THE BENEFITS OF ON-DEMAND TRANSIT IN BELLEVILLE: FINDINGS FROM A USER SURVEY

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Executive Summary

In September 2018, the City of Belleville launched an on-demand transit (ODT) pilot that allows riders to book stop-to-stop bus trips at night. The service was launched with the agency’s existing busses, bus-operators, and network of bus stops. However, the busses do not follow fixed routes. Instead, routes are dynamically optimized in real-time according to riders’ trip requests. Riders can request trips online, using a mobile app, or by telephone (during business hours). The technology enabling this service is developed and provided by Pantonium Inc., a Toronto-based mobility technology company. This service placed Belleville at the forefront of transit innovation in North America.

The on-demand transit service serves residents that have travel needs at night. After one year of operation, the service has approximately 3,000 users registered, with ridership steadily climbing. Despite the technology platform enabling the analysis of an exhaustive dataset of fleet operations, little is known about the profile of the riders, their trip purposes, or the impacts of the new night-bus service on activity participation and wellbeing. Such understandings are required to assess the social and economic benefits and burdens of the service. This information will inform decision makers who are considering the adoption of on-demand transit technologies and services.

One year after the launch of the pilot project, an independently funded research team from University of Toronto, working in partnership with Pantonium Inc., conducted interviews and collected survey data on pilot riders. This data enabled the team to learn more about the ridership profile, trip purposes, and self-stated impacts on quality of life and activity participation rates of pilot users.

First, in August 2019, the team conducted three user interviews to gauge user experiences and satisfaction levels, as well as inform the design of an online user survey. We also interviewed two managers of transit operations at the City of Belleville, and three ODT bus drivers to obtain operator perspectives. Interview questions centered primarily on the goals and expectations for the ODT program, and on the types of changes that could be made to increase its social benefits. We also participated in a 2-hour ride-along, to observe operations of the service first-hand.

Next, from November 12th to December 21st 2019, a 15-minute survey was conducted to collect information on user profiles and the travel experiences of the ODT service. At the time of data collection, there were 2,744 ODT accounts, and 1,342 of them had used the service at least once. The research
team sent online survey invitations to these active users through email via an online survey platform. Paper flyers containing an invitation link to the online survey were also distributed to riders of the ODT night buses. The survey received a 19.60% response rate (263 respondents). A $10 gift card was provided to all survey and interview participants as an incentive for participation in the study.

**Who are the users of the on-demand transit service?**

On-demand transit users appear to belong to one of several well-defined profiles. Overall, this population is typified by having low personal annual incomes (less than $30,000 annually), low car ownership (6%), and high proportion living in large households (66% living with 3 or more people). Riders tend to be younger in age (66% in 15-29), with a high proportion being part-time workers (46%) and students (24%).

**What are the top trip purposes of the on-demand transit service?**

We asked riders what sorts of activities they use ODT service for. We found that 72% of the respondents use ODT for work, 44% of the respondents use ODT for groceries, and 39% of the respondents use ODT for visiting friends and families. The least two activities are recreational activities (30%) and school (13%).

**Do respondents feel satisfied with the on-demand transit service?**

In general, respondents feel satisfied with the on-demand transit service. On-demand service provides affordable and accessible travel choice at night. Compared to fixed-route bus service, the schedule of on-demand transit is more flexible, and the operating hours are longer, fulfilling more travel needs. However, many respondents suggested that the predictability of on-demand transit can be improved, and expressed that the wait time of the bus should be reduced.

**How does on-demand transit impact activity participation and wellbeing?**

Riders report that the new service has positive impacts on many aspects of their lives and overall sense of wellbeing, including enhanced employment, social activity, and overall trip experience. Over
70% of survey respondents indicated that ODT service made travel at night more convenient. ODT was found to provide new opportunities for night travel, allowing people to find and maintain night shifts, participate in more leisure activities, and maintain social networks. Most of the respondents from the survey reported that they increased activity participation and felt positive changes in wellbeing as a result of the ODT night bus.

I. Introduction

1. Background

Many towns and cities are struggling to provide adequate transit service in low-density areas and at off-peak times of day, due to the high costs of operation in relation to low ridership and fare revenue. A new generation of technology-driven on-demand transit services, akin to traditional dial-a-ride services, are entering the market with the promise to greatly improve operational efficiencies and user experience of transit systems. One of the first such pilots within the Canadian context commenced in September 2018, when the City of Belleville introduced an on-demand transit service to improve its night bus service for customers. This service enables passengers to hail and schedule transit trips on the city’s late-night Route 11 bus, from 9 p.m. to midnight on weekdays, and 7:30 p.m. to midnight on weekends.

