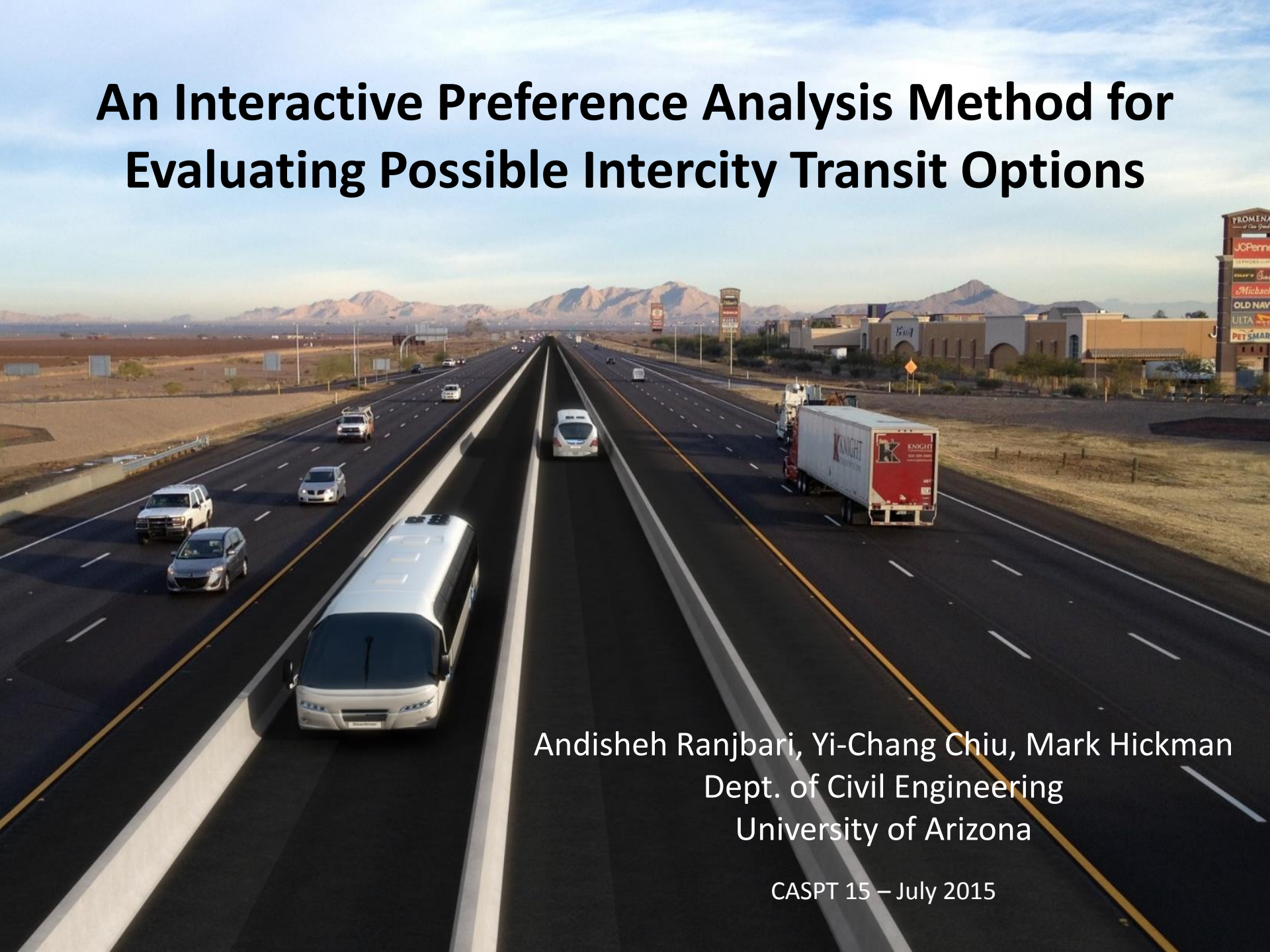
An Interactive Preference Analysis Method for Evaluating Possible Intercity Transit Options



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Future of Intercity Travel

- Expanding urban areas
- Population growth
- Regional economic development
- Cities growing socially and economically interconnected

Severe traffic congestion

on intercity freeway corridors

Intercity Public Transit

Rail

- High capital cost
- Long implementation
- Overestimated ridership

Bus

- A cost-saving option
- Easy to implement
- More sustainable
- Successful experiences of curbside bus industry

Urban Access vs. Intercity Mobility

High Speed Bus Transit

- ✓Tire-based mode
- ✓Low-profile electric-powered transit vehicle
- ✓High Speed of up to 150 mph on a dedicated traffic lane
- ✓Higher accessibility (compared to traditional trunk-line systems)

