PUBLIC TRANSIT DESIGN FOR SMART GROWTH:
USING CHOICE EXPERIMENTS TO QUANTIFY TRADEOFFS, VALUES AND FUNDING IMPLICATIONS

Final Report

CTLS 08-04

by

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16. Abstract

Studying public perception of public transportation and the environment in which it operates is crucial to understanding the symbiotic relationship between transportation and the built environment. This report documents research completed to quantify the value of public transit using choice experiments in the form of stated preference surveys. The study was implemented in two phases; a pilot study and a full scale implementation. The general study methodology for each phase use choice experimentation administered in the form of a stated preference surveys. The choice experiments used in the both studies place respondents into personalized hypothetical scenarios and examine their preferences for new transit service and the environment in which it operates. The survey instrument developed investigates public response in a hypothetical bond referendum, a realistic funding context in today's transportation funding environment. Data obtained was used to develop preference models by fitting them with logit models, which are used to identify tradeoffs users make between various transit service attributes and built environment attributes.

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DISCLAIMER

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EXECUTIVE SUMMARY

Studying public perception of public transportation and the environment in which it operates is crucial to understanding the symbiotic relationship between transportation and the built environment. This report documents research completed to quantify the value of public transit using choice experiments in the form of stated preference surveys. The study was implemented in two phases; a pilot study and a full scale implementation. The general study methodology for each phase use choice experimentation administered in the form of a stated preference surveys. The choice experiments used in the both studies place respondents into personalized hypothetical scenarios and examine their preferences for new transit service and the environment in which it operates. The survey instrument developed investigates public response in a hypothetical bond referendum, a realistic funding context in today's transportation funding environment. Data obtained was used to develop preference models by fitting them with logit models, which are used to identify tradeoffs users make between various transit service attributes and built environment attributes.

Several salient results emerged from this study:

- The general public, on average, is willing to pay for enhancements to the transit stop environment (placemaking) in conjunction with service improvements.
- The willingness to pay for placemaking varies significantly with respect to owner/renter status, the type of placemaking improvements made, and the willingness to ride transit.
- Stated preference surveys are a useful tool for evaluating placemaking's value.
- Visual stimuli (images of places) are more useful in surveys than textual descriptions.
- Electronic delivery of the survey in-person produces a more representative sample and more reliable results.

In the first phase of the project, a pilot study was constructed. The pilot study was conducted using a mail-in paper survey in the city of Meriden, CT. The purpose of the pilot study was to test the survey design, validate the choice of survey attributes, and examine the demographic representation in the responses. The pilot survey, like the full survey, asked respondents to consider a hypothetical bond referendum in which they would be making a choice between two new transit service alternatives (with varying levels of the six attributes describing each). Respondents always had the option of selecting "Neither" project, meaning that they would pay no additional taxes and no new service would be constructed.

The pilot survey characterized transit service by six attributes; fare, travel time, placemaking, comfort, cost to household and service type. Attributes were selected and tested through several focus groups using established procedures. The data from the pilot survey was used to estimate a preference model from which willingness to pay for the service attributes was computed. The placemaking variables in this study had two levels which were interacted in this study with owners of homes versus renters and potential riders and stated non-riders of the hypothetical transit service. The study discovered that homeowners were more willing to pay for placemaking

in the stop environment than were renters and potential riders had a higher willingness to pay for placemaking than stated non-riders.

The full-scale implementation of the study in phase two used a survey with a similar number of attributes. However, changes from the pilot study were made eliminating two attributes from the pilot survey: fare and travel time. In their place two new attributes: service reliability and parking. In addition to these changes, the placemaking variable, which was categorized in to two levels was further subcategorized into its component variables resulting in four levels. Each level of placemaking represented an additional built environment treatment that would build upon the previous level. For example, a first treatment might be wider sidewalks and improved lighting, a second level treatment would include reduced building setbacks in addition. In this full-scale implementation, open-source survey software was leveraged to design a conditional and branching survey instrument that allowed for adaptive context and control variables. In short, a wireless electronic in-person survey was created that improved upon the paper-based version of the pilot study. The results of phase two again found that people place a significant value on the quality of public spaces created by transit, with the breakdown of placemaking suggesting that people eare more willing to pay for *functional placemaking* (lighting, wider sidewalks, reduced setbacks) as opposed to *aesthetic placemaking* (greenery and other architectural treatments). It is hypothesized that the practical elements are related to personal safety while the aesthetic elements are considered luxury items. Another interesting result suggests that an individual's willingness to pay for public spaces varies based on geography of their community – that is, whether the respondent resides in an urban or suburban region

Following is a brief summary of each chapter of the document:

Chapter 1 provides a general introduction and background of transit service, its associated community development, and a statement of the project objectives and the problem.

Chapter 2 presents an overview of the relevant studies found in literature. This chapter provides a review of the use of stated preference methodology and its use in transit and transportation planning studies. This chapter also provides an overview of the general relationship between transportation and land use.

Chapter 3 presents a discussion of the methodological approach used to accomplish the objectives of the study. This chapter describes the development and implementation of both the pilot study and full electronic survey instrument. It describes the development of the surveys used, the modeling approach and the interpretation of the results obtained from this study.

Chapter 4 describes the full-scale implementation of the study. Variables used in the survey and improvements in the design of the survey are presented alongside the new delivery methodology. Chapter also details data collection methods and the selected modeling approach.

Chapter 5 provides analysis and interpretation of model results for the second stage of the project, extracting salient results from model output. ***Chapters 6 and 7*** provide conclusions and suggest recommendations for future inquiry.

1.0 INTRODUCTION

1.1 BACKGROUND

There is a shift in national transportation planning and policy from an automobile-oriented approach to a people-oriented one, which has resulted in an emphasis on travel management, advocacy for transit development, and consideration of other modes of travel. Rising highway construction and maintenance costs, concerns about air quality, and ever increasing highway congestion precipitated this shift. Multimodal solutions with an emphasis on transit have been proposed to address these problems. As transportation policy and planning evolves in such a manner, the importance of a well-established transit system cannot be overemphasized. A well-developed transit system has the ability to foster the creation of livable neighborhoods and communities. A well patronized transit system would also lead to a reduction in congestion and, eventually, the reduction of vehicle emissions. Properly designed and operated public transit can serve a broad spectrum of regional and corridor travel demands. Public transit can serve this demand with a smaller environmental footprint than the equivalent personal automobile network; can serve it more reliably, and in a more sustainable fashion. Public transit also tends to promote dense, mixed-use development near stations – leading to a stronger sense of community and smarter growth practices.

Transit systems have been known to encourage the creation of high quality public spaces that promote and enhance social interaction and economic activity; a phenomenon usually referred to as placemaking. Public transit stops have the potential to develop into centers of community life which rejuvenate and strengthen communities. These strengths of transit are well established in the minds of transit managers, transportation professionals, and those in the industry. Many riders, potential riders and even non-riders of transit are aware of its public transit's benefits. The USDOT has listed environmental stewardship, including community enhancement, as a priority along with other traditional mobility-based goals. Proper design and enhancement of public transit promotes these priorities. To reach its potential, however, better correspondence between public needs and transit design are needed. Moreover, a closer tie between those who value and pay for transit is needed.

1.2 PROBLEM STATEMENT

Even though much strength have been established for the developmental impacts of public transit, they are not well quantified in the scholarly literature. Public transit faces many challenges in the political arena, primarily because most measures of transit value are given solely in terms of mobility or congestion improvements on highways. Certainly, mitigating congestion on highways is a worthy goal, but it cannot be the sole metric used to measure the value of public transit. If this framework continues to be used, public transit will forever be relegated to a supporting role and as a self-fulfilling prophesy, will never reach its considerable promise. Simply put, the predominant focus of transit managers and professionals on mobility or congestion goals alone overlooks a substantial source of public value created by public transit, and can result in sub-optimal design and funding of public transportation. There is a lack of a

systemic measure of transit's value and its attributes, both mobilizing and developmental, which results in a serious gap in the current communication between citizens and the policy makers.

1.3 OBJECTIVES AND SCOPE OF PROJECT

This project uses choice experiments, in the form of a hypothetical bond referendum, to quantify the value of key mobility and non-mobility related attributes of public transit. The bond referendum context allows the measurement of willingness to pay in a context that was plausible to the survey respondent. The use of this technique will help eliminate the bias commonly associated with the more common ridership-centric stated preference surveys. To accommodate the different forms of public transit, multiple attribute configurations are incorporated into the design, allowing public preference models to identify tradeoffs the general public is willing to make and pay for in a transit system.

The project also seeks to identify the value transit provides beyond mobility and access: which requires looking beyond traditional mobility-centric transportation planning and acknowledging the reciprocal relationship between development and transportation and its impact on our societal well-being.

1.4 RESEARCH TASKS AND REPORT ORGANIZATION

The research tasks of the project included:

1. Development of preference models and surveys using established methods including focus groups and cognitive interviews (§ 3.1 and 3.2);
2. Refinement of survey instruments using focus groups and verbal protocols (§ 3.5);
3. Development of experimental designs and other requirements for survey pilot tests (§ 3.8 and 3.9);
4. Formal pilot testing and validation of surveys and public preference models (§ 3.1);
5. Survey instrument refinement for demographic and behavioral considerations (§ 3.6);
6. Full-scale deployment of survey instruments (§ 3.8); and
7. Analysis and willingness-to-pay estimation (§ 4.0, 4.1, and 4.2).

This report will first review the application of stated preference (SP) techniques in various transportation contexts and the extent to which previous studies investigated the value of public transportation and the public's interpretation of the value of transit. This is followed by a comprehensive review of the constituents of high quality public spaces supported by transit to provide a framework for placemaking and subsequently a review of the empirical evidence supporting a relationship between transportation and land use. The methodology and the results are then presented showing the outcome of a hypothetical bond referendum stated preference choice study and the estimates of logit model parameters. Lastly, recommendations are made for future research.

2.0 LITERATURE REVIEW

The relationship between transit service and the environment in which it operates is one that merits study. Several questions were investigated about this relationship and addressed by the project, one of which was whether there existed a public preference for rail over bus. This question had been addressed by a some transit studies; some of which found a significant preference of rail over bus whilst others found no evidence of such a bias towards rail service. Ben-Akiva and Morikawa(*2002*) found no evidence of such a bias towards rail services when both services had equivalent travel times and fares. However the same study found that a bias existed when rail offered a higher quality of service. Yannes et al., (*2010*) also found no significant public preference for rail service over bus service.

In many transit valuation studies, stated preference (SP) techniques are used to elicit user preferences for the transit service and remain one of the only tools capable of evaluating transit service options that do not yet exist. In public transit applications, SP modeling has been used to valuate public transit systems through people's Willingness to Pay (WTP) for services, weigh transit options, and to predict mode choice and ridership (with somewhat controversial results). *(Hensher, 1990)* used SP techniques to develop a bus preference model to predict the relative satisfaction or dissatisfaction of users. The method involved the application of an ordered probit model to identify the attributes which influence the attitudes of bus users. Their results indicated that non-users did not value options of express and all-stop services comparable to users and had a high disutility for both services. SP techniques have been also been used to estimate the WTP for different aspects of transit service by users *(Molins and Timmermans, 2006; Phanikumar and Maitra, 2007* and *Das et al., 2009).*The use of SP methods is not without issues; the major shortcoming being the potential for hypothetical bias, defined as cases in which hypothetical choices do not correspond to real life choices obtained from revealed preference (RP) data. Methods suggested in the literature for reducing hypothetical bias include,the inclusion of a null or opt out alternatives in choice experiments, using "cheap talk' scripts to explain objectives in choice experiments, and utilizing a combination of RP and SP data (*Ben-Akiva et al., 1994, Hensher, 2010*). Johnston, (*2006*) and Johnston et al. (2005) suggest reducing hypothetical bias related through "the familiarity and salience of goods and equivalence of information in both hypothetical and binding choice contexts". The research discussed in this study seeks to overcome the potential for hypothetical bias by providing respondents with plausible scenarios and soliciting responses from both potential public transit riders and self-designated non-riders.

