INVERTED SAMPLING METHOD FOR HOUSEHOLD TRAVEL SURVEYS

INVESTIGATING REACHING HOUSEHOLDS THROUGH EMPLOYERS

2018-04-25

Transportation Tomorrow Survey 2.0

Tian Lin, Siva Srikukenthiran

Khandker Nurul Habib & Eric J. Miller

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING
Transportation Research Institute

EXECUTIVE SUMMARY

For most in the transportation field, the household travel survey has been the benchmark in data collection for transportation planning. For decades, it has evolved and adapted to successive generations of new mediums. However, the changing technological and demographic landscape has brought new challenges. The household travel survey must evolve again with the times to fulfill the data needs of the future.

It is under this setting that the inverted sampling method is proposed. By "inverting" the sampling process and reach the individual indirectly through employers, the method leverages the scale of the firm and possibly exploit the authority of the employer. Two pilots were conducted to test the real-world feasibility of this proposed methodology with slightly different goals in mind. One focused on the private sector, while the other focused on the public sector.

Findings from the pilots show mixed results. Initial reception from businesses was positive, but the final distribution rate was lower than expected. Feedbacks from businesses indicate a need for more logistical support during the distribution process, particularly for small businesses. On the other hand, participation was high among some industry sectors, including retail. This shows the potential to reach some previously underrepresented demographics using this new methodology. Final employee responses rates from both pilots were also encouraging.

The results lend some credence to the method as a candidate for replacing some traditional methods in certain scenarios or be used to complement those methods. However, it is difficult to ignore that while the method has some advantages, implementation of the method under real-world conditions require a particular level of care and support that may outweigh its benefits.

Inverted Sampling Method for Household Travel Surveys

TRANSPORTATION TOMORROW SURVEY 2.0

Table of Contents

List of Tables

List of Figures

1 INTRODUCTION

The process of transportation planning involves studying and learning the mobility behaviour of people in order to forecast future conditions and anticipate their future needs. This process of extrapolation requires information that accurately reflects the characteristics of the population; as a result, those in the transportation field relies on the availability of trusted data sources to inform their analysis.

For years, the household travel survey has been a key source of data. Household travel surveys have been conducted around the world for decades either in person, through the mail, over the phone, or on the web. The Transportation Tomorrow Survey (TTS), the primary household travel survey of the Greater Toronto Area (GTA) has been running since 1986. It has been relied on by transportation professionals to provide accurate information on the travel of households in the GTA. Like many of its peers, the quality and reliability of data from the TTS are dependent on the continued proliferation of conventional family and household arrangements, and ongoing use of landline telephones. However, technological innovations and demographic shifts have slowly eroded the validity of these assumptions. In particular, the development of the internet and mobile communication technologies have impacted the quality and reliability of the traditional data collection methods, while indirectly reducing response rates from conventional household surveys. At the same time, the gradual decline of traditional nuclear families, and the expansion of non-traditional household arrangements, especially transient ones, have increased the difficulty with which planners, researchers, and could reach some segments of the population. Over time, this has increased the uncertainty of the geographic and demographic completeness of survey data.

In an effort to combat these issues, in this report, we propose and investigate inverted sampling as an alternative collection methodology to replace or complement the existing portfolio of tools used in conducting household surveys. The inverted sampling method attempts to survey households indirectly through their place of work. Employers are recruited to distribute travel surveys to their employees from business listings, either in person or through the telephone.

Two pilots were carried out to validate the effectiveness and practical use of the proposed method. The first was carried out in the summer of 2017 among private establishments, with a second in the winter of the same year with cooperation from one government agency

The purpose of this report is to outline the rationale for developing and testing the inverted sampling method, provide a detailed description of the method and present the findings from the two pilots. The remainder of this report first presents a literature review of the current state of research into the potential shortcomings of the traditional survey methodologies, and alternatives proposed to address those issues. Next, the report describes, in detail, the general methodology of inverted sampling and the implementation of the two pilots that were conducted. The report concludes with the findings from the two field tests and a discussion of their implications.

2 LITERATURE REVIEW

A review of both transportation specific and general survey methods literature shows numerous known issues and developing trends documented during the last few decades. These include those associated with transportation-specific surveys, such as household travel surveys, as well as data collection efforts in other fields.

Among the known issues noted in the literature are interviewer bias and sample frame coverage. It has been well documented that survey interviewers can introduce biases in the response of those being surveyed. This is especially true for ego-driven questions, such as questions about income or social behaviours, where the presence of an interviewer can lead to the respondents providing a more socially acceptable or desirable response rather than the objective truth. The issue can usually be avoided through self-guided survey formats, which are already widely used, or be accommodated through post-survey calibration (Atkeson, et al., 2014; Dillman, et al., 2009).

The issue with coverage, especially demographic coverage, has also been a well-acknowledged challenge to investigators. The use of any survey mode inevitably excludes a certain demographic group that cannot be easily reached through the chosen method. While the landline telephone became almost ubiquitous in households of the developed world through the later decades of the 20th century, its use has been decreasing since cell-phone service became widely available both geographically and socio-demographically. This has prompted concerns about the exclusion of some demographic group who now eschews landline telephone ownership (Keeter, et al., 2008; Link & Lai, 2011; Roorda, et al., 2011). There has been general agreement amongst researchers of the clear differences between the demographic characteristics of traditional landline households and cell-phone-only (CPO) households (Phoenix Strategic Perspectives Inc., 2012), and research into this demographic group has found that CPO households tend to be younger, poorer and more likely to be a member of economically disadvantaged groups (Carey, et al., 2014; Grande & Taylor, 2010). This poses problems to phone-based surveys like the TTS, which have relied on the ubiquity of landline telephones to ensure coverage and representativeness (Hu, et al., 2011). The inclusion of cell-phones in telephone surveys with random dialing could become costly while also creating sampling issues with a geographical distribution that may ultimately affect the representation of other demographic cross-sections in the sample (Phoenix Strategic Perspectives Inc., 2012; Roorda, et al., 2011).

The existing literature has also documented a continuing trend of decreasing response rates, and the associated effects, that have been afflicting traditional phone and mail surveys (Curtin, et al., 2005). The decreasing response rate is both a consequence of technological developments, such as the proliferation of mobile communication and the widespread use of the internet and gradual increase in the number of surveys being conducted over time. These decreasing response rates force industry professionals to devote more resources to conducting surveys (Stopher & Greaves, 2007). Indirectly, the decrease in response rates has also raised concerns about the effect of non-response bias on the quality of the collected data. While there are still disagreements on the magnitude of such bias in the traditional mail and phone surveys, there is general agreement that it could affect the results of some specific variables being measured (Groves, 2006; Keeter, et al., 2006).

These concerns have prompted industry professionals and researchers to look for alternative methods and tools, both to address these concerns and to prepare for future data needs. The simplest of the proposed alternatives is the use of address-based sampling. Address-based sampling is a comparatively low-tech, but effective method in capturing CPO households. However, research into the method shows that differential non-response persists, and initial contact and recruitment still prove difficult. In addition, extra post-survey measures are still needed to adjust for the lower response rate in unmatched numbers (Link & Lai, 2011).

In more recent years, internet technologies, particularly web-based surveys, have been increasingly used to complement or replace traditional survey methods. Web surveys were hoped to be more cost effective compared to older survey methods owing to lower labour and overhead costs, and also receive more responses overall as the general populace spends more and more time online. Early research into web surveys focused on possible coverage issues and selection errors (Manfreda, et al., 2008). Researchers were concerned with the limited coverage of web surveys as only internet users could be reached. It was also feared that among those surveyed, only those of specific demographics would be inclined to respond, and this kind of self-selection would occur due to differing levels of familiarity with new technologies (Couper, 2000). These concerns are much less of an issue with web-based surveys today, with internet access reaching near ubiquity in the developed world and the web becoming both an indispensable and an avoidable part of life.

