Passengers' Perception of and Behavioral Adaptation to Unreliability in Public Transportation

Andre Carrel, Anne Halvorsen, Joan L. Walker

Civil and Environmental Engineering | University of California, Berkeley

Introduction and Motivation

What is Reliability?

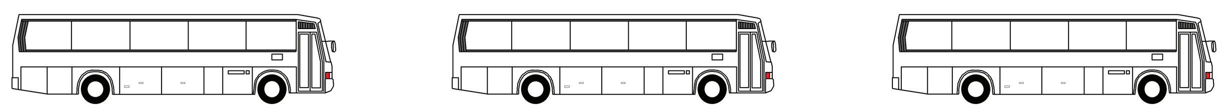
- Commonly associated with travel time variability, but other considerations as well: schedule adherence, arrival punctuality, probability of finding a seat, or the chance of mechanical problems
- More comprehensive view of reliability involves repeatability and predictability, and adherence to some "base line."
- Unreliability is dependent on what a passenger perceives as normal; unreliability may be predictable!

How Does Reliability Affect Ridership?

- Previous surveys have been done on the importance of reliability aspects
  - But had no behavioral component (link to ridership)
- Current behavioral models are based on travel time distributions
  - Assume travelers understand statistics
  - Assume rational decisions
  - But are passengers truly this knowledgeable?
- Our approach: Exploratory survey to investigate passengers' *long-term* adaptation to transit unreliability
  - Learn what strategies passengers use to deal with unreliability
  - Understand influence of prior experiences with unreliability on adaptation strategies
  - Determine if there is a link between previous experiences and people's perceptions of reliability
  - Try to show that passengers care about more than just when the bus arrives: type of delay and when it occurs are also important

Research Approach

- An online survey was distributed to current and former users of the San Francisco Municipal Transit Authority (MUNI)
- Two surveys were created: for current MUNI users and for ex-MUNI users. They contained the following parts:
  - Frequency of use and knowledge of the system
  - Description of a common trip
  - Experiences with each of 26 types of unreliability incidents
    - Users were asked the last time they encountered incident (proxy for frequency)
    - Nonusers were asked for an approximate frequency of occurrence, and whether the incident contributed to their cessation of use
  - 27 questions regarding behavioral adaptation to cope with unreliability
  - How they plan trips (optional)
  - Socio-Demographics
- 123 complete responses from users and 15 from non-users were received



Contact Information:

Andre Carrel*
Dept. of Civil Engineering
University of California, Berkeley
109 McLaughlin Hall, Berkeley, CA 94720
Tel: (510) 642-3585
acarrel@berkeley.edu

Anne Halvorsen
Dept. of Civil Engineering
University of California, Berkeley
annehalvorsen@berkeley.edu

Joan L. Walker
Dept. of Civil Engineering
University of California, Berkeley
joanwalker@berkeley.edu