One essential aspect of transit and its relationship between the environment it operates in can be found in the general transportation-land use relationship paradigm. Transportation policies and investments have been shown to influence land development patterns which in turn affect travel patterns *(Handy, 2005).* This reciprocal relationship between transportation and land use warrants its consideration in any form of transportation policy and planning. Shinbein (*1997*) and Polzin (*1999*), emphasize the need for a more integrated approach to transportation and land use planning to further our understanding this reciprocal relationship. Current transit policy and planning strategies should focus on this relationship, and use it as a guideline for planning and

evaluation of transit systems. This section highlights a number of studies that which explore and help to establish this relationship between transit and land use.

TCRP Report 16 (*1996*) states that transit can influence urban form in four distinct ways: the value of land and its nearby improvements, the density of development, the structure of the urban environment and the timing of development. Khasnabis (*1998*) concluded from case studies spanning several modes of transit that while transit plays an essential role in the concentration of development and creation of economic opportunities, it is not alone responsible for Transit Oriented Development (TOD). Polzin (*1999*) characterized the relationship between transportation and land use by exploring the correlations between transportation investments and land-use responses. Polzin identified three precursors for transportation to improve land use accessibility: existing market demand for additional improvement, transportation capacity or performance constraints, and ability of new investments to improve accessibility. Other factors like the existing quality of transit service, local and regional transportation and land use policies, and political goodwill were also to be considered.

Research on transit's impact on land value and its nearby improvements has been focused on rail transit. Studies such as Armstrong, (*1994)*, Fejerang, (*1994*), Dueker and Bianco(*1999*) and Cervero and Duncan, (*2002*), found moderate increases in the value of both commercial and residential property in proximity but not directly contiguous to transit facilities. (Parsons Brinkerhoff*,* (*2010*) provides a review of studies on the effect of rail transit on property values and suggests that although research exists with contradictory results, the impacts of rail transit on property values are generally positive. Although there exists a great deal of evidence of transit's influence on urban form and the interactions between the two, an exact causal relationship is yet to be established. What has been established however is that they often influence each other synchronously such that the relationship cannot be simply reduced to just measures of impacts *(TCRP 1996)*. Other factors such as policies, political support, quality, and market for transit come into play in the examination of this relationship *(Khasnabis, 1998; Polzin, 1999)*. Further research is still required to fully explore and understand the relationship between transportation and land use patterns since it is an essential aspect of transit policy and planning.

While transportation and land use has been the subject of a great deal of research, only a limited number of studies explore the relationship between transit and placemaking in the stop environment. Yannes et al., (*2010*) used a choice experiment approach to find that the public placed a high value on placemaking in the stop environment. The study communicated the concept of placemaking in a transit environment using digitally rendered images of the built environment. This study found that people place a significant value on placemaking in new transit services, and that this value can change depending on the respondents' propensity to use transit and home ownership status. The choice experiments were structured in the context of respondents' commutes. While a useful design, structuring the pilot survey around commuters alienated segments of the population, such as people who are unemployed, retired, do not work, or work from home. For such respondents, concepts like time in vehicle (defined relative to respondents' current commute) became irrelevant and confusing. The current study seeks to overcome this shortcoming by allowing respondents to select the kind of trips they would most likely make using the service. The subsequent section provides a detailed summary of (*Yannes et al.*, 2010) methodology behind the development, testing, and evaluation of their pilot survey which was Phase I of this project.

3.0 METHODOLOGY

3.1 PHASE 1: PILOT STUDY

The first phase of this project entailed a smaller scale pilot study to identify best practices for survey distribution, survey design and sampling practices. A hypothetical bond referendum was utilized as context for an SP survey distributed as a paper survey through the postal service. The design of this survey, the methodology used and the results of the calculation of WTP and tradeoffs between attributes are included in detail in this section of the report.

3.1.1 SURVEY CREATION

Creating a survey which includes every attribute that influences a traveler's mode choice decision is a nearly impossible task. Individuals have a wide variety of opinions and values that they place on all aspects of a trip. It is important that the design process ensures a balance is maintained between those aspects which are critical to the individuals responding to the survey and maintaining a feasible experimental design. The research team consulted economic literature, leveraged considerable experience with these types of surveys within the design team and used focus groups to test content and versions of the survey to create a final pilot design. The list of attributes initially considered for this SP experiment was extensive. Reviewing previous choice research in transportation listed above, an inventory of potentially important aspects when considering a commute trip was compiled. They included but were not limited to: service type, fare, frequency, travel time, access, reliability, comfort, transfers, the station amenities, safety in both the station and the transit vehicle, and placemaking. Theoretically, it would be ideal to include all of the attributes listed above, but this results in a rather overwhelming survey as respondents become confused by the number of comparisons they must analyze. Previous research suggests that four to six attributes is the limit at which respondents can accurately predict their behavior in a real referendum (*Johnston et al., 2002*).

To pare the list of attributes to a more manageable number, focus groups were conducted to ascertain the importance of an attribute with respect to commute trips. In the focus groups, respondents were guided through a series of questions eliciting their opinions on public transit and the importance they place on particular characteristics. Common themes arose in the focus groups, with respondents continually returning to travel time, comfort, cost and safety no matter the guided discussion topic. These results gave researchers a clear indication of those attributes which were most important to the public and resulted in a final set of attributes to be included in the survey

The final pilot survey contained six attributes listed in Table 3.1. The attributes were selected based on discussion in the focus groups and the desired research objectives. The subsections following Table 3.1 explain how variables were originally defined and detail the significance of each attribute to the research questions.

Table 3.1: Pilot Study Survey Attributes

Attribute	**Level**	**Description**
Service Type	1	Bus
	2	Train
Placemaking	1	Good
	2	Bad
Travel Time	1	Decrease in current commute by 5 minutes
	2	Increase in Current Commute by 15 minutes
	3	Increase in Current Commute by 30 minutes
Fare(Oneway)	1	$0.50
	2	$1.00
	3	$1.50
	4	$2.00
Comfort	1	Low
	2	High
Cost To Household	1	$100 per year
	2	$175 per year
	3	$240 per year
	4	$275 per year

3.1.1.1 Service Type

This study employed a simple two-level service type attribute which classified the transit service as either bus or rail. Simplifying this attribute provides the opportunity to address bias towards rail in a straightforward manner. Respondents comparing the two levels will group their opinions on bus and rail systems allowing for the determination whether the public prefers bus or rail more than the other. Traditionally, this bus versus rail debate has been answered anecdotally through observation of ridership and travel behavior data. Ben-Akiva and Morikawa (*2002*) investigated this question using SP and RP techniques, finding that with all service attributes being equal the public has no preference between bus and rail systems for their commute trips. This differs from generally accepted theory and with the consensus of the focus groups. Further investigation, through the inclusion of this attribute will gain more insight into this relationship.

3.1.1.2 Stop Environment (Placemaking)

The idea of placemaking is becoming a progressively more common in community planning and design research. Many believe good placemaking results in vibrant and pleasant spaces for the community, which in turn sparks social and economic development. Transit-oriented Development (TOD) literature highlights these benefits among many others. Despite the potential benefits of placemaking and TOD, few studies attempt to quantify the value the public puts on placemaking. It is undetermined whether public is willing to pay for such community development and

if so, the extent to which they are willing to pay? Placemaking was included as an attribute with the intention of answering this question.

Communicating such a foreign concept as placemaking to survey respondents without directly defining it is a difficult process. To incorporate placemaking as a transit service attribute, renderings of urban development environments were purchased from Urban Advantage. Urban Advantage renders photorealistic images depicting pleasant and vibrant urban spaces. The renderings integrated many of the key placemaking features known to create a vibrant, appealing place following accepted new urbanist practices. Pedestrian friendly walkways and sidewalks, trees, improved lighting, bike lanes and storage facilities, curb extensions to shorten road crossings, traffic calming medians and pavements to slow traffic and improved storefronts close to the roadway are used to morph the auto-dominant areas into social gathering places.

Images were selected which satisfied two important criteria:

1. They were representative of the pilot survey location, Meriden, CT.
2. They had no transit vehicles as they may bias the service type attribute.

Using the aforementioned criterion the images were pared through a third and final focus group. Participant's reactions to the images, specifically the desirability of the environments, along with a discussion of the amenities, helped the research team to define "good' and "poor" levels of placemaking. Six images which best exemplified "good" and "poor" placemaking were purchased from Urban Advantage, for inclusion in the final survey. An example of "poor" and "good" placemaking can be seen in Figure 3.1a and 3.1b, respectively. In the final survey design, it was ensured individual respondents only viewed and compared each image once, therefore eliminating bias from comparing the same image across questions.

Figure 3.1: An example of "Poor" Placemaking

Figure 3.2: An example of "Good" Placemaking

3.1.1.3 Travel Time

Travel time from origin to destination is believed to be one of the primary factors affecting mode choice. Focus group participants were found to have similar opinions, stating that travel time and cost were the principal considerations when making a commute mode choice. This assertion will be evaluated with results of the model estimation. The inclusion of travel time in the choice experiments allowed for quantitative comparisons in the form of tradeoffs to be made between travel time and the other service attributes.

In order to create a plausible, personal choice, travel time was defined as an adjustment from a respondent's current commute time. This definition was advantageous as it removed the need to define a specific origin and destination for a respondent to consider. The travel time attribute had three levels which were selected consulting data from the Transit Capacity and Quality of Service Manual (*TCQSM, 2004*). One level reduced the travel time of the commute by five minutes, while the other two levels increased travel time by 15 and 30 minutes, respectively. The values were based on the TCQSM's Transit-Auto Travel Time Level of Service (LOS) delineations which defines how tolerant transit riders are to changes in travel time when auto is the alternative. The TCQSM identifies transit travel time increases of 15 minutes relative to auto as the maximum tolerance of most travelers. Transit travel time increases above 30 minutes resulted in virtually all users using personal vehicles. Matching the travel time attribute levels with the LOS delineations gives a structured basis for comparison.

3.1.1.4 Comfort

Comfort was an important and recurring topic in the focus groups. Participants stated that comfort, although not as important as fare or travel time, was a concern when selecting a mode for a commute trip. Incorporating comfort into the model creates many interesting comparison and tradeoff possibilities.

Comfort was defined by a system similar to that used in a SP and RP travel demand modeling study by (*Espino et al., 2007*). In this study the comfort of a bus was defined using a three-tiered system, the middle level of which was comparable to an

automobile. The lower and higher values had a corresponding comfort compared to an automobile. For this survey, two levels of comfort were specified. High comfort was considered equivalent to that of an automobile while low was an experience less comfortable than personal auto. The two-level design again helped maintain a manageable experimental design and at the same time offered a clear choice for respondents.

3.1.1.5 Fare

The cost of transportation is paramount to commuters. Consequently, it has become standard practice to incorporate fare into transportation choice modeling. Its inclusion in this model provides insight into the relationship between fare and the other service attributes such as service type, travel time, and comfort.

In this study, fare was defined as the amount a rider pays for a one way commute trip from home to their place of work. A one-way fare value was used for comprehension and comparison. The trend toward weekly or monthly passes is important, and was noted in focus group sessions. However, monthly pass costs could lead to ambiguity in the interpretation of fare, as some riders will plan to ride once a month, while others will plan to ride every day. Single-ride fares offered a consistent baseline for all riders. To select the choice fare levels, fares for several systems across the country were reviewed. The four levels included in this survey were $0.50, $1.00, $1.50 and $2.00.

3.1.1.6 Cost to Household

Along with fare, the cost of the increase in taxes and fees, (if the hypothetical referendum were passed) was an important attribute of the survey. Cost is significant in the sense that it is the amount that all respondents can expect to pay regardless of whether they intend to utilize the system. Inclusion of this attribute allows several questions to be addressed: Is the public willing to pay more in taxes for a system which has a pleasant atmosphere? How much more or less are they willing to pay? Similar to fare, it is hypothesized that these values will differ between those who ride transit and those who do not ride transit and those who own a residence in the area and those who rent.

For this survey, the cost to household was calculated based on an increase in the mil rate for town property taxes. The mil value increase was then calculated as a single monetary sum (Tax increase value given in the choice experiment) to ease the comprehension and comparison with other attributes and projects. The single monetary value was calculated using the current mil rate (44.51) and an average property value for Meriden of $200,000. The final values used in the survey for cost to household were $100, $175, $240, $275 which corresponds to increases in the mil rates ranging from 0.50 to 1.375.

The final subsection includes a discussion of the attributes which were controlled for in the survey but were not included explicitly in the choice questions.

