Attitudes of bus operators towards real-time transit information tools

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Abstract

Although it is apparent that providing useful information has a positive effect on transit riders, no studies to date have investigated bus operators' reactions to real-time arrival information and other potential rider information tools. In this study, the project team surveyed 253 bus operators to determine their views and values concerning the existing use of real-time information and to ask about future transit rider information applications. Almost all operators (93% and 91% on two separate questions) were positive or neutral to the provision of real-time information. In addition, operators were receptive to building other new information applications, with all applications in the survey being supported by at least 60% of the bus operators. The two most widely supported potential applications in the survey were additional tools to help blind and deaf-blind riders (89% of bus operators favored) and an application that would aid riders in identifying physical stop, shelter and bus issues such as graffiti, broken parts or a need for lights (88% of bus operators). Applications displaying data about past performance or current bus capacity received the least support (66% and 61% respectively). This research gives a better understanding of the impact of rider information tools on bus operators, including the views and values of the operators, and the harms and benefits of such tools.

Keywords: Transit, Bus Operator, Real-time Arrivals, Traveler Information, Technology

Introduction

Providing greater information about transit services has a profound impact on transit riders. Better transit traveler information increases rider satisfaction and can result in a mode-shift to public transportation (Multisystems 2003). Rider information is empowering, allowing transit riders to have greater control over their trip (Ferris et al. 2010). Existing studies of real-time arrival information have shown that the ability to determine when the next vehicle is coming brings travelers' perception of wait time in line with the true time spent waiting (Dziekan and Kottenhoff 2007, Watkins et al. 2011). Real-time arrival information can even increase ridership on the system (Ferris et al. 2010, Tang and Thakuriah 2012). Transit users value knowing how long their wait is or whether they have just missed the last bus. However, although it is apparent that greater information has a positive effect on transit riders, no studies to date have focused on bus operators' views and values regarding real-time information for riders and other potential information tools.

The OneBusAway (OBA) project provides real-time bus arrival information via a website, smart phone applications, voice response telephone, and text-message to transit riders in greater Seattle-Tacoma. In order to improve the usability of public transit, the developers of OneBusAway began a systematic evaluation of potential tools that could be developed to aid transit riders in all aspects of their trip. To make the evaluation more comprehensive, the team decided to follow the Value Sensitive Design (VSD) methodology, a principled approach for examining the set of ethical values implicated in a technological system (Friedman et al. 2006), used widely in the development of human-computer applications. The VSD process involves iterating among three types of investigations - conceptual, empirical and technical – to help identify the harms, benefits and underlying values arising from a technological innovation or program. In this case, the first step in using the VSD process was to make an initial list of the direct and indirect stakeholders of transit rider information tools, along with the applicable benefits, harms and underlying values for each stakeholder group. This was followed by brainstorming a list of potential rider information tools with the ultimate goal of prioritizing those tools for future development.

In order to investigate the impact to direct stakeholders (those who would use the rider information tools), group forums and cultural probes were conducted with King County Metro's Transit Advisory Committee (Watkins, et al. 2012). In addition, a review of many transit rider and non-rider surveys allowed for the investigation of typical rider needs and reasons why people chose not to take transit. The values for many indirect stakeholder groups (those impacted by the tools but who are not direct users) were initially considered during the conceptual investigation by brainstorming indirect stakeholder values and implications. It was through this process that it became apparent that there was one major group of indirect stakeholders that should have a larger stake in the process - the bus operators.

The overall goal of this VSD process is to investigate, rank, and shape the design of potential rider information tools based on many factors, such as how often they would be used by riders, how big of a difference they would make in gaining new transit riders or in improving the experience for existing riders, and how they would affect the job of bus operators and other transit employees. Often such tools are implemented without the input of the bus operators, who have day-to-day contact with the riders and know them the best. Therefore, in order to learn about bus operator's views and values regarding potential rider information tools, a set of semi-structured interviews and a survey were conducted. While the primary intent of the survey was to ask about future transit rider applications, operators' reactions to the existing use of real-time information were probed as well.

Literature Search

The health and psychology literature has done a fairly thorough job of establishing the links between characteristics of the work environment and the health of transit operators (Ragland et al. 1998; Rydstedt et al. 1998; Cunradi et al. 2005) In addition, multiple studies have been conducted to investigate the ties between bus operator performance and safety while riding public transportation (Rey et al. 2002; Blower et al. 2002; Chen et al. 2008; Wahlberg 2008; Palacio et al. 2009; Wahlberg and Dorn 2009). Research has even combined the two, looking at the impact of health and wellness among commercial operators as related to traffic safety (Krueger et al. 2007). However, little research has been done related to bus operators outside the areas of health effects and traffic safety.

In their review of literature related to bus operator well-being, Tse, Flin and Mearns conclude that the burden from traffic, violent passengers and tight running schedules affect operators severely and that these job stressors cannot simply be written-off as part of the job of an urban transit operator (Tse et al. 2006). It seems critical then that operators' values and the potential harms and benefits to them should be considered as part of any new implementation of technology.

The one study that looked at the effects of real-time vehicle location information on transit operators was done by Lee, Chon, et al. using data from MTA in Baltimore, Maryland. Their investigation showed that schedule adherence was improved after implementation of intervention from an automatic vehicle location system (Lee et al. 2001). A self-report survey conducted as part of the study showed that 29 of 40 operators always or almost always check their schedule at each time point; 30 of 40 operators drag the line to get back on schedule if they are running ahead; and 31 of 40 operators try to adjust speed to get back on schedule if they are running late.

In addition to these studies from the literature, some transit agencies will formally and informally poll their operators when considering implementation of new technology or practices. However, these types of input into agency decisions are rarely documented in a way that could provide information to other transit agencies or researchers.

