

# **An Agency-Wide, Consolidated Approach to On-Board Transit Rider Surveys Conducted with Electronic Handheld Tablets**

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**ABSTRACT**

Transit agencies rely on on-board rider surveys to produce data in support of planning initiative, Title VI and FTA reports. The findings and statistical analysis provide valuable information about riders; travel patterns; and the effects of new rail alignments, service and fare changes.

Historically, on-board surveys have been collected with paper methods. In more recent years, with the advent of technology, transit agencies are turning to electronic methods to gather the information in lieu of paper. This approach has many advantages; however, significant changes to methodology and approach are necessary.

TriMet has migrated all on-board rider surveys from paper to electronic tablet data collection. The survey budgets were consolidated and a position has been created to manage and oversee the implementations at an agency-wide level. The new approach includes the recruitment of local college students to conduct the on-board surveys, and the utilization of robust and cost affordable open source software. This strategy resulted in significant time and cost savings; more accurate and reliable data; offers a more eco-friendly approach; and improved customer relations.

This paper focuses on the consolidation and migration from paper to tablets for all on-board surveys, and includes the materials, methods and data of a system-wide fare survey conducted in the spring of 2016. Results and findings from a 2014-15 Origin & Destination (O&D) Before Study, which also used tablets, are referenced for comparison. The paper is intended to represent best practices in a format that can easily be adopted by other agencies.

## INTRODUCTION

Current technology provides unrealized opportunities for the collection of transit rider and travel pattern information. Advanced techniques, such as using tablets to collect survey data, in comparison to paper methods, can achieve more efficient, cost effective, and accurate data results.

The data that is collected is used to analyze transit ridership patterns, inform planners on ways to improve the system, and to help the region improve travel forecasting models to better understand impacts of planned projects.

The FTA recognizes the use of electronic survey tablets as a legitimate and preferred survey data collection method. Prior research also suggests using tablets, as well as recommending personnel interviews over the typical self-administered methods (1).

### Advantages of Tablet vs. Paper

The benefits TriMet has realized using the new electronic survey method over the last couple years include:

- Significant time and cost savings
- Time savings is achieved with real-time data capture method: information is available for analysis immediately as opposed to months later due to paper data collection and entry, and geo-analytical processing. College students (\$17-25/hour), as opposed to contract survey companies (\$50 +/hour), is cost effective and provides opportunities for local area students.
- Eliminates additional and potentially significant fees for: paper, printing, postage, data entry, GIS post-processing.
- No oversampling required to meet quota, as real-time data capture is monitored.
- Survey responses can be weighted by route, direction, time-of-day, and geography, resulting in more efficient survey collection and improved accuracy by ensuring that all major travel patterns are collected, including short trips.
- Provides platform for one-on-one customer interaction and engagement, which can be quite positive.
- Data entry errors are decreased and can be auto-validated, compared to interpreting handwriting, which can be difficult and time consuming.
- Data accuracy is vastly improved and location information for stops on/off is auto-captured. Survey throw-out rate is almost non-existent.
- Use of tablets publicly demonstrates the use of innovation in technology and being environmentally conscientious.

### Consolidation of Resources

The consolidation of survey data collection and resources at an agency-wide level can result in even greater efficiency and cost savings. Internal business units benefiting from on-board surveys range from: Capital Projects and Construction; Finance; Service Planning; Public Affairs; and Operations. Common surveys that support internal business needs, as well as Title VI and FTA reports include:

- “Before and After” studies
- “Origin and Destination” studies
- Fare studies

- Automatic Passenger Counter (APC) validation
- Ad-hoc surveys for planning and analysis, which can be conducted more frequently with tablets as-needed without previous resource budget and time constraints.

Following the demonstration of benefits, a new position, Electronic Survey Developer and Analyst, was created in the IT-GIS Department. This position manages all aspects of survey data collection using digital methods on an agency-wide support basis. The responsibilities of this position include:

- Collaboration with business units to identify survey requirements and formation of questionnaires
- Overarching oversight to ensure consolidation of surveys in support of agency-wide initiatives
  - Title VI and FTA acceptance measures
  - Technical and programming aspects involving mobile applications and devices
  - Staffing, managing and scheduling aspects
  - Post-data analysis and reporting functions
  - GIS spatial database management, generation, and data distribution

An on-going budget for agency-wide electronic surveys consolidates resources, which is more cost-effective, and it simplifies billing across multiple departments and overlapping surveys. The budget includes funding for cellular fees; peripherals (vests, tablets, bags) and replacements; and a reserve for surveyor wages for unplanned data collection on an as-needed basis. The larger and more extensive surveys, which are planned in advance, have budgets within the lead department for surveyors and supervisors.