3.1.1.7 Controlled Variables

The introductory survey information instructed respondents to consider their current commute trip while reviewing the attributes included in the choice experiments. Using the respondent's current commute as opposed to creating a hypothetical situation where there is an arbitrary origin and destination places the respondent in a realistic and familiar situation while easing the interpretation of the attributes.

In addition to the context of the decision, other variables, not included in the choice experiments, needed to be defined before the respondent could make an informed decision. Including variables, in addition to those in the choice experiments that may enter into the decision process, allows researchers to control for confounding variables, all while maintaining a number of attributes that respondents could feasibly compare in each choice experiment. Information about parking, the number of transfers and the maximum wait time are all important factors when considering a transit trip. The following information was given within the introductory material as shown below:

The following **apply to both projects in each of the questions**:

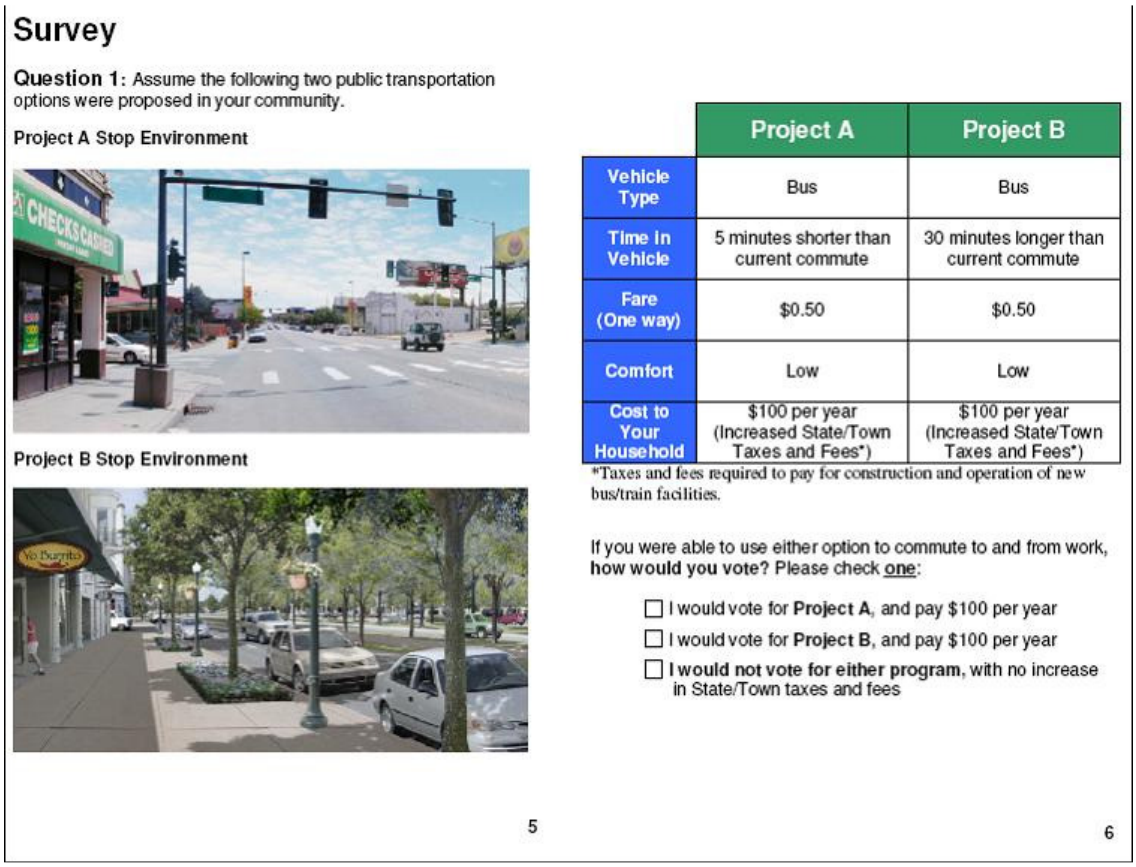
- The service is available for **your commute** to/from work
- It takes **15 minutes or less** to **walk or drive** to the stop **from home**
- You can **comfortably walk** to/from the stop to work.
- **Parking is freely available** at the stop near home.
- There are **no transfers** on the bus or train trip
- The **maximum wait time** at the stop **is 10 minutes**.

Figure 3.3: Pilot survey context and control variables

An important issue that must be addressed by the context and control variables is the physical geography relating the respondent to the transit system. The above control variables place the respondent within the access area both at the home and work end of their commute trip. A situation in the real environment that is not possible for all residents of a region. It is possible that this geographical context could influence the results of the econometric analysis. Researchers are aware of the possibility of upward influences in WTP values and the results will be carefully interpreted as to not overstate the importance of the magnitude of the WTP values.

The design resulted in 12 versions of the survey with 4 choice modeling questions each. Each question was reviewed and 11 were altered to eliminate trivial and nonsensical choice options. An example of the choice experiment used for collection of the SP dataset in the pilot survey is shown in Figure 3.3. It includes the photo comparison of a placemaking attribute on the left side with a table of the five remaining transit service attributes on the right. The final and most important portion of the survey asks respondents to indicate whether they would vote for project A, project B or neither project in a public referendum. Through econometric analysis of the responses to this simple question, WTP values for each attribute can be obtained and the value of tradeoffs between the attributes can be realized. The survey also included demographic questions and Likert scales. The demographic variables allow for segmentation of the respondents and hold the potential to interact with the service attributes and placemaking. The

Likert scales measure attitudes towards seven transit aspects (safety, travel time, cost, etc.) on a scale of 1 (not important) to 5 (very important) which provide insight into what aspects respondents stated were important and their WTP for the aspects.



Survey

Question 1: Assume the following two public transportation options were proposed in your community.

Project A Stop Environment

Project B Stop Environment

	Project A	Project B
Vehicle Type	Bus	Bus
Time in Vehicle	5 minutes shorter than current commute	30 minutes longer than current commute
Fare (One way)	$0.50	$0.50
Comfort	Low	Low
Cost to Your Household	$100 per year (Increased State/Town Taxes and Fees*)	$100 per year (Increased State/Town Taxes and Fees*)

*Taxes and fees required to pay for construction and operation of new bus/train facilities.

If you were able to use either option to commute to and from work, **how would you vote?** Please check **one**:

- ☐ I would vote for **Project A**, and pay $100 per year
- ☐ I would vote for **Project B**, and pay $100 per year
- ☐ **I would not vote for either program**, with no increase in State/Town taxes and fees

5

6

Figure 3.4: Example of Survey Choice Experiment

3.1.2 LOCATION SELECTION

Selecting the location of our target area for the pilot survey proved to be a non-trivial process. A desirable area was one where residents were familiar with public transportation, but not a place where transit services were already fully implemented as the question of providing a new service in the choice experiment would be unrealistic. For the hypothetical bond referendum to produce the most reliable results, a location where a potential transit project is being discussed is ideal. Although it is still in its early stages, the New Haven – Hartford – Springfield (NHHS) Commuter Rail Line has received considerable attention (See Figure 3.4 for proposed route). Selecting an area in close proximity to this project was ideal for this choice experiment. After narrowing the options, Meriden, CT was selected as our survey location. Meriden boasts a three-line local bus system, express bus service to Hartford and Amtrak services. Based on information from the focus group, the two bus systems have issues with reliability and service hours and Amtrak is usually used for non-commute trips, thus satisfying the possible need for a new transit system.

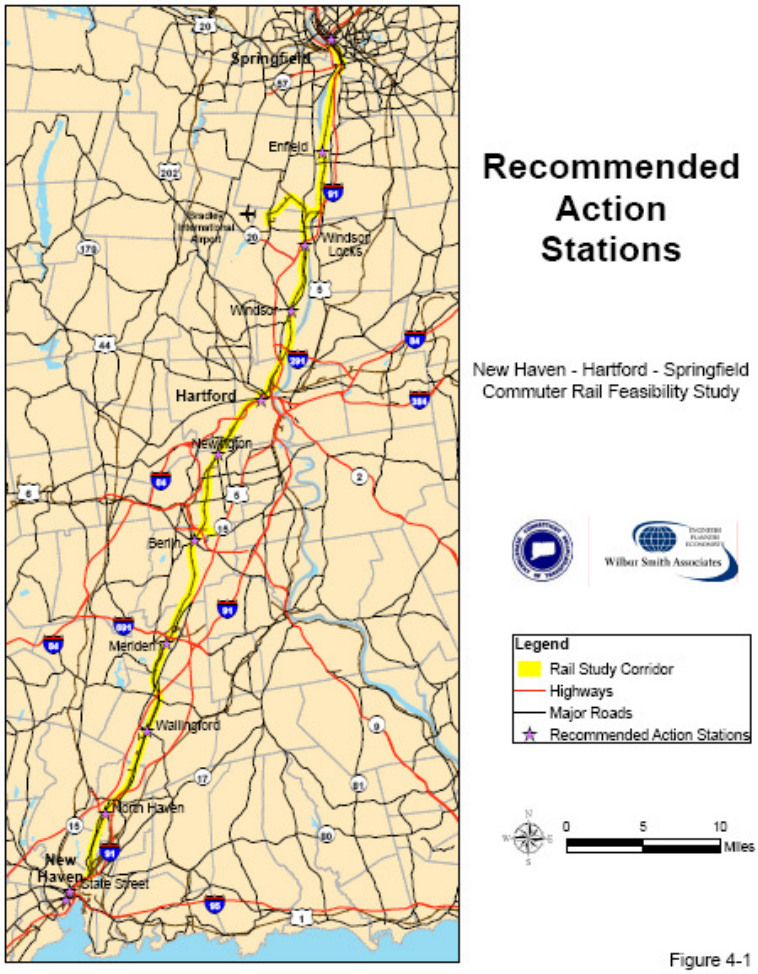


Figure 3.5: Proposed Right-of-Way of the New Haven – Hartford – Springfield (NHHS) Commuter Rail

3.1.3 IMPLEMENTATION

After location selection and a final survey design were complete, a pilot study of Meriden residents was conducted to test and verify that the survey yielded accurate results. The pilot surveys were printed and mailed to a demographically representative sample of 590 Meriden residents. The pilot surveys included a prepaid return envelope and letter explaining the instructions and stressing the importance of response. Respondents received one of the twelve versions of the pilot survey each with four choice questions. A total of 104 surveys were completed and returned (after accounting for addresses errors within the sample), resulting in a response rate of 21.6 percent. This section focuses on the results, with the aim of validating the research method and suggesting improvements for the second, larger distribution of the survey.

3.1.4 RESULTS

Table 3.2 shows the results of the Main Effects Conditional Logit Model. Three of the attributes, placemaking, travel time and cost were found significant at the 0.95 level. Comfort was found significant just under the 0.85 level. Mode and fare were found to be insignificant, suggesting that all controlled attributes being equal, neither significantly affect the decision for a respondent

to pay for a new public transportation service. Initially these results seem rather counter-intuitive, but after careful analysis many of these relationships can be explained rather fundamentally.

Table 3.2: Main Effects Conditional Logit Model Results

Variable	Abbreviation	Coefficient (t-values)
Service Type	ST	-0.169 (-1.019)
Good Placemaking	**PM**	**0.531 (3.096)**
Travel Time	**TT**	**-0.027 (-4.523)**
Fare	F	-0.025 (-0.164)
Low Comfort	*C*	*-0.241 (-1.421)*
Tax cost per household	**T**	**-0.003 (-2.100)**
ρ^2		0.037
Log-Likelihood at convergence		-406.56
Log-Likelihood at equal shares		-422.03
No. of Observations		405

Notes: Model significant at the 1% level ($\chi^2 = 30.94$, $df = 7$)

Transit mode, the question of the preference for bus vs. rail, was an important research objective. The results from this study suggest that while considering paying for public transportation the public does not statistically show a preference between bus and rail. This result conflicts with the general belief that the public prefers train to bus travel, but coincides with a previous study which have found there to be no preference when all service characteristics are equivalent (*Ben Akiva and Morikawa, 2002*). This is important as it highlights that there is no need to limit the alternatives by preselecting a bus or rail system, as the citizens are more concerned with mobility and placemaking characteristics of a system than they are with the type of system implemented.