The pilot was an experiment to transform a traditional, fixed route bus service into an on-demand transit (ODT) service. The technology that made this trial possible was developed by the company Pantonium Inc., and Belleville is the first city in North America to test it.

After one year of the operation, a research team from University of Toronto conducted a series of evaluation toward the on-demand project. The goal of the study is to assist City of Belleville in understanding the profile of the ODT users, and the degree to which, or if at all, the on-demand transit service had impacted activity participation and wellbeing of the riders.

1.1 On-demand Transit

On-demand transit is seen as a combination of regular public transit services (fixed route, fixed schedule) and personalized taxi services (flexible route, flexible schedule). It is used where traditional
public transit services are lacking or not cost-effective, such as rural and suburban areas. It also can provide affordable services at night when regular transit services are not running. Riders can book a trip by calling or using mobile apps only when needed, lowering operating costs while maximizing the level of service in the transit network.

Emerging technologies, such as online request systems and mobile ride-hailing apps, give public transit agencies opportunities to improve the transit management system and delivery of on-demand transit service. Compared to private cars or car-based ride-hailing services, on-demand transit is more affordable and can utilize the existing transit network, which is sustainable and efficient. By cooperating with technology companies to deliver ODT services, public transit agencies may be able to better attract riders and provide more sustainable transport options in their regions.

1.2 City Belleville

The city of Belleville is located along the Quebec City-Windsor Corridor and has a population of 50,000 people (Statistics Canada, 2016). It is located approximately halfway between Toronto and Ottawa and has a strong industry base, due in large part to its proximity to the St. Lawrence River and Highway 401 (Figure 1). Today, the manufacturing, packaging, food processing, distribution, and logistic sectors are the primary employment generators in Belleville, and the Canadian Forces Base located in the town of Trenton just west of Belleville is also a major contributor to the region’s economy. Belleville is home to Loyalist College, which is increasingly becoming a destination for international students who now account for 17% of yearly student enrolment (Loyalist, 2018). Spread over an area of 247 km2, the majority of Belleville’s municipal land remains rural, especially in the northern and eastern parts of the city. Belleville’s densest urban area is located along the Bay of Quinte and extends northward to just beyond Highway 401. Presently, the majority of residents in Belleville commute to work by car (78%), and active modes and public transit account for 10% and 4% of work trips, respectively (Belleville Transport Plan, 2014).
1.3 The Pilot Project

Prior to January 2, 2018, there was no transit service at night in Belleville. All transit service ended at 9 p.m. on Weekdays, 7 p.m. on Saturdays, and 6:30 p.m. Sundays. Starting on January 2, 2018, the city ran a late-night fixed route service (Route 11, see Figure 2). This original "late-night" route took an hour to complete and operated with two buses from 9:30 p.m. until 12:30 a.m. (30 min headway, one bus in each direction). This route operated from January 2, 2018 to September 17, 2018.
The city then launched the on-demand transit with 2 buses in September, 2018. The two buses used for the fixed route were simply re-dedicated to this service. For example, from a bus driver’s standpoint, driver shifts did not change, and the same drivers who before did the fixed route began driving the on-demand route instead. Riders can book trips between any two bus stops in the entire city (see Figure 3). On October 30, 2018 a third bus was added to accommodate increased demand. On July 2, 2019, the City of Belleville added 2 more buses to accommodate growing demand and improve wait times. At the time of writing, the on-demand service runs from 9 p.m. to 12:30 a.m. on weekdays and 7:30 p.m. to 12:30 a.m. on weekends, with a typical supply of five conventional 40-foot busses.
To book their bus trips on the ODT route, riders can install a smartphone app developed by Pantonium Inc., a Toronto-based mobility technology company. Riders are able to request a ride and have three options they can choose from: to be picked up at a specific time; to arrive by a specific time; or to arrive as soon as possible. Rides can be booked well in advance or at the time transit is desired, the earlier a trip is booked the more likely the rider will be able to obtain a ride at their desired time. A call-in reservation service is also available during weekday office hours for those who prefer not to use the web or app interfaces. The bus changes its route in real time according to the pick-up and drop-off demand points. Users can get on and off at any bus stop within the city.

After a year-long pilot, the service now has approximately 3,000 users registered, with rider numbers steadily climbing (as of November 2019). ODT has allowed Belleville Transit to increase the quality of service to riders, reduce ride times and increase the late-night service area.
2. Approach

2.1 Objectives

This report reveals the profiles of ODT users in Belleville, and evaluates the ODT pilot project by looking at its impacts on travel behaviour, activity participation, and wellbeing of the users. The research team conducted semi-structured interviews and an online survey to answer the following questions: 1) Who are the users of Pantonium’s ODT system in Belleville? 2) How have users’ travel patterns changed in response to the service? 3) What impacts does ODT service have users’ activity participation? 4) What impacts does ODT service have on riders’ wellbeing and quality of life?