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Figure 1

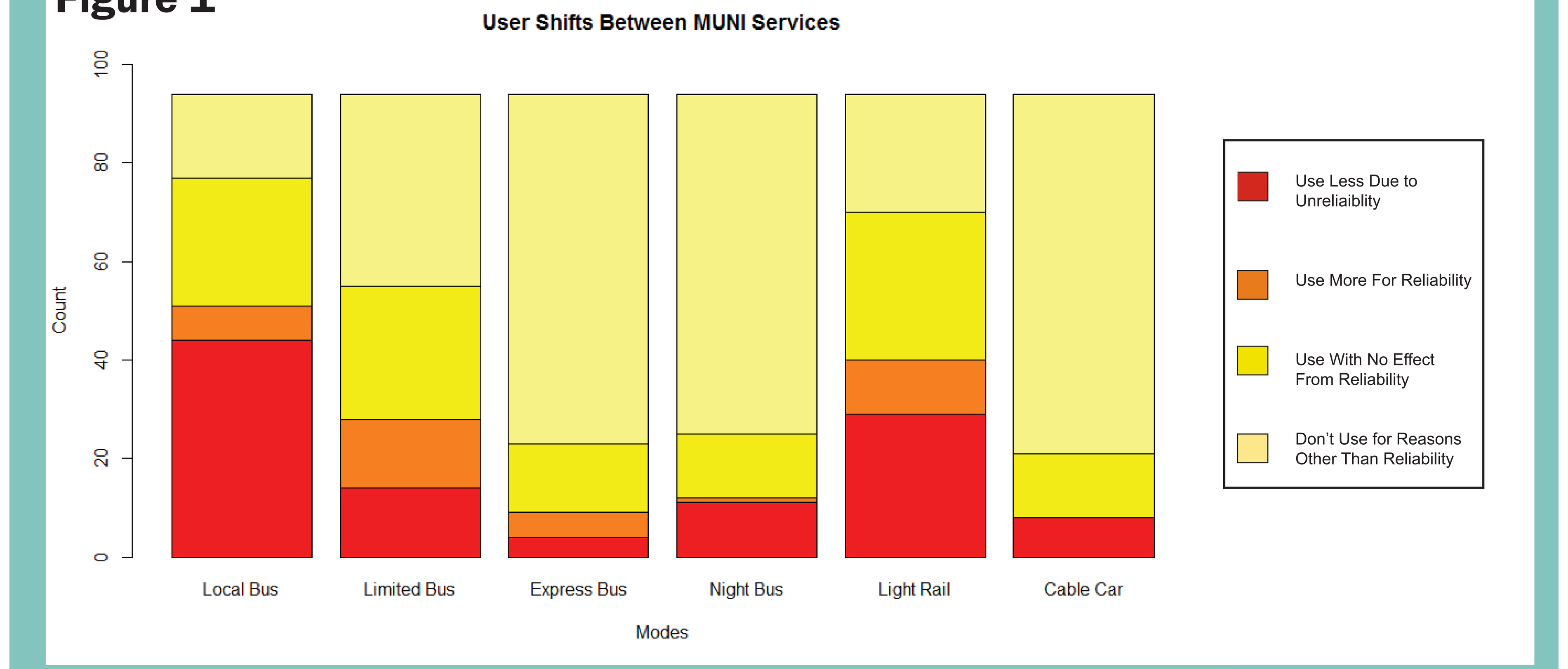
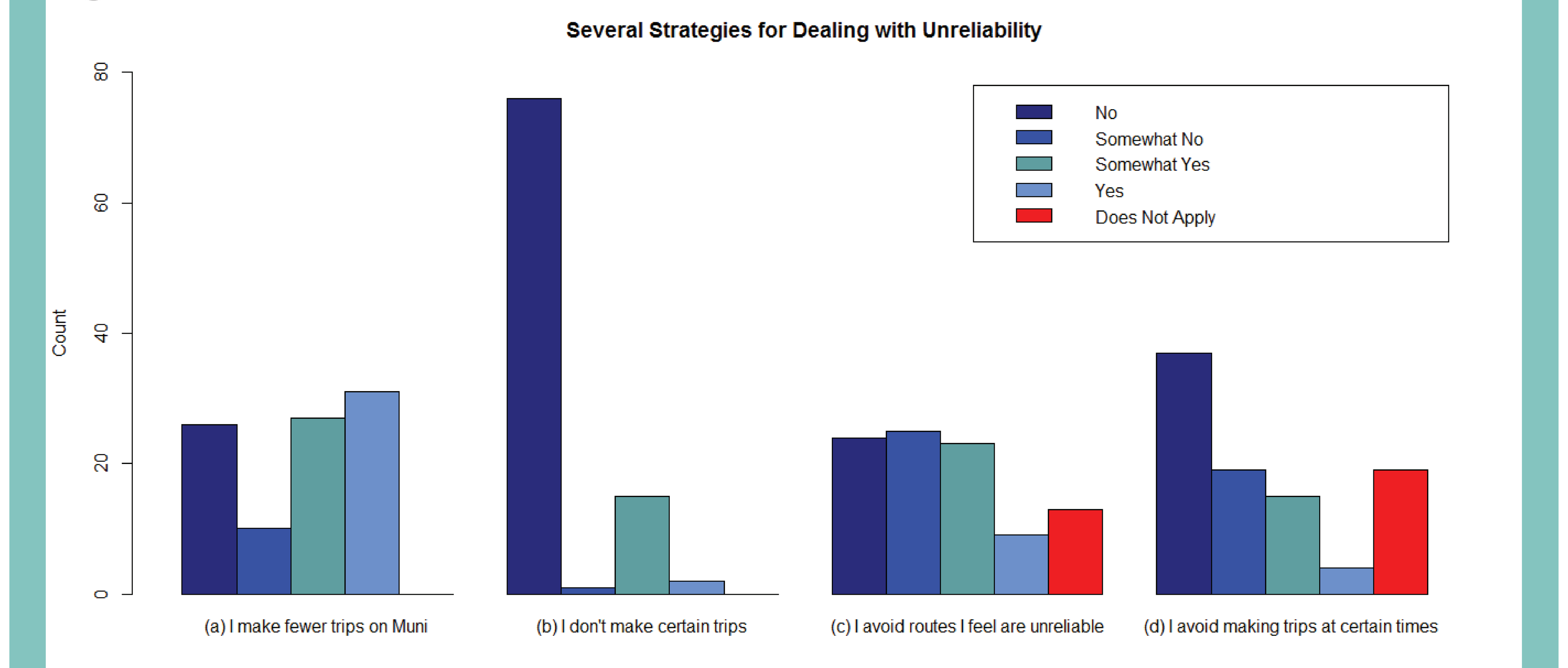