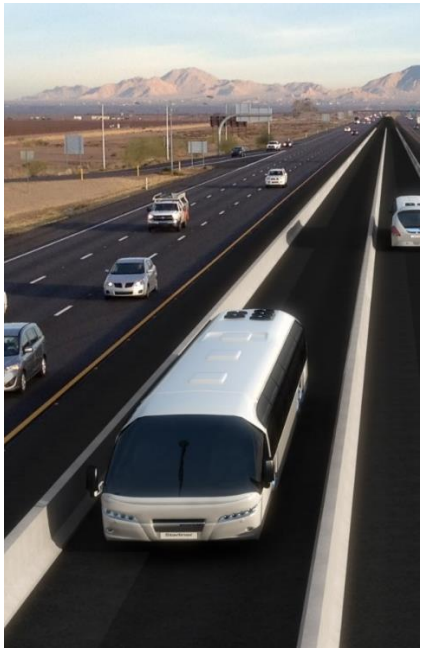
The first high-speed bus vehicle: “Superbus”

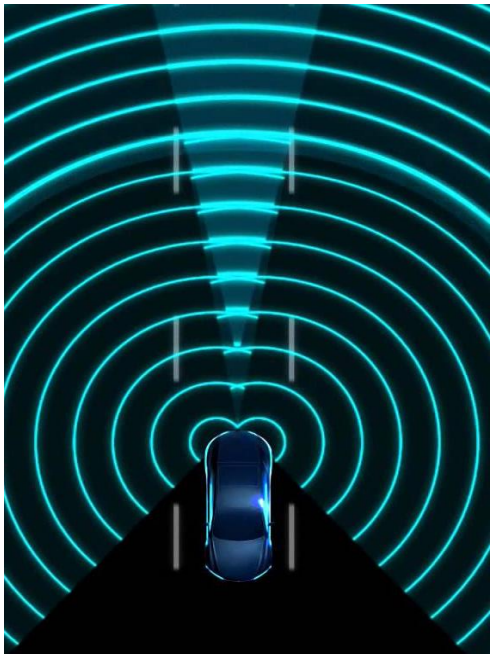
- Designed and built by Ferrari and TU Delft in Netherlands in 2011
- Field operated in Europe, Dubai, and Abu Dhabi 2012-2013

