# Measuring User Acceptance of and Willingness-to-pay for CVI Technology

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## Introduction

Connected vehicles (CVs) are equipped with on-board technologies to communicate wirelessly with each other (V2V), infrastructure (V2I), and other mobility means (V2X). Altogether they are referred to as Connected Vehicle/Infrastructure (CVI). The potential safety impacts of CVs stand out among many benefits. A full implementation of CVI would reduce 81% of target vehicle crashes involving unimpaired drivers. A reduction in crashes and non-recurring congestion may substantially improve the mobility of people and goods.

On February 3, 2014, the National Highway Traffic Safety Administration (NHTSA) of the U.S. Department of Transportation (USDOT) announced that it will begin taking steps to enable V2V communication technology for light vehicles. And, the Federal Highway Administration (FHWA) plans to complete deployment guidelines this year. Assuming every step is taken on schedule, it may take about 6 to 18 years to reach 50% deployment rate and 15 to 25 years to reach 80%.

Public policies are supposed to be preceded by the identification of public needs, because the most important goal of public policy is to allocate limited resources among competing potential needs to achieve societal goals. That being said, the current policy action on CVI deployment lacks the identification of public needs: acceptance, preference, and willingness-to-pay (WTP). Several studies that measured drivers' acceptance of and WTP for CV technologies employed a direct question method that does not simulate consumers' choice behaviors in the market.

***This research identifies drivers' preferences and WTP for CV technologies with the consideration of socioeconomic attributes, innovativeness, prices, and budget.***

***The adaptive choice-based conjoint (ACBC) analysis*** was carried out.

## Research Objectives

- To understand drivers' preference structures based on the survey of drivers
- To analyze drivers' preferences of CVI technologies by socioeconomic attributes, innovativeness, prices, and budget
- To identify preferred sets of CV technologies and WTP by socioeconomic attributes, innovativeness, prices, and budget
- To provide policy suggestions

## Adaptive Choice-based Conjoint Survey Design

The ACBC analysis is the newest member of a family of conjoint analysis and a stated-preference method that mimics consumers' choice behavior to identify their preference structures. In particular, the ACBC analysis is appropriate for estimating preferences and WTP for new products or products not yet in the market. Despite the complexity and a long survey completion time, ACBC surveys are considered more engaging and yield better quality of data than conventional choice-based conjoint surveys.

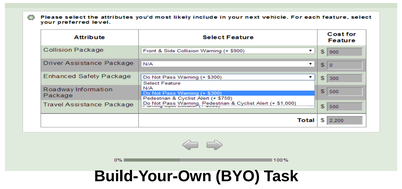
The survey was developed using Sawtooth Software's SSI Web software, commercial software specializing in conjoint analysis and market simulation.

## ACBC Structure

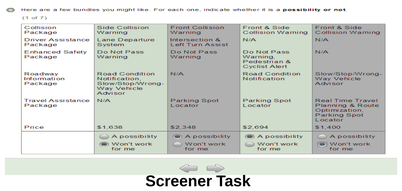
Build-your-own (BYO) task is a basis for the ACBC survey to obtain each participant's initial preference for alternatives. A participant was first provided with descriptions and illustrations of the CV technology features. Then, the participant was asked to select the level of each attribute that he/she would prefer. The attribute levels had corresponding prices estimated based on an extensive technology scan.

Participants then moved on to the screener section. Four CV technology bundles with prices were presented at each screener page. Over a series of the screeners, respondents had to decide bundles that were "Unacceptable" or "Must Have." Then, the information collected from this section became input for the next section, the choice tournament section.

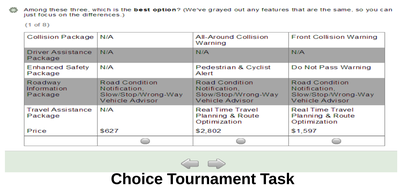
During the choice tournaments, technology bundles tailored for each respondent were presented, three bundles at a time. Bundles identified as "Possibilities" during the screener section were carried forward to the choice tournament. The winning concept from each round moved on to subsequent tournaments and the choice tournament proceeded until the most preferred bundle (the final winner) was determined.