Figure 2



Survey Results

- **Socio-demographics:** Because the sample population was affiliated with UCSF, it does not entirely mirror San Francisco's population: they were younger, more educated, and more female. However, many answered that they did have other modes of transportation available to them (e.g. bikes, cars, or car sharing memberships).
- **Importance of Reliability:** Riders were asked to describe how important several metrics of unreliability were for a chosen trip. For both work and non-work trips:
  - Most Important= frequent, consistent service (e.g. can make connection, can walk up to stop leave stop within 10 min)
    - "Frequent" Service = 10.2 min intervals (see figure 3)
  - Least Important= comfort (e.g. crowding, ability to find a seat)
- **Experiences of Unreliability:** Incidents were reported as being seen less than once per month on average to almost never (on a scale of 1=once/week to 6=never). The full rankings, controlled for frequency of use, can be seen in table 1 above.
- **Behavioral Adaptation:** Over 50% of respondents reported either having a "strategy" for dealing with unreliability or having reduced their use of the service, and 82% report an adaptation. Some of these strategies are described by figures 1 and 2, above.
- **Trip Planning:** Respondents were very likely to know how long their trip should take (95%) and when it should depart (88%). The use of *real-time information* was also common: 81% refer to it rather than a schedule and 57% check it before going to a stop.
- **Non-User Results:** Unreliable service and services cuts were both given as reasons for leaving MUNI by a large proportion of the group (50% and 40% respectively). They also were quite different demographically than users, being older, more likely to live outside SF, and more likely to have children, so lifestyle changes may also play a part in their mode shifts.