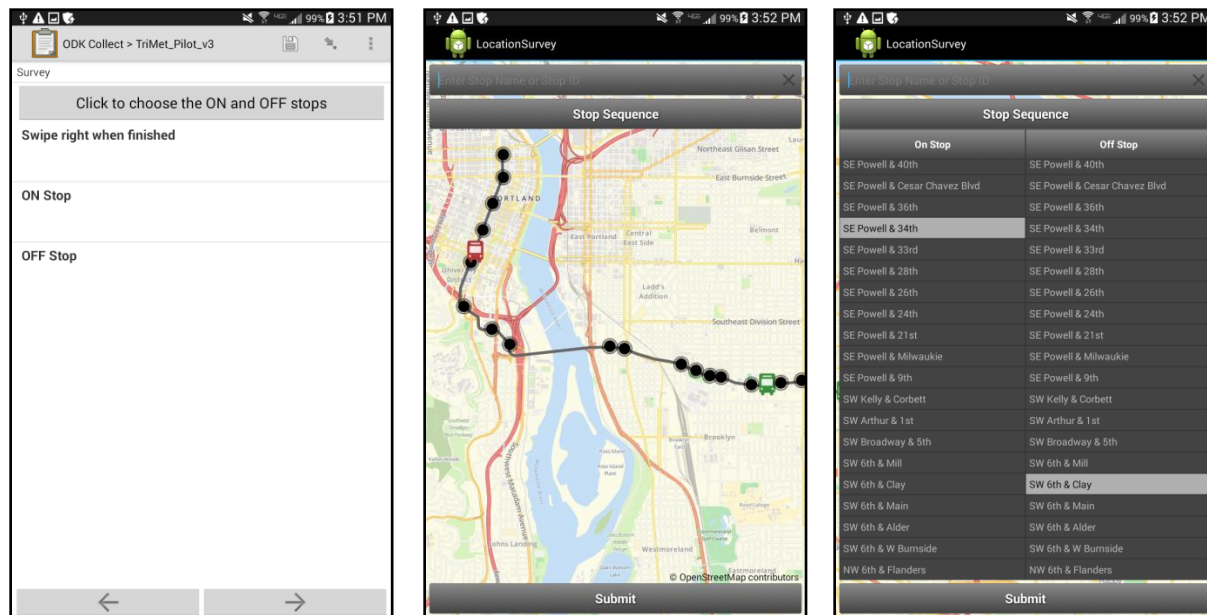
All payroll for temporary employment for survey projects are managed under one contract. An unanticipated result of this is that other departments within the agency are using them in a variety of ways in addition to surveying, such as customer outreach events and on-street backup resources, and even to fill-in where positions are vacant. Because they are employed under one contract, only an account number is necessary for ad-hoc needs. The surveyors are mainly local college and university students; they know the system well; are extensively trained; and are often bilingual.

### **TriMet's Experience with Electronic Survey Tablets**

Prior to the implementation of the following two surveys, a significant amount of research was performed. Advice was sought from FTA and other transit agencies, and extensive testing, prototyping, and pilots were conducted.

The 2014-2015 Origin and Destination (O&D) Before Study for the Orange Line was the first to use hand-held tablets in lieu of paper. The study consisted of a two-step process: a short on-off survey and a more detailed long survey. This is in alignment with FTA recommendations, and best practices commonly followed by others (2).

The mobile devices and personal interview enabled the real-time capture of origins, destinations, on-stops and off-stops. The design of the input screens allowed for quick input, immediate verification, and data validation (Figure 1). Other agencies have also implemented similar designs for auto-location capture (3).