However, the widespread use of the internet has brought with it the same problems that have plagued older survey methods. Earlier comparisons of web surveys with more traditional survey methods have shown promising results; however, the prevalence of internet usage and the surge in the number of web surveys conducted has created fatigue towards web surveys in the general public, slowly eroding response rates (Fleming & Bowden, 2009; Manfreda, et al., 2008). This was not unlike the situation with telephone surveys in the 1990s as landline telephone ownership reached its peak.

It is clear then, that over the long term, no single survey method can be completely relied upon to produce an unbiased, representative sample in a cost-effective manner. Therefore, research on survey methods, especially for transportation surveys, has turned to the use of multi-frame surveys. The fundamental concept is to negate the shortcomings of any single sample frame through the utilization of multiple sampling frames. Multi-frame structures involving mail, landline telephones, cell-phones or web surveys have been tested in recent surveys. The use of GPS and other passive data sources have also been included in multi-frame data structures proposed in more recent years (Dillman, et al., 2009; Keeter, et al., 2008; Hu, et al., 2011; Stopher & Greaves, 2007; Callegaro, et al., 2011; Kempf & Remington, 2007; Kunert & Follmer, 2005; Ampt & Stopher, 2005).

Multi-frame sampling, however, is not without its issues. While the use of multiple sampling frames can address the issue of coverage and sampling bias found in some survey methods, it does not inherently reduce response bias. This is more easily calibrated for in single frame surveys but could pose problems in multi-frame structures due to the complex post-processing required to estimate the appropriate weighting and adjustments so as to address the differences in response rate and bias from different frames (Callegaro, et al., 2011; de Leeuw, 2005; Lohr, 2011). Regardless of these complications, the combination of multiple sampling frames still represents the most promising

approach available to obtain an unbiased and representative sample for study, and an approach that should be adopted for future travel surveys such as the TTS.

Given that the advantage of adopting a multi-frame approach stems from the combination of different sample frames and methods to complement each other, it would then stand to reason that having a wide range of alternative sampling frames and methods would be beneficial.

As a result, the authors of this report sought to explore an inverted sampling method as a new alternative to the existing range of sampling methods. Under this method, employers are recruited to distribute the household travel survey to their employees, acting therefore as an 'inverted' approach to reaching households.

A number of employer/employee surveys already exist, but most are conducted for the purpose of measuring employment levels, or employer/employee sentiments. While these surveys are distributed to employees, their distribution methods differ from the proposed inverted sampling frame. For example, the Workplace and Employee Survey (WES) conducted by Statistics Canada encloses the survey with the annual tax forms mailed to all individuals who received an income through employment during the previous year. The survey samples are drawn from the Business Register, also maintained by Statistics Canada (Statistics Canada, 2009).

Another example would be the employee surveys conducted as part of the Smart Commute program operated by Metrolinx. The program enlists employers throughout the GTA to participate in its initiatives, providing resources and incentives for employees of enlisted workplaces to adopt more sustainable commute options. The program conducts surveys on the employees of those work places, collecting information about changes in their commuting habits. While the distribution method is similar to inverted sampling, the survey does not include a complete travel diary found in a conventional travel survey and therefore does not cover any non-work trips (Lanyon, 2007). The survey achieved a response rate of 1.7%, based on the total number of employees employed by the participating employers.

The StudentMoveTO survey, conducted last in 2015, is another survey that utilizes a similar sampling and distribution method to the inverted sampling frame. Invitations to the survey were sent to students through their school email accounts; however, unlike the Smart Commute program, StudentMoveTO had respondents fill out a complete trip diary (Habib, et al., 2017).

3 METHODOLOGY

The general concept of the inverted sampling method involves two steps. First, employers need to be recruited as distributors of the survey. Once they are recruited, the surveys or the information needed to access the survey will be sent to the employers. They could be paper surveys sent through mail or fax or web surveys accessed through a web link. Upon receiving the survey or the survey access information, the employers are asked to distribute them to their employees, so travel data may be collected from the employee households. Since the employers need to be contacted for recruitment, the process of recruitment also presents an opportunity to collect information about the employers themselves. Therefore, an employer survey was also added to explore this opportunity for employer data collection. In order to accommodate a wide range of English language abilities and educational backgrounds, the language and wording of all written contents that are to be distributed were kept clear and concise.

The underlying rationale for the methodology is to leverage the size of firms to distribute surveys to more potential respondents with fewer resources. It has the potential to reach some hard-to-reach demographics and to be highly scalable. However, it also has some inherent issues. First, it further distances the investigator from the respondents. Second, it places the burden of survey distribution on the recruited employers, which would make it more difficult to persuade employers to participate. Being an untested survey method, it is unclear whether this shortcoming would outweigh its benefits, so to test the feasibility and effectiveness of the proposed inverted sampling method, two pilots were devised.

The first of the two pilots targeted private sector businesses, focusing on testing the feasibility of the proposed recruitment and distribution mechanism. There were three steps to this business pilot. First, an information brochure was distributed to inform employers of the survey and its purpose. The brochures contained basic descriptions of the pilot as well as links to websites where employers can find more details of the pilot. It was first sent in PDF format to local municipalities to be forwarded to their respective affiliated chambers of commerce (CoC). The idea was that the local CoCs would then distribute them amongst their member businesses.

Employers in the survey area were then contacted by interviewers over the telephone. During the phone interview, they were given the opportunity to take part in only the employer survey or to participate in both distributing the employee survey and answering the employer survey. They would complete the employer survey over the phone if they chose to participate, and they would be provided with the access information to the employee travel survey should they have chosen to participate in both parts. Finally, they would be asked to forward the access information to the employee survey to their employees.

The second of the two pilots were directed towards public sector agencies, focusing on testing the performance of the proposed distribution mechanism in isolation. The goal was to see how inverted sampling would perform if employer recruitment was not an issue, and employers were engaged and committed to the carrying out the survey. It was also an opportunity to see how the methodology would work with large employers. As such, the recruitment process for the second pilot was somewhat different from the business pilot. Government agencies affiliated with the TTS survey program were recruited directly through contacts from those agencies. The distribution process of

the employee survey and the collection of responses remained the same as the business pilot. Agency contacts were provided with web-links to the employee survey and asked to forward them to employees.

3.1 Sampling

The first pilot required that a random sample of the business establishment be drawn to produce a list of businesses that would be contacted. A complete listing of businesses in the Greater Golden Horseshoe Area (GGHA) was obtained from InfoCanada to serve as the sample frame. However, the list is updated on a 5-year cycle, which resulted in about 80% of the list is accurate and up to date. A final sample of 10000 random samples, randomly drawn from the full population, was used for the business pilot.

Comparisons between the full sample population and the drawn sample show a good level of consistency between the two in terms of geographical distribution, business size and industry sector as seen from **Table 1** to

Table 3. Businesses with less than 5 employees were excluded from the pilot as surveying businesses of this size would lose the potential scalability advantage of the inverted sampling frame in comparison to sampling households directly. Their employees would be better captured through more direct household-based sampling methods.