The willingness to pay for placemaking is a value that has had little background investigation. Many transportation-related studies were more focused on the service-oriented attributes of transit systems as opposed to the developmental aspects. From the results, the WTP value for placemaking is $193 per year per household. In other words, a system which implemented good placemaking techniques is valued on average $193 higher per year in household taxes than a system which did not include such practices. Creating a system that involves community development procedures increases the value the public as a whole places in that system. Ideally, this will create more positive avenues to create a vibrant and sustainable environment.

Travel time savings was a recurrent theme in the research. Focus groups and previous studies suggest that cost and travel time are the two most important factors when considering commute mode. The results verify this assertion. Travel time was significant when deciding whether to pay for a new transportation system. The WTP value for a minute of per ride travel time was $10.00 per year per household. This is an annualized rate, meaning that respondents are placing a value on one minute of travel time experienced on many occasions as they commute over the course of a year. If one assumes 200 work days per year, this results in roughly 400 commutes per year. In this case, each minute is valued at roughly $0.025, which is close to the values suggested in literature of $0.05 - $0.10 per minute (*Caissade et Al., 2006*; *Cornejo and Martinez, 2003*, and *Bradley and Gunn, 1990*).

As mentioned earlier, fare was included as it is standard choice modeling practice in the transportation literature. However, fare was found to be insignificant when estimating the WTP

for funding a new public transportation system. The likely cause of this result was the fact that personal cost was already included in the choice question within the household tax increases. The tax increase was significantly higher in magnitude than the fare, which likely led the respondents to ignore fare, particularly if they were not considering riding the service daily.

The ability to compare service attributes and placemaking was an important goal of this research. WTP values allow tradeoffs to be made between the service characteristics and placemaking to gain a better understanding of the public view of transit and its relation to the community. The WTP values for travel time, comfort, and placemaking suggest that the relative importance of travel time compared to comfort and placemaking depends on the severity of the travel time change. For lower values of travel time change (< 10 minutes, < $100 per year per household), placemaking has higher WTP values while comfort is essentially the same. For higher values of travel time change (> 30 minutes, > $300 per year per household), travel time is valued greater. Although these values apply to those within the service area of the transit and could be slightly overestimated for the general public, this relationship reflects the truly interactive nature of service attributes and land development benefits when the public considers paying for a new transit service.

In addition to the main effects analysis, researchers were interested in analyzing WTP for placemaking for demographic segmentations of the population. Ownership of a residence and transit ridership propensity were hypothesized to have an influence on the WTP for placemaking. To test this hypothesis, two demographic variables, which differentiated respondents as owners or renters of property in Meriden and whether they were potential riders or non-riders of the transit service, were interacted with placemaking. Current riders of transit could not be included due to lack of statistical data and was planned to be addressed in the larger implementation of this survey. Including ownership and transit ridership propensity demographic segmentations provided the ability to quantify the value difference subsets of the public place in community development potential of public transportation. Both of the interactive relationships were found significant, with placemaking-own/rent significant at the 0.85 level and the placemaking-potential/non-rider significant at the 0.95 level.

Table 3.3 shows the results of the model separating owner/renters and potential/non rider segments of the population and Figure 3.5 shows the WTP for these segments of the population. Non-riders, or those who stated that they would never consider transit for their commute trip, who owned property realized a drop in utility. Non-riders, owners viewed good placemaking policy incorporated with a new transit system as a cost of $82.00 yearly per household. The negative impact of non-ridership cannot be overcome by the positive influence of placemaking on ownership of a home. Renters who were stated non-riders of transit had an even more negative view than non-rider, owners with a cost of $281 annually per household. Renters of residences and potential riders, those who claimed to consider the new system for their commute trips, were WTP $105 annually per household for transit that incorporated placemaking policies. Although renters view placemaking as a cost (shown by the negative coefficient for the placemaking – own/rent interaction), the potential of using the new system increases the WTP to a positive value. The owners and potential riders had a much more positive view of placemaking compared to the other three segments. Those who owned a residence and considered themselves potential riders were willing to pay $304 annually in household tax increases. This result makes logical sense, as owners logically have a vested interest in the development of the community

and potential riders would enjoy using good placemaking facilities. The interactive effects of ownership and transit ridership propensity can help planners tailor the type of transit systems to the areas in which they will serve.

Table 3.3: Mixed Effects Conditional Logit Model Results

Variable	Abbreviation	Coefficient (t-values)
Service Type	ST	-0.171 (-0.998)
Good Placemaking	PM	-0.237 (-0.815)
Travel Time	**TT**	**-0.028 (-4.574)**
Fare	F	-0.038 (-0.241)
Low Comfort	*C*	*-0.234 (-1.353)*
Tax cost per household	**T**	**-0.003 (-2.136)**
*Placemaking * Own / Rent*	*PM_OR*	*-0.578 (-1.530)*
Placemaking * Potential / Non-Rider	**PM_PNR**	**1.120 (3.621)**
ρ^2		0.054
Log-Likelihood at convergence		-382.77
Log-Likelihood at equal shares		-404.41
No. of Observations		388

Notes: Model significant at the 1% level ($\chi^2 = 43.28$, $df = 9$)
Italics = significant at 0.80 level, **Bold = significant at the 0.95 level**
OR = 0 for owner, 1 for renter
PNR = 0 for non-rider, 1 for potential rider

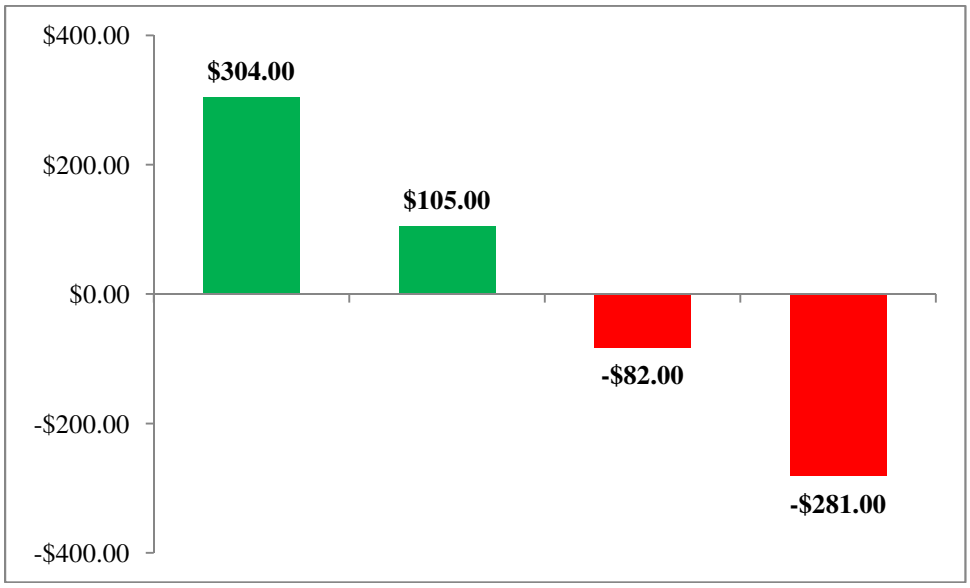


Figure 3.6: WTP for Placemaking

As seen by the results, the inclusion of the two placemaking interactions, differentiating between owners and renters and potential and non-riders, creates changes in the significance of the good placemaking attribute. Placemaking in the mixed effect model was found insignificant. The relatively small sample size and the inclusion of three terms involving placemaking are likely producing these inconsistent results. A more robust sample size in the second implementation of this survey helped to confirm that placemaking is a significant factor in the decision to pay for new transit systems and that ownership and transit ridership propensity, along with other demographic interactions are significant.

3.1.4 PHASE I CONCLUSIONS AND RECOMMENDATIONS

Placemaking, travel time, comfort and tax increase cost were the most important predictors when respondents decided their WTP for new transit systems. Interestingly, the transit vehicle and fare did not influence the decision, thus highlighting the importance mobility savings and developmental benefits to the general public. Ownership of property and a higher propensity to ride transit had a positive influence in WTP for placemaking.

Although the pilot study produced a healthy set of preliminary results, a few alterations to the content and form were recommended to create a more efficient survey instrument. The removal of fare from the choice experiment attributes was recommended to enhance the accuracy of the results. As previously mentioned fare was included as standard transportation choice modeling practice. The insignificance of fare in the preliminary model suggests that the tax increase, with a significantly higher value, is dominating the cost decision of individuals, particularly those who do not consider riding the transit system regularly or even at all. Removing fare from the choice experiments while controlling for it in the introductory information would still allow the model to capture this value but would help to eliminate confusion.

Respondent understandability, length, attribute content and demographic distributions of the survey all influence the reliability and accuracy of the model. The next section provides an in-depth analysis of these characteristics and offers suggestions for the full scale implementation of the survey.

3.2 PHASE I PILOT SURVEY: SAMPLING FRAME ANALYSIS

3.2.1 Foreword

This section contains an analysis of the Meriden, Connecticut survey sample collected as part of the Phase I CTLS project “Public Transit Design for Smart Growth: Using Choice Experiments to Quantify Tradeoffs, Values and Funding Implications”. This analysis was conducted to review the demographic and survey feedback data portions of each survey – this analysis does not incorporate any of the choice data or attributes. This analysis is important in identifying demographic strata that may tend to have lower response rates and need to be oversampled in subsequent survey distribution. The 590 households to which the survey were sent were demographically representative of Meriden’s 2000 census data – the responses in some cases, were not. This section contains several graphics to help identify potential areas for the survey to be improved and collect a more demographically representative sample during Phase II of the project. The first section presents general feedback on the survey design, collected in Question 5

of the survey (see Appendix A-1 for example). It is followed by the Likert scale ratings of the survey, collected in Question 6 (see Appendix A-1 for example). The last segment of the report contains descriptive statistics, histograms and cross tabulations of survey respondent demographic and socio-economic characteristics as well as ideas for sampling improvement.

3.2.2 Question 5: Survey Feedback

The completeness, readability, and confidence of survey respondents are central concerns when creating any survey. To measure these values, the final design included Likert scales which allowed survey respondents to express how comprehensible they found the survey and how confident they felt in their responses.

Table 3.4: Survey Feedback
\

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The survey provided enough information for me to make informed choices	12	19	33	32	9
I feel confident about my answers	1	5	22	55	22
Information in the survey was easy to understand	3	14	21	50	17
I would vote the same way in an actual public vote or referendum	2	2	25	50	26

It is interesting to note that while many respondents felt confident about their answers, there still seemed to be a desire for more information to make better informed choices. Table 3.4 and 3.5 summarize the feedback on survey design collected by question 5. Table 3.4 presents the raw numbers of responses for each question, while Table 3.5 gives the summary descriptive statistics for the same questions.

This characteristic of survey respondents is consistent with previous research team experience and general behavior of survey respondents. That is, survey respondents tend to always want more information- however; the additional information may not necessarily make them more confident in their answers. As shown in Table 3.5, completeness and readability of the survey both received mean Likert scale values of 3.8, while the confidence in responses was closer to 4.0. The respondents tended to rate the information (quantity and quality) somewhat lower, though they were on average quite confident of their answers.

Table 3.5 : Survey Feedback Basic Descriptive Statistics

	Number of Observations	Lowest Value	Highest Value	Median	Mean	Mode	Variance	Standard Deviation
The survey provided enough information for me to make informed choices	5	3	5	3	3.80	3	1.29	1.14
I feel confident about my answers	5	3	5	4	4.00	4	0.69	0.83
Information in the survey was easy to understand	5	3	5	4	3.80	4	1.01	1.00
I would vote the same way in an actual public vote or referendum	5	3	5	4	4.20	5	0.73	0.86

A qualitative review of the survey responses and comments provides a key reason for the low confidence values. A major oversight in the initial design was that residents from each household are commuting to work daily. Unexpectedly, many of the respondents were retired with no regular commute schedule or worked from home and were confused about how to answer the choice questions. Over 45% of the respondents did not work or worked from home, which likely had a large influence on how the questions were posed and the confidence of responses. It was therefore recommended that future distribution of the survey either locate a greater percentage of commute workers or adapt the survey for respondents who do not commute or work from home.

Similar to confidence and readability, the length of the survey affects the reliability and accuracy of the results. An alarming trend where respondents continually ignored the final few pages of the survey indicated that the survey could possibly be taking longer than many of the respondents thought was necessary. Based on this observation, it was recommended that for the full scale implementation, efforts should focus on reducing the overall length of the survey by possibly reducing the number of choice questions or reducing the length of the Likert and demographic information. Additionally, over forty respondents did not fill out the final page of demographic data which was paired on the opposing side with a comments section (See Appendix A-1 for example). It seems as though respondents, after completing the first fourteen pages, saw the comments section and never fully opened the page to reveal more demographic questions on the back side of the page. This could be a function of the length or design, but it was recommended to alter the design by moving the blank pages located at the beginning of the survey to the end.