Semi-Structured Interviews

The Value Sensitive Design (VSD) process has three components - conceptual, empirical and technical - which are used iteratively. VSD as such does not proscribe a particular order in which these must be used. In the work reported here, the first stage was a conceptual investigation to address the questions of who are the stakeholders affected by the design and what are their values that are implicated. The issue of impact of transit information tools on bus operators was first identified during a conceptual investigation and is described below. Then, in the empirical investigation, the use of surveys, interviews and other interactions with the stakeholder groups allowed refinement of the understanding of values, harms and benefits. This component will be the focus of this paper. The results will feed into further technical investigation of specific rider information tools as they are developed for the last part of the VSD process.

The empirical investigation in this case has two parts, an initial series of semi-structured interviews with a small number of operators, and a subsequent survey of a larger number of operators. Together, these interviews and survey refine the understanding of bus operator values, harms and benefits associated with rider information tools.

The initial conceptual investigation identified values of operator safety, privacy and self-image as possibly being impacted. Some of the tools envisioned, such as notification of a standing-room only bus, notification of full bike racks or notification of full wheelchair spaces, would potentially require manual input by operators into their consoles if the technology for such tools were incompatible or too expensive. This may impact their safety and the safety of their passengers by taking their attention away from other tasks. However, applications that would take away some of the need of operators to communicate with riders could have a positive impact on safety and speed of operations. Some of the tools envisioned give the on-time status of the bus or statistics related to how frequently that bus is on-time. These tools may affect the operators' privacy, because it makes their on-time performance more transparent. Other tools include a rate-my-route or rate-my-driver type program. These may impact the bus operator's self-image. All may affect the operators' reputations. In contrast, many of the proposed tools may improve self-image and reputation through the improved interaction with better informed riders.

The purpose of the semi-structured interviews is to gauge the types of values that may be impacted from rider information tools by asking more open-ended questions. Six interviews were conducted with members of the Amalgamated Transit Union for King County Metro (KCM).

The small sample size means that the results will generally not be statistically significant, but the semi-structured interview format allows for a much richer and open-ended probe of operator views and values (Kahn 1999), and informs the design of the subsequent larger survey instrument described later in this paper. The interviews were scheduled in advance over the phone and took place in local restaurants or on the bus during a layover. All interviewees were male in their thirties to fifties. At the beginning of the interview, the bus operators were asked several warm up questions, including:

- What are the 5 best things about driving a bus?
- What are the 5 worst things about driving a bus?
- What would you change about driving a bus given the chance?
- What would you leave the same about driving a bus?

They were then asked a series of rider information needs questions, including:

- What kinds of information do riders typically ask you for?
- How frequently do you get these types of questions?
- What kind of information should KCM provide to riders?

The follow-up included a series of questions pertaining to safety and privacy. Safety questions included the types of things they currently have to do while operating a bus and their ability to add an additional task reflecting their bus being standing-room only or that the wheelchair spaces are taken. The privacy questions addressed their opinions about real-time information, including the value to passengers and the potential violation of their privacy by providing the information as countdown to arrival as well as a historic on-time status for that particular bus. The interview also included a series of questions about running “hot” (i.e., ahead of schedule), and the impact that real-time information might have on this. The interview concluded by giving the operators an opportunity to share other benefits or harms that they could foresee from providing greater rider information.

The themes regarding the best aspects of driving a bus revolved around social interaction and independence. Operators enjoyed “meeting people you wouldn’t normally meet” and being able to “leave their job at work”. However, this independence was countered by what was considered the worst aspect – management and policy’s interference with their ability to do their job well. Things like “draconian rules” and “a 180 page contract” made their job stressful. Aspects of the job they would want to change hit on this same theme, with reduced political interference and improved interaction with other parts of the transit agency topping the list.

The operators thought the transit agency should be providing basic and advanced trip planning components and next bus information. However, the operators also specifically mentioned providing ways the public can offer opinions about the service, fare payment information, and effective rider alerts. One operator commented that “rider alerts should be more effective”, including an “interactive system to get the word out about known closures”. They made specific suggestions about interior stop announcement signs including alerts and materials to encourage transit access to attractions. Operators also stressed the importance of access to information for riders who don’t use fancy phones or computers.

There were a range of views regarding operators needing to push a button to provide greater information about a full bus, full racks, etc. – some felt they would remember and others did not think they would always remember – or that at least some other operators would not remember. Most importantly, unless operators felt strongly about the benefits of information the extra effort produced, they wouldn’t even try to remember. Operators considered the idea of providing the information good, but they weren’t sure it would make a difference to most riders. Operators guessed that if riders sit at their desks an extra minute because of a full bus, then that would help the entire system, but if riders were already at the stop, most of them would still climb on despite knowing that another, emptier bus is coming in just a minute. It was felt that this information needed to be 100% accurate, otherwise no one would use it.

For both early and late buses, operators alter how they drive to match the schedule. There was some discrepancy about how well operators know that they are on schedule. If they are significantly early, they will sometimes pull over and sit, but this is psychologically painful for them and the riders, so they try not to. Instead they drive very slowly and follow guidelines painstakingly, such as allowing all passengers to sit before they start to drive.

Some participants thought operators would adhere to the schedule more if people were more aware of on-time status, but that this might actually make on-time status worse. Currently, operators will purposefully run late or early at the beginning of a route because they know what will happen further down the line. They attempt to drive so that most of the route is on-time using their knowledge of historic traffic and the day's events. Early running may stop completely, but late running might increase. Likewise, the practice of leaving late might stop, but they would end up sitting at a stop, which riders do not like. If they are given pressure to stay on-time at all the stops, this may put more pressure on the schedulers as well. Many operators felt that more awareness of on-time status would not make any difference, because they already do everything they can to stay on schedule.

The current vehicle location technology was considered not accurate enough, but providing next bus information was considered highly important to riders, especially in the city where "people have options for their wait time". However, caution in the use of real-time information was emphasized because operators can get back on schedule after a rider has looked at the information. So, riders always need to plan for a couple of minutes before the anticipated arrival time. None of the operators saw real-time arrivals as a violation of their privacy. (For example, one stated that "it is part of my job to perform in the public eye".) However, information about the percent of on-time arrivals historically for a route was seen as a violation of their privacy. Many worried that this would lead to disciplinary action over something the operator is unable to control. It could also increase public confrontation with operators, such as in-your-face passengers asking them "Why are you always late?"