TABLE 1: GEOGRAPHICAL DISTRIBUTION COMPARISON BETWEEN FULL POPULATION AND SAMPLE

Regional Municipalities	All businesses	Sample
Brant	1.51%	1.71%
Dufferin	0.63%	0.49%
Durham	4.92%	4.74%
Grey	1.31%	1.29%
Haldimand-Norfolk	1.17%	0.94%
Haliburton	0.30%	0.28%
Halton	5.59%	6.21%
Hamilton	5.04%	5.04%
Hastings	1.71%	1.83%
Kawartha Lakes	0.91%	0.78%
Muskoka	1.12%	1.17%
Niagara	5.16%	5.26%
Northumberland	1.04%	0.92%
Oxford	1.21%	1.01%
Peel	11.53%	13.06%
Perth	1.03%	1.10%
Peterborough	1.86%	1.91%
Simcoe	5.14%	4.95%
Toronto	29.38%	28.92%
Waterloo	5.57%	6.59%
Wellington	2.48%	2.32%

York	11.38%	9.45%
Total	100%	100%

TABLE 2: SIZE DISTRIBUTION COMPARISON BETWEEN FULL POPULATION AND SAMPLE

Size Range (# of Employees)	All Businesses	Sample
5 to 9	51%	49%
10 to 19	24%	24%
20 to 49	15%	16%
50 to 99	5%	5%
100 to 249	3%	3%
250 to 499	1%	1%
500 to 999	0%	0%
1000 to 4999	0%	0%
5000 to 9999	0%	0%
10000+	0%	0%
Grand Total	100%	100%

TABLE 3: INDUSTRY SECTOR DISTRIBUTION COMPARISON BETWEEN FULL POPULATION AND SAMPLE

NAICS Level 1 Sectors	All Populations	Sample
Agriculture, forestry, fishing, and hunting	0.33%	0.31%
Mining, quarrying, and oil and gas extraction	0.46%	0.24%
Utilities	0.12%	0.07%
Construction	7.11%	8.16%
Wholesale Trade	6.46%	6.03%
Information and cultural industries	1.95%	1.74%
Finance and insurance	4.73%	4.50%
Real estate and rental and leasing	2.72%	3.42%
Professional, scientific and technical services	7.77%	8.95%
Management of companies and enterprises	0.04%	0.05%
Administrative and support, waste management and remediation services	3.23%	3.65%
Educational services	1.08%	2.99%
Health care and social assistance	9.54%	9.52%
Arts, entertainment, and recreation	2.03%	1.77%
Accommodation and food services	12.64%	7.98%
Other services (except public administration)	6.56%	11.80%
Public Administration	3.05%	1.67%
Nonclassifiable	2.25%	1.02%
Manufacturing	9.91%	7.11%
Retail	15.41%	16.77%
Transportation and Warehousing	2.60%	2.26%

Total	100.00%	100.00%

3.2 Business recruitment

Recruitment for the first pilot proceeded in two stages. The first stage informed businesses of the pilot prior to its start. The contact and recruitment of businesses for the employer survey and the employee survey distribution happened during the second the stage.

3.2.1 Informational Brochure

During the first stage, an initial attempt was made to inform businesses using a short brochure that provided the most basic information about the pilot. The brochure was laid out in three sections. The first section was a summary, informing the reader of the pilot, its basic premise, its starting date and the possibility for participation. The middle section provided more details of the pilot, including the purpose of the pilot, its general structure, the types of information that would be collected and the employer involvement that would be required during the process. Businesses were informed both of the information that would be collected from the businesses themselves and from their employees during the pilot to provide transparency to the process. The brochure ended with the link to a website dedicated to providing information about the pilot, the overall TTS 2.0 project, and the contact information of the researchers for possible inquiries. This detailed information included a step by step description of the entire pilot process and a complete list of the information that would be solicited from both the businesses and the employees. Again, to provide transparency and some level of reassurance to the potential participants.

Distribution of the brochure was entrusted to the various local CoCs within the survey area. The brochures were first sent to the municipalities to be passed on to their affiliated CoCs, who would in-turn be asked to distribute them to their business members through e-mail. The use of this method of distribution was meant to both make use of the membership network of the CoCs and to lend credibility to the brochure. The brochure was given two weeks to circulate in the business community before the first businesses were contacted over the phone.

3.2.2 Phone Interview

After the two-week period, businesses sampled from the full sample frame were contacted by telephone by interviewers between June to August of 2017. Interviewers were asked to make a maximum of 3 attempts to reach a business before it was deemed “unreachable” and removed from the sample list. In all, over 3000 businesses were called, and just over 1000 of them were reached.

The phone interview process consisted of two parts: the recruitment and the employer survey. During the recruitment phase, the interviewer’s focus was to first make sure that the interviewee was informed about the pilot, and then ask for their participation. Businesses were first asked if they had received the information brochure. A short brief about the pilot would be given if they had not received the brochure or was unclear about the pilot for any reason. The brief provided in the phone interview is a more concise version of the information brochure and contains the same general content. Additional information for more specific questions about the survey was also provided upon request. Once the business representative was informed of the purpose and the process of the pilot, they were given the option to participate in just the employer survey, to participate in the employer survey and help distribute the employee survey, or not to participate at all. If the employer contact agreed to take part in the employer survey, then the survey would have been conducted by the interviewer over the phone.

3.2.3 Employer Survey

Given the target audience of the employer survey and the cold call nature of this first contact, particular attention was given to the length of the survey to avoid exhausting the patience of the respondents. Both the total length of the survey and the length of each question were kept to a minimum. The total length targeted to be under 10 minutes but was able to be reduced to under 7 minutes in practice.

The employer survey asked for three categories of information: basic contact information, including name and location; demographic information, including business size and gender split; and transportation-related facilities, including parking provisions and active transportation facilities.

With the additional burden of distributing the employee survey, it was expected that businesses would require some form of incentive to motivate their participation. With the insufficient budget for any monetary support or incentive, an alternative incentive was devised. It was hypothesized that aggregate results and findings from the survey might be of interest to at least some businesses. Businesses looking to set up programs to reduce automobile use may be particularly interested to have such information, and the provision of that information at the end of a survey could provide a good incentive. So to gauge business interest in receiving these findings, the businesses were asked near the end of the phone interview of their general interest to receive them, as well as the specific findings of interest.

Finally, a question was pitched to the businesses who refused participation as to whether they would participate if they were directly contacted by a government agency instead. The question was meant to directly measure the difference, if there is any, in the businesses' reception towards assisting in this type of survey distribution when contacted by government authorities rather than a third-party institution.

3.2.4 Agency Recruitment

Recruitment for the government agency pilot was much simpler compared to the business pilot. Managerial staff at a number of government agencies were directly contacted to solicit interest for the second pilot. Several of the agencies contacted showed interest to participate and were enlisted for the pilot. The agencies that made up this sample frame cover most of the TTS survey area. They include some of the largest population centres in the region, as well as other agencies such as the Ontario Ministry of Transportation, the Toronto Transit Commission, and Metrolinx.

3.2.5 Employee Survey Distribution

If the business contact agrees to help distribute the employee survey, then their e-mail is collected at the end of the phone interview. The invitation to the employee survey was then provided to them through the e-mail address collected. The invitation provides a short description of the test and the survey, as well as the instructions and other necessary information for accessing the survey to employees.

Several combinations of invitation formats were tested during the pilot. These included two versions where a PDF copy of the invitation was attached: one formatted in HTML and one formatted in plain text. The other two tested was a version of the invitation sent in HTML format only and a version with PDF invitation only.

Invitations were also sent to the government agencies in the agency pilot but in HTML formatted e-mails only. Additionally, as the participating agencies all directly fund the TTS surveys and its associated projects, they were explicitly mentioned as the funding and cooperating parties of the pilot in the invitation e-mails to agency employees. Their agency logos were also displayed to show their involvement in the pilot project.