3.2.3 Question 6: Respondent Priorities

Question 6 asked the survey respondents to identify the importance of several aspects of a public transit system. Tables 3.6 and 3.7 summarize the respondents' prioritization of these aspects. Table 3.6 presents the raw numbers of responses to each question, while Table 3.7 gives the summary descriptive statistics for the same questions. As expected, most attributes were important to individuals, especially vehicle and stop environment safety. Cost to ride, commute time and tax also ranked highly. Vehicle appearance seemed to be the least significant, as it rated moderately important on average. The importance of vehicle appearance also seemed to vary more greatly as it had the highest variance at 1.21.

Table 3.6 :Aggregate Responses of Respondent Priorities

	Not at all Important		Moderately Important		Very Important
Safety in vehicle	1	1	10	23	71
Comfort	4	1	42	36	23
Cost to ride	1	2	25	29	49
Commute Time	3	2	14	30	57
Taxes Paid by my household	1	4	19	23	58
Safety around stop or station	1	1	11	26	68
Vehicle Appearance	7	13	35	34	17

Table 3.7: Characteristics of Respondent Priorities

	Number of Observations	Lowest Value	Highest Value	Median	Mean	Mode	Variance	Standard Deviation
Safety in vehicle	106	1	5	5	4.53	5	0.61	0.78
Comfort	106	1	5	4	3.69	3	0.90	0.95
Cost to ride	106	1	5	4	4.16	5	0.84	0.92
Commute Time	106	1	5	5	4.28	5	0.93	0.96
Taxes Paid by my household	105	1	5	5	4.27	5	0.91	0.76
Safety around stop or station	106	1	5	5	4.51	5	0.58	0.76
Vehicle Appearance	106	1	5	3	3.39	3	1.21	1.10

An interesting interaction is that between place making variables and the importance of vehicle appearance. Residents who place a higher value on stop environment may as a result have higher expectations of vehicle appearance. As a result vehicle appearance was something that was controlled for in Phase II.

3.2.4 Respondent Characteristics

A final concern that arose during the analysis is the very low response rate of segments of the population. As mentioned earlier, many respondents did not have jobs outside the home. The age, commute mode, transit usage response rate distributions were also unsatisfactory in the pilot survey. To identify which subsets of the population needed to be oversampled in order to achieve an acceptable distribution representative of the target area, the following analysis was conducted.

3.2.4.1 *Age Distribution*

The age distribution of the sample reveals a significant overrepresentation of older individuals. Tables 3.8 and 3.9 summarize the age distribution of the survey sample and census information for the City of Meriden. Table 3.8 summarizes descriptive statistics, while Table 3.9 displays age distributions of the survey sample and Meriden. This overrepresentation introduces a significant potential for bias in our survey results. An older sample may be less likely to work, may be on a fixed income, and may have different attitudes towards transit than the other segments of the population. The mean age of sample respondents was found to be 60.1 years, which is significantly higher than the population mean of 38.3 years (Census 2000). The standard deviation of the sample was only found to be 15.7 years. Figure 3.6 and 3.7 illustrate the age distributions of the survey sample and Meriden, respectively. One can see that the sample population mean is not only shifted to the right, but the distribution skewed in that direction as well. Stratified sampling was one consideration for the Phase II sampling plan to obtain a more representative age distribution.

Table 3.8: Age Descriptive Characteristics

Age	Meriden	
Analysis	**Survey Sample**	**Census Data**
Observations	107	-
Measures of central tendency		
Mean	60.14	-
Median	60	38.3
Mode	60	-
Measures of dispersion		
Range		
Lowest Value	25	-
Highest Value	88	-
Variance	245.39	-
Standard Deviation	15.66	-

One can see from Table 3.8 and Figure 3.6, the sample frame does not contain individuals less than 25 years of age. Since the survey was addressed to the heads of households, one would expect non response from individuals less than 19 years of age. However, we do expect to have coverage of the 20 to 24 years old age group. As previously mentioned the non-coverage of this age group was a significant shortcoming of the sample.

Table 3.9 :Age Distribution

Age Distribution	Meriden	
Age Interval	**Survey Sample**	**Census Data**
Observations	107	58,844
Under 5 years	0.0%	6.2%
5 to 9 years	0.0%	6.3%
10 to 14 years	0.0%	5.9%
15 to 19 years	0.0%	7.1%
20 to 24 years	0.0%	6.0%
25 to 34 years	7.5%	13.6%
35 to 44 years	11.2%	15.8%
45 to 54 years	13.1%	15.4%
55 to 59 years	15.9%	6.1%
60 to 64 years	13.1%	4.9%
65 to 74 years	14.0%	5.6%
75 to 84 years	18.7%	4.9%
85 years and over	6.5%	2.2%
	100.0%	100.0%

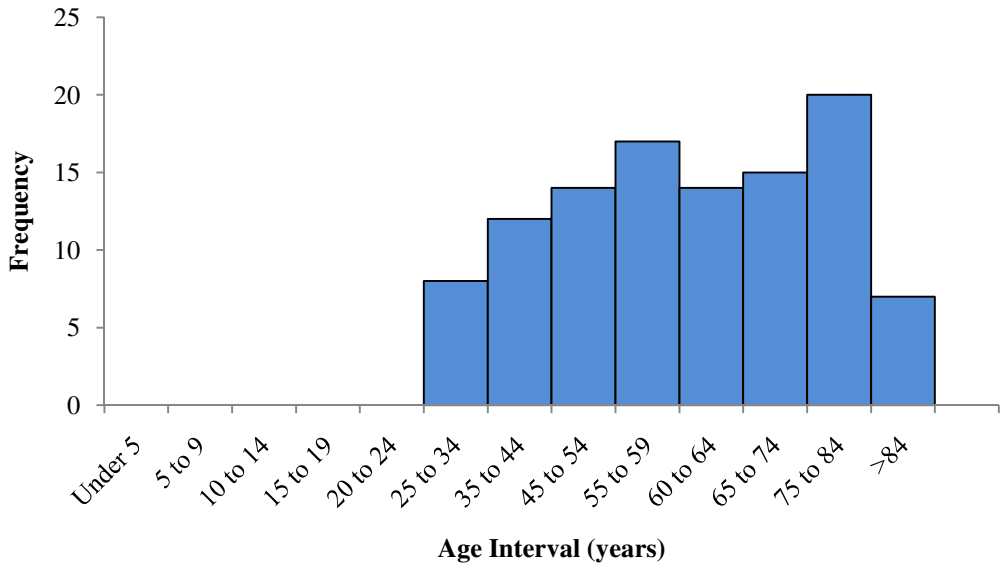


Figure 3.7: Survey Sample Age Distribution

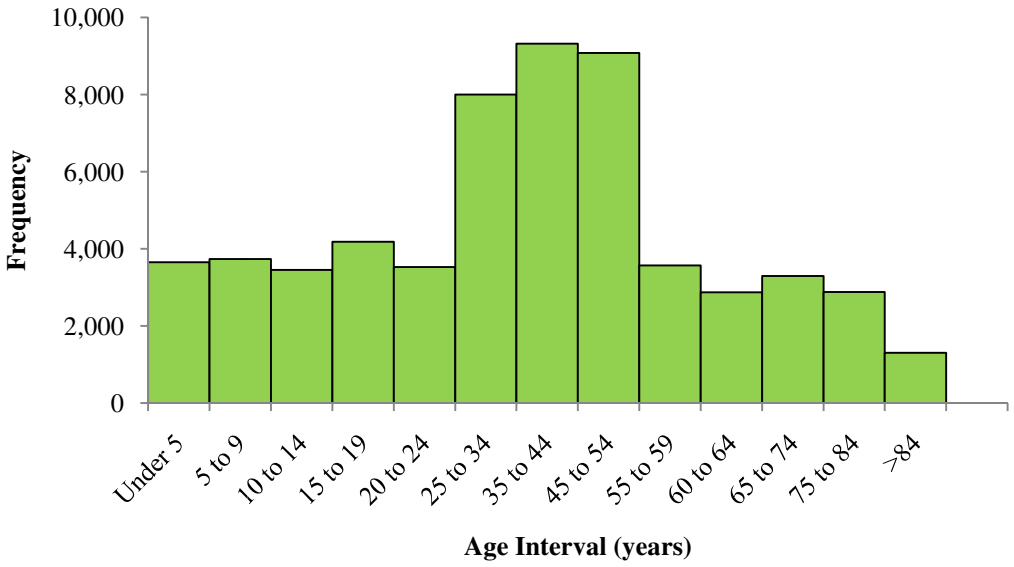


Figure 3.8: Meriden's Age Distribution (Census 2000)

3.2.4.2 *Demographic Interactions*

What follows is an investigation of interactions between demographics and socio-economics that attempts to highlight any impacts the sampling frame would have on responses. The three most salient findings are:

1. An overrepresentation of older individuals
2. A significant bias towards home owners
3. A bias towards both highly educated individuals and high income households

Table 3.10 displays the frequency distribution between age and household income. The crosstab of age vs. income indicates that the majority of survey respondents belong to households that earn greater than the median household income of Meriden. According to the census the median household income of a Meriden resident is $52,000. It is likely that this higher income is due in part to the age distribution of our sample. The underrepresentation of younger adults in our sample very likely excluded some of the lower income households comprised of people at the beginning of their careers in entry-level positions.

Crosstabs are used throughout the remainder of the section to compare demographic and socioeconomic variables and determine how they are interrelated. Variable definitions are placed in the rows and columns. The number in the cells provides a count of the number of people in the response group that have characteristics defined by that row and column. Cells containing percentages show the percent of the respondent's in a demographic group that have characteristics defined by that column. The cells have been conditionally formatted in a two color scale based on their cell values. The color scale ranges from yellow (assigned to the lowest values) to orange (assigned to the highest values). The horizontal grand total is a count of respondents defined by a particular

demographic group. The vertical grand total is the count or percentage of respondents across the entire demographic that exhibit a particular trait or characteristic of interest.

Table 3.10 : Age vs. Income

Age. Interval	Income (in thousands) < $10	$10 - 19	$20 - 39	$40 - 59	$60 - 79	$80 - 99	> $100	Total
25 to 34	0.0%	0.0%	0.0%	16.7%	33.3%	16.7%	33.3%	6
35 to 44	0.0%	0.0%	10.0%	30.0%	50.0%	0.0%	10.0%	10
45 to 54	0.0%	8.3%	0.0%	25.0%	50.0%	0.0%	16.7%	12
55 to 59	0.0%	7.7%	23.1%	15.4%	15.4%	7.7%	30.8%	13
60 to 64	0.0%	9.1%	0.0%	9.1%	36.4%	27.3%	18.2%	11
65 to 74	0.0%	0.0%	33.3%	22.2%	22.2%	0.0%	22.2%	9
75 to 84	0.0%	36.4%	27.3%	18.2%	9.1%	0.0%	9.1%	11
85 and Over	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	1
Grand Total	0	7	11	14	22	5	14	73

3.2.4.3 *Gender Interactions*

Figure 3.8 shows the gender distribution of the survey sample and Meriden. As one can see the sample's gender distribution closely represents Meriden's actual gender distribution.

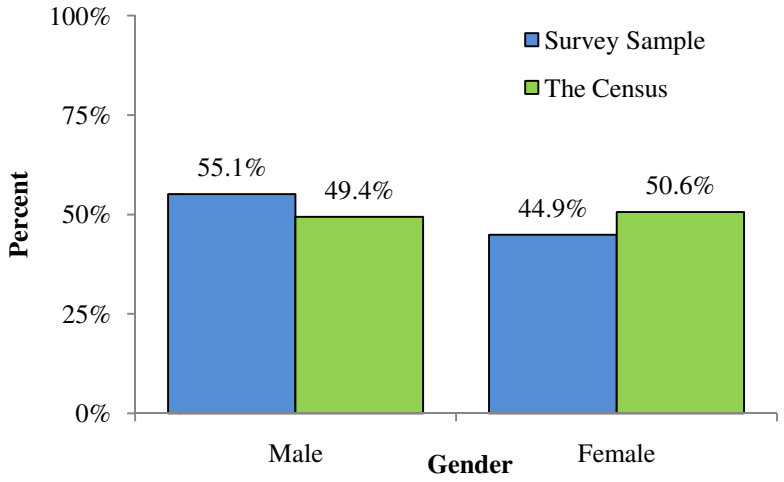


Figure 3.9: Gender Distribution

There appeared to be some discrepancies between genders and the value of attributes in the sample. Table 3.11 shows the frequency distribution between gender and willingness to ride transit. The crosstab implies that females are much more open to riding transit for commute trips to and from work. Approximately 81% of females stated that they would ride a bus or train or at the very least consider it, as opposed to 62% of males.