Dedicated traffic lane built on or adjacent to existing intercity freeways

Semi-Autonomous Navigation

- “Auto-pilot” mode on the dedicated traffic lane

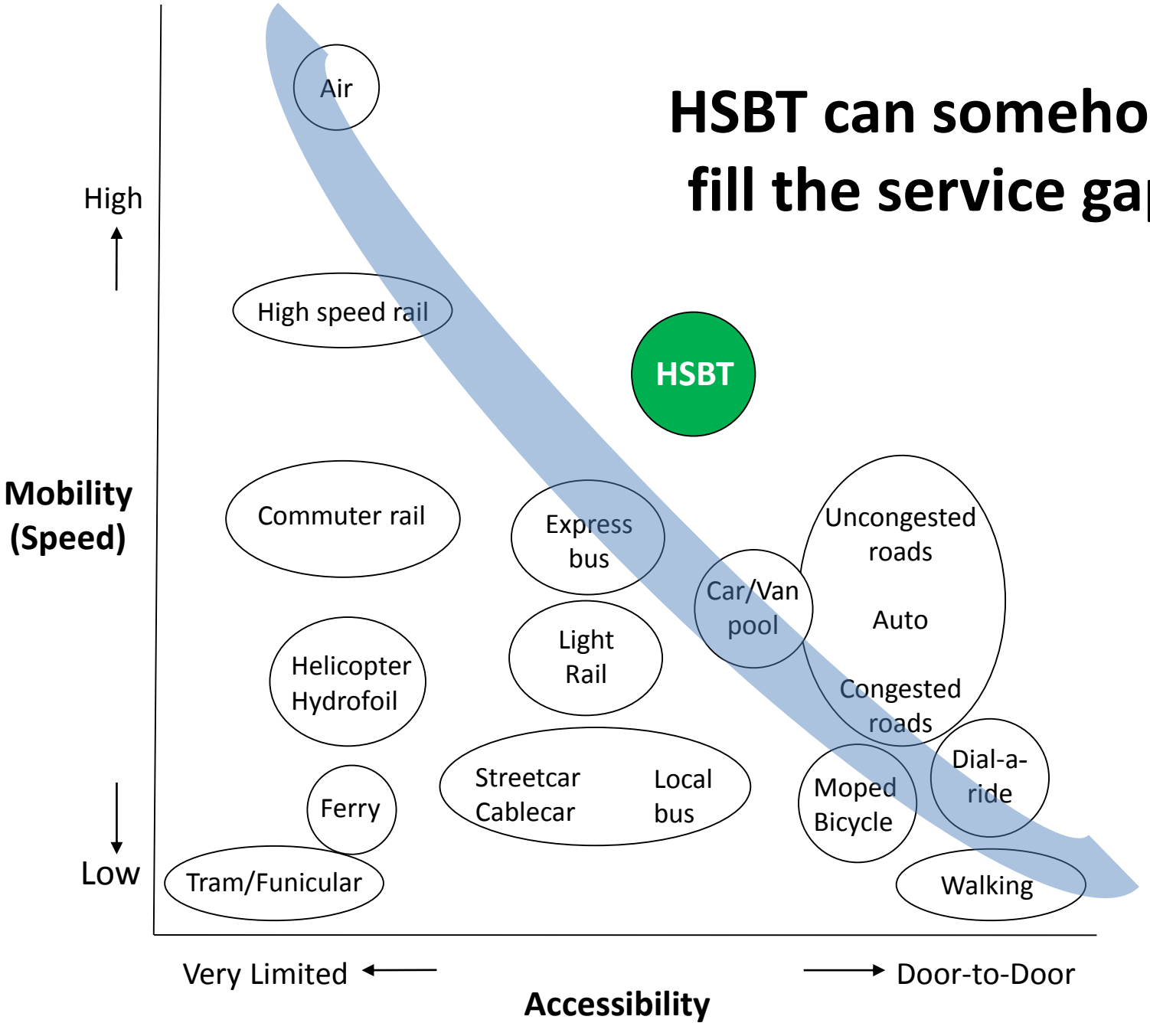




- Driver control in the urban area

Multiple Terminals in the metropolitan area

HSBT can somehow fill the service gap



1. Feasibility and potential consumer market of “High Speed Bus Transit”?

2. Significant factors influencing people’s choice of intercity travel mode?

The Study Corridor

The intercity corridor between metropolitan areas of Tucson and Phoenix in Arizona, US

- 120 miles
- Primary driver of Arizona's economy
- The two cities growing increasingly interconnected
- Increasing traffic congestion problems particularly on Interstate 10

The Study Corridor

The current viable modes:

Driving

Demand-responsive service (Arizona Shuttle)

Regular bus (Greyhound)

The possible modes:

Intercity passenger rail

HSBT (High Speed Bus Transit)

Data Collection

Stated Preference (SP) Method

Forecasting individuals' responses/attitudes in hypothetical contexts

- Alternatives are defined in terms of combinations of varying levels of attributes.
- Respondents are asked to state their preference in the hypothetical context

Data Collection

Questionnaire Design

- ✓ Interactive SP survey
- ✓ Respondent-specific attribute values are estimated in a real-time manner, customized to the respondents' individual information
- ✓ Other attribute values (e.g. headways, shuttle or regular bus fares) are either fixed or generated randomly within a specified range
- ✓ The generated choice set will reflect each individual's travel context more accurately

Data Collection

- Personal and Trip-related Information

Respondents are asked to conceptualize their last trip between the two cities.

- Choice-set table

Alternatives' attribute values will be calculated for the complete door-to-door trip and are customized to each individual's travel context.

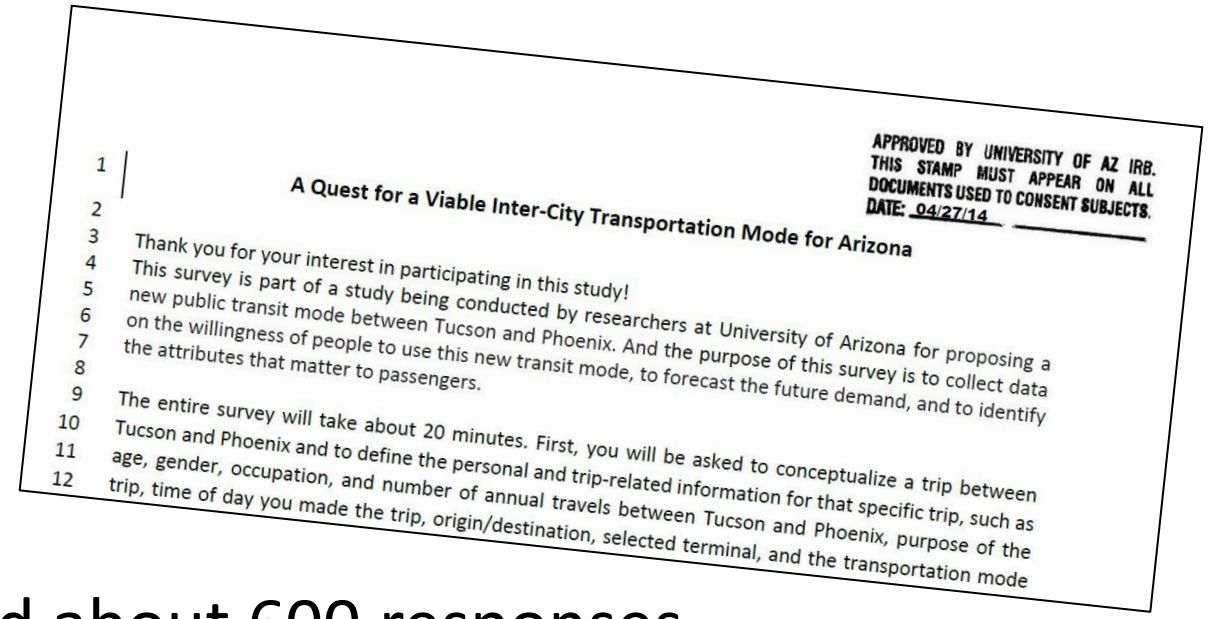
Choice	Mode	Total Cost ($)	Total travel time from home to final destination (min)	Service Interval (min)
	HSB	66	85	20
	Rail	42	124	50
	reyhound	11	159	180
	Shuttle	32	127	60
	Drive	21	139	—