Feelings on the “rate my stop/route/driver” were mixed. Operators felt that any ratings would have to be anonymous and not considered in any disciplinary action by the agency. One operator felt it would not be a bad thing to “let operators know they were considered grumpy”, but another was worried that the public might not use it in the right way. In general, they were worried about discipline coming out of tools and possible physical or mental harm from rowdy passengers. This ties to stress on the job being listed as another worst aspect of the job during the warm-up section of the interview.

The bus operators really wanted to have real-time arrival information on their consoles, so they could help passengers. Indeed, another aspect they said the wanted to change during the warm-up questions was to provide more information to the operators to enable them to answer passenger questions. Alternately, they would like to have real-time arrival and trip planning information in an on-bus kiosk, so passengers could get information themselves about where to get off or the timing of their transfer.

The semi-structured interviews have provided an expanded understanding of the values, harms and benefits from rider information tools. However, understanding how widely held these beliefs are requires a statistically robust survey of bus operators. The results of the semi-structured interviews were used to develop the questions on the survey and give a range of responses for multi-choice questions.

Survey

The purpose of the survey was to inform value dams and flows analysis (Miller et al. 2007) to help determine which rider information tools should be pursued and in what order. In this analysis, value dams would be potential rider information tools or components of those tools that are strongly opposed by a set of stakeholders, even if that group is small. A small group of strongly opposed stakeholders can cause a project to fail. Value flows are potential rider information tools or components of tools that a large percentage of stakeholders would like to see included. As the primary indirect stakeholder group that impacts the rider experience, the bus operators' opinions are critical to the analysis.

Methodology

In June and July of 2010, a survey of bus operators was conducted. The paper survey instrument was mailed out to 500 operators randomly selected from the Amalgamated Transit Union (ATU) Local 587's database of 2,687 operators who work for King County Metro in greater Seattle, Washington. Because of the sensitivity of the operator's personal information, the randomly selected addresses were given to a mailing services company that routinely works with the union rather than the study researchers. Responses were completely confidential with no return address or identification of any type.

Prior to survey distribution, the survey was mentioned in the monthly ATU newsletter. Several days before the survey instrument was mailed out, a pre-letter was mailed to all survey recipients giving them notice that a survey was coming in the mail. The survey instrument included a letter of explanation and a $2 bill as a small incentive and thank you for their response. A week after the survey was mailed out, a follow-up postcard was mailed to the recipients to remind them about the survey. A few months after the survey, another notice was posted in the ATU monthly newsletter thanking the participants and asking if any non-respondents needed another copy of the survey.

All of these techniques, including repeated contact through pre-letter, survey and follow-up postcard and the small monetary incentive, were included in order to increase the response rate to have a representative sample, as suggested by the Tailored Design Method (Dillman et al. 2009) In total, there were 255 surveys returned, 2 of which were returned completely blank. The remaining 253 surveys were substantially complete, equating to a response ratio of over 50%. 127 surveys were returned in the first few days of the survey before the follow-up postcard was mailed out. Another 85 surveys were returned in the week after the follow-up postcard. The remainder were returned in the second half of July (33 surveys), August (7 surveys), September (1 survey), October (1 survey) and November (1 survey).

As shown in Table 1, of the operators who responded to the survey, 75% were male. The number of years of experience was roughly broken into quarters with approximately a quarter (26%) that had worked as a bus operator for 20 or more years, 23% that had worked 10 to 19 years, 25% that had worked 5 to 9 years and 25% that had worked less than 5 years. The median age of operators fell in the range of 50 to 59 years, with 43% of the respondents in this category. As shown by the Chi-Square Goodness of Fit Tests, the survey responses were a representative sample of the actual bus operator population.

All questions in the survey were tested for differences in responses based on years of experience, age of the bus operator, gender of the bus operator and frequent PM peak or night operators, and results were corrected for multiple comparisons using Holm's sequential Bonferroni method (Holm 1979). All significant results are discussed along with each question in the results section below.

Table 1 – Survey Response and Operator Population by Category

	All Bus Operators (N=2687)		**Survey Respondents (N=252)**		**Chi-Square Goodness of Fit Test**
Gender	**N**	**%**	**N**	**%**	$\chi^2 = 0.640$, 1 d.f. *p* = 0.424
Female	607	23%	62	25%	
Male	2080	77%	189	75%	
Years of Experience	**N**	**%**	**N**	**%**	$\chi^2 = 6.168$, 4 d.f. *p* = 0.187
Less than 5	780	29%	63	25%	
5 to 9	598	22%	62	25%	
10 to 14	458	17%	34	13%	
15 to 19	249	9%	26	10%	
More than 20	602	22%	67	27%	
Age	**N**	**%**	**N**	**%**	$\chi^2 = 5.704$, 4 d.f. *p* = 0.222
Less than 30	69	3%	6	2%	
30 to 39	306	11%	20	8%	
40 to 49	693	26%	56	22%	
50 to 59	1052	39%	108	43%	
60 or more	567	21%	60	24%	

Note: The comparison is between entire operator population and respondents. Only 500 drivers were surveyed, equating to a response rate of over 50%.