The analytical findings can be used to assess the equity and social inclusionary implications of the delivery of ODT services, and extrapolate how expansion of ODT service in Belleville, or in other municipalities, can help achieve the social goals of public transportation provision.

2.2 Interviews

To gather contextualized data on how the ODT program impacted users, we conducted a series of semi-structured interviews in the summer of 2019. These interviews lasted approximately 30 minutes. First, we interviewed transit planning officials (2 interviews) and ODT bus drivers (3 interviews) to obtain a variety of operator perspectives. Interview questions centered primarily on the goals and expectations for the ODT program, and on the types of changes that could be made to increase its social benefits. Researchers also conducted ride-along observations with an ODT bus driver to further examine, and observe first-hand, how this program impacted users. We also interviewed representatives from different types of ODT riders (3 interviews), including students and shift workers. These interviews provided us with a better understanding of users’ lived experiences and challenges they face related to the ODT program. Participants were given a $5 Tim Horton’s gift card for their time. Upon completion, all interviews were transcribed for thematic analysis by the research team.

2.3 Online User Survey

The research team designed and collected survey data from a sample of existing users of the ODT system. Cooperating with Pantonium and City of Belleville, online questionnaire links were sent to
users via email. The questionnaire was administered with Qualtrics, a platform that can send anonymous links to email addresses of respondents. When receiving the link, respondents could open the questionnaire by clicking the link on their laptops, desktops, tablet computers, and smart phones. The survey instrument consisted of five parts: (1) travel behaviour in the past few months, including travel purpose, travel frequency, and travel mode; (2) riders’ reasons for using ODT services and their user experience compared to regular transit services; (3) riders’ satisfaction with ODT services; (4) whether and how the ODT services affect their participation in activities and their wellbeing; (5) each user’s sociodemographic profile and availability of mobility tools. The survey instrument included a combination of multiple choice, Likert scale questions, and matrices allowing participants to provide information relevant to their travel behaviour and experience using on-demand transit service. It took about 15 minutes for a respondent to finish the survey. After authors verified the response to the survey, we sent each respondent a $10 electronic gift card. In addition to email invitations, flyers invitations were distributed on the night bus by bus operators.

At the time of the survey, 2,744 potential on-demand transit users had created an account on the ODT system, and 1,342 of them had used the service at least once. We only sent survey links to users who had used the service at least once. The data was collected from November 12 to December 21, 2019. 263 responses were recorded, and the response rate was 19.60%.

II. Key Findings and Analysis

1. Qualitative Analysis

The thematic analysis of our semi-structured interviews revealed several of the challenges and response mechanisms pertaining to the ODT program. From our interviews with the transit planning officials, we got a sense that they understood and were aware of the problems related to the ODT program, but that they felt that these were simply growing pains and that overall the program was a resounding success. They often referred to the reported 300% increase in nighttime bus ridership to support their views.

What emerged from our conversations with the ODT program’s bus drivers is how most of them had become weary of its feasibility in the City of Belleville through their first-hand experiences. The drivers that we spoke to were critical of the ODT program and reported that passengers had complained to them directly about this service. Recurring challenges that were brought up by the drivers include:
1) The common occurrence of “ghost-stops”, which they defined as passenger pick-up locations registered through the Pantonium smartphone app but with no awaiting passengers. This they indicated may be due to passengers booking trips through the app, but then omitting to cancel them if no longer needed;

2) Many passengers, when arriving at a stop and seeing that other passengers were waiting, would not take the time to book their trip through the app, which in turn would require drivers to register them manually upon entry in the bus. This they recalled, would impact the bus route and shifted the passenger drop-off order in real-time, which caused delays and changes in arrival time for the passengers on board;

3) The inability to see beyond their next pick-up or drop-off location, which prevented the drivers from sharing arrival information with anxious on-board passengers. An updated version of the software allows drivers to see beyond the next immediate stops, but this information changes frequently, and so may not always be helpful;

4) Drivers would often stop and pick up passengers who had been assigned to another bus, as they felt it was their duty to pick up passengers waiting at bus stops along their route, regardless of whether these passengers were assigned to their bus. This, they recognized, likely increased the occurrence of “ghost-stops”, but they felt it was immoral, and at times dangerous, to leave passengers waiting out at night in the cold.