**FIGURE 1 Sequence of O&D survey input screenshots for the capture of location data.**

The 2016 Spring Fare Survey project was conducted at a system-wide level. This survey also used hand-held tablets to collect data. It was important for TriMet's fare modeling process to ensure data consistency for comparisons to previous paper surveys. That goal was achieved, as the data results of the 2016 survey were similar to 2012 fare survey findings. In addition, TriMet achieved a 30% cost reduction and data results were available within one month, as opposed to six.

To avoid research bias with tablets, fielding practices need to be revised, as paper surveys are handed out to everyone. For the O&D study, which was route-based, a random number generator on tablet was used to determine which rider to approach. However, for the 2016 Spring Fare Survey project, as many people as possible were surveyed on each trip, with the data weighted against passenger counts from APCs.

## **MATERIALS**

The materials used for the fare survey include equipment, peripherals, service/cellular fees, and software. A variety of products and services were researched and narrowed down based on costs and requirements. These options were then tested in the field prior to bulk purchases.

During training, each surveyor signed an agreement for the receipt, responsibility terms, and the return of their equipment and TriMet identification badges. All necessary materials were delivered in one gear bag. They were responsible for charging, possession and software updates.

### **Equipment and Peripherals**

Costs per unit are as follows:

- Samsung Galaxy 8" tablet - \$250
- Samsung Galaxy tablet case - \$17
- Safety Vest - \$25
- Reading Light with Clip - \$8
- Tech Gear Bag – \$8

- iRoller (liquid free, reusable touch screen cleaner for dirt and bacteria) - \$20
- Extra batteries were not necessary due to battery life of devices and shift hours

### **Cellular Service**

- Android Tablets - \$40/month
  - Phone fees for supervisors (necessary for immediate 24/7 communication with surveyors)
- \$37/month

### **Software**

- Open Data Kit (ODK) was selected based on requirements, costs and the ability to easily customize for various surveys. It is a collection of open source tools for survey design, collection, and data aggregation and is recommended by industry experts (4).
- In-house developed Android apps integrated with ODK to capture the on-off stop information.
- The Trello software program is used to track materials; meetings; milestones; stakeholders; staffing; and tasks.
- Google Docs is used for shift scheduling and shared project documentation.
- Google Groups is used for communication between surveyors and management.

### **Incidentals**

Incidentals included Lyft and Uber fees for travel to and from start and stop locations before or after transit service hours. Initially projected at \$1,500, the final costs were less than \$100. Surveyors were reimbursed with submitted receipts.

## **METHODS**

The following includes the refined processes for the more recently conducted system-wide fare survey, while noting lessons learned from the previous O&D study, as well as electronic surveys conducted by other agencies in recent years.

It should be noted that the fare survey data was collected at the route level and weighted against the the APC data. The O&D survey data was collected at the route level and weighted by geography to better ensure survey responses reflected observed travel patterns.

### **Project Scope and Timeline**

January 2016

- Iterative on-street pilot testing (include stakeholders)
- Refine methodology
- Finalize timeline and budget based on pilot results
- Finalize survey instrument
- Approval to proceed
- Recruitment and training

February 20 – June 1, 2016

- Conduction of on-board surveys
- Survey monitoring and supervision
- Data monitoring and reporting

The project was completed on May 1, one month ahead of schedule.

**Outreach and Communication**

The identification of stakeholders and supporting staff for continued meetings, communication, and collaboration started off the project. These included: Finance, Data Analysts, Title VI & Equity Programs, IT, GIS, Policy and Planning, and Revenue Operations. Formal approval was sought from all the stakeholders prior to implementation. Meetings were held monthly and status reports were released weekly.

Internal notices were released to the stakeholders and Operations staff two weeks prior to fieldwork commencing, and reminders were sent several days in advance. Information was also shared through an internal newsletter, posted in the bullpens, and a public website was created about the project, which riders were directed to for more detailed information.

**Recruitment and Training**

The survey team consisted of eighteen local college and university students and three supervisors who had worked on the previous O&D study.