Results

The survey began by asking bus operators about the questions they are asked by riders and how they feel about being asked such questions. For the first, operators ranked each type of rider question as being asked several times per hour, about once per hour, several times per day, about once per day, at least once per week, not very often or almost never. Questions were grouped as those about how to get to a certain location, those about bus arrivals, those about schedules, and those about safety. Table 2 shows the responses to the frequency that operators are asked questions about trip planning, bus arrivals, schedules and safety. Most operators felt trip planning type questions (How do I get downtown? Does this bus go to the University District?) were the most predominant, with 90% responding that they are asked trip planning questions at least once per day. Questions about bus arrival (Where is the #65 bus? How long until the #71 bus?) and schedules (When will we get to Northgate Mall?) were the next most frequent with 74% indicating they are asked bus arrival questions at least once per day and 69% indicating they are asked schedule questions at least once per day. Safety questions (Is this a safe stop at which to wait?) are substantially less frequent with only 3% being asked such questions on a daily basis. However, bus operators who drive frequently at night (10 PM to 6 AM) were more likely to indicate that they are asked questions (Kruskal-Wallis, χ^2=16.56 to 18.52, 1 d.f., p=0.0001 for all), including questions about safety. 12% of Night operators indicated that they are asked questions about safety at least once per day compared to 0% of non-Night operators.

Table 2 – Frequency of which bus operators are asked questions about trip planning, bus arrivals, schedules and safety

	Trip planning questions such as “How do I get to XXX?” or “Does this bus go to XXX?”		Bus arrivals such as “Where is the ### bus?” or “How long until the ### bus?”		Schedules such as “When will I get to YYY?” where YYY is a certain location such as the downtown?		Safety of bus stops or areas of town such as “Is this a safe stop to wait for the next bus?” or “Is route ### safe?”	
Several times per hour	58	23%	29	11%	19	8%	0	0%

About once per hour	34	13%	25	10%	26	10%	0	0%
Several times per day	112	44%	90	36%	68	27%	3	1%
About once per day	25	10%	44	17%	62	25%	6	2%
At least once per week	14	6%	35	14%	33	13%	19	8%
Not very often	7	3%	25	10%	35	14%	77	30%
Almost never	1	0%	3	1%	7	3%	146	58%
No answer	2	1%	2	1%	3	1%	2	1%
Total	**253**	**100%**	**253**	**100%**	**253**	**100%**	**253**	**100%**

In a related free-form question, operators stated what other types of questions they are frequently asked. Many indicated they received fare-related questions (71 operators) such as "What is the cost of the trip?" or "Where does the ride-free zone end?" Others (23 operators) expanded on the schedule question above to point out related questions about the arrival of the last bus, frequencies of buses or weekend or holiday service. Operators also expanded on trip planning type questions that were related to specific local information, such as local destinations (16 operators), stop locations (11 operators) or transfers (14 operators). Questions about the current time were mentioned by 18 operators. Another 21 operators indicated that they are asked about service alert type questions such as "Why are you late?" or "Why has the ### bus not shown up?" Destination alerts were listed by 4 operators ("Can you tell me when we get to XXX?"). Finally, a few operators mentioned questions about future service changes, service planning or routing. Of course, some questions will always remain a part of driving the bus, such as personal questions ("How do you like driving? Where is your accent from?") or question related to passenger comfort ("Can you turn down the heat? Do you have a paper towel?")

As a follow-up question to set the stage for the rest of the survey, operators were asked how they felt about being asked questions. They were given three ideas, with Idea 1 representing a more negative response toward being asked questions, Idea 2 representing a more positive response, and Idea 3 being more neutral toward being asked questions. Prior experience with VSD methods (Kahn 1999) has shown that presenting multiple ideas that participants can select among, rather than just presenting one idea and asking for a reaction to it, leads to richer and more accurate interview data. As shown in Table 3, most operators (66%) are neutral about questions, stating it is a part of their job. Few operators (8%) said they would miss being asked questions. Based on Kruskal-Wallis tests of equality, these feelings about being asked questions were not associated with the frequency of which questions were asked by riders.

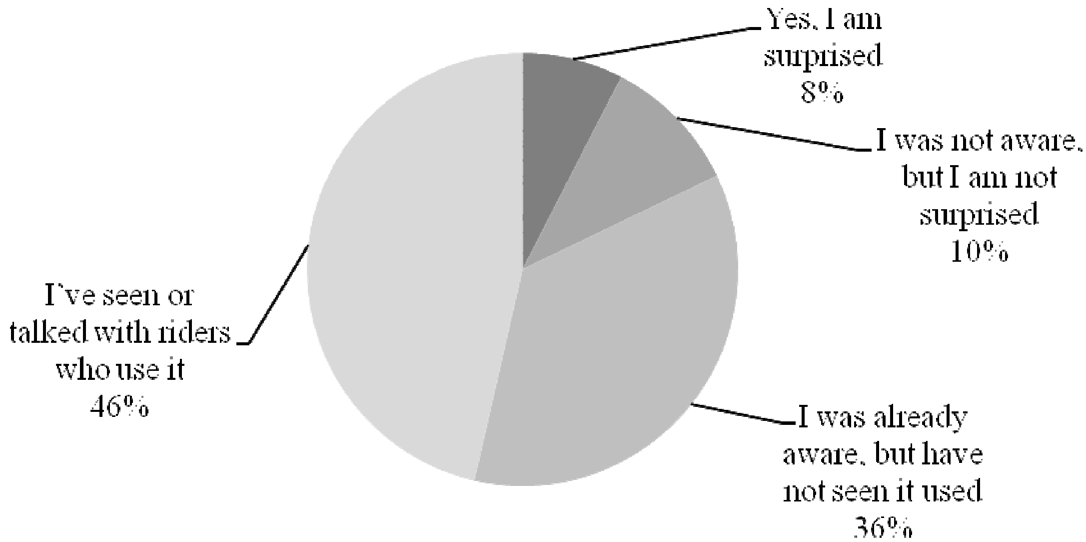
Table 3 – Operators feelings about being asked questions

IDEA 1: Some drivers say it would be great if riders asked fewer questions because they could spend more time focusing on other parts of their job and may be able to speed up bus service.	63	25%
IDEA 2: Other drivers say they enjoy interacting with passengers and would miss the chance to answer questions about taking the bus if people got their information elsewhere.	21	8%
IDEA 3: Other drivers say that answering questions is part of their job and even with new information sources, people will always ask them a lot of questions.	168	66%
No answer	1	0%
Total	253	100%

Existing Rider Information Applications

The next set of questions related to the existing applications that give real-time information in greater Seattle, applications such as OneBusAway, King County Metro's own Tracker application and related programs such as MyBus. In response to being aware of existing applications that are available to provide real-time arrival information, most operators were at least aware that such information is available to the public (82%). Of the 253 respondents, nearly half (46%) of the operators in the survey had seen the tools being used, had spoken with riders who use them or (as indicated in the comments to the question) had used the tools themselves. Results are shown in Figure 1.