Pantonium’s service includes the option of a scanner and barcode function that avoid and or minimizes these problems; although, at the time of this study Belleville has not adopted the use of this function. Additionally, after the implementation of this questionnaire, Pantonium has updated their software to allow drivers to see planned stops beyond the next bus stop.

In response to these challenges, the drivers described how they had come up with some innovative solutions. They started communicating amongst themselves via walkie-talkies to inform other drivers that they had picked-up passengers likely assigned to another bus, and used the walkie-talkies to share their locations and to coordinate passenger exchanges to optimize bus routing manually amongst themselves. They also increasingly began to ignore the application’s instructions and to manage the drop-off order verbally with passengers directly upon entry on the bus. Examples of such behaviour were observed during our ride-along interview with a driver, where upon receiving a pick-up request in one remote part of the city they cancelled the trip stating that that passengers had already
been picked-up by another driver. Upon picking-up passengers during this ride-along, the driver would also ask them where they were going and when they needed to arrive by, in order to ensure that they could get them there on time, regardless of the optimized routing instructions.

Our three interviews with passengers revealed two contrasting opinions with regards to the ODT program. Some passengers echoed the views shared by drivers and described how this program had negatively impacted their mobility and access to employment opportunities. A passenger explained how they could no longer take night shifts at work from fear of arriving late, and shared the story of their friend who had lost their job due to the uncertainty and unpredictability of the ODT service. One preferred the previous fixed-route night bus service and explained how despite often being slower, the fixed-route was at least predictable and they could plan their schedule around it. Student interviewees also mentioned how private, unregulated taxi alternatives, run mostly by Loyalist students, were rapidly emerging to capture the travel demand unmet by the city’s night transit. That being said, other passengers reported being very satisfied by the ODT service and did not seem to experience any of the delays or travel-time uncertainties expressed by others. The satisfied passengers were, however, most often international students from Loyalist College that had not experienced the previous fixed-route night bus system.

While obviously a small sample size, these semi-structured interviews enabled us to grasp some of the challenges and benefits associated with the ODT program, and were used to inform the survey questionnaires.

2. Demographics

This section describes the socioeconomic profile of sampled ODT users in our study. We found that users in our sample were young, with a high proportion being part-time workers (46%) and students (24%). Most of the sampled riders are low-income earners, and a high proportion are living in large households (66% living with 3 or more people). From the mode availability of the respondents we found that over 50% of the riders don’t have car access, and less than 20% of them have bicycles. It indicates that ODT service can provide nighttime travel options to both socioeconomic and transportation disadvantaged groups.
2.1 Gender and Age

In the sample, 51.3% (134) of the respondents are female, and 48.6% (127) are male. This distribution is quite close to the City’s overall demographic make-up (2016 Census), in which females are 51.2% of the population versus 48.8% for males.

The respondents in our survey are much younger than the City’s overall population. The mean age of our sample is 29 (see Table 1), whereas the mean age of the City is 43 years (2016 Census).

Table 1. Summary of Age and Gender

<table>
<thead>
<tr>
<th></th>
<th>Female</th>
<th>Male</th>
<th>All</th>
<th>2016 Census</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>29</td>
<td>29</td>
<td>29</td>
<td>43</td>
</tr>
<tr>
<td>Median</td>
<td>26</td>
<td>25</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td>Min</td>
<td>16</td>
<td>18</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Max</td>
<td>63</td>
<td>62</td>
<td>63</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 shows the distribution of age and gender of sampled riders. Compared to the city level distribution, the dominant age group of our sample is much younger (15 to 29 years old), and we don’t have respondents over 65 years old. (It is noteworthy that we only collect responses from riders who are over 15 years old). This indicates that the on-demand transit attracted more young people compared to other age groups.

In addition, the percentage of females in 30 to 49 years is significantly higher than male, which shows that although the means are same, there are more middle-aged female in our sample.

Table 2. Description of Age and Gender of Sampled Riders

<table>
<thead>
<tr>
<th></th>
<th>Sample (%)</th>
<th>2016 Census (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Male</td>
</tr>
<tr>
<td>0 to 14 years</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>15 to 29 years</td>
<td>66.3</td>
<td>70.1</td>
</tr>
<tr>
<td>30 to 49 years</td>
<td>27.2</td>
<td>21.2</td>
</tr>
<tr>
<td>50 to 64 years</td>
<td>6.5</td>
<td>8.7</td>
</tr>
<tr>
<td>65 years and over</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: Pearson’s Chi square test of age vs. gender in our sample is significant. Chi-square value: 60.8, p-value: 0.04.
2.2 Personal Annual Income

Figure 4 shows the distribution of personal annual income for 2019. The data show that ODT users skew much lower income than Belleville, on average. While a third of respondents did not provide an income response, among those who did, 62% of the respondents reported earning less than $20,000 per year. Roughly 30% of the respondents earn $20,000 to $40,000 per year, and only less than 10% of the respondents earn over $40,000 per year.