In addition to the different survey formats, two different e-mail subjects were also tested to look for differences in how their reception by employers and employees. The first was a more generic subject making mention of the University of Toronto, while the second was worded more inquisitively in an attempt to more directly engage the reader, and invoke interest.

3.2.6 Employee survey

The employee survey was built on the TRavel and Activity Internet Survey Instrument (TRAISI) survey platform developed as part of the TTS 2.0 project. The platform was designed specifically for the purpose of creating and facilitating household travel surveys through the web. The platform identifies employers based on an employer code, which allows for the tracking of responses from different employers. These employer codes were generated and provided to employers in the survey invitations and are required for employees to access the survey.

The employee survey was meant to replicate the existing TTS survey. It contained two large sections. The first section was mostly concerned with socio-demographic, information of the household and the individual household members. The second section focuses on the trips made by members of the household. Several categories of socio-demographic information were solicited from the employee respondents, including household information, household member information, and mobility tool information. **Table 4** lists the information question types included in the survey.

TABLE 4: EMPLOYEE SURVEY QUESTIONS AND QUESTION TYPE

Employee Household Information Collected	Question Type
Home location	Map and Pin
Dwelling type	Multiple Choice
Approximate household income range	Multiple Choice
Number of a vehicle owned	Short Answer
Gender	Multiple Choice
Age	Short Answer
Employment status	Multiple Choice
Student Status	Multiple Choice
Occupation	Multiple Choice
Work location	Map and Pin
Driver's license ownership	Multiple Choice
Transit pass ownership	Multiple Choice
Trips made during the previous day	Map and Pin

The first section was mostly presented in short written answer or multiple-choice format, while the second section recorded the trip information in a trip diary format. The trip diary is similar to most household travel surveys, but with the addition of an interactive map, interface to allow for more precise input of locations and travel routes.

3.2.7 Follow up survey

A follow-up call was made with the business contact 2 weeks after the phone interview to ensure they have received the employee survey invitation and distributed the employee survey to their employees. It was also meant to address any questions or issues they may have with the pilot, and to collect other feedbacks from the survey. As part of the feedback collection, the follow-up call also explicitly asked for their method of distribution and, where applicable, any reason they may have for not distributing the employee survey.

4 PILOT SURVEY RESULTS

4.1 Business Pilot

4.1.1 Employer Responses

Initial responses from the employers are positive. Attempts were made to contact 3054 businesses, of which 1068 were reached. Within those 1068, 491 agreed to and completed the employer survey during the phone interview, while 427 of the 491 agreed to take part in the distribution of the employee travel survey. This corresponds to 46% and 40% of the total number of businesses reached, respectively, and shows a high level of initial interest and participation among the contacted businesses.

4.1.1.1 BUSINESS SIZE

Businesses of all sizes show similar levels of interest toward the idea of distributing the survey to their employees. However, the proportion of businesses that followed through with the distribution varies between businesses of different sizes. In general, a greater proportion of larger businesses carried out the employee survey distribution, while a lesser proportion of smaller businesses did so. This could be the result of more structured nature of larger firms or due to the small absolute number of medium to large sized business in the complete sample. Overall, employee responses were received from 55 of the 427 businesses that took part, about 5% of all businesses reached, at the conclusion of the pilot.

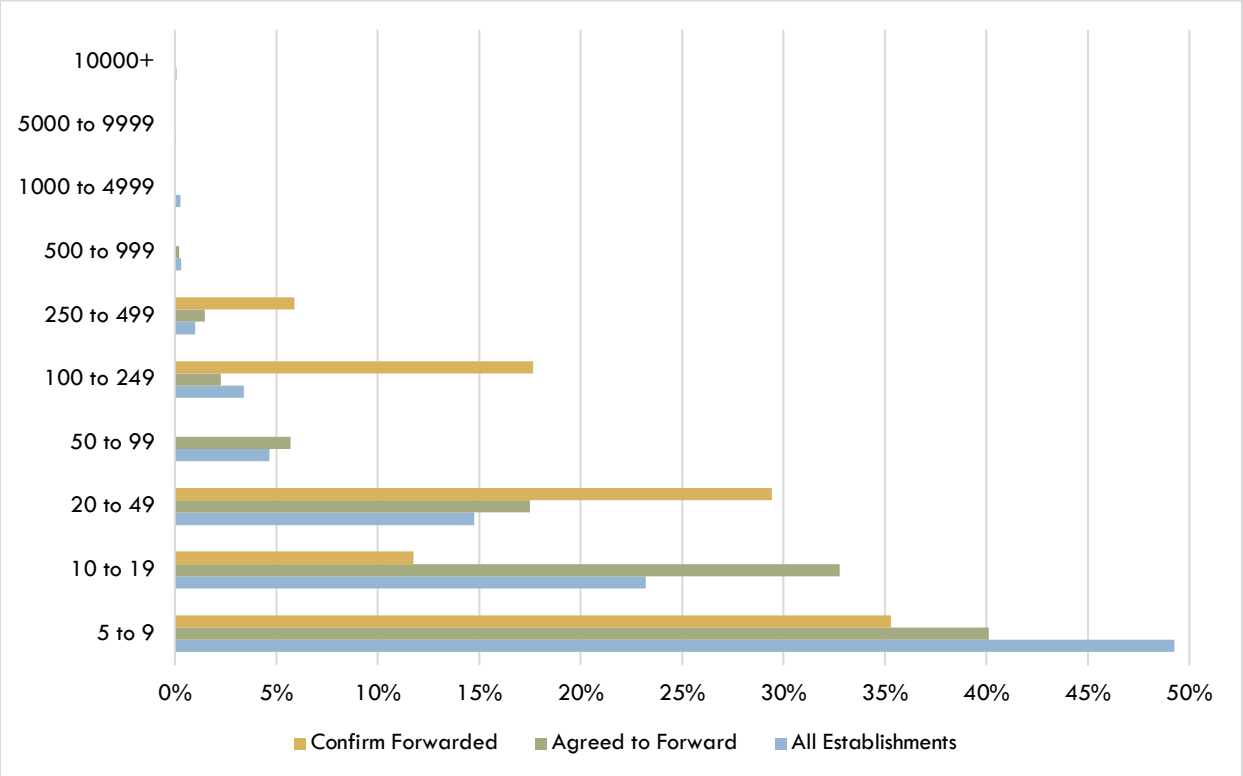

FIGURE 1: PARTICIPATING ESTABLISHMENTS DISTRIBUTION VS. ALL ESTABLISHMENTS (BY NO. OF EMPLOYEES)

4.1.1.2 INDUSTRY SECTORS

Similar levels of interest are observed across most industry sectors. The finance and insurance sector show the least initial interest towards participation in the pilot, while retail, education, administrative support services account for large proportions of businesses that have been confirmed to have distributed the survey. The high rate of confirmed distribution among retail businesses is of some importance as these businesses are more likely to employ workers, especially youths, in the minimum wage and seasonal positions. These retail businesses could be a channel through which to reach youths and low-income earners, which are two of the underrepresented group in TTS.