Figure 1 – Response to question "Are you surprised to learn that [real-time arrival] information is available to the public?"



In terms of how the operators feel about such information being provided, the response was mostly positive. To gauge this response, operators were asked two questions, one which inquired about their feelings and one which asked them to choose one of three ideas. For the emotion question, operators were asked to check off how they feel from a list of 9 possible feelings, 3 of which were positive ("That's cool", "Relieved" and "Excited"), 3 of which were neutral ("So what?" "Doesn't hurt anyone" and "Uninterested") and 3 of which were negative ("Shocked", "Worried" and "Invades my privacy"). Almost all operators (93%) selected only positive or neutral responses to the information being provided. Only positive emotions were chosen by 67% of the operators. The second question asked operators to choose between three ideas, 1 of which was positive, 1 of which was neutral and 1 of which was negative:

IDEA 1: Some drivers say it's OK that next bus arrival information is available to the public because trying to keep the schedule is part of their job, and riders already know whether or not their bus is on time. (Neutral)

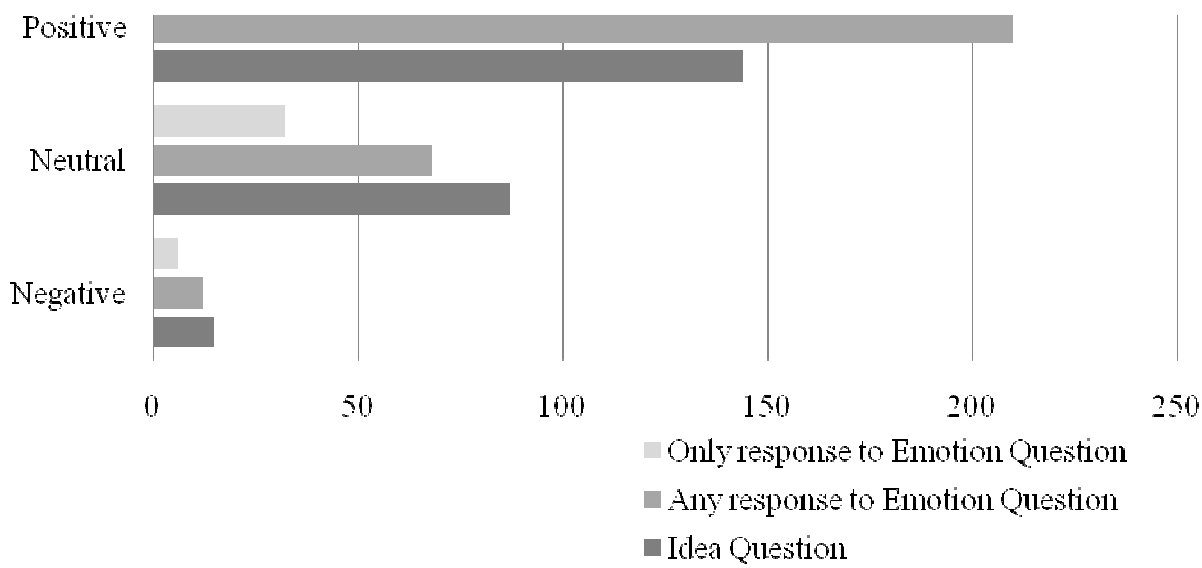
IDEA 2: Other drivers find it troubling that this information is available to the public, because it reflects on how well they do their job and may cause issues with riders or management. (Negative)

IDEA 3: Still other drivers really like having this information available, because it improves the experience for riders, and happier riders make their job easier. (Positive)

Almost all operators (91%) were positive or neutral. The positive idea was chosen by 57% of the operators. Results for responses to both questions are shown in Figure 2. For each feeling (positive, neutral, negative), the first bar shows respondents who chose only that feeling in the emotion question (i.e., only “Cool”, “Relieved” or “Excited” if shown as positive), the second bar shows respondents who chose any emotion associated with that feeling (i.e., “Cool”, “Relieved” and / or “Excited” and possibly also another emotion) and the third bar shows the results from the idea questions. For both questions related to operators’ feelings about real-time information, the response was overwhelmingly positive.

Responses to the two questions about existing real-time information were highly related. For example, among those who selected the positive option (Idea 3) on the idea question, 91% also selected at least one positive response on the emotion question, while among those who selected the negative option (Idea 2) on the idea question, only 40% selected at least one positive emotion. Operators who selected the positive or neutral options (Idea 1 or 3) on the idea question very rarely selected any negative emotions (3%), while 33% of operators who selected the negative idea (Idea 2) also selected at least one negative emotion.

Figure 2 – Responses to questions about how operators feel about real time information



Treating responses to the idea question as an ordinal variable (from negative to positive), responses were positively associated with the number of positive emotions selected (Kendall's tau-b = 0.211, p<0.0005), negatively associated with the number of neutral emotions (tau-b = -0.133, p = 0.031), and negatively associated with the number of negative emotions selected (tau-b = -0.172, p = 0.005)

Operators who were not aware that real-time arrival information was available to the public were more likely to select the negative response to the idea question than operators who were aware (18% vs. 3%, respectively, p=0.002, Fisher's exact test). Similarly, operators who were not aware were more likely to select at least one negative response to the emotion question (13% vs. 3%, p=0.010, Fisher's exact test). The operators who had a negative opinion of providing real-time arrivals were more likely to be the ones who were not aware of the existence of real-time information, especially those who were neither aware of it and were also surprised that it existed.