Table 3.11 : Gender vs. Potential Ridership

Personal Info.	Potential Rider			
Gender	Yes	No	Maybe	Grand Total
Male	31.0%	37.9%	31.0%	58
Female	44.1%	18.6%	37.2%	43
Grand Total	**36.6%**	**29.7%**	**33.6%**	**101**

Males and females also appeared to consider the importance of safety differently. Table 3.12 and 3.13 show gender vs. vehicle safety and station safety, respectively. Crosstab 3.12 suggests females consider vehicle safety more important than men do. The average rating of vehicle safety for females was 4.62 as opposed to 4.45 for males. Crosstab 3.13 suggests females place a higher value on the safety of a stop environment then men do. The average rating of station safety for females was 4.64 as opposed to 4.40 for males, suggesting that in addition to propensity to ride and home ownership status, the gender of respondents may play a significant role in households willingness to pay for placemaking.

Table 3.12: Gender vs. Vehicle Safety

Likert Scale	Vehicle Safety					
Gender	1	2	3	4	5	Grand Total
Male	1.7%	0.0%	8.6%	31.0%	58.6%	58
Female	0.0%	2.1%	10.6%	10.6%	76.6%	47
Grand Total	**1.0%**	**1.0%**	**9.5%**	**21.9%**	**66.7%**	**100.0%**

Table 3.13: Gender vs. Station Safety

Likert Scale	Station Safety				
Gender	1	3	4	5	Grand Total
Male	1.7%	10.3%	32.8%	55.2%	58
Female	0.0%	10.6%	14.9%	74.5%	47
Grand Total	**1.0%**	**10.5%**	**24.8%**	**63.8%**	**100.0%**

3.2.4.4 *Income Effects*

The income distribution of the survey reveals an underrepresentation of low income households and a bias towards very high income households, particularly those with incomes above $100,000. Table 3.14 and 3.15 summarize the household income of the survey sample and Meriden. Table 3.14 presents summary descriptive statistics, while Table 3.15 gives household income distributions. It is important to note that the household income variable is measured on an interval scale and that the income intervals chosen for the survey sample differ from the income intervals the census uses to report household income. Due to the nature of the household income variable the summary characteristics were presented as ranges. It was recommended that in Phase II the categorical options for household income be structured consistent with intervals of the census data. The household income survey question had the highest non response rate, of the 111 surveys returned; only 74 of the surveys returned a value for this item. Given this response it appeared necessary to reiterate that this information is confidential to increase the response for this particular item in future implementations of the survey.

Table 3.14: HH Income

HH Income	Meriden	
Analysis	**Survey Sample**	**Census Data**
Observations	74	234,999
Measures of central tendency		
Mean	61,149	65,009
Median Values	60,000-79,000	52,818
Mode Values	60,000-79,000	50,000-74,999
Measures of dispersion		
Range		
Lower Bound	10,000-19,000	<10,000
Upper Bound	>10,0000	>200,000

Table 3.15: HH Income Distribution

HH Income Distribution	Meriden		
Survey Sample		**Census Data**	
Income Range	Percentage	Income Range	Percentage
< 10	0.0%	< 10	10.2%
10-19	9.5%	10-14	4.4%
		15-24	9.0%
20-39	16.2%	25-34	9.5%
40-59	18.9%	35-49	14.2%
60-79	29.7%	50-74	20.4%
80-99	6.8%	75-99	14.1%
> 100	18.9%	100-149	13.0%
		150-199	3.4%
		>200	1.9%

As one can see in Table 3.14 the mean household income of the survey sample and census data appear to be close however, the sample median is much greater than the median household income in Meriden. Figure 3.9 and 3.10 present the household income distribution for the survey sample and Meriden, respectively. Together Table 3.14, Figure 3.9, and Figure 3.10 show discrepancy in the sample distribution. In the survey sample there are no observations in the left extreme and far too many observations in the right extreme. The sample completely overlooks impoverished and low income households while placing too much weight on high income houses (greater than $100,000). Meriden's poor population may account for the greatest proportion of public transit riders. This is a very difficult group to target, however the response rate for lower income households must be increased to obtain a representative sample. One solution for this was the oversampling of renters within the full scale implementation to not only eliminate the property owner bias, but also promote a more representative income distribution. The survey also oversampled high income households. The danger associated with oversampling high income houses is that they will be much less sensitive towards the project attribute "Cost to Your Household" than average income houses. Since our survey measures the value of transit oriented development and place making attributes through ballots for hypothetical projects, an overrepresented wealthy population can be expected to considerably influence results.

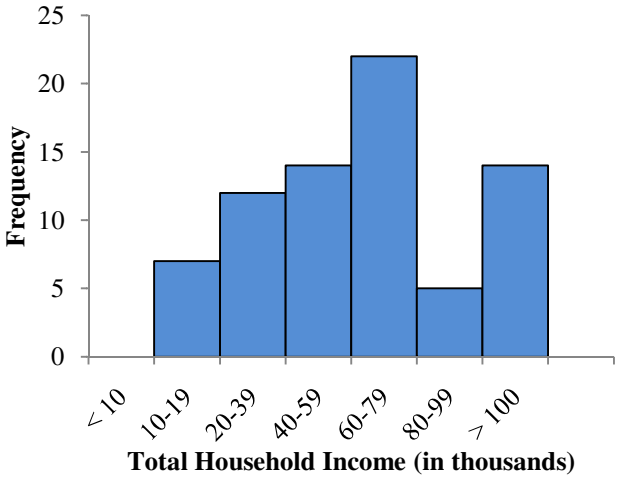


Figure 3.10: Sample Household Income

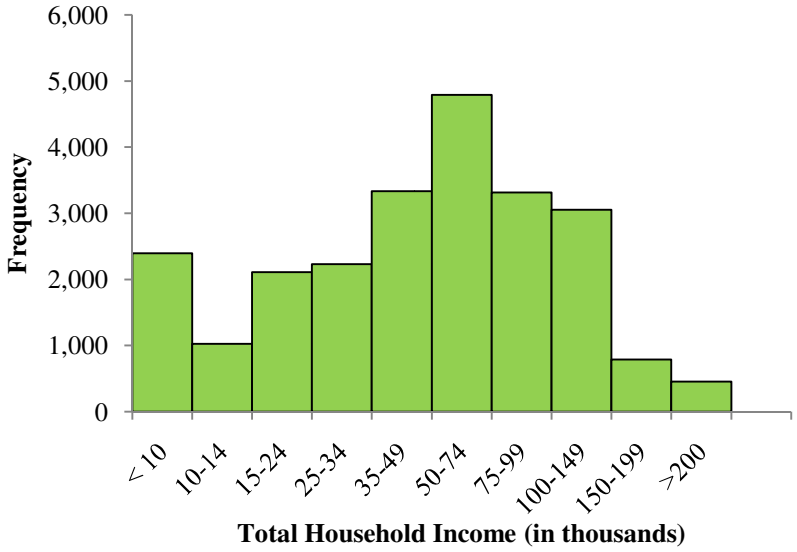


Figure 3.11: Meriden Household Income Distribution

3.2.4.5 *Educational Attainment*

The educational distribution of the sample reveals a bias towards individuals with high levels of education. Figure 3.11 shows the distributions of educational attainment for the survey sample and Meriden residents. As one can see from the figure, there was an oversampling of highly educated people. According to the census data, 73% of Meriden resident's highest educational attainment is less than that of an Associate's degree. These residents can be expected to have lower incomes, fewer cars, and be more likely to be renters than homeowners. To overcome this upwards educational bias, it is hypothesized that by targeting a more representative sampling frame with respect to age and home ownership, the education bias can be mitigated.

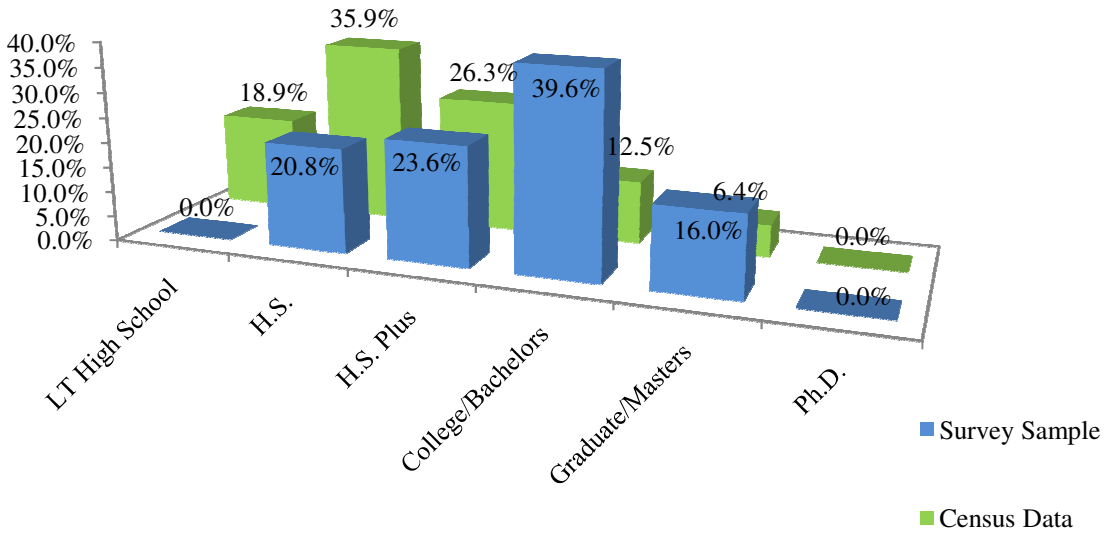


Figure 3.12: Distributions of the Levels of Educational Attainment in Meriden

3.2.4.6 *Home Ownership Interactions*

The sample distribution between home owners and renters revealed a significant bias towards owners. Figure 3.12 shows the sample distribution of owners and renters to census data for Meriden. The sample population overestimates the number of property owners by 22%.

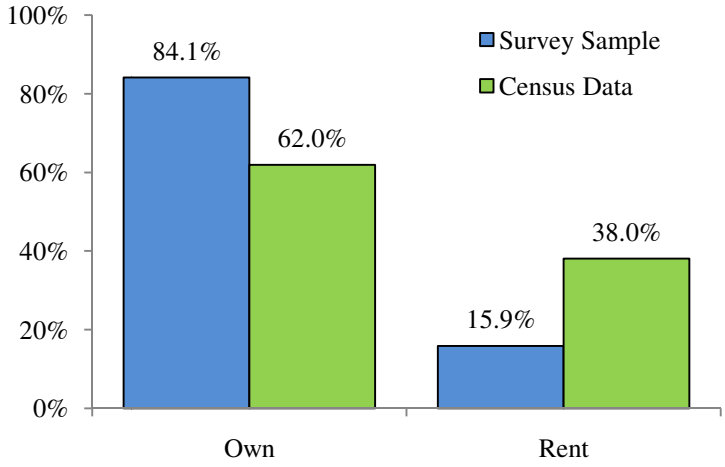


Figure 3.13: Home Ownership Distributions

The population ratio of property owners to renters is approximately 1.6 whereas the sample ratio is much greater at 5.3. Renters are likely to have lower incomes, fewer cars, and lower levels of education than property owners.

Tables 3.16a and 3.16b show the frequency distribution of property ownership to education. As one can see from the tables, property owners are more likely to be highly educated than renters. Table 3.16b. shows that 56% of the renters sampled have less than a college education, whereas for owners this percentage is 42%. Owners in our sample tend to be more educated with 58% having some college at least, whereas for renters the figure is 44%. This lends support to the hypothesis that the education bias can be addressed, at least in part, by a sampling plan designed to correct the owner/renter bias.