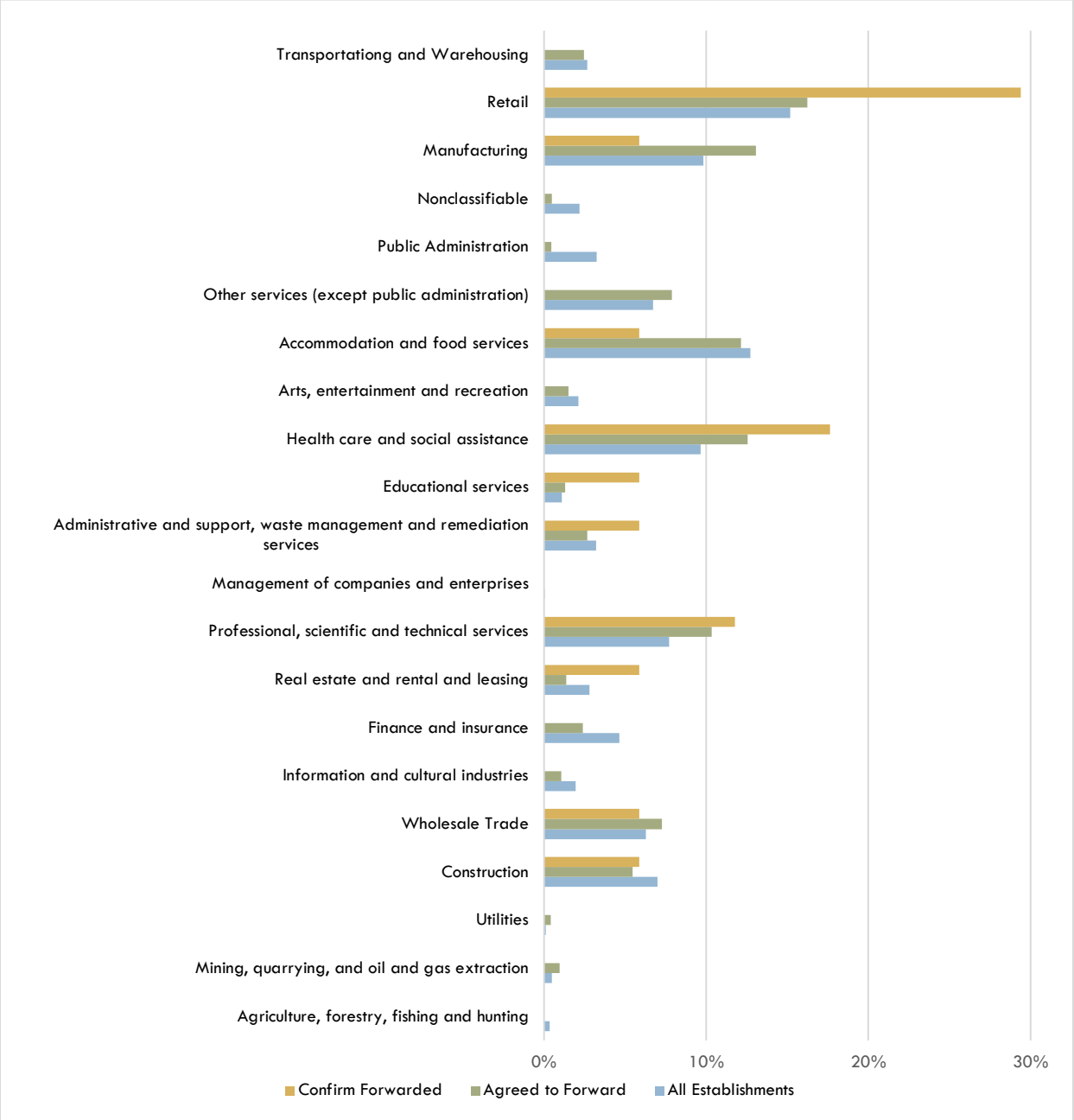

FIGURE 2: PARTICIPATING ESTABLISHMENTS DISTRIBUTION VS. ALL ESTABLISHMENTS (BY INDUSTRY SECTOR)

4.1.1.3 GEOGRAPHIC DISTRIBUTION

Both the geographic distribution of all businesses who agree to participate in the pilot and those from whom we received employee responses aligns with employment centres within the TTS survey area, indicating good geographical distribution and coverage.