Future Rider Information Applications

The next set of questions revolved around operator's opinions about types of future applications that could be built. Questions about six general applications were asked throughout the remainder of the survey. Five were in this section and a sixth was in the final section on blind and deaf-blind riders. Although these six applications form only a small portion of the potential applications that could be built to inform transit riders, they were chosen because they represent the six areas that are most likely to affect bus operators.

Each of the applications was investigated to see if operators thought the application should be built or not. The first two applications related to data that the public would input, including physical issues at stops, shelters, or on buses, and opinions about social aspects of bus-riding. These applications could be created so that only the transit agency would see the results, or they could be created so that results would be seen by both the public and the agency. Operators were therefore given two choices within "build it": data open to the public or data seen by the agency only. Operator responses are shown in Tables 4 and 5. In addition, for each question, operators were given the ability to comment as to why they thought an application should or should not be built. These free-form answers allowed further investigation of their responses. This was particularly important in determining if the respondent had any barriers (known in Value Sensitive Design as value dams) that could be identified in opposition to an application. Many comments revolved around the expense of building rider applications in tough economic times. The OneBusAway program is funded independently from the transit agency and so financial matters are not currently relevant as a barrier.

Table 4 - Operator responses to public input applications: "Should an application be developed to...?"

	To identify physical issues at stops, shelters or on buses (graffiti, broken parts, the need for lights, etc)		To give opinions about social aspects related to stops or bus routes (routes in pretty area, friendly people, stops with vagrants, or unsafe at night)	
Build it and open it to the PUBLIC	157	62%	154	61%
Built it to be seen by agency ONLY	66	26%	40	16%
Should NOT be built	24	9%	51	20%
No answer	6	2%	8	3%
Total	**253**	**100%**	**253**	**100%**

The first application, identifying physical stop, shelter and bus issues (graffiti, broken parts, need for lights, etc), was supported by 88% of the operators, with 62% saying it should be seen not only by the agency, but also by the public. Regarding the 9% of operators that thought this was not a good idea, most were concerned with the financial cost of creating such an application, especially if operators and riders already have the ability to report these issues. Only 6 operators responded with comments that could be possible barriers. They were concerned with false reports, the agency's ability to follow-up on reports, or the creation of potential conflicts between operators and riders or operators and management. The comments were overwhelmingly positive, showing support for easier identification of issues and the likelihood that this would create a fairer system through which issues get addressed.

The second application would allow riders to give opinions about social aspects (routes in prettiest parts of town, routes with the friendliest people, stops with many vagrants or drug dealers or routes that feel unsafe at night). This application was supported by a similar number of operators (61%), but far more operators were opposed (20%). Furthermore, the comments identified many possible barriers, such as the possibility that such as application would encourage stereotypes, would be subject to differing and changing opinions and circumstances, would be misused, or would possibly even proliferate negative issues on certain routes.

The next four applications were based on data either currently available at the agency or data that could be available given basic technological advances. All would report information to the public to make transit use easier in their particular situation. These four applications were to see past performance data (on-time performance based on time of day, how full buses typically are, or the likelihood of finding park and ride spots), to be notified about the on-time status, to be notified about capacity aspects of the bus (seats full, bike racks full, wheelchair spaces full) or to allow blind and deaf-blind riders easier access. Results are shown in Table 5.

Table 5 – Operator responses to question: "Should an application be developed to…?"

	To see past performance data (historic on-time, full).		To allow notification about the on-time status of the bus > 10 minutes late.		To allow notification about how full the bus is.		Aid blind and deaf-blind riders.	
Build it	167	66%	191	76%	154	61%	224	89%
Should NOT be built	74	29%	46	18%	90	36%	15	6%
No answer	12	5%	16	6%	9	4%	14	5%
Total	**253**	**100%**	**253**	**100%**	**253**	**100%**	**253**	**100%**

The first application shown in Table 5 would be used to display past performance data to the public. Rather than just real-time information, this application would allow riders to see how frequently buses were early or late, how full buses typically were or the likelihood of finding a park and ride spot, all by the time of day and route for their personal situation. Here, 66% of the bus operators were in favor of such an application and 29% were against it. The reasons for being against such applications mostly revolved around a lack of funds, the variability in the information, or a lack of need on the part of riders. Some operators felt that frequent riders already have this information and infrequent riders could obtain it by asking fellow passengers. One operator was concerned that it might discourage ridership rather than encourage ridership. In addition, many operators were not opposed to the general idea of past performance data, but were concerned about the ramifications. The on-time status in particular brought about concerns with operators being responsible for things that were outside their control (such as traffic or improper scheduling). This concern about the impact of such information on the rider or management opinion of job performance could be considered a barrier for such an application.

The next application in Table 5, which would send e-mail or text-message notification to riders if a bus was unusually late (greater than 10 minutes as an example), was supported by many more operators (76%). Of the 18% who thought the application should not be built, most were concerned about the cost or about the need when existing applications already give the information. Although many potential concerns were identified for future investigation, no barriers to implementation were identified in the responses. In the comments, many operators indicated that a better use of such a notification application would be to provide information about service alerts, indicating why a bus is unusually late (weather, traffic, breakdown, etc). Although the regional transit agencies currently have this service, it is not specifically tailored to individual trips, but is instead sent out for an entire route.

An application notifying riders of a full bus (no standing room), a bus with full bike racks, or a bus with full wheelchair spaces was the least favored application. Only 61% of operators were in favor of such an application. Most operators were concerned that the stop-to-stop rapidly changing conditions would negate the usefulness of such an application. In addition, operators indicated that in their experience, riders would use the full bus anyway because they are more concerned with arrival time than room to sit or stand.