Table 3.16: Household Ownership vs. Education (Count)

Personal Info.	Education				
Owner/Renter	HS or =	HS + Tech	College or B.S.	Grad or Masters	Grand Total
Own	18	20	35	17	90
Rent	4	5	7		16
Grand Total	22	25	42	17	106

Table 3.17: Household Ownership vs. Education (Percentage)

Personal Info.	Education				
Owner/Renter	HS or =	HS + Tech	College or B.S.	Grad or Masters	Grand Total
Own	20.0%	22.2%	38.9%	18.9%	90
Rent	25.0%	31.3%	43.8%	0.0%	16
Grand Total	**20.8%**	**23.6%**	**39.6%**	**16.0%**	**100.0%**

Table 3.17 shows the frequency distribution of property ownership and household size. The mean household size in Meriden is 2.47 persons while the median and mode were both 2 persons. The mean household size of the sample was found to be 2.05 persons. The owners HH Size distribution closely represents the Census data while the renters HH Size is skewed significantly to the left. This may have considerable implications for transit demand. Overall small household unit sizes may have an effect on the value of transit. Renters with single person households and cars will have lower demands for transit. Additionally, an older household is likely to have fewer members than a younger household. It was hypothesized that addressing age and owner/renter representation in Phase II sampling would help mitigate household size bias.

Table 3.18:Household Ownership vs. Household Size

Personal Info.	Personal Info.HH Size (in persons)					
Owner/Renter	1	2	3	4	5	Grand Total
Own	20	46	14	8	2	90
Rent	11	6				17
Grand Total	**31**	**52**	**14**	**8**	**2**	**107**

Table 3.18 shows frequency distribution of property ownership to the consideration of transit for commute trips to work. The results are particularly interesting in that property owners appear to be more evenly divided on the consideration of transit for commute trips. Whereas the majority of renters stated they would at least consider transit for

commute trips. Over 80% of renters considered using transit for commute trips. Based on the recommendations of (*Yannes et Al.*, 2010) and this sample frame analysis, the question of "Would you ever consider using a bus or train for your commute to work" was reconstructed for the second distribution of the survey. The original phrasing limited the positive response to work-based commute trips as opposed to trips of any purpose. An important part of Phase II was to discern whether respondents would consider riding the hypothetical service for trip purposes other than commuting. The evidence suggested that again, addressing owner/renter representation in the Phase II sample would have secondary effects – such as producing a sample with a larger portion of respondents willing to consider transit.

Table 3.19: Household Ownership vs. Consideration for Transit

Personal Info.	Consider Transit			
Owner/Renter	Yes	No	Maybe	Grand Total
Own	37.6%	31.8%	30.6%	8
Rent	31.3%	18.8%	50.0%	16
Grand Total	36.6%	29.7%	33.7%	100.0%

As previously revealed there was a large bias towards higher income households and property ownership. Table 3.19 shows the frequency distribution of property ownership to household income. Table 3.19 illustrates the income disparity between property owners and renters, lending evidence to support the hypothesis that renters are likely to be lower income households, have fewer cars, and lower levels of education than property owners. This emphasizes the need to oversample renters to attain more representative income and educational attainment distributions.

Table 3.19: Household Ownership vs. Income

Personal Info.	Income (in thousands)						
Owner/Renter	$10 - 19	$20 - 39	$40 - 59	$60 - 79	$80 – 99	> $100	Total
Own	5.0%	11.7%	20.0%	31.7%	8.3%	23.3%	60
Rent	30.8%	30.8%	15.4%	23.1%	0.0%	0.0%	13
Grand Total	**9.6%**	**15.1%**	**19.2%**	**30.1%**	**6.8%**	**19.2%**	**100.0%**

Table 3.20 shows the frequency distribution of property ownership to commute time. There did not seem to be a major difference in commute times for property owners and renters. However, it does present an interesting question; "Do the majority of property owners live in the suburbs and work in neighboring cities" and "Do renters choose to live in the vicinity of their workplaces." A future frequency distribution of home owners and/or renters versus commute time could identify whether home owners and/or renters choose Meriden as a place of Residence because it is in the proximity of their workplace. If this is true, homeowners/and or renters may not find the rail or express bus service a viable option for their commute trip. This again highlights a lesson from the pilot design: it is important not to constrain transit patronage solely to commute trips. To address this, it was proposed to include a plan of the New Haven Hartford Springfield (NHHS) line, a local map of Meriden clearly indicating the access to the line, and a question asking the respondent to specify the purpose (if any) they would use the service in the Phase II survey. This would effectively provide respondents with more plausible scenarios and as a result produce more realistic responses.

Table 3.20: Household Ownership vs. Commute Time

Personal Info.	Commute Time					
Owner/Renter	< 10	10 - 20	20 - 30	30 - 45	> 45	Total
Owner	54.0%	17.5%	25.4%	3.2%	0.0%	63
Renter	50.0%	28.6%	14.3%	7.1%	0.0%	14
Grand Total	53.2%	19.5%	23.4%	3.9%	0.0%	100.0%

Since our survey measures the value of transit oriented and place making attributes through ballots for hypothetical projects, the sensitivities of home owners and renters towards transportation costs is also of interest. Several discrepancies were found between property owners and renters towards the importance of transportation costs. Tables 3.21, 3.22, and 3.23 show the frequency distribution of property ownership to the cost to ride, commute time, and cost to household, respectively. As one might expect, renters placed a greater importance on fare prices then property owners. Surprisingly, renters placed a greater importance on travel time than property owners. Property owners placed a greater importance on the taxes to their household than renters did. While travel time and fare were later removed from the choice experiments to accommodate other attributes they became important context and control variables in the survey redesign.

Table 3.21:Household Ownership vs. Cost to Ride

Likert Scale	Fare					
Owner/Renter	1	2	3	4	5	Grand Total
Owner	0.0%	2.3%	25.0%	29.5%	43.2%	88
Renter	5.9%	0.0%	17.6%	11.8%	64.7%	17
Grand Total	1.0%	1.9%	23.8%	26.7%	46.7%	100.0%

Table 3.22:Household Ownership vs. Cost of Time

Likert Scale	Travel Time					
Owner/Renter	1	2	3	4	5	Grand Total
Owner	2.3%	2.3%	14.8%	29.5%	51.1%	88
Renter	5.9%	0.0%	5.9%	23.5%	64.7%	17
Grand Total	2.9%	1.9%	13.3%	28.6%	53.3%	100.0%

Table 3.23: Household Ownership vs. Cost to Household

Likert Scale	Taxes					
Owner/Renter	1	2	3	4	5	Grand Total
Owner	0.0%	3.4%	19.3%	19.3%	58.0%	88
Renter	6.3%	6.3%	12.5%	31.3%	43.8%	17
Grand Total	1.0%	3.8%	18.3%	21.2%	55.8%	100.0%

3.2.5 Conclusions

While age was the largest bias in the pilot survey results, income, education, and property ownership were also shown to exhibit significant biases. To achieve a representative age distribution it was necessary to explore alternative methods of sampling (i.e. sample stratification to place greater weight on the younger population) and delivery (i.e. electronic delivery). One possibility to overcome the property ownership bias was to oversample renters. It was believed a secondary effect of oversampling younger age cohorts and renters would be the mitigation of the income and education biases.

Through (*Yannes et Al.*, 2010) findings and the sample frame analysis it was recognized that the application of the survey tool in other areas could quantify the regional differences and identify areas which support transit with and without the integration of community development policies. It is believed that as knowledge and implementation of transit systems proliferate, increasing support will create more positive avenues to fund more transit ventures which create a vibrant and sustainable environment for citizens.

Addressing the recommendations of (*Yannes et Al.*, 2010) and the sample frame analysis resulted in a much more comprehensive and realistic paper-based survey instrument. Front matter was added to the survey instrument to introduce the hypothetical transit service and subsequently a number of context and control variables, two of which (fare and travel time) had previously been attributes included in the choice experiments. However, the front matter came at expense to the survey respondent. The redesigned survey was not only anticipated to increase the time to for respondents to complete the survey, but it was also expected to be much more intellectually demanding of respondents; with fare and travel time proving the most difficult to implement requiring respondents to look up values through the use of figures and tables.

After considerable deliberation and discussion of the alternatives the paper-based design was abandoned in favor of an electronic delivery method. Electronic delivery had several advantages. It allowed for the creation of an adaptive survey to deliver very unique and personal experiences. Adaptive context and control variables allowed for a higher level of immersion of respondents and made hypothetical scenarios presented appear much more plausible. Adaptive context and control variables helped increase comprehension of the survey by presenting the information in a much clearer and concise manner. This consequently decreased the time required to complete the survey. Lastly, it increased the response rate reliability with the provision of supplemental information to respondents who had questions and prevention of respondents from submitting incomplete surveys.

To obtain a more representative sample of Meriden and ensure future samples were representative of their respect populations, it was decided that the electronic delivery would best be done in person as an intercept survey; realizing that the in person intercept survey could be conducted in public locations, such as grocery stores, libraries, malls, and transit stops as many days as necessary in order to obtain a representative sample. Phase II methodology describes the synthesis of these recommendations into a final survey design.

4.0 PHASE II: FULL-SCALE SURVEY IMPLEMENTATION

Phase II of the project provided and extension and expansion of the pilot study during which the survey instrument was refined and tested on a focus group. The pilot study utilized a useful design, which was structured around commuters, this however alienated segments of the population, such as people who are unemployed, retired, do not work, or work from home. For such respondents, concepts like time in vehicle (defined relative to respondents' current commute) became irrelevant and confusing. Phase II sought to overcome this shortcoming by allowing respondents to select the kind of trips they would most likely make using the service. Significant components of phase II of the study included:

- Categorization of placemaking into component variables
- Introduction of two new survey attributes; parking and service reliability
- Focus group testing
- Changes in survey design and delivery medium
- Describing a hypothetical transit service

The remainder of provides the methodology behind these components, in addition to the econometric modeling process which was omitted from the discussion in Phase I.

4.1 SURVEY ATTRIBUTES

4.1.1 Placemaking Image Categorization

In the pilot study, (*Yannes et Al., 2010*) estimated the public's willingness to pay for placemaking in a public transportation system through a choice experiment categorizing placemaking into two types; good and poor place making. As knowledge and implementation of transit systems with good placemaking proliferate, increasing support will create more positive avenues to fund more transit ventures which incorporate these features of good placemaking. They found that placemaking is an important attribute of the built environment as it fosters the creation of good public spaces. (*Yannes et Al., 2010*) identified the need to break the placemaking variable in the choice experiment into its component variables such that different levels of placemaking could be defined by different features of placemaking.

After further analysis, three levels of placemaking (relative to a base level or the existing conditions of much of urban space) were identified to separate the placemaking variables used in (*Yannes et Al., 2010*) choice experiments into component variables. A number of digitally altered images were selected to represent these levels of place making. The images had to be plausible environments for the survey locations (i.e., no palm trees in Connecticut). A summary of these placemaking variables can be seen in Table 4.1. The levels are further described and depicted in the following sections.

Table 4.1: Summary of Placemaking Features

Placemaking Features	Level of Placemaking			
	Poor (Base)	Fair	Good	Very Good
Wider Sidewalks	×	✓	✓	✓
Improved Lighting	×	✓	✓	✓
On-street Parking	×	✓	✓	✓
Reduced Building Setback	×	×	✓	✓
Street Trees & Greenery	×	×	×	✓

4.1.1.1 *Poor Placemaking (Baseline)*

The poor level of placemaking is considered to be the reference level. It is essentially the existing conditions before the placemaking variables are introduced into the built environment. None of the placemaking variables are included in this level. It is portrayed by images containing narrow sidewalks, utility lines, poor lighting, no trees, and large building setbacks. Figures 4.1 shows the images selected to represent the base level. A closer look at the image shows several undesirable features: sidewalks which are narrow, unconcealed power and utility lines and very wide travel lanes which make these spaces unfriendly for pedestrians.

Figure 4.1: Images Selected to Depict Poor Placemaking

4.1.1.2 *Fair Placemaking (Level 1)*

The first level of placemaking is depicted by images with wider sidewalks and improved lighting (relative to that of the reference level) and the addition of on-street parking. Figure 4.2 illustrates the effects of these features on images of poor placemaking. The wider sidewalks and improved lighting make the images in Figure 4.2 appear safer to pedestrians. The addition of on-street parking helps to reduce the effective width of travel lanes and tends to cause drivers to reduce their travel speeds. It also acts as a barrier protecting pedestrians from vehicles on the roadway.

