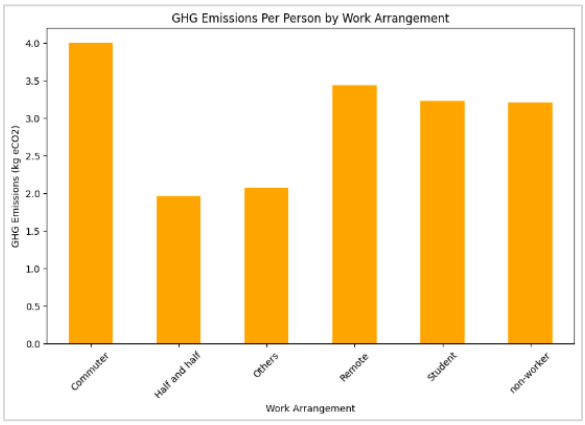

Fig. 10 GHG emissions in Okanagan

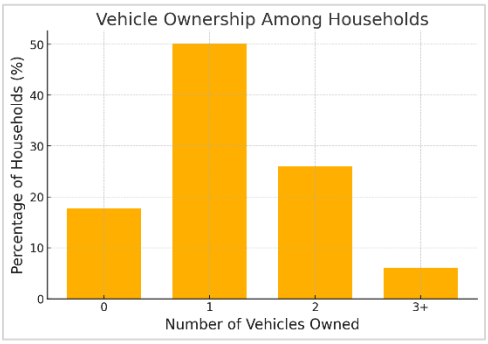

Fig. 11 Vehicle Ownership in Metro Vancouver

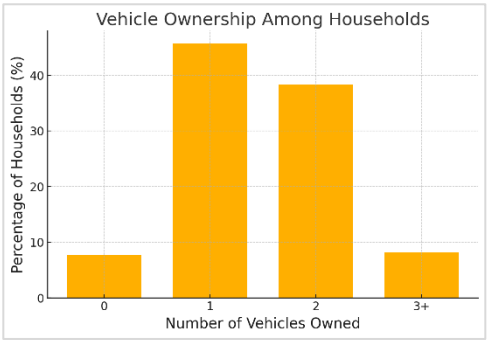

Fig. 12 Vehicle Ownership in Okanagan

Gasoline-powered vehicles dominate Metro Vancouver (84.2%) and Okanagan (85%) (Fig 13 and 14). EV adoption remains low, with plug-in electric, hybrid, and plug-in hybrid vehicles making up less than 10% in both regions. Diesel vehicles account for ~3%. The low adoption of electric and hybrid vehicles suggests barriers such as limited charging infrastructure and higher upfront costs, among others. In Metro Vancouver, 40.3% of households are unsure about buying an EV, while 31.7% do not plan to, likely due to cost or charging concerns (Fig. 15). 12.8% intend to buy a plug-in EV, 8.0% a hybrid EV, and 7.1% a plug-in hybrid. The high uncertainty and reluctance highlight the need for better incentives, infrastructure, and public awareness to boost EV adoption. A significant portion of households in the Okanagan remain uncertain about purchasing an electric vehicle (40%), while over 30% have no intention of buying one (Fig. 16). This suggests a lack of awareness, affordability concerns, or infrastructure limitations. Among those considering EV adoption, less than 10% plan to buy a plug-in electric vehicle (e.g., Tesla), while smaller shares (~5-7%) are interested in hybrid or plug-in hybrid EVs. The low commitment to EV adoption highlights the need for stronger incentives, expanded charging networks, and increased public education to drive sustainable vehicle choices.