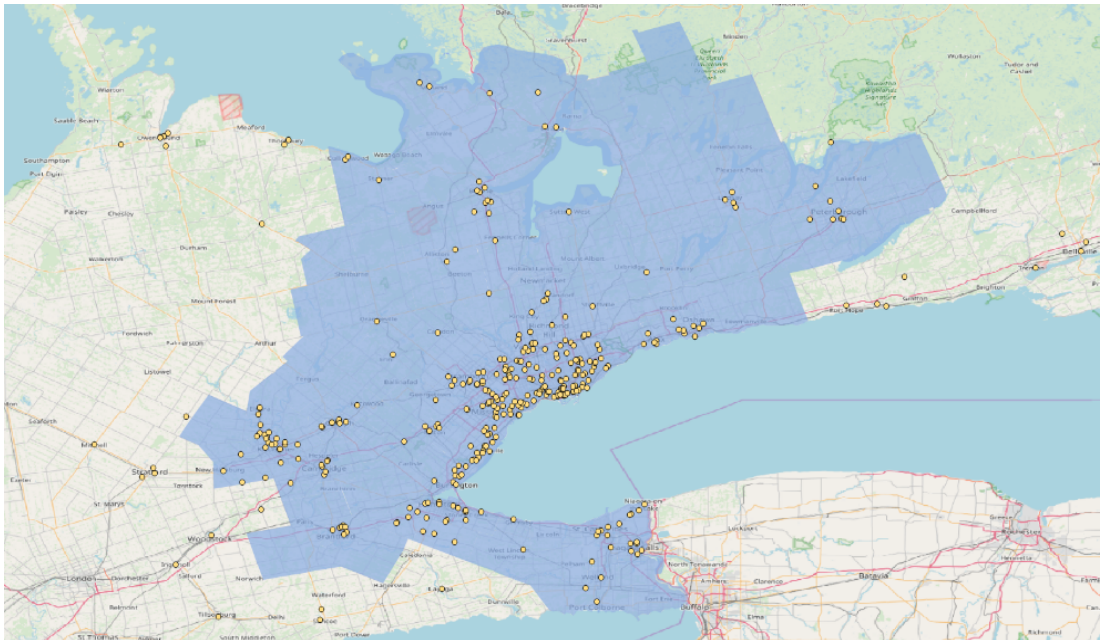

FIGURE 3: GEOGRAPHIC DISTRIBUTION OF ALL EMPLOYERS PARTICIPATING IN THE SURVEY DISTRIBUTION

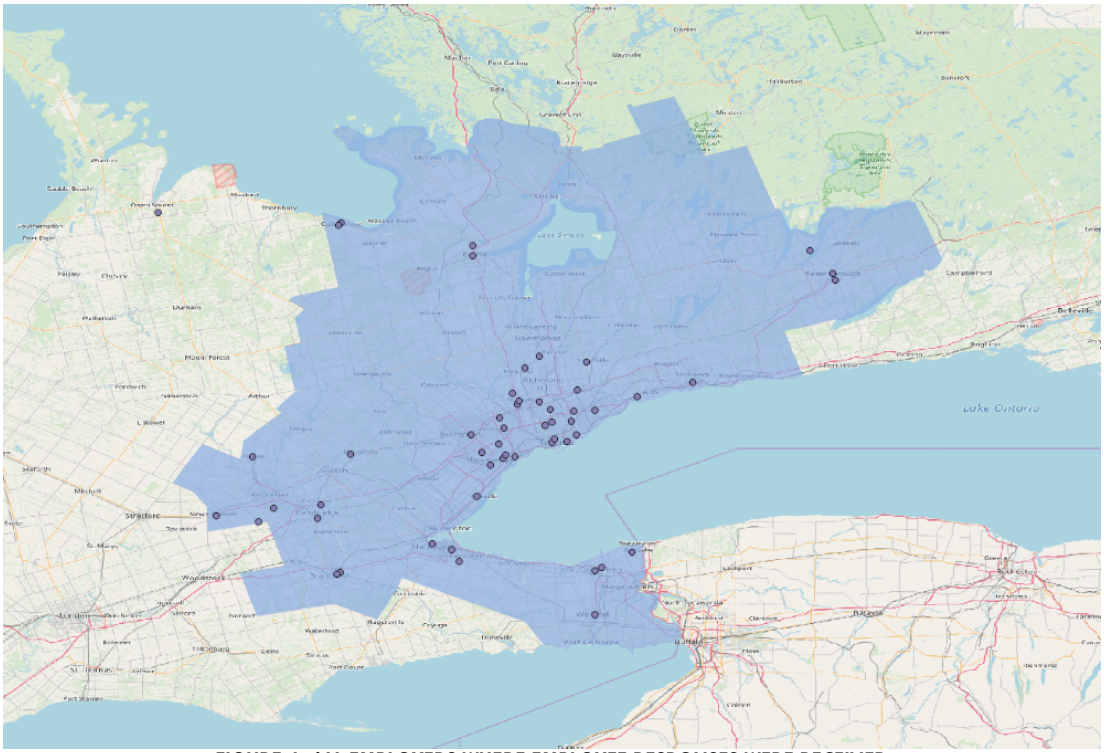

FIGURE 4: ALL EMPLOYERS WHERE EMPLOYEE RESPONSES WERE RECEIVED

4.1.1.4 OTHER EMPLOYER QUESTION RESPONSES

When post-survey findings were pitched as an incentive to businesses, only about an eighth of the participating businesses show interest in receiving them. While this does not completely dismiss the provision of aggregated employee commuting statistics as viable incentives to businesses, it shows clearly that there is little interest from businesses in this type of information beyond perhaps a small selected group. The majority of those who show interest would like to receive findings of the average travel time, distance or cost of their employees.

When asked to confirm the receipt of the initial information brochure circulated before the start of the first pilot, the vast majority of the businesses responded never having received it. It appears that a delay in distribution may have played a factor in the receipt of the e-mail brochure, as more businesses reported having received the brochure during the later weeks of the pilot. Nevertheless, the total number of businesses who report having received the e-mail brochure remains minuscule, which points to a very limited reach of the business networks of local CoCs.

Finally, of the businesses who refused to participate in the pilot, the great majority of them would not have changed their decision even if contacted by a government agency, which means that while government authorities add legitimacy to the business pilot and data collection process, it does not factor into the businesses' decision to participate otherwise.

4.1.2 Employer Follow Up Call Responses

Attempts were made to follow up with all recruited businesses, of which 171 of the 427 recruited businesses were able to be reached. Results from the follow-up calls are revealing with regards to how businesses communicate with their employees as well as their reasons for not distributing the employee survey. The majority of the employers use e-mail to distribute the survey to their employees. Printed posters are the second most popular choice. This was likely affected by the fact that the pdf poster format was the only other alternative provided and was sent to only a portion of the employers, but the number of employers who used this method indicates that there is still a place for physical mediums in employers and employees communications. This should be an importation consideration in future implementations of inverted sampling. An expanded range of physical mediums should be considered for use in the distribution process.

Is is clear from the employee response data, that many businesses who agree to the distribution during the initial contact and recruitment phase do not complete the distribution. Most businesses did not provide a reason for their non-participation, but others cite being too busy or understaffed, and/or lack of upper management approval as the primary cause. It is possible that some businesses contacts are not entirely truthful when agreeing to distribute the survey to their employees. However, that cannot be verified with the available data.

4.1.3 Employee responses

Regarding the actual distribution of the employee surveys, a total of 176 employee responses were received, translating to a response rate of 10.9% based on a total employee count of 1609 at businesses where employee response was received. This is in line with response rates of other

methodologies currently used in household travel surveys (Manfreda, et al., 2008; Ashby, 2018; Kaplowitz, et al., 2004).

4.1.3.1 INVITATION VARIATIONS

Of the multiple invitation format combinations used for the employee survey, the HTML formatted e-mail with pdf attached produced the highest rate of employee responses. The reason for this might be the flexibility it provided employers, as the invitation and access information could be both forwarded through either e-mail or to be circulated in print form. It is also likely that the more graphical appearance of the HTML invitation makes it easier for the businesses to recognize it and makes it better at attracting the employees' attention. There are no noticeable differences in the performance of the two invitation wordings tested. Both invitation wordings used perform equally well judging by the employee responses from the pilot. This suggests that there is no advantage to be gained through the elaborate wording of title, headlines or e-mails subject lines with respect to web-based surveys, as long as the purpose or the source of the survey is clearly communicated. However, there is a possibility that the results observed here are more influenced by the clarity of the directions given in the phone interview than they are by any wording, formatting or content of the invitations themselves.

4.1.3.2 BUSINESS SIZE

Similar to the businesses participation rate noted earlier, small businesses with 5 to 10 employees have the highest response rates across the size range. Most businesses of other sizes have similar response rates. This is the case when looking at all businesses who agree to the distribution, as well as businesses with employee responses. The sole exception to this was businesses within the 50 to 100 employee range, which have similarly high response rates to the 5 to 10 group among businesses who agree to distribution, and much higher responses than the rest among those confirmed to have distributed. It is clear from these results that smaller businesses overall generate more employee responses, most likely due to fewer logistical hurdles in the distribution process because of the smaller size. However, there is no clear indication of why businesses of 50 to 100 personnel in size have such high number of responses.

4.1.3.3 INDUSTRY SECTORS

Comparing between industry sectors, the employee response rates show the opposite trend to the initial interest observed from their employers. Employees in professional and financial services have the highest response rates, despite their employers being some of the least interested in participating. The higher response rates from this sector are perhaps best explained by the fact that occupations in this field tend to require higher levels of education and are relatively stable employment, a hypothesis that is supported by findings from previous studies on survey response rates (Tolonen, et al., 2006).

4.1.3.4 DEMOGRAPHIC REPRESENTATION

Characteristics of the respondents and their household from the employee survey were examined to determine the demographic representation, especially of demographic groups that have historically been underrepresented in the TTS. For the purpose of analyzing the representation of

employee respondents, results from the employee survey are compared to demographic data from the 2016 Canadian census.

Comparison in age group representation between the census and individual respondents from the employee survey shows the very encouraging result. Age distribution of respondents from the pilot closely tracks that of the census. More importantly, the employee survey had a representation of the youth population between the age of 15 to 29. The youth demographic has historically been an underrepresented group in the existing TTS survey and has been an area of focus in the research of survey methods. The result here shows that the inverted sampling method can be used to capture that demographic group without dedicating resources specifically to them.