**Build-Your-Own (BYO) Task**




**Screener Task**




**Choice Tournament Task**

## Data Collection

- Draft survey review by technical advisory committee of the study
- Pilot study on small group (~ 50 people)
- Survey posted online from *September 26, 2013*, to *April 16, 2014*
- Total participants: 1,432
- Participants with complete surveys: 611 (42.7%)
- Useable surveys after data cleaning: 529 (36.9%)

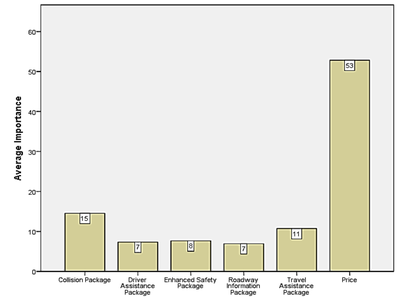
| Demographic Characteristics | | Count | Percent |
|---|---|---|---|
| Gender | Male | 271 | 51.2% |
| | Female | 258 | 48.8% |
| Age | Younger than 30 | 113 | 21.4% |
| | 30-39 | 114 | 21.6% |
| | 40-49 | 121 | 22.9% |
| | 50-59 | 113 | 21.4% |
| | 60 and older | 68 | 12.9% |
| Race/ethnicity | White (non Hispanic) | 345 | 65.6% |
| | Hispanic | 27 | 5.1% |
| | Black or African American | 91 | 17.3% |
| | Asian | 31 | 5.9% |
| | American Indian or Alaska Native | 9 | 1.7% |
| | Native Hawaiian or other Pacific Islander | 3 | 0.6% |
| | Other | 20 | 3.8% |
| Education | Associate degree and lower | 202 | 38.5% |
| | Bachelor's degree | 167 | 31.9% |
| | Master's degree | 102 | 19.5% |
| | Doctoral or postdoctoral degree | 53 | 10.1% |
| Household annual income | Less than 50K | 186 | 36.1% |
| | 50K-100K | 167 | 32.4% |
| | More than 100K | 162 | 31.5% |

## Analysis & Findings

Participants prefer to have some CV technologies; the "No package" level of each attribute received the lowest utilities, while the most comprehensive packages received the highest utilities for all attributes. Despite a high acceptance, their preferences and potential purchase decisions are likely to be constrained by price levels. As package prices go up, utilities drop sharply, indicating a high sensitive to the changes in prices.

| Attributes | Levels | CV Technologies | Total |
|---|---|---|---|
| Collision Package | 1 | No collision package | -39.84 |
| | 2 | Front collision warning | -.93 |
| | 3 | Side collision warning | -8.64 |
| | 4 | Front & side collision warning | 11.73 |
| | 5 | All collision package | 37.68 |
| Driver Assistance Package | 1 | No driver assistance package | -14.53 |
| | 2 | Lane departure system | 7.12 |
| | 3 | Intersection & left turn assist | -3.72 |
| | 4 | All driver assistance package | 11.13 |
| Enhanced Safety Package | 1 | No enhanced safety package | -16.27 |
| | 2 | Do not pass warning | -1.87 |
| | 3 | Pedestrian & cyclist alert | 4.33 |
| | 4 | All enhanced safety package | 13.81 |
| Roadway Information Package | 1 | No roadway information package | -11.60 |
| | 2 | Road condition notification | 5.56 |
| | 3 | Slow/stop/wrong-way vehicle advisor | -5.76 |
| | 4 | All roadway information package | 11.81 |
| Travel Assistance Package | 1 | No travel assistance package | -10.91 |
| | 2 | Real time travel planning & route | 7.93 |
| | 3 | Parking spot locator | -9.85 |
| | 4 | All travel assistance package | 12.83 |
| Summed Price | | Utility for Price: $0 | 132.54 |
| | | Utility for Price: $1398 | 43.97 |
| | | Utility for Price: $2520 | 3.89 |
| | | Utility for Price: $3727 | -53.51 |
| | | Utility for Price: $5850 | -126.89 |
| Mean Utility | | | 97.38 |

The comparison of the average importance score of each attribute indicates that price would be the main factor in purchasing decisions. Of CV technology attributes, "Collision package" has the highest importance score. Like past studies, safety benefits are most appealing to drivers.

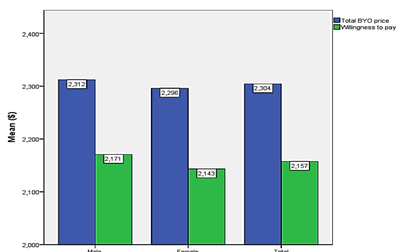



**Average Importance Scores of Attributes**

The WTP estimated by the ACBC analysis illustrates the irrationality of direct question-based methods employed in past CV studies. The statistically significant difference between BYO and WTP exemplifies that ***the ACBC survey mimics real purchasing behavior reasonably*** so that participants make purchasing decisions by contemplating trade-offs of alternatives.

It was found that ***drivers between 40 and 49 years old, African-Americans, those with less than bachelor's degree, and a higher budget for vehicle purchase*** are positively related to WTP.

The level of ***CV knowledge and individuals' innovativeness*** are also strongly associated with WTP.




**Mean Build-Your-Own and Willingness-To-Pay**

## Next Steps

- Identifying potential interactions of variables
- Estimating the choice behaviors
- Identifying preferred bundles by socioeconomic characteristics