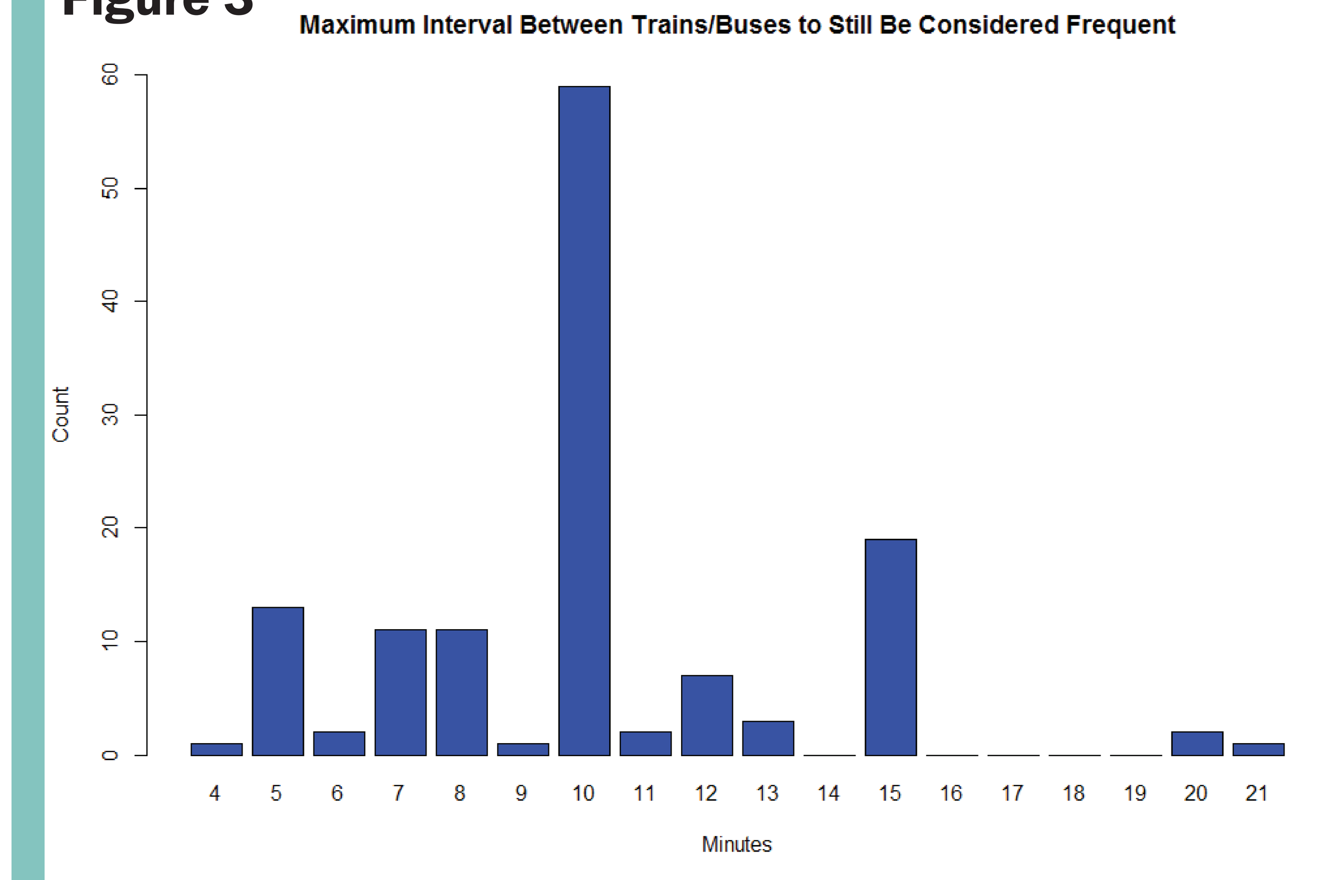
Table 1: Frequency of Unreliability Incidents

Average Frequency	Rank	Statement	Mean
More Than Once per Month (x <3)	1	Had to wait at least twice a long as the scheduled interval between vehicles on a frequent route	2.57
	2	Real-time data showed a bus was arriving but it did not	2.97
More Than Once Every 6 Months (x <4)	3	A bus unexpectedly arrived that was not shown by real-time data	3.17
	4	Delayed by on-street traffic	3.21
	5	Delayed by unseen problem further down the line	3.22
	6	Missed bus because real-time data was incorrect	3.47
	7	Delayed because other MUNI vehicles blocked bus	3.47
	8	Ran up to top in the last moment but the bus pulled away right in front of me	3.50
	9	Delayed due to a mechanical problem, on-board emergency, or similar problem	3.56
	10	Had to wait at least 20 min. past the expected departure time of an infrequent route	3.84
	11	Bus stopped but was too crowded to get on	3.89
	12	Had to wait at least twice the scheduled interval between vehicles	3.95
More Than Once per Year (x <5)	13	Bus did not stop because it was too full	4.05
	14	Bus delayed for a reason not mentioned elsewhere	4.21
	15	Bus turned around before destination	4.35
	16	Had to wait at least 20 min. past the expected departure time when transferring to an infrequent route	4.35
	17	Missed a scheduled connection transferring to a route with an interval greater than 10 min	4.43
	18	Bus stuck at the entrance to or exit from a tunnel	4.50
	19	Bus delayed by fare inspection	4.64
	20	Had to wait because route shown by real-time data was not the one that actually arrived	4.77
Less Than Once Per Year (x >5)	21	Bus did not stop at my stop even though I requested it to	5.01
	22	Bus did not stop because the driver did not see me	5.04
	23	Bus was switched to a different route while riding and didn't serve intended stop	5.06
	24	Bus didn't serve stop because of a change in routing	5.22
	25	Missed the last bus of the day because bus was not running according to schedule	5.32
	26	Bus's bike rack was full	5.89