![Figure 4 Distribution of Annual Personal Income](image)

According to the 2016 Census data, in 2015, the median total income of individuals in City of Belleville is $30,661. Table 3 compares the personal pre-tax income of sampled users and 2016 Census. Compared to the city level, three quarters of the respondents earn less than the median income of the city, showing that users in our sample are more likely to be low-income earners.

<table>
<thead>
<tr>
<th>Personal Pre-Tax Income</th>
<th>Sample (%)</th>
<th>2016 Census (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under $10,000 (including loss)</td>
<td>27.3</td>
<td>12.4</td>
</tr>
<tr>
<td>$10,000 to $19,999</td>
<td>34.7</td>
<td>19.6</td>
</tr>
</tbody>
</table>
2.3 Household Size

Household size is a common indicator of socioeconomic status, as well as a determinant of travel behaviour outcomes. Table 4 shows the distribution of household size in the sample. It is noticeable that over 50% of the respondents are living with 4 or more people. However, the 2016 Census shows that at the city level only 19% of the population lives in similarly large households, and the majority of Belleville residents live with less than 3 people. These results, in combination with our results on income, suggest that on-demand users are more likely to have limited housing budgets, and thus share housing with more people.

Table 4. Household Size of Sampled Riders

<table>
<thead>
<tr>
<th>Household Size</th>
<th>Count</th>
<th>Sample (%)</th>
<th>City level (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 person</td>
<td>47</td>
<td>17.87</td>
<td>27.50</td>
</tr>
<tr>
<td>2 people</td>
<td>42</td>
<td>15.97</td>
<td>38.24</td>
</tr>
<tr>
<td>3 people</td>
<td>41</td>
<td>15.59</td>
<td>15.27</td>
</tr>
<tr>
<td>4 people</td>
<td>61</td>
<td>23.19</td>
<td>12.34</td>
</tr>
<tr>
<td>5 or more</td>
<td>72</td>
<td>27.38</td>
<td>6.65</td>
</tr>
</tbody>
</table>

2.4 Employment Status

Figure 5 shows the employment status of the respondents. 33.8% of the respondents are full-time workers, and 46.0% of the respondents indicated that they have part-time jobs. About a quarter of the respondents are students, and 52% of them are international students who come from South Asia. In addition, about 14.4% of the respondents are unemployed. At the city level, according to the 2016 Census, 33.9% of the residents aged 15 years and older are full-time workers, and 28.8% of the labour force are part-time workers. The percentage of population who did not work is 37.2%. From the comparison, we can see that there are more part-time workers in our sample, presumably many of whom are working nighttime shifts.
It is important to recognize that responses to employment status are not mutually exclusive. Of the student population, we find that 58% report themselves as also being full or part-time employed.

![Graph showing employment status distribution](image)

*Figure 5. Employment Status of Sampled Users*

### 2.5 Mode Availability

Figure 6 shows the mode availability of the respondents. The majority of the respondents have smartphones and data plan, which enables them to book ODT trips through online app. Only 5.7% of the respondents own private cars, and about half of the respondents cannot take a free ride by their friends or family members. In addition, less than 20% of the respondents have a bicycle, which indicates that users in our sample might have limited travel mode choice other than ODT.
Table 5 shows the Pearson’s Chi Square test of car access vs. income and employment status. Based on the premise that most of the respondents don’t own private cars, low-income earners even are less likely to have friends or family members that can drive them places, compared to those in the higher income bracket. Also, compared to full-time workers, students and part-time job workers are also less likely to be able to rely on friends and family to drive them places. The results indicate that the launch of the ODT service can provide travel choices for transport disadvantaged groups.

Table 5. Car Access vs. Income and Employment Status

<table>
<thead>
<tr>
<th>My friends and family can drive me places</th>
<th>Income group</th>
<th>Employment Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;10k</td>
<td>10-20k</td>
</tr>
<tr>
<td>No</td>
<td>31</td>
<td>22</td>
</tr>
<tr>
<td>Yes</td>
<td>17</td>
<td>39</td>
</tr>
<tr>
<td>Chi2</td>
<td>23.9</td>
<td></td>
</tr>
<tr>
<td>p-value</td>
<td>0.0005</td>
<td></td>
</tr>
</tbody>
</table>
3. Travel Behaviour and Experiences

In this section we analyzed travel behaviour and experiences of sampled users. We find that ODT can provide travel choices for essential travel needs, such as work, grocery, social network, and recreational activities. We also find that except for groceries, low-income earners participated in limited activities compared to other income groups, although we see an increase of travel frequency after the launch of ODT service. The wait time and in-vehicle time of ODT varies depending on demand for service, number of buses in service, types of trips being requested and how far in advance rides are booked.