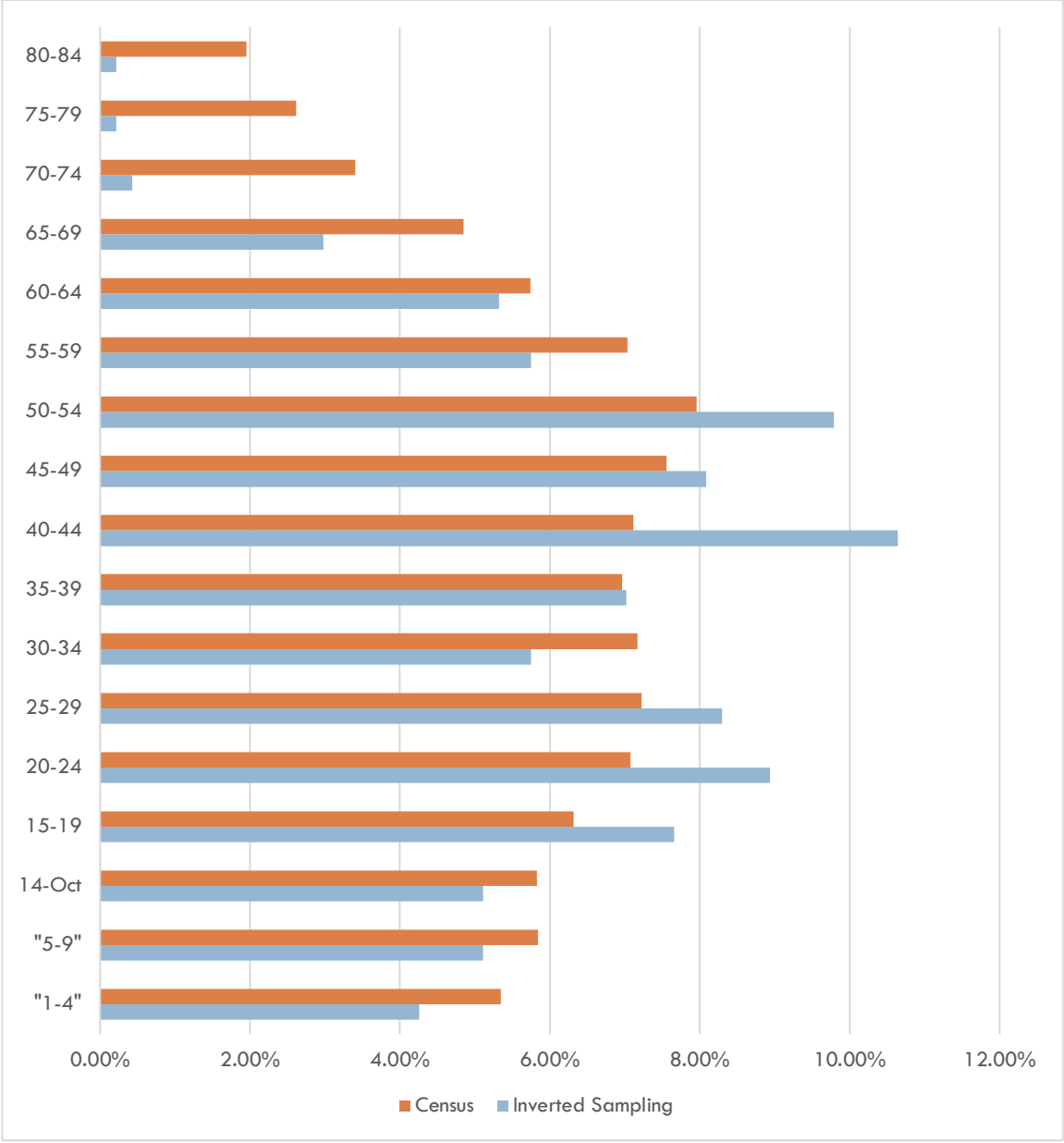

FIGURE 5: EMPLOYEE PRIMARY RESPONDENTS BY AGE GROUPS

The employee survey only collected household income and income group representation was not quite as positive. Results from the pilot show high overrepresentation in the mid to high-income brackets, with the low to very low-income groups underrepresented. The reason for the lower responses is unclear, as it could be due to factors from the employers, the employees or a combination. Based on observations and feedback from the business pilot, lack of an alternative to e-mail and web survey collection might be a crucial factor.

Several employers requested that paper copies of the survey allow to be filled and returned through fax. These employers cited lack of access to computers by their employees to complete the survey as the reason for this request. This was not expected by the authors of this report, as internet access is documented to have reached near ubiquity nationwide (Statistics Canada, 2017), especially in large metro areas such as the GTA. In addition, despite the provision of pdf versions of the invitation to employers, responses from lower income group remain depressed. It is possible that the employers misunderstood the intention of the employee survey and thought that the employee survey was required to be filled at the workplace. If that is the case, then the lower response rates could be explained by the lower internet usage by smaller businesses (Statistics Canada, 2014).

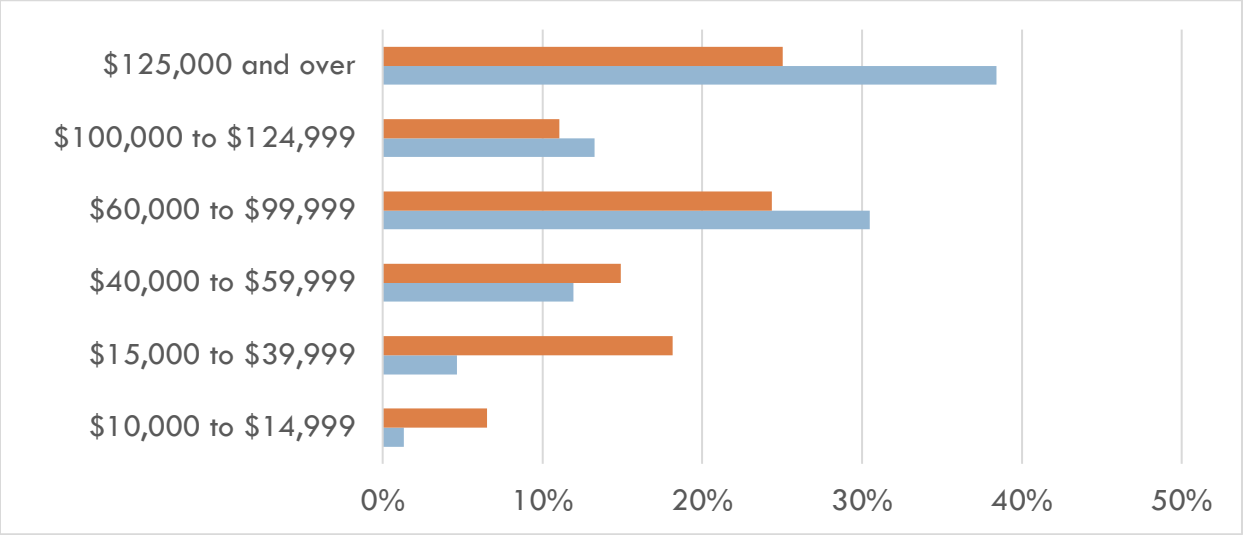

FIGURE 6: EMPLOYEE HOUSEHOLDS BY INCOME GROUPS

4.2 Agency Pilot

A total of 10 government agencies were contacted for participation in the second pilot, of which five agencies agreed to participate and answered the employer survey. However, only the Planning Branch of the Ministry of Transportation (MTO) distributed the surveys at the time of this report. At the MTO planning, 19 out of a reported total of 36 employees responded to the employee survey, which equates to a response rate of 53%. While this is much higher than the average rate attained in the business pilot, the limited sample size precludes a clear conclusion. If similar results are observed from other participating agencies, then the combined results would suggest that response rates from employees can be much higher than most conventional methods when the employer is properly engaged, and that employer authority and scale can be leveraged for the purpose of

reaching individual respondents. However, results from the agency pilot have equally highlighted the difficulty in engaging those employers, even when they are government agencies who should have a greater motivation to participate.

5 CONCLUSION AND RECOMMENDATIONS FOR FUTURE WORK

Based on the results from the two pilots, it can be concluded that while the inverted sampling method can be an effective alternative to existing methods, a great deal of care is needed in order to capitalize on its advantages. The primary hurdles in deploying the inverted sampling method are the need to motivate the employers and the need to minimize the logistical burden for employers. We have recommended several potential improvements based on observations from the pilot, but overcoming either challenge might prove difficult as the investigator has little control over much of the distribution and engagement process.