*Recruitment*

Recruitment involved contacting local universities and students through various recruitment resources. The announcement included the job description, requirements, and a request for resume and cover letter. Preliminary interviews were performed on the telephone. Reference checks were performed on the leading candidates, and several group face-to-face interviews were held to accommodate the number of students. Skills and traits that were required included:

- Tech savvy
- Familiarity of TriMet system
- Customer Service skills
- Racial/ethnic diversity and Spanish-speakers (desirable)
- Professional attitude and appearance
- Solid work history (background check required)

*Training*

The Training Program consisted of three full days of training. It included:

- Project overview, objectives, scope
- Tablet assignments and setup
- Safety and Customer Service training
- Methodology and sampling procedures
- Device and software training
- Shift sign-up and communication methods
- On-line shift sign-up and responsibilities
- Supervised fieldwork

*Scheduling*

Workers had to commit to at least 20 hours of work per week. Minimum shifts were approximately 4 hours and were designed so that workers could do back-to-back shifts, if available, with sufficient breaks. In the initial O&D survey fielding, scheduling students proved

challenging due to need to work around class schedules. Certain shifts were being filled more regularly than others. For the 2016 Fare Survey, student surveyors with diverse availability were hired so that they could cover different shifts. Also, we used the WhenIWork tool to lay out all the shifts and assign surveyors shifts based on their availability. This proved to be more efficient, which led to completion of the survey one month ahead of schedule.

### Quality Assurance

Quality assurance included the assignment of six-seven surveyors per one supervisor; emphasizing fielding rules; and providing additional training and meet-ups as needed. Supervisors closely monitored the surveyors in the field while documenting observations for follow-up and review. Additionally, the progress of the surveyors was also monitored in real-time via dashboards (Figure 2) and resources were reallocated as quotas were met (Figure 3).

### Data Analysis

Survey data analysis was conducted in-house and through the collaboration of several departments and in conjunction with the survey manager. The 2016 fare survey data were weighted to passenger census, transfers, and youth. The analysis was used to produce the Title VI report. The Finance Department also used it for fare modeling. The survey results were displayed and visualized through a website dashboard. The dashboard has been used by service planning, customer service, and other stakeholders to easily access survey results.

On-Off Dashboard						
<div> Route: 4-Division/Fessenden ▾ </div> <div> Direction: All ▾ </div> <div> Surveyor: All ▾ </div> <div>Download</div>						
Date	Time	User	Route	Direction	On Stop	Off Stop
2015-12-04	18:17:48/18:12:42	richardm/richardm	4-Division/Fessenden	To St Johns	SW 6th & W Burnside	NW Everett & 5th
2015-12-04	18:17:43/18:07:56	richardm/richardm	4-Division/Fessenden	To St Johns	SW 6th & Taylor	NW Everett & 5th
2015-12-04	18:17:36/18:12:47	richardm/richardm	4-Division/Fessenden	To St Johns	SW 6th & W Burnside	NW Everett & 5th
2015-12-04	18:17:29/18:12:56	richardm/richardm	4-Division/Fessenden	To St Johns	SW 6th & W Burnside	NW Everett & 5th
2015-12-04	18:17:23/18:13:01	richardm/richardm	4-Division/Fessenden	To St Johns	SW 6th & W Burnside	NW Everett & 5th

**FIGURE 2** Dashboard screenshot of surveyors progress.



On-Off Dashboard									
	Total	Inbound				Outbound			
		AM	Mid	PM	Eve	AM	Mid	PM	Eve
4-Division/Fessenden	117%	59%	118%	65%	158%	182%	131%	191%	108%
9-Powell Blvd	0%	0%	0%	0%	0%	0%	0%	0%	0%
17-Holgate/Broadway	0%	0%	0%	0%	0%	0%	0%	0%	0%
19-Woodstock/Glisan	0%	0%	0%	0%	0%	0%	0%	0%	0%
29-Lake/Webster Rd	0%	0%	0%	0%	0%	0%	0%	0%	0%
30-Estacada	0%	0%	0%	0%	0%	0%	0%	0%	0%
32-Oatfield	0%	0%	0%	0%	0%	0%	0%	0%	0%
33-McLoughlin/King Rd	0%	0%	0%	0%	0%	0%	0%	0%	0%
34-Linwood/River Rd	0%	0%	0%	0%	0%	0%	0%	0%	0%
35-Macadam/Greeley	0%	0%	0%	0%	0%	0%	0%	0%	0%
70-12th/NE 33rd Ave	0%	0%	0%	0%	0%	0%	0%	0%	0%