3.1 Trip Purposes

Users were asked to indicate all of the different trip purposes for which they used ODT services (Figure 7). The vast majority of respondents indicated that they used ODT for work (72%) followed by groceries (44%), visiting friends and family (39%), and recreational purposes (30%). Interestingly, few students use the service for school trips, likely because most campus activities end before nighttime services begin. The data demonstrates that in addition to the ODT providing essential services for work commutes, many users indicate using ODT for shopping and social activities as well.
Table 6 shows that different income groups might have different travel demand at night. The table shows that almost all the middle-income earners work at night, whereas less than half of the low-income earners work at night. Low-income earners also do less visiting and recreational activities than other income groups. There is no significant difference of groceries trips across income groups, from which we can infer that compared to other activities, low-income earners are more likely use ODT for groceries.

Table 6. Pearson’s Chi-square Test of Night Trip Purposes vs. Income

<table>
<thead>
<tr>
<th>Activity</th>
<th>Income</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Chi2</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;10k</td>
<td>10-20k</td>
<td>20-30k</td>
<td>30-40k</td>
<td>40-50k</td>
<td>50-60k</td>
<td>&gt;60k</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work</td>
<td>No</td>
<td>14</td>
<td>23</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>11.03</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>34</td>
<td>38</td>
<td>22</td>
<td>22</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Groceries</td>
<td>No</td>
<td>27</td>
<td>34</td>
<td>14</td>
<td>16</td>
<td>5</td>
<td>0</td>
<td>3</td>
<td>3.45</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>21</td>
<td>27</td>
<td>10</td>
<td>11</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Visiting</td>
<td>No</td>
<td>36</td>
<td>29</td>
<td>15</td>
<td>17</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>14.02</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>12</td>
<td>32</td>
<td>9</td>
<td>10</td>
<td>3</td>
<td>2</td>
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3.2 Travel Frequency

The respondents in the survey can be divided into three groups based on their experience with Belleville’s transit system before and during the pilot. This allows us to gauge how travel frequencies have changed in accordance with changes in the supply of nighttime transit services. Group 1 (Established Residents) lived in Belleville before the operation of fixed-route night buses. Group 2 (Relative Newcomers) came to Belleville during the operation of the fixed-route night bus. And Group 3 (New Arrivals) reported moving to Belleville during the operation of on-demand transit pilot.

Figure 8 shows self-reported changes in travel frequency at night for a typical month for each group. Most of the New arrivals travel 4 or more times per week. Figure 3 also shows how this travel frequency changed from before the existence of night transit in Belleville (period 1), to the period during which the city offered fixed-route night service (period 2), to the period of the ODT pilot (period 3). Respondents in groups 1 and 2 increased their travel frequency after the ODT service became available. Fewer people in each group travelled less than 2-4 times at night per month after the
adoption of ODT services, suggesting increased trip-making during the pilot period.

Figure 8. Self-reported Changes in Travel Frequency at Night for a Typical Month

3.3 Wait Time

We asked respondents to tell us how long they typical had to wait for the bus to arrive after booking. Figure 9 indicates that the wait time experienced by ODT users varied substantially. About 85% of respondents were evenly distributed in the range from 5 minutes to 40 minutes, with about 15% stating typical wait times in excess of 40 minutes. About 40% report typical wait times of 20 minutes or less. The operators of the ODT system are trying to optimize the software to keep wait times under or around 20 minutes.
3.4 In-vehicle Time (compared to regular-bus)

Respondents with experience riding the daytime fixed-route service reported that the ODT service often took longer. Although, it is important to note that during daytime service hours the city uses 13 buses to provide service to the city’s bus stops and that during ODT service, the city uses between 3-5 buses to service the entire city. Figure 10 shows the self-reported in-vehicle time compared to a typical fixed-route bus trip. Respondents have experienced significantly different in-vehicle time. About 40% of respondents said that the ODT service often or always takes 20 minutes longer than a comparable non-ODT transit journey, and 33% stating that it usually takes 10-20 minutes longer. Despite the majority of respondents saying that ODT trips are often longer duration, 26% felt that ODT trips were often or always shorter in duration than traditional fixed route comparisons. From these we can ascertain that most riders acknowledge an increase in travel time associated in on-demand transit, but drawing out more nuanced understanding from this is challenged by not knowing precisely to which hypothetical services respondents are comparing ODT.
4. Satisfaction