Businesses have shown to be receptive to the concept of carrying out a survey among their employees for the purpose of transportation planning. At the same time, it was also apparent that the positive reception did not translate well into eventual employee responses. Results from the pilots and feedback from employers point to a need for more support for smaller businesses in the distribution process. This could be as simple as providing a wider range of distribution options, or more effective pre-survey communications that would help businesses better understand the methodology and both improve participation and increase eventual distribution. Responses from the follow-up survey support the need for more logistical support, based on the responses from businesses which did not follow through with distribution. They also support the need for better early communication, with many employers also citing managerial approval as the primary barrier to actual distribution. We feel that this could be alleviated to a large degree if the informational brochure was able to reach more employers before the start of the pilot. In addition, in light of evidence suggesting little interest among employers in post-survey findings, we feel that better understanding of how the TTS would impact their businesses might be one of the only ways to motivate them, outside of monetary incentives. This would ideally be in the form of a more concerted effort in marketing the TTS, but a tailored and timely initial contact e-mail can still help greatly in creating that understanding. All of this would add up to a considerable up-front investment for the investigator, making the inverted sampling method unfavourable from a cost perspective.

However, if the above-mentioned improvement measures are implemented, it is quite possible that the employee response rate can be much higher, as was the case in the second pilot where the government agency fully supported the survey. Furthermore, given that retail businesses have some of the highest participation rates, being able to increase the number of employee response from each participating business may open up a potential entry point into some previously underrepresented and hard to reach demographic groups. Therefore, we feel that while the method might be unsuitable when used in the same fashion as existing methods in household travel surveys, an alternative implementation where long-term participation agreements are secured with employers can be viable. This could both ensure commitment from the employers and help spread the initial investment into recruitment and implementation.

The proposed inverted sample frame can be a useful alternative method of travel data collection. As an alternative collection method, the inverted sampling frame has its distinct advantages as a replacement for existing methods in specific contexts where there is a need for information relating to both travel and employment. In other cases, the complex nature of the method makes it better suited as a complementary tool to other methods.

6 REFERENCES

Ampt, E. & Stopher, P., 2005. Mixed Method Data Collection in Travel Surveys: Challenges and Opportunities.

Ashby, B., 2018. *TTS 2016 DATA GUIDE,* Toronto: Malatest.

Atkeson, L. R., Adams, A. N. & Alvarez, R. M., 2014. Nonresponse and Mode Effects in Self- and Interviewer-Administered Surveys. pp. 304-320.

Callegaro, M. et al., 2011. Combining Landline and Mobile Phone Samples - A Dual Frame Approach.

Carey, R. N., Reid, A., Peters, S. & Fritschi, L., 2014. Do Demographic Profiles of Listed and Unlisted Households Differ? Results of a Nationwide Telephone Survey. *EpidemiologyResearchInternational,* pp. 1-5.

Couper, M. P., 2000. Web Surveys: A review of issues and approaches. *Public Opinion Quarterly,* Volume 64, pp. 464-494.

Curtin, R., Presser, S. & Singer, E., 2005. Changes in Telephone Survey Nonresponse over the Past Quarter Century. *Public Opinion Quarterly,* 69(1), pp. 87-98.

de Leeuw, D. E., 2005. To Mix or Not to Mix Data Collection Modes in Survyes. *Journal of Official Statistics,* pp. 233-255.

Dillman, D. A. et al., 2009. Response Rate and Measurement Differences in Mixed Mode Surveys Using Mail, Telephone, Interactive Voice Response (IVR) and the Internet. *Social Science Rsearch,* Volume 38, pp. 1-18.

Fleming, C. M. & Bowden, M., 2009. Web-based surveys as an alternative to traditional mail methods. *Journal of Environmental Management,* Volume 90, pp. 284-292.

Grande, E. D. & Taylor, A. W., 2010. Sampling and coverage issues of telephone surveys used for collecting health information in Australia: results from a face-to-face survey from 1999 to 2008. *BMC Medical Research Methodology,* 10(77).

Groves, R. M., 2006. Nonresponse Rate and Nonresponse Bias in Household Surveys. *Public Opinion Quarterly,* 70(5), pp. 646-675.

Habib, K. N., Weiss, A. & Hasnine, S., 2017. *On the heterogeneity and substitution patterns in mobility tool ownership choices of post-secondary students in Toronto*. Washington DC, Transportation Research Board.

Hu, S. S., Balluz, L., Battaglia, M. P. & Frankel, M. R., 2011. Improving Public Health Surveillance Using a Dual-Frame Survey of Landline and Cell Phone Numbers. *American Journal of Epidemiology,* 173(6), pp. 703-711.

Kaplowitz, M. D., Hadlock, T. D. & Ralph, L., 2004. A Comparison of Web and Mail Survey Response Rates. *Public Opinion Quarterly,* 68(1), pp. 94-101.

Keeter, S. et al., 2008. Costs and Benefits of Full Dual Frame Telephone Survey Designs.

Keeter, S. et al., 2006. Gauging the Impact of Growing Nonresponse on Estimates from a National RDD Telephone Survey. *Public Opinion Quarterly,* 70(5), pp. 759-779.

Kempf, A. M. & Remington, P. L., 2007. New Challenges for Telephone Survey Research in the Twenty-First Century. *The Annual Review of Public Health,* Volume 28, pp. 113-126.

Kunert, U. & Follmer, R., 2005. Methodological Advances in National Travel Surveys: Mobility in Germany 2002. *Transport Reviews,* July, 25(4), pp. 415-431.

Lanyon, R., 2007. *Smart Commute Initiative - Establishment of a Multijurisdictional Workplace-based Transportation Demand Management Program Serving the Greater Toronto Area and Hamilton.* [Online]
Available at: http://conf.tac-atc.ca/english/resourcecentre/readingroom/conference/conf2007/docs/s14/lanyon.pdf
[Accessed 13 3 2018].

Link, M. W. & Lai, J. W., 2011. Cell-Phone-Only Households And problems Of Differential Nonresponse using An Address-Based Sampling Design. *Public Opinion Quarterly, 75*(4), pp. 613-635.

Lohr, S. L., 2011. *Alternative survey sample designs: Sampling with multiple overlapping frames,* s.l.: s.n.

Manfreda, K. L. et al., 2008. Web surveys versus other survey modes: a meta-analysis comparing response rates. *International Journal of Market Research,* 50(1), pp. 79-104.

Phoenix Strategic Perspectives Inc., 2012. *Secondary Research into Cell Phones and Telephone Surveys,* Ottawa: s.n.

Roorda, M. J., Shalaby, A. & Saneinejad, S., 2011. Comprehensive Transportation Data Collection: Case Study in the Greater Golden Horseshoe, Canada. *Journal of Urban Planning and Development,* 1 June, 137(2), pp. 193-203.

Statistics Canada, 2009. *Workplace and Employee Survey (WES).* [Online]
Available at: http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=2615

Statistics Canada, 2014. *Digital technology and Internet use, 2013.* [Online]
Available at: www.statcan.gc.ca/daily-quotidien/140611/dq140611a-eng.htm

Statistics Canada, 2017. *The Internet and Digital Technology.* [Online]
Available at: www.statcan.gc.ca/pub/11-627-m/11-627-m2017032-eng.htm#moreinfo

Stopher, P. R. & Greaves, S. P., 2007. Household travel surveys: Where are we going?. *Transportation Research Part A,* Volume 41, pp. 367-381.

Tolonen, H. et al., 2006. 25-year Trends and Socio-demographic Differences in Response Rates: Finnish Adult Health Behaviour Survey. *European Journal of Epidemiology,* June, 21(6), pp. 409-415.