**FIGURE 3 Dashboard screenshot of data collection status.**

## Sampling

### Goals

- 10% of Bus and MAX trips
- 25% WES trips
- Samples pulled must align with current sign-up
- Survey as many as possible, average 10 surveys an hour

### Extent

- System-wide with prioritization (Bus, MAX, WES)

### Day Types

- Weekday and Weekends
- Excluding Holidays, Spring Break, Memorial Day Weekend, and planned service disruptions.
- Surveys periods: 8 weekends, 12 weeks

### Time of Day Periods

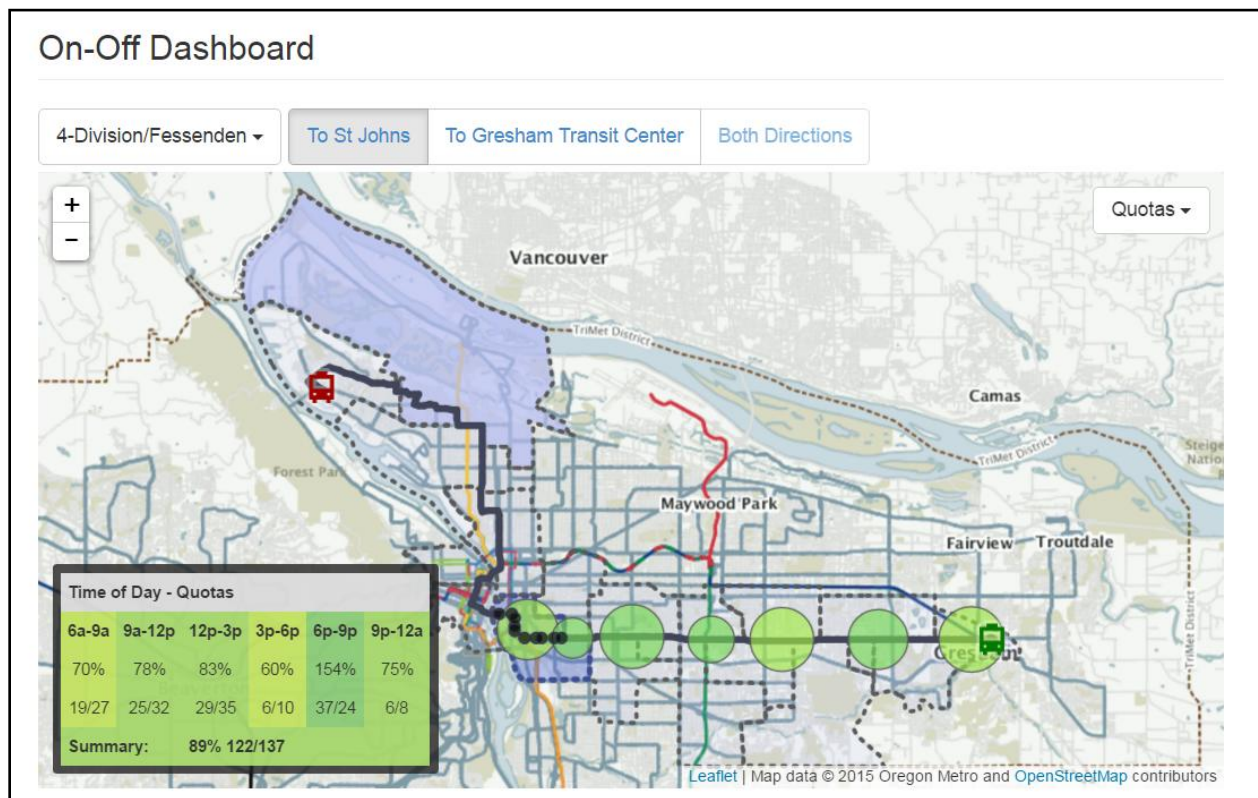
- AM Peak (6am-9am)
- Midday (9:01am-2:59pm)
- PM Peak (3pm-6pm)
- All other hours (before 6am and after 6pm)

The four ‘time of day’ periods correspond to time periods with observed different travel patterns in the TriMet system. Number of completed surveys for each time period should adequately support data expansion requirements for travel demand modeling.