HSB
Rail
Greyhound
Shuttle
Drive

Data Collection

Survey Administration

- Residents of Tucson and Phoenix
- Interview-based
- Oct 2014 – Feb 2015



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DATE: 04/27/14

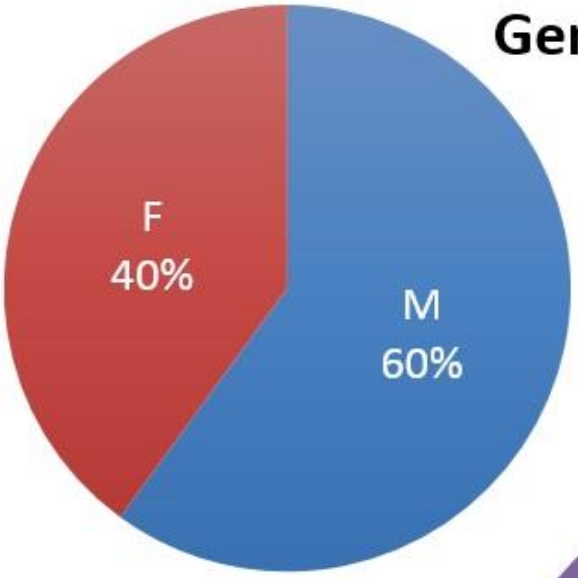
A Quest for a Viable Inter-City Transportation Mode for Arizona

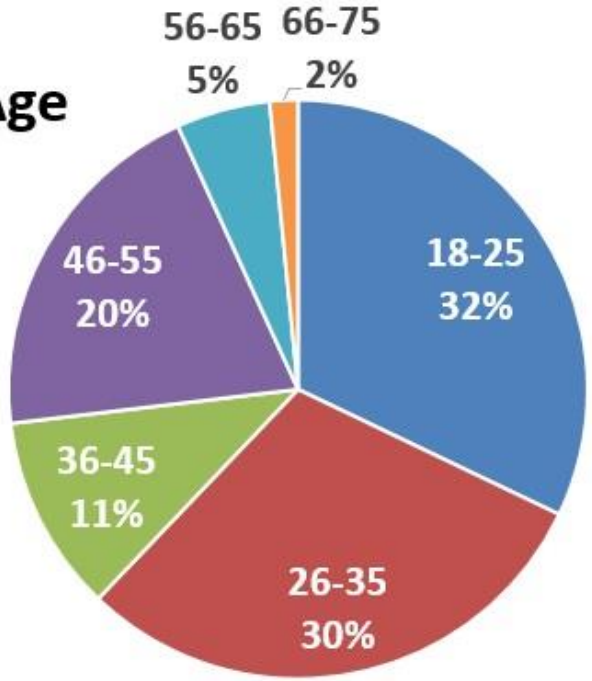
Thank you for your interest in participating in this study!
This survey is part of a study being conducted by researchers at University of Arizona for proposing a new public transit mode between Tucson and Phoenix. And the purpose of this survey is to collect data on the willingness of people to use this new transit mode, to forecast the future demand, and to identify the attributes that matter to passengers.