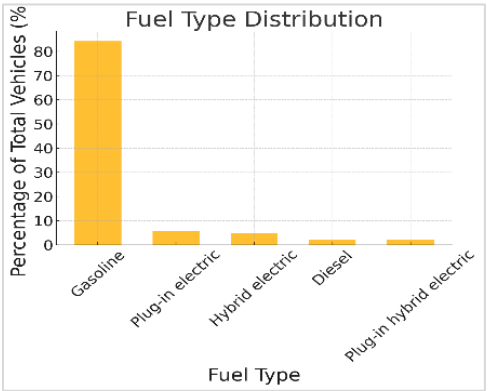

Fig. 13 Fuel type distribution in Metro Vancouver

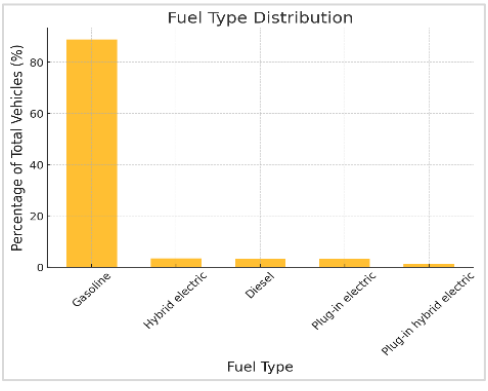

Fig. 14 Fuel type distribution in Okanagan

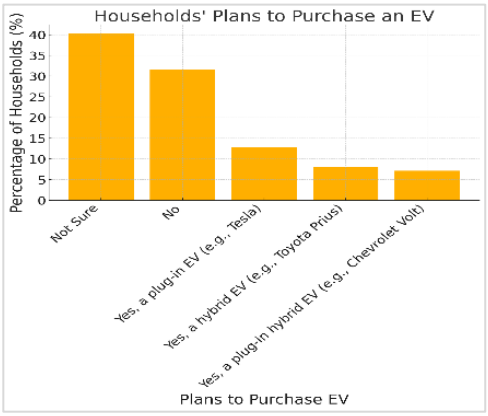

Fig. 15 EV purchase plan in Metro Vancouver

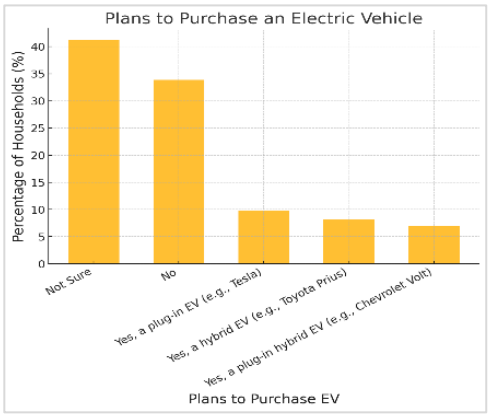

Fig. 16 EV purchase plan in Okanagan

Results from the smartphone app data revealed interesting weekday and weekend variations in activity patterns based on work arrangements in Metro Vancouver and Okanagan region in BC. For instance, commuters exhibited sharp morning and afternoon peaks for work trips, dining peaks at lunch and dinner, and shopping trips in the late afternoon and evening, likely due to work-related time constraints. Hybrid workers showed early morning work peaks, no strong afternoon peak, and a higher frequency of personal business trips in the first half of the day (Fig. 17)

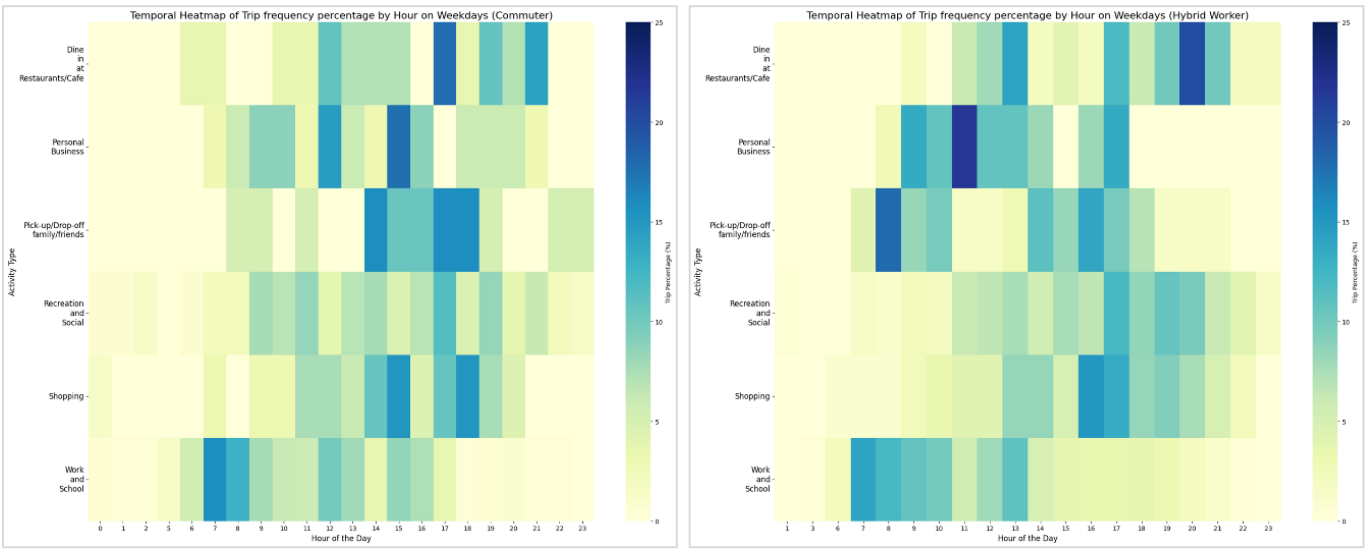

Fig. 17 Trip frequency by hours on weekdays based on work arrangements in Metro Vancouver and Okanagan region in BC

Conclusion

This study highlights the evolving patterns of time use, travel behavior, vehicle ownership, and emissions in British Columbia, emphasizing regional differences and their implications for emissions. The findings provide critical insights for policymakers to develop data-driven strategies that support sustainable and efficient transportation systems.

References

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