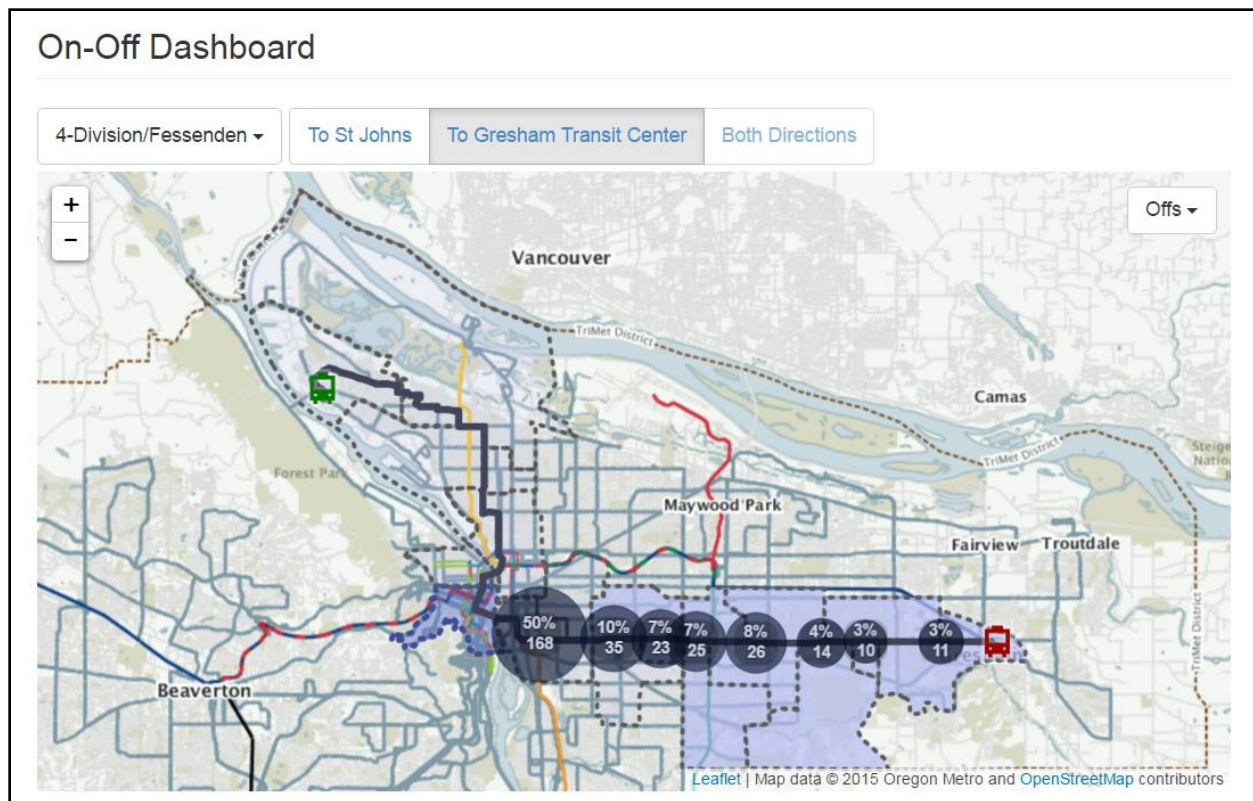
The management of the sampling was addressed through the following:

- Extensive training
- Scheduled group meetings with surveyors
- Field supervision
- On-board real-time monitoring of interviewer performance and progress
- Real-time report monitoring dashboards

Dashboards can be designed to show the real-time progress, location, and data of the surveyors (Figure 2); to monitor the progress of the quotas to better allocate resources (Figure 3); to display quotas by time of day and location (Figure 4); and to show preliminary analytics (Figure 5).



**FIGURE 4** Dashboard screenshot of quotas by time of day represented by location aggregation.



**FIGURE 5 Dashboard screenshot of the preliminary high level analysis (unprocessed data). The bubbles show the % and number of offs. The ons originated in the highlighted Traffic Analysis Zones (TAZ).**

### Methodology and Rules

Fielding rules were developed and reviewed extensively with the surveyors during training and beyond. The document includes scripts for commonly asked questions; directions for uncommon situations (partner doesn't show up, or connection is missed); helpful tips and techniques; what is not appropriate (dress code included); and daily reminders such as charging batteries and verifying schedules.