Table 2: Model Estimation Results

Model Specific Parameters	Estimated Coefficient, β_i	p-value
Alternate Specific Constants		
ASC reduce (reduction of transit use)	-2.36	0
ASC not reduce (no reduction of transit use)	0	fixed
Parameters Specific to Ordinal Logit		
τ_1	-0.61	0
τ_2	0	fixed
τ_3	1.55	0
Explanatory Variables in $\Sigma\beta_i x_i$ (eqn. 1)	Estimated Coefficient, β_i	p-value
Mode Access		
Own a Car	0.21	0.67
Own a Bike	0.17	0.74
Decision-maker Characteristics		
Have a phone with a data plan	1.24	0.01
Live in a neighborhood close to UCSF	0.39	0.4
Household budget per person	0.23	0.15
Used MUNI for less than 1 year	-0.83	0.16
*Unreliability experiences for than once/month (except *)*		
Delayed on-board due to other transit vehicles backed up or problems on the transit route downstream	1.08	0.07
Experienced long wait/gap at transfer stop	0.57	0.23
Missed departure due to wrong real time information*	0.56	0.34
Unable to board or denied boarding due to crowding (left behind)	0.43	0.39
Delayed on-board due to emergency, mechanical failure, etc.	0.35	0.46
Experienced long wait/gap at access point	0.28	0.57
Came running to the stop but the bus/train pulled away	0.06	0.89
Delayed on-board due to traffic	-0.04	0.94

Figure 3



Mean: 10.2 minutes
Median: 10 minutes
Standard Deviation: 3.26 minutes

Logit Model and Results

- Ordinal Logit Model used to find relationship between unreliability experiences and decrease in MUNI use:

$$U_{notreduce} = ASC_{notreduce} + \varepsilon_{notreduce}$$
$$U_{reduce} = ASC_{reduce} + \Sigma\beta_i x_i + \varepsilon_{notreduce}$$
$$\text{with } \Sigma\beta_i x_i = \beta_{auto}x_{auto} + \beta_{recent}x_{recent} + \beta_{traffic}x_{traffic} + \ldots$$

- Dependent Statement: "I make fewer trips on MUNI due to unreliability and use other modes instead."
- Explanatory Variables: frequency of negative events, socio-demographics
- Full results are in table 2, to the left. Some key points:
  - Socio-demographics are insignificant, as are auto and bike access
  - Living close to work and owning a smartphone with dataplan (so easier access to real-time info) are significant
  - The incidents that are most significant can be perceived as the agency's fault (e.g. delay from backed up transit vehicles)
  - Where a delay occurs seems to matter: on board delays considered worse than those at a stop, and transfer delays more important than delays at access points
  - Wrong real-time information only important when it occurs more than once per week

Recommendations

- For Operations control:
  - May be preferable to cancel trips or hold empty vehicles rather than hold full buses
  - Communication is key, especially when delays are not agency's fault.
- For Operations planning:
  - Be aware of the importance of wait time at transfers vs. origin stops, planners should attempt to minimize transfer wait times ("guaranteed connections" or vehicles to fill gaps)
  - Crowding seems ok, but not being left behind
  - Passengers seem to prefer small, high-frequency vehicles over larger, low-frequency vehicles, even if they may encounter some crowding
- Use of real-time information instead of timetable
  - Line between schedule delays and delays due to unreliability is blurring for riders