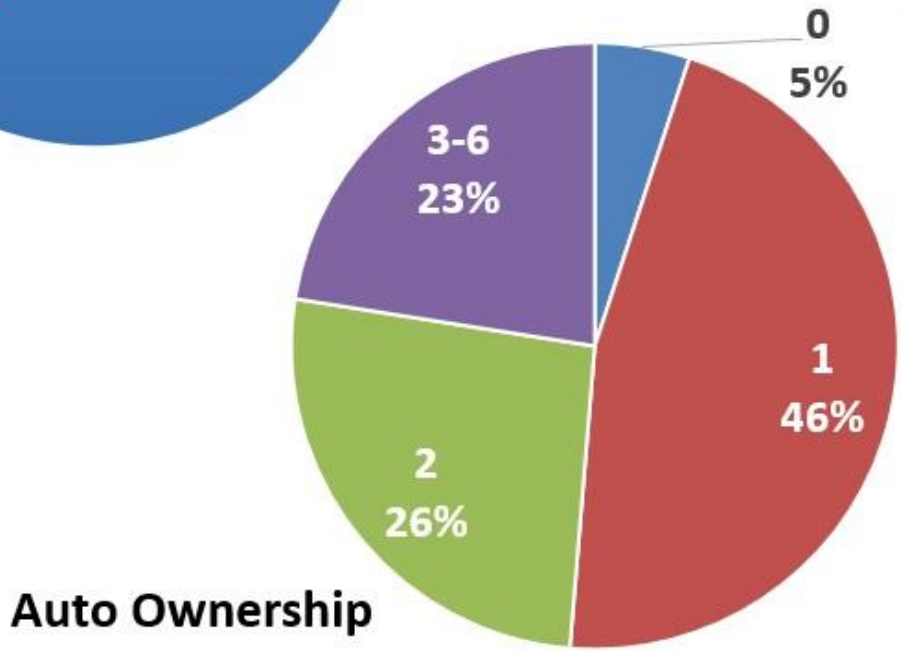
The entire survey will take about 20 minutes. First, you will be asked to conceptualize a trip between Tucson and Phoenix and to define the personal and trip-related information for that specific trip, such as age, gender, occupation, and number of annual travels between Tucson and Phoenix, purpose of the trip, time of day you made the trip, origin/destination, selected terminal, and the transportation mode

- Collected about 600 responses

The Collected Dataset





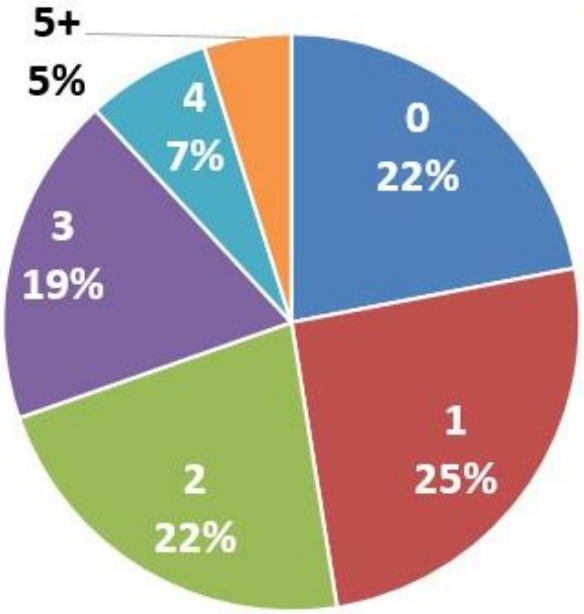


Not a representative sample

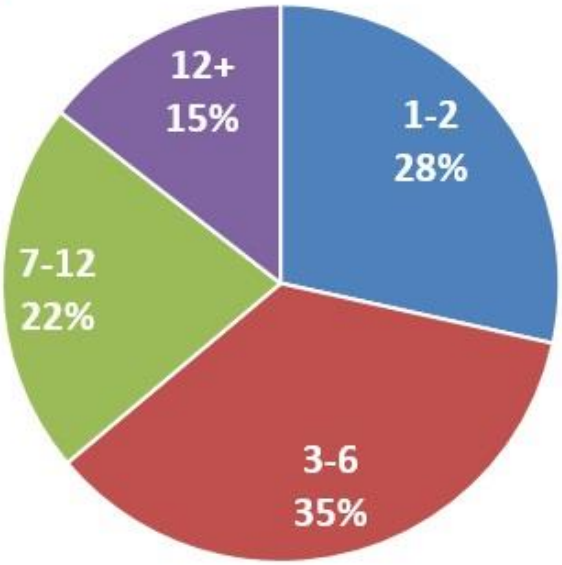
Needs to be weighted in subsequent analysis