As follow-up to the question about capacity notifications, one way to design this application would be to use passenger counting equipment or sensors for the bike racks or wheelchair spaces. Another way would be to have the operators push a button on their consoles to allow a message to be sent to riders. This could be an inexpensive means to acquire the information, but would be highly dependent on operators themselves. Therefore, operators were asked their reactions to pushing a button for such items. Only 32% of operators felt this was a safe and reasonable task. A full 20% felt it was unsafe and 29% felt it would be safe but unreasonable given the other necessary tasks of driving. Of the remaining, 14% thought that pushing a button could be possible, but only if other elements of driving could be made easier.

In addition, operators were asked how often they would remember to push a button if information was acquired in this fashion. In anticipation of operators believing that they are more likely to remember than most operators, a second question about how often they think a typical operator would remember to push a button was asked. As shown in Table 6, a full quarter (27%) of the operators readily admitted that they would remember less than half of the time and 42% indicated that a typical operator would remember less than half of the time. Less than 5% felt that a typical operator would remember more than 95% of the time, a level of accuracy that could be desired for many applications of this nature.

Table 6 – Percentage of time that operators thought they would remember to push a button to indicate something about the bus

	Themselves		Typical operator	
<50% of the time	67	26.5%	105	41.5%
50 – 75% of the time	60	23.7%	77	30.4%
75 – 95% of the time	54	21.3%	40	15.8%
>95% of the time	54	21.3%	12	4.7%
No answer	18	7.1%	19	7.5%

The most widely supported potential application in the survey was additional tools to help blind and deaf-blind riders. The application was described as allowing “blind and deaf-blind riders to better get around by giving them next bus arrival information and alerting them that their stop was approaching once they were on the bus.” 89% of operators supported such an application, commenting that such tools would not only make bus operators work easier, but would empower blind riders by allowing them to get around without as much assistance from other people. The major concern identified by the 6% of operators who were opposed to the application were that blind riders make up a small portion of the general ridership, making such a tool prohibitively expensive for development. Although this should be considered, it does not represent a barrier for such an application.

In summary, the applications were all well supported by the bus operators. Every one of the applications was supported by more than 60% of the respondents. Operators were most supportive of building apps to aid blind & deaf-blind (89%) and identify physical stop, shelter, & bus issues (88%). Operators were least supportive of building apps to notify about full buses (61%) and see past performance (66%). McNemar tests show that the first two are significantly more popular than the other 4 among operators ($p<.002$ for all tests), and the last 2 are significantly less popular than the other 4 ($p<.006$ for all tests). Male operators tended to be more likely to favor the new applications, however with correction for multiple comparisons, only the physical issues at stops application was significant (Chi-squared, $\chi^2=16.31$, 2 d.f., $p<0.0005$), with men being 11% more likely to favor the application. There was no association between favoring new applications and the number of years of experience or the age of the operator.

In addition to these questions about specific rider information applications, operators were asked what other types of information that should be provided to riders. Most of their answers revolved around service alerts and interruptions, such as informing riders about breakdowns, event reroutes, adverse weather reroutes, severe tie-ups that delay the service, etc. Many other comments were about improvements to the trip planner, either by redoing the existing trip planner, making trip planning tools more widely available or by tying trip planning into real-time information. The third piece of information mentioned was improved and more widely available mapping, including better maps of downtown service, detailed bus stop location maps for high transfer or unusually-located stops, points of interest maps with bus routes, and easier to read route maps. Operators also indicated that automatic stop announcements and clocks on the bus would help riders en-route. One commented about hold notification between buses in to aid transfers. Another commented about providing information about the last scheduled trip on a route. Similar to the responses about questions they received from riders, better information about fare rules and payment details was listed by a few operators. Finally, operators saw the benefit of a modified version of some of the suggested applications, such as public-access to reports about safety security ("use facts rather than opinions") or a website that gives riders tips, rules, etiquette, and safe-use principles.

On-time Status on the bus

The next section of the survey related to real time on-time status of the bus. In the first question, operators were asked how often they think the bus they drive is more than 1 minute early or more than 5 minutes late per week. The results, shown in Table 7, indicate that operators feel they are infrequently early, as should be the case, because there are relatively few reasons to be early. Many more operators indicated that they are frequently more than 5 minutes late, with 70% indicating they are more than 5 minutes late at least once per day. This was particularly true for PM peak hour operators who were significantly more likely to say they are behind schedule (Kruskal-Wallis, χ^2=14.71, 1 d.f., p=0.0001).

Table 7 – Frequency of time that operators indicate their bus is running early or late

	> 1 minute early		> 5 minutes late	
At least once per run	12	4.7%	33	13.0%
Several times per day	14	5.5%	102	40.3%
About once per day	19	7.5%	42	16.6%
A couple times per week	21	8.3%	27	10.7%
About once per week	14	5.5%	20	7.9%
Almost never	164	64.8%	24	9.5%
No answer	9	3.6%	5	2.0%
Total	253	100%	253	100%

As suggested by some operators in the earlier interviews, another important class of tool would be for operators rather than riders. For example, a simple gadget that gave the on-time status of their bus (x minutes early or late) could be placed on the console and give information based on the bus location and schedule. Some transit systems already have such indications inside the bus, but at the time of the survey, King County Metro did not. To determine if operators agreed with this suggestion, they were asked how hard or easy it is to know if they were on schedule. Most operators (84%) indicate that it is easy to know if they are ahead of or behind schedule and another 12% said that sometimes it is easy and sometimes it is hard. No operators indicated that is hard to know if they are on schedule.

As a follow-up, operators were asked if there was better information for operators about running ahead or behind schedule via such a device, would they be ahead or behind less often. Only 12% thought that such a device would make a difference. Of the 79% that said it would not improve on-time performance, most commented that when they were late, they already are doing everything they can to get back on schedule. Knowing if they are early is simply a matter of looking at their runcard frequently enough.

Discussion

In the survey, bus operators indicated that they are asked a lot of questions, including trip planning, bus arrivals, schedule, fare-related and service alert type questions. Taking the time to answer these questions can impact service speed, reliability and even safety. Trip planning, bus arrival and schedule questions were asked of the majority of operators at least once per day, often multiple times per hour. Only a small percentage of operators (8%) indicated that they would miss this form of customer interaction. Therefore, applications that help riders get this information elsewhere may have a positive impact on transit operations.