A random number generator was utilized via the tablet to avoid bias for the previous O&D study, also implemented by other agencies (5), which worked well for route-level data. For trip level data, it was more effective to survey as many riders as possible. The data was weighted against the passenger counts using the results from the completed phase one 'On-off' survey to provide accurate representation of the total transit riding public per route. Riders were often interviewed more than once as we are surveying the trip not the people.

A consistent on-board approach to the customers was critical. The surveyor would work their way systematically around the bus, beginning with the riders on the operator's side of the bus, and starting with those closest to the window to avoid repetition.

Some agencies have requested phone numbers for follow-up interviews for those that were not interviewed (6), however, TriMet has found that this approach yields a low response rate and is not cost effective.

## 2016 Fare Survey Form

This survey was an opportunity to obtain a system-wide perspective of our riders, so the questions were extended beyond the basic requirements for compliance with FTA mandates. The importance and value of the additional questions were compared against the value add and additional resources and time that it would create. The main objectives and requirements for the survey include:

- Relationship of Fare Change and Ridership Change
- Fare, route, transfers, age (to determine whether they are honored citizen due to age or disability (under 65))

Expand to include equity for planning and analysis purposes, including Title VI.

- College student
- Ethnicity
- Income in differing income classes
- Language spoken at home
- “How well do you speak English?”

The survey questionnaire had many reiterations to decrease the completion time to less than three minutes (average 2.5 minutes). This was done by refining the questions, re-ordering them, and determining which questions should be asked by the surveyor, and which questions would be more appropriate for the rider to complete. It was easy for the participants to by selecting a response, the swiping to next screen.

## DATA

For evaluation, the 2012 paper fare survey results are compared against the 2016 tablet survey results (Table 1). The comparisons were performed in-house.

**TABLE 1 Fare Survey Comparisons**

<b>Fare Survey Comparisons</b>	<b>2012</b>	<b>2016</b>
Distribution	Paper and pencil – handed to all passengers	Tablets – survey as many as possible
Languages	Full survey: English/Spanish LEP questions: 4 languages	Full survey: English/Spanish LEP questions: 11 languages
Questions asked (full survey)	19	24
Sample Trips: representative of service day	Bus – 8% weekday, Saturday, Sunday MAX – 15% weekday, Saturday, Sunday WES – 50% weekday Portland Streetcar – 15% weekday, Saturday, Sunday	Bus – 10% weekday, 8% Saturday, Sunday MAX – 10% weekday, Saturday, Sunday WES – 50% weekday
Sample hours pulled (includes 2 surveyors on MAX)	1,506	1,514

Surveyor hours (includes training/travel)	1,735	2,309
Surveyor training hours	15	276
Supervisor/scheduler hours	711	1,082
Completed surveys (includes all languages)	16,982	17,719
Response rate	44%	65%
Results available after fielding	>6 months	1 month
Shift length – average surveying hours (not including travel time)	8 hours	4 to 5 hours to accommodate student schedules
Cost	\$107,502 (fielding, translations, printing, postage, data entry)	\$73,313 (fielding, translations, programming, cell phone and incidental fees)
Cost per sample hour	\$71.40	\$48.40
Cost per completed survey	\$6.30	\$4.10
Completes per sample hour	11.3	11.7
Supervisor/scheduler hours as % of sample hours	47%	71%

## DISCUSSION OF RESULTS

Consistency between the 2012 fare survey and the 2016 was achieved to ensure consistency for TriMet's fare modeling process.

In comparing 2016 to 2012, for the same sample hours, the 2016 survey:

- Cost less: percentage decrease was 32%
- Had a better response rate: percentage increase was 48%
  - Passengers like new survey technology (word of mouth)
  - Skip logic shortens survey
  - Personal attention from surveyor
- Had a higher percentage of completed surveys: percentage increase 4%
- Obtained greater information: more questions included
- Better Quality Assurance
  - Training and supervision - more rigorous
  - Real-time data monitoring - extra level of quality control
- Introduced Dashboards
  - Real-time data monitoring – better resource distribution and progress reporting
- Had fewer errors
  - Surveyor present to administer some questions and clarify other questions
  - No misinterpretation of handwriting
  - No data entry keystroke error
- Results were more timely
- Allowed for shorter shifts to accommodate student schedules
  - Produced more travel time, however, the surveyors experienced less

burnout

- Was more environmentally friendly than paper
- Enabled TriMet “ambassadors” (students) to interact directly with 27,118 riders and 203 bus drivers/WES conductors.