The Collected Dataset

Trip Purpose

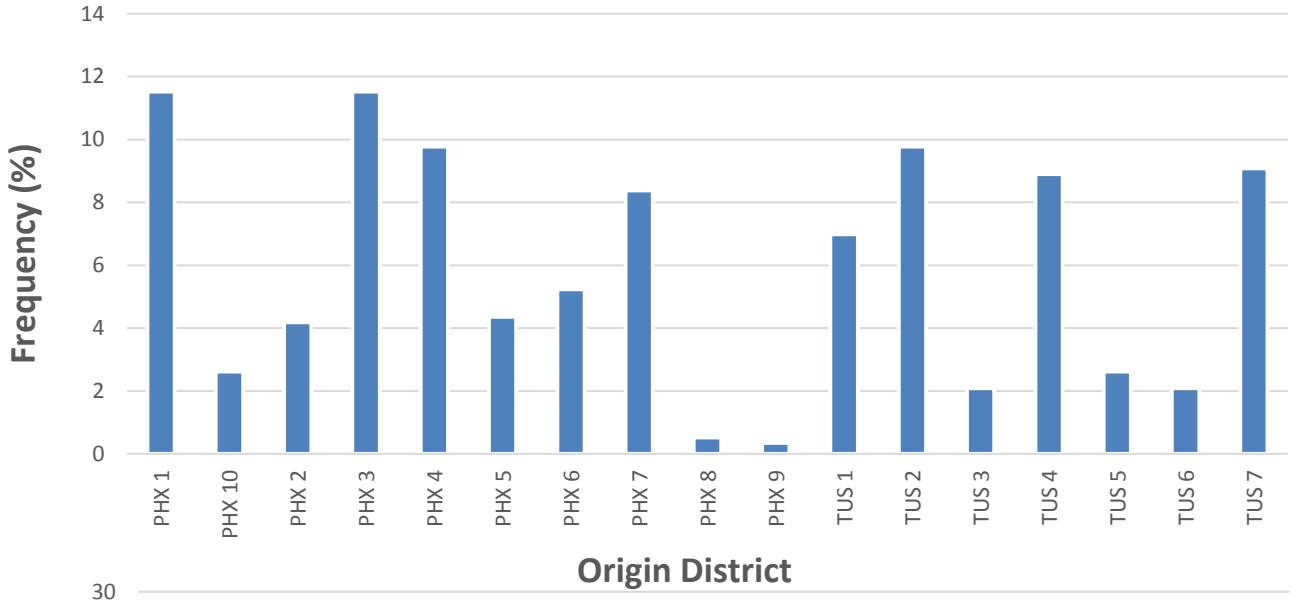


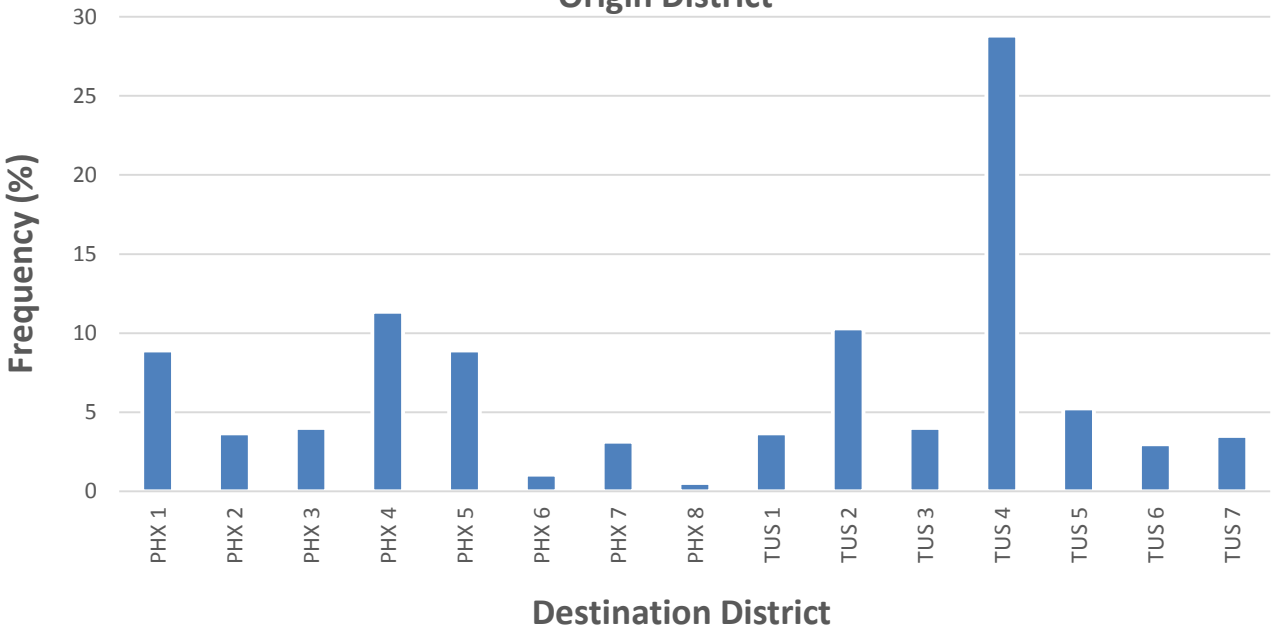
No. of People Traveling with



Tucson-Phoenix Travels Per Year

The Collected Dataset





Choice Analysis

Discrete Choice Modeling

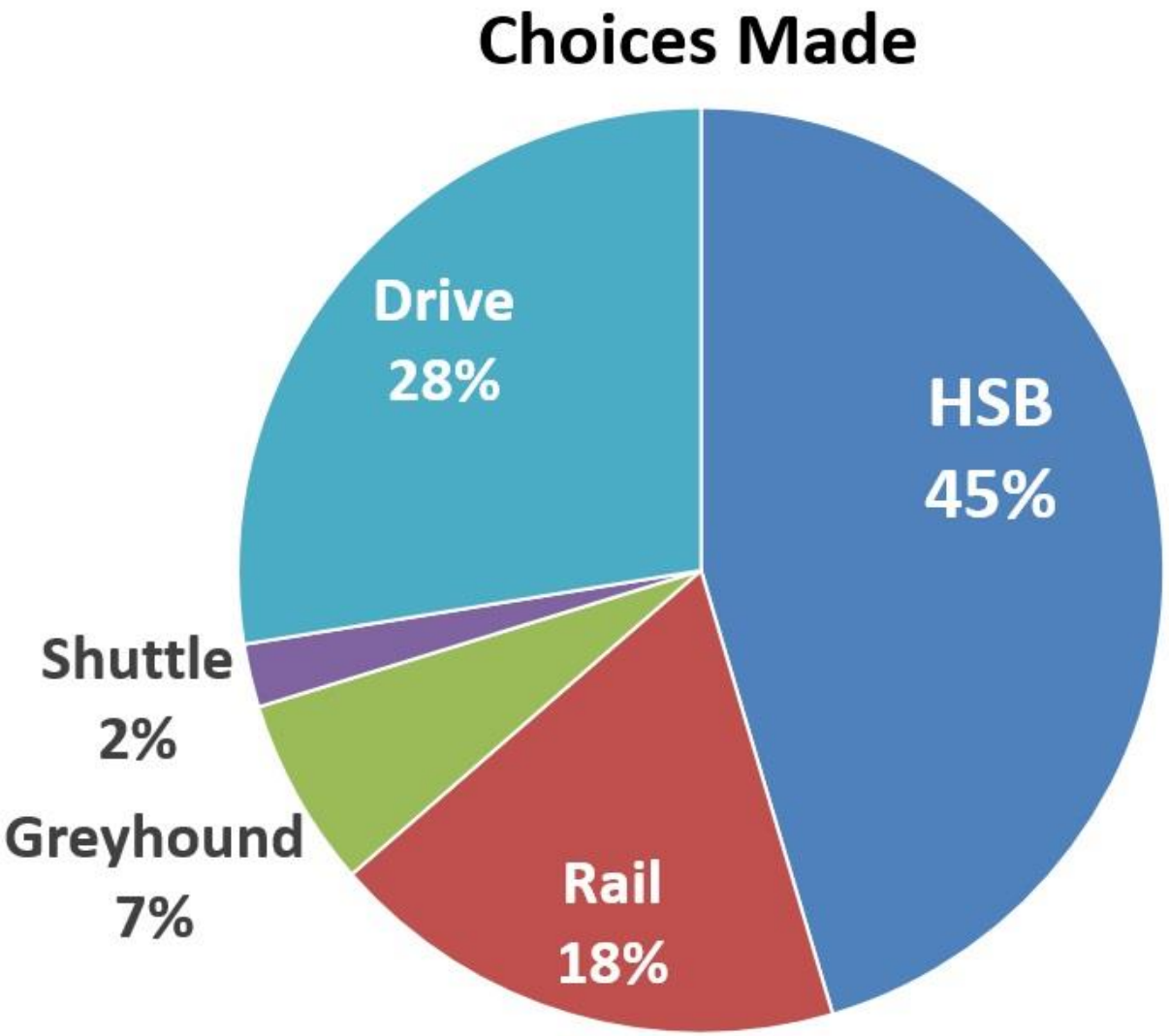
- People choose the alternative with the greatest utility
- **Utility:** a linear weighted sum of the independent variables associated with an alternative

$$U_i = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + \cdots$$

Tested discrete choice models

- Multinomial Logit (MNL)
- Nested Logit (NL)

Results – Market Share



Results – MNL Model

Parameter	Description	Associated Alternative	Coefficient	t-stat
Generic Parameters				
Total Cost	($)		-0.0382	-7.0081
Headway	(min)		-0.0101	-2.6751
Alternative Specific Parameters				
Constant		Rail	1.7066	5.567
		GH	4.198	5.5023
		Drive	1.8661	2.6457
Total Travel Time	(min)	HSBT	-0.0096	-2.4006
Gender	1: F, 0: M	HSBT	0.3839	1.8533
		GH	-1.1561	-2.4864
Young	Age<35	Drive	0.4174	1.7702
Senior	Age>60	Drive	-1.3957	-1.7452
Occupation: Accounting, Administrative, Insurance, Government, Education & Teaching	1: Yes, 0: No	Drive	-0.6168	-2.2249
Occupation: Automotive, Business, Executive, Manufacturing, Sales, Marketing, Real Estate	1: Yes, 0: No	HSBT	0.4969	1.8047
Occupation: Engineering, Design, IT, Planning, Media & Journalism	1: Yes, 0: No	HSBT	0.4514	1.7369
Occupation: General Labor, Food Services, Transportation	1: Yes, 0: No	GH	0.6931	1.754