In general, respondents felt satisfied about the on-demand transit service. Most respondents reported high satisfaction on accessibility to the bus stop, service quality such as personal security and competence of bus drivers, number of transfers, and availability of service information. However, compared to daytime fixed-route service, respondents were not satisfied with average wait times and predictability of travel times. According to the survey, the average perceived wait time of the on-demand transit service was about 20 minutes. Moreover, the wait time varies quite substantially, with some respondents waiting less than 10 minutes, and others waiting over 40 minutes. Wait times vary based on demand for the service, the number of vehicles allocated to the service, how far in advance trips are booked, and the length of requested rides. Data obtained from Pantonium shows that 92% of rides fall within scheduled pick-up or drop-off times.
4.1 User Interface and System Design

Figure 11 shows the average scores of user satisfaction with user interface and system design characteristics, where (1) means “I feel very unsatisfied”; (2) means “I feel a little bit unsatisfied”; (3) means “I feel neutral”; (4) means “I feel satisfied”; (5) means “I feel very satisfied”. In general, satisfaction levels across items in this category are moderately positive, with means between 3 and 3.8. We conducted one-way analysis of variance (ANOVA) for the comparison between ODT and regular bus, and the results show that only satisfaction with availability of service information have significant difference among ODT and regular bus users. In addition, the distribution of responses were more varied for satisfaction with interface and availability of service information, and less varied for operating hours and accessibility to transit stops.

4.2 Wait Time and Predictability

Figure 12 shows that respondents felt satisfied about the booking process of ODT service. Their overall satisfaction with availability of bus and handling speed of the system is high. The ANOVA shows that compared to daytime fixed-route bus, they were less satisfied with their perceived wait times and
detours while on the bus. On average, users rated their satisfaction on these measures for fixed-route services ahead of ODT services.

Due to the initial surge in demand from riders during the pilot, wait times increased. Since then, efforts have been taken to improve the wait and ride times of the service by adding additional vehicles. The added vehicles reduced wait times and variability of the ride times. It is unclear which users are answering based on experience with the system during the initial period of offering, or later on, after additional busses were added to the system.

4.3 Service Quality

As for service quality, respondents indicated that they felt satisfied about the competence and manner of drivers, personal security, bus stop maintenance, and the service quality of the customer service center (see Figure 13). Respondents reported lower satisfaction with the affordability of the service, which is priced the same as fixed route transit, likely a result of the service drawing mostly part-time workers and low-income riders. The ANOVA suggests that there is no significant difference between fixed-route bus service and on-demand transit service in terms of service quality, because the ODT service uses existing bus facilities and bus drivers.
5. Impacts on Activity Participation

Survey results demonstrate that on-demand transit can significantly encourage participation in night trips (see Figure 14). In summary, roughly 50% of respondents reported increases in work and recreation trips, while about 40% reported increases in visiting friends and family, going shopping, and going grocery shopping. Smaller numbers of respondents reported increases in school and gym/exercise trips, which is understandable given the nighttime service under study. Across all activities, the single largest response frequency is one for "no change in behaviour", and very few have reported reductions in activity participation.
6. Impacts on Wellbeing

Survey results highlight many positive impacts on users' wellbeing, including increased employment, better travel experience, and increased social activities. In general, on-demand transit adds to people’s night travel choices, and gives people more opportunities to find jobs, participate in leisure activities, and maintain social networks.

6.1 Employment and Travel Outcomes

Overall, on-demand transit has had positive impacts on users’ employment-related wellbeing and made travel at night easier (see Figure 15). About 40% of the survey respondents strongly agreed that they can work at night at least partially as a result of the introduction of the ODT service. About one quarter of the respondents strongly agreed that they have a better job than they did before the ODT
service came into being. However, many respondents also showed their concerns on the impacts of ODT on the night job market. A majority of respondents believed that the job market would become more competitive as the ODT service would increase the number of job seekers for night shift work.