## CONCLUSIONS

The results of TriMet’s 2016 Fare Survey project demonstrate, as does prior research (7), that there are many advantages to conducting on-board surveys with tablets instead of paper, and to moving away from self-administered surveys to the personal interview style. Changes in approach and methodology are necessary to successfully incorporate the technology, while maintaining continuity with previous surveys for comparative analysis.

Bias needs to be addressed differently, as paper surveys are handed out to everyone (8). For the O&D study, which was route-based, a random number generator on tablet was used to determine which rider to approach. However, for the fare survey, as many people as possible were surveyed on each trip, with the data weighted against passenger counts from APCs.

Recruiting local students, in lieu of contracting out the work, proved to be very successful on many levels. The students are tech savvy; hourly wages are more affordable than contractors; they generally use transit and bikes as their main means of transportation so they know the system well; and they represent the agency in a very positive manner with good customer service skills. Training is more extensive though due to lack of experience in other areas, such as survey methods and security.

The cost per sample hour from the tablet survey is significant lower (Table 1) than that of paper-based surveys. This is mainly due to the low cost of student surveyors, adoption of open source software, and consolidated organizational resources. The hourly cost of a student surveyor is 40% or less than that of a consultant. Using software such as Open Data Kit (ODK) means that there is no license fee or annual fee. The cost for survey project management, in-house app development, software customization, and dashboard development are not included in the total cost. These responsibilities are handled by the full-time survey manager.

Software and hardware choices need to be piloted and tested. For example, we found that the 7” tablets were too small for readability and the 9”, which is more common, was too large to hold securely in one hand. Further, data management aspects, backend infrastructure, and technical support need to be established.

Questionnaire design requires time and extensive testing. Reducing the time it takes for a rider to complete the survey can save valuable time and money. It will also minimize risk the of under-surveying short trips and high-volume routes.

Field supervision is an important factor in surveying to ensure consistency and accuracy in the data collection techniques. With tablets, this can be supplemented with dashboards and the monitoring of real-time data quotas and validity, thus reducing the need for oversampling.

Finally, just as with the paper survey method, centralizing the management of all electronic surveys within an agency consolidates resources, increases efficiency, and can combine potentially overlapping studies. Equipment and software are shared, and the cost of an additional employee to manage all aspects from a high level is cost effective. Additional benefits to the agency are also realized: an overarching perspective from a management and operations standpoint; retention of the knowledge base in-house; and better consistency in collection techniques from year to year.

## CHALLENGES

There may be challenges for other transit agencies that wish to adopt the tablet survey methodology. These challenges range from the need for an organization-wide paradigm shift in surveying methodology to resource constraints. More specifically, the challenges could include ensuring buy-in from the management, overcoming a lack of dedicated resources, and maintaining a well trained surveying team.

First of all, ensuring buy-in from senior management and other stakeholders in the organization could be difficult. The paper and pencil survey method has been used for decades. Resistance to change, fear of loss of data, and concerns about data security are among some major barriers to overcome. To address some of these issues, a small pilot project can be introduced to showcase the benefits of tablets and data security to management. Also, encouraging close communication with and involvement by stakeholders throughout the pilot project would be vital to getting their support.

Secondly, it is important to formulate ways to overcome any lack of dedicated resources and technical infrastructure. Not many organizations have dedicated staff or the resources needed to move to tablet surveys. Tablet survey projects may require a full-time project manager with significant expertise in project management, data infrastructure, as well as a full-stack developer for the back-end database, tablet programming, and app development. Securing the required equipment and personnel requires commitment from the management.

The third challenge is the hiring, training, and maintenance of student surveyors. Student surveyors have other obligations and their schedules change frequently. Some trained student surveyors might be lost due to graduation or other commitments. Therefore, it is critical to constantly hire and train new surveyors.

Although the challenges can be daunting, the payoff from the tablet survey greatly outweighs the initial cost in setting up the infrastructure and the program. In our view, the most important part of coping with the initial challenges is the buy-in from management through a successful pilot project.

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