Results – MNL Model

Parameter	Description	Associated Alternative	Coefficient	t-stat
No. of autos owned		Drive	0.3484	3.2774
Trip Purpose: Business	1: Yes, 0: No	GH	-1.2349	-2.1903
		HSBT	0.7518	2.1788
Trip Purpose: Event	1: Yes, 0: No	HSBT	0.8372	2.5295
Trip Purpose: Flight Connection	1: Yes, 0: No	HSBT	1.9883	3.0784
Trip Purpose: Family/Friend Visit	1: Yes, 0: No	HSBT	0.8953	3.1346
No. of visited places		GH	-0.9154	-3.8618
		Drive	0.1078	2.0937
Has a ride to station	1: Drive, Drop-off 0: Other	HSBT	1.6114	3.1923
Public Transit to station	1: Bus, LRT, Streetcar 0: Other	HSBT	2.4213	4.2225
		GH	1.9983	3.8115
Public Transit from station to final destination	1: Bus, LRT, Streetcar 0: Other	HSBT	-0.5922	-2.0373
Commuter (Avg. No. of TUS-PHX travels per year)	1: >=6; 0: <6	HSBT	-0.804	-3.8693
No. of intercity bus rides in the past 10 years		HSBT	-0.0019	-2.774
Percent of time experienced delay on I-10		GH	-0.0374	-2.7238
Avg. delay experienced on I-10	(min)	HSBT	0.0256	3.2515
HSBT Safety Rank	1: Very Low; 2: Low; 3. Moderate; 4: High; 5: Very High	HSBT	0.2859	2.3804
		Drive	-0.5701	-4.2315

Results – MNL Model

Parameter	Description	Associated Alternative	Coefficient	t-stat
Accessibility is one of the two most important factors	1: Yes, 0: No	HSBT	1.5601	2.4808
		Rail	1.4451	2.6116
		Drive	1.7159	2.9152
Frequency is one of the two most important factors	1: Yes, 0: No	GH	-3.6251	-3.2832
Model Statistics				
Log Likelihood at Zero				-912.5513
Log Likelihood at Constants				-735.723
Log Likelihood at Convergence				-605.1417
Rho Squared w.r.t. Zero				0.3369
Rho Squared w.r.t Constants				0.1775
Adjusted Rho Squared w.r.t. Zero				0.2974
Adjusted Rho Squared w.r.t Constants				0.1333
Number of Cases				567
Number of iterations				14

* HSBT and GH respectively represent High Speed Bus Transit and Greyhound.

Results – MNL Model

General Parameters

- Total Cost ↑
- Service Interval ↑ → Choice Probability ↓
- Travel Time (HSBT) ↑

Travel Time was only significant for the HSBT alternative

=> Small differences in travel time may not be meaningful

Results – MNL Model

Gender

- Females: HSBT ↑
  Regular Bus ↓

Age

- Young (<35): Drive ↑
- Seniors (>60): Drive ↓

Results – MNL Model

No. of autos owned ↑ → Drive ↑

No. of visited places ↑ → Drive ↑

Regular Bus ↓

Being a TUS-PHX Commuter:

(Avg. yearly travels >= 6) → HSBT ↓

Results – MNL Model

Trip Purpose

- Business: Regular Bus 
  HSBT 
- Event: HSBT 
- Family/Friend Visit: HSBT 
- Flight Connection: HSBT 

Reliability and travel time may contribute to the attractiveness of HSBT for these purposes

Results – MNL Model

Local Access

- Drive/Drop off (Origin City): HSBT

- Public Transit (Origin City): 1. HSBT
  2. Regular Bus

- Public Transit (Destination City): HSBT

HSBT seen as flexible to meet local transit at origin, but not at destination

Results – MNL Model

No. of intercity bus rides in the past 10 years ↑ HSBT ↓

Avg. percent of time experienced delay on I-10 ↑ Regular Bus ↓

Avg. delay experienced ↑ HSBT ↑

HSBT Safety Rank (People's Impression) ↑ HSBT ↑

Results – MNL Model

If Accessibility is important:

1. Drive
2. HSBT
3. Rail
4. Regular Bus

If Frequency is important:

Regular Bus 

Summary

- The challenge of meeting the future intercity travel demand in a cost-effective manner, and the existing service gap from the standpoints of mobility and accessibility
- High Speed Bus Transit (HSBT): An innovative intercity transit service for high-demand corridors
- An interactive SP survey + a discrete choice analysis: To estimate the potential market share of HSBT, and to identify the significant factors influencing choice behavior

Summary

- The findings from this study are not exclusive to HSBT service and can be used as insights for researchers and policy makers to improve intercity transit services in general.

- The interactive survey method proposed in this study can be employed for similar SP methods, and leads to a choice analysis model with more accurate results.

Thank you for your attention!