Bus operators in greater Seattle were for the most part at least aware that real-time information is available to the public (82%). However, the 18% of operators who were not aware, including 8% who were surprised that tools exist, indicate that further attention should be paid to increasing awareness about such tools. In terms of how the operators feel about such information being provided, the response was mostly positive. Almost all operators (93% and

91% on two separate questions) were positive or neutral to real-time information being provided. The operators who had a negative opinion of providing real-time arrivals were more likely to be the ones who were not aware of the existence of real-time information, especially those who were neither aware of it and were also surprised that it existed. This gives some indication that operators may at first be opposed to the notion of providing real-time information to riders, but over time may see that more benefit than harm comes from doing so. Agencies should be aware of this initial pushback and use results such as these as evidence that real-time information has a positive impact on operators.

Six potential transit information applications were chosen as a range of applications that would be most likely to affect bus operators. Each of the applications was tested to see if operators thought the application should be built or not. In addition, operator comments allowed for the association of negative opinions with any potential barriers to implementation (also called value dams). All applications were supported by the majority of operators who responded to the survey, with at least 60% of the bus operators favoring each of the applications.

The two most widely supported potential applications in the survey were additional tools to help blind and deaf-blind riders (89% of bus operators favored) and an application would aid riders in identifying physical stop, shelter and bus issues such as graffiti, broken parts or a need for lights (88% of bus operators). Both of these applications had relatively few potential barriers for the bus operators. Operators stated that the blind rider tool would not only make their work easier, but would empower blind riders by allowing them to get around without as much assistance from other people. Therefore, researchers at the University of Washington have further pursued tools for blind and deaf-blind riders (Azenkot et al. 2011). The second tool would allow agencies to more easily account for issues in the system and help them be more responsive to riders' needs. These types of applications are beginning to be pursued by developers through civic app development competitions and should be encouraged by transit agencies and local governments.

Bus operators also supported (76%) an application to send e-mail or text-message notification to riders if a bus was unusually late (greater than 10 minutes as an example). In the related comments, operators indicated that service alert notifications, showing why a bus is unusually late (weather, traffic, breakdown, etc) would be a critical component of such an application. Although many transit agencies currently have this service, it is not specifically tailored to individual trips, but is instead sent out for an entire route or service. This application had no major barriers. Therefore, the work of integrating service alerts into applications such as OneBusAway has been pursued further (Watkins, et al. 2012).

The three other applications tested had more potential barriers. An application that would allow riders to give opinions about social aspects (routes in prettiest parts of town, routes with the friendliest people, stops with many vagrants or drug dealers or routes that feel unsafe at night) brought up valid concerns about the negative impact on routes and ridership. An application that would display past performance data, such as typical on-time status could have negative implications for the bus operator's relationship with riders or management even if performance was outside their control. Finally, an application identifying a full bus (no standing room), a bus with full bike racks or a bus with full wheelchair spaces was the least favored application (61% in favor). This lack of enthusiasm amongst the operators pairs with the difficulty of implementing such an application. Agencies and other outside developers should use caution when considering tools that would have substantial impact on indirect stakeholders including bus operators and neighborhood residents.

Future Research

It is important to note that the findings here are from one single agency and operator attitude toward technology deployment may be impacted by the ongoing relationships between labor and management. Similar research should be conducted with other agencies as transit rider information tools are pursued.

In addition, bus operators, while important indirect stakeholders, are only one potential group impacted by these tools. Research about other indirect stakeholders, such as transit service planners and transit agency telephone agents, should be included in the process of developing any transit information tool that may affect them. The Value Sensitive Design process gives a principled means of suggesting which indirect stakeholders should be consulted.

Finally, this is only one piece of an entire body of research in the use of enhanced rider information to improve public transportation. Research should be conducted as to the barriers that commuters face to inform application developers of other potential tools. Additional research is needed to identify the impacts of various tools on perception of transit and travel behavior. The implementation of tools must take into account the transit agency role in providing data in an equitable and cost-effective manner. Finally, as the tools and applications are operated, questions of the importance of data currency and data quality must continue to be addressed.

Conclusion

Although bus operators are a key to the transit rider experience, they are infrequently directly consulted when planning and implementing new transit initiatives. Improved transit rider information has been identified as a critical component to building ridership, and with the opening of more transit data to developers, more applications are being developed for rider use. However, to date, bus operator perspectives about real-time information and other transit information tools have never been gathered. In this study, operator views and values about the implications of existing real-time arrival data and possible future rider information tools were investigated through interviews and surveys. Surveying operators about such tools allows for tools that operators believe in to be prioritized over those they are concerned about. This process of identifying the barriers and support for implementation (called value dams and flows in Value Sensitive Design) has been successful in multiple information technology applications.

This research gives a better understanding of the impact of rider information tools on bus operators, including their values, harms and benefits. This study was performed to aid application developers in deciding the next transit tools to develop and identify barriers (or value dams) to be cognizant of in future design. In summary, applications that are beneficial for riders without being detrimental to bus operators include real-time arrivals; blind and deaf-blind rider tools; applications to identify physical stop, shelter and bus issues; integration of service alerts and rider notification; and greater rider information on trip planning, bus arrivals and schedule planning. Other applications should be pursued only with careful consideration of impact to indirect stakeholders.

At the conclusion of the survey, operators were given the opportunity to comment about the survey and OneBusAway program in general. The overwhelming response was to thank us for giving them the opportunity to take the survey. Operators appreciated the chance to have their voices heard on these issues. Relatively few surveys have been conducted to ask operators how they feel about transit rider information. The results have already served to inform the OneBusAway team about operator values. Hopefully the results can also be used by other transit agencies and developers looking to work on innovative tools to help increase transit rider satisfaction and transit ridership.

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