As for travel experience, over 70% of the respondents agreed that ODT service made travel at night more convenient. Most of the respondents also indicated that they were willing to make more trips at night as a result of the ODT service. Over 50% of the respondents thought that ODT has a positive impact on their activity participation at night, that is, that they could participate in more meaningful and enjoyable activities at night.
Figure 15. Impacts on Employment and Travel Behaviour
(Note: Pearson’s Chi-square Test: Chi2=159.28, p-value=2.2e-16)

### 6.2 Social Activities

The survey also shows that ODT had positive impacts on respondents’ social activities (see Figure 16). Over half of the respondents reported that they were able to visit family and friends more, and could spend more time on social leisure activities at night. In addition, nearly 50% of the respondents said that the ODT service made them feel a sense of belonging to the community. The introduction of ODT service also encourages residents to go out for entertainment and physical activities at night. Many respondents said that they spent more time on these activities.
III. Recommendations and Conclusions

Based on our analysis, in this section we will discuss the social impacts of ODT service and its potential to maintain and attract ridership in the future.

1. Social Impacts of ODT service

On-demand transit has significant social impacts. First, our analysis shows that on-demand transit gives the residents of Belleville an additional travel choice at night to fulfill their basic needs. It encourages travel of people who want to go out at night but don’t have car access. From our analysis we know that most of the sampled users are young people, low-income earners and part-time job workers, living in rental rooms with 4 and more people. The results also show that the majority of the respondents use ODT for commuting. They have limited budgets, and might be struggling to commute at night without car access. On-demand transit not only provides travel choices for them, but also gives
them opportunities to find/keep a job to increase their incomes. The results also show that low-income people can use ODT service for essential daily activities, such as groceries, needed to sustain their quality of life.

In addition, on-demand transit can assist riders to maintain their social network by visiting their friends and family members, and go for recreational activities. The survey results show that respondents reported that they are more likely to visit their loved ones, to participate in night recreational activities, and to participate in physical exercises. They also felt a stronger sense of belonging to the community. It is noticeable that there are many international students studying in Belleville, and ODT can give them opportunities to find part time jobs, make friends, get familiar with the city, and live a better life.

2. Increasing Reliability to Maintain Ridership

Both survey and interview results highlight a desire to improve the reliability of Belleville’s on-demand transit wait times. The average reported wait time of an on-demand bus is about 20 minutes, however, some respondents reported that they had to wait for longer than 40 minutes. It is likely that demand for transit, number of available vehicles and the length and location of rides requested would play a large factor in the length of wait time for a ride requested “as soon as possible”. In addition, compared to daytime fixed-route buses, many respondents indicated that they spend more time when travelling by on-demand transit, which might be the result of long detours or request mismatch. Although, it is important to note that the city provides considerably more transit resources during the daytime to service the same area. Some interview participants expressed concerns about fleet deadhead miles and trip cancellations. Cancellations are increasing the wait time and in-vehicle time for other riders on the same route, and certainly add to the negative perceptions of reliability of the service.

To reduce the number of trip cancellations and deadhead miles, the transit agency can cooperate with Pantonium to improve the features of the online system, and make it easier for bus drivers and riders to communicate with each other. In the short term, giving people more ways to cancel the request, or having the app ask people 5 minutes before arrival if they were still waiting, may drive improvements in predictability. The integration of payment into the service including penalties for booking rides and not showing up are also likely to assist with this issue. On-demand routing systems require strict adherence by both the users of the system (e.g. booking trips accurately, only getting on the vehicle that you are assigned to) as well as drivers (e.g. adhering to the optimal route, picking up unscheduled passengers). Training and education campaigns may improve rule adherence, but in the long-run, the transit agency may need to adopt more customer tracking and cancellation penalty strategies currently
being used by ride-hail companies, and even other on-demand transit operators. These are difficult political decisions to make, as there are both privacy and equity concerns related to customer tracking and levying fines on low-income bus riders.3. Possibility to Attract More Ridership

The current sample profile of ODT users skews young and lower-income. From the survey we know that the on-demand transit service may eliminate the barriers of travel at night for those disadvantaged groups. And with improved service quality and predictable wait times, more people from disadvantaged groups will benefit from the emerging travel mode.

However, we still need to explore the potential of on-demand transit for attracting additional groups. For example, the proportion of elderly people in our sample is very low. The reason could be that elderly people might have higher income and access to private cars. or that they were less inclined to respond to the survey. They might also have limited needs to travel at night. In this case, improving service quality may only have limited attraction for these people. However, there is another possibility that elderly groups have difficulties using the mobile app or scheduling service to book a trip. Therefore, further study is necessary to find out if there are unfulfilled travel needs among those residents not using ODT, and eliminate their barriers to travel by providing tailored services.

The research team from University of Toronto is conducting further research to understand the scale and magnitude of travel behavior impacts. The results are aiming to help the City of Belleville to improve the service quality of on-demand transit and launch tailored policies to satisfy the various travel needs and preferences of local travellers.

IV. Acknowledgements

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