Figure 4.2: Images Selected to Depict Fair Placemaking

4.1.1.3 *Good Placemaking (Level 2)*

The second level of placemaking alters the images of the first level of placemaking reducing the setbacks of buildings. Figure 4.3 illustrates urban spaces with wider sidewalks, on street parking, improved lighting and reduced building setbacks.

Figure 4.3: Images Selected to Depict Good Placemaking

4.1.1.4 *Very Good Placemaking (Level 3):*

The third level of placemaking is also the highest level of placemaking and is characterized by images containing all the selected features of good placemaking, i.e. wider sidewalks, on street parking, reduced building setbacks, street trees and improved lighting. Figure 4.4 shows images of urban spaces which combine all the features of good placemaking.

Figure 4.4: Images Selected to Depict Very Good Placemaking

4.1.2 Selection of the Remaining Attributes for Choice Experiments

As fare was found to be insignificant in the pilot survey and the survey was no longer structured around respondent's commutes (making change in travel time relative to a respondents commute irrelevant) new attributes had to be considered for the choice experiments. Service reliability and parking were chosen to enter into the choice experiment (in place of fare and travel time), alongside four of the attributes from the pilot study: service type, placemaking, comfort and cost to household. There were again six attributes included in the final choice experiment design. Table 4.2 lists each of the attributes and the levels at which they were investigated in the final survey design. The following section provides formal definitions for the attributes and explains their overall significance.

Table 4.2 : Survey Attributes and Levels .

Attribute	Level	Description
Service Type	1	**Express Bus**
	2	**Commuter Rail**
Placemaking	1	**Poor**
	2	**Fair**
	3	**Good**
	4	**Very Good**
Parking	1	**Free**
	2	**Not free**
Reduction in Service Reliability	0	**0**
	1	**0.01**
	2	**0.05**
	3	**0.15**
	4	**0.25**
Comfort	1	**High**
	2	**Low**
Cost to Household	1	**$100 per year**
	2	**$175 per year**
	3	**$240 per year**
	4	**$275 per year**

4.1.2.1 *Service Type*

(Ben-Akiva and MoriKawa, 2002) investigated public preference for rail travel over bus using both stated reference and revealed preferences data. They found no significant preference for rail over bus when the service characteristics, such as cost and travel time, were equal. In the current study, survey respondents were presented with two hypothetical services that used the same right of way in the same travel corridor. The inclusion of this attribute provides more insight into the issue of the existence of any public bias towards rail travel.

4.1.2.2 *Reduction in Service Reliability*

Transit service reliability is a primary factor affecting transit service quality and passenger satisfaction *(TCRP Report 47,1999)*, as it affects passenger wait times and total travel times *(Bates et al.,2001)*. It has also been shown that reliability affects travelers' valuation of transit service and ultimately their mode choice decisions *(TCQSM, 2003)*. The most common measures of transit service reliability are on-time performance and followed headways between vehicles (*Paliska and Starrin, 2006)*. This study uses the on time performance as the measure of service reliability. On-time performance of the hypothetical service is defined similar to what is used in the Transit Capacity and Quality of Service Manual *(TCQSM, 2003)*: the probability the transit service arrives within 0 to 5 minutes of the scheduled or expected time.

The levels of the service reliability variable were defined, using level of service measures (LOS) for on-time performance from (*TCQSM, 2003)* as a guideline. The levels were coded in the model as a percentage reduction in service reliability from a baseline reliability (100%) or the assumed reliability of a personal automobile.

4.1.2.3 ***Comfort***

Comfort of transit service affects the user's perception of the quality of the transit service and impacts mode choice decisions *(TQCSM, 2003)*. Transit users' perceptions of comfort are dependent on a variety of factors, including the availability of seating, crowding of vehicles, cleanliness of transit vehicles and stops, safety at stops, agreeability of temperatures, required transfers, etc. The private automobile is perceived by most travelers as the most comfortable mode of transportation. The levels of the comfort attribute were defined using the system described in *(Espino et al., 2007)*, the same system adopted in *(Yannes et al., 2010*) with high comfort being comparable to that of a private automobile

4.1.2.4 ***Parking***

Parking referred to whether parking at a respondent's chosen final destination would be free or not free if he or she chose to drive instead of utilizing the proposed transit service. The "not free" level of parking was not defined by any specific dollar amount. *(Hess, 2001)* investigated the effects of free parking on commuter mode choice for work trips and found that the cost of parking has a major influence on commuter mode choice. The parking attribute was included because it was hypothesized to be a primary motivator of decisions to utilize transit and influential in the perception of the value of a service and its effect on the built environment.

4.1.2.5 ***Cost to Household***

The cost to household in this study captures the hypothetical increase in annual household taxes as a result of implementing a particular transit project. The cost to household was calculated based on an increase in rate of the town property taxes and then a single monetary sum was calculated for this, increase to help provide respondents a better understanding of this monetary value. This cost was one that was incurred by respondents whether or not they chose to utilize the transit service.

4.2 FOCUS GROUPS

Focus groups are small discussions conducted to assist in the development of survey material. Usually, a moderator guides these discussions according to a predetermined agenda. After the placemaking attribute had been broken down into its component variables, the remainder of the attributes selected, and the front matter finalized, a third focus group was conducted to evaluate the survey delivery method and to gain a better understanding of respondent's perceptions of and reactions to the survey. The agenda of the focus group is shown below:

(10 min.)	Brief Introduction (No questions solicited)
(55 min.)	TASK 1:
	Survey Delivery Method Evaluation
	Front Matter Presentation
	Guided Survey Discussion
(55 min.)	TASK 2:
	Discussion of Transit and Placemaking Images
(5 min.)	Wrap-up – Background on the project

The discussion lasted approximately two hours, in which valuable insight was gained into public perception and use of public transportation. The next sections describe the tasks and responses of participants in more detail.

4.2.1 Task 1: Survey Delivery Method Evaluation

The purpose of the first task was to obtain feedback regarding our electronic delivery method. Focus group participants were given a power point presentation of the introductory material (front matter) of the electronic intercept survey planned to be implemented in the New Haven – Hartford – Springfield (NHHS) corridor. Focus groups were required to listen to a narration, slide-by-slide and answer questions as if they were participating in the actual survey. Respondents were subsequently asked to comment on the technical aspects of delivery, such as slide design, the clarity of pictures, and the legibility of font. The discussion then shifted to the content of the presentation, to determine whether enough information was provided for respondents to confidently answer questions. It was also used to identify areas where people were having difficulty comprehending what they were being asked to do. It was imperative that the process of describing the individual's hypothetical trip was presented in a logical manner and that there was a natural progression to the questions being asked. The discussion also gave a sense of how comfortable people felt providing the research team with the information they were being inquired about.

Overall, the focus group highlighted the significant difficulty in describing anticipated trip-making behavior without the provision of supplemental information, such as modal choices and local geography. While describing trip making behavior at the destination end appeared to be a trivial process for individuals who currently utilized public transit to frequent their destinations, individuals whose travel behavior would be altered by the hypothetical passenger service found it to be much more difficult to describe the latter portion of their trip. This concern was addressed in the final survey by allowing respondents to select their hypothetical trip from a pre-defined list of common trips along the corridor.

4.2.2 Task 2: Discussion of Transit and Placemaking Images

Task 2 directed the discussion around two distinct image packets. One packet centered around images of transit vehicles and the other images of placemaking. Respondents were shown several images of transit vehicles and given time to individually review them and then respond to a series of questions such as: What strikes them most about the transit vehicles? What features that most stand out? What are their expectations of transit vehicles and the service they would provide?, Where they would expect to find them operating? Could they imagine the transit vehicle operating in Connecticut? The questions helped identify images which represented realistic express bus and commuter rail vehicles for the NHHS corridor. A sample of the images discussed in the focus group can be seen in Figure 4.5.

Figure 4.5: Images of Transit Vehicles Selected for the Focus Groups

A similar process was used to assess the extent to which individuals recognized the features that characterized the levels of placemaking. Focus group participants were shown pairs of images of locations thought to be similar to the ones in their community and then given a few minutes to review each pair and write down any comments that they might have had. Focus group participants were next asked to identify the features of the images which stood out most at each location, describe each location in their own words, and to compare the locations (i.e. identify the features which distinguished the first location from the second location). The focus group substantiated that individuals were able to perceive and categorize the features of placemaking consistent with the study's definitions.

4.3 FINAL SURVEY DESIGN

After comprehensive analysis of the pilot study and intensive focus group testing the final survey was ready for design. Figure 4.6 shows the major components of the 2010 Transportation Survey. To see the survey in its entirety see Appendix A-2. The following section describes the platform most compatible with the final survey design, in addition to each of the components.

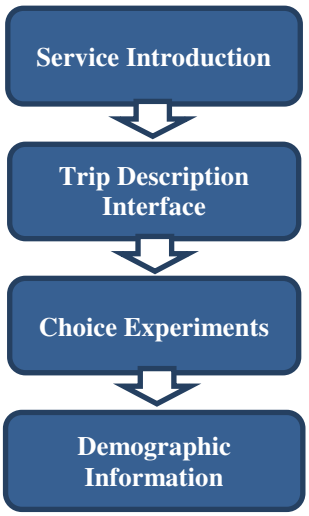


Figure 4.6: Flow Chart of the 2010 Transportation Survey

4.3.1 Survey Instrument Design

The final survey was designed as an electronic intercept survey. An intercept survey is an in-person format in which surveys are distributed on-site, attempting to intercept a representative cross-section of the population of interest. Site selection is an important consideration, as survey locations that cater to specific demographic or socioeconomic groups may bias survey results. Electronic delivery was deemed the most appropriate method of disseminating the survey because it allows the flexibility of nesting questions, lessens the paperwork and material burden, and speeds the delivery of a survey. The focus group helped confirm this notion, expressing the need for the provision of information on destinations accessible via the hypothetical transit service – meaning that the survey team must be able to quickly and accurately display information on a variety of potential trips to respondents in the field.

LimeSurvey was selected for the survey software platform. Lime survey is an open-source survey application based on the Hypertext Preprocessor (PHP) development language and requires no previous knowledge of coding to develop, deliver, and collect responses to surveys, making it the ideal platform for such a large team of researchers. The software allows for the creation of an unlimited numbers of surveys and questions in a survey, and can accommodate any number of participants.

Limesurvey's most desirable features in respect to this project were its wide array of question types, very straight forward integration of pictures, skip logic and branching capabilities, token control, advanced templating and its ability to collect data anonymously. All LimeSurvey versions of the 2010 Transportation Study were designed around a standard laptop and tablet computers. The survey was hosted on a University of Connecticut engineering server and therefore required a constant connection to the web to conduct the survey and record data. To ensure uninterrupted wireless access at all survey locations, the team used mobile wireless hotspots.

4.3.2 Service Introduction

The service introduction consisted of characterizing a new hypothetical public transportation service. In order to accomplish this, respondents were first shown the right of way and service route of the new public transportation service. The new service was specifically referred to as a passenger service throughout the survey so that the service type attribute could be incorporated into the subsequent choice experiments. The respondents were then informed that two transportation alternatives were currently under consideration, an express bus service and a commuter rail service. It was emphasized that both services would use the same right of way along the same corridor. To control respondents' perceptions of the transportation alternatives, they were provided with pictures and brief descriptions of typical vehicles utilized by each of the services. After the presentation of this new material, respondents were asked if they could imagine themselves making a trip using either of the transportation alternatives for the proposed passenger service.

4.3.3 Trip Description Interface

The trip description interface was used to collect information on trip making behavior of potential riders as well as convey specific control variables such as service fare and travel time. If the respondent could imagine him or herself using the passenger service, a series of questions were presented to explore his or her trip making behavior. The survey offered respondents two distinct means of describing the final leg of their trip: building a trip or selecting from a predefined list of trips. The former was intended to describe a trip made frequently by the respondent and the latter for describing a trip that the respondent would likely make if the new passenger service was in place. A screener question was used to determine which trip description method was most suitable for each respondent. Figure 4.7 illustrates the flow of the survey for those who could imagine using the service, presenting the major decisions a respondent may be asked to make in addition to the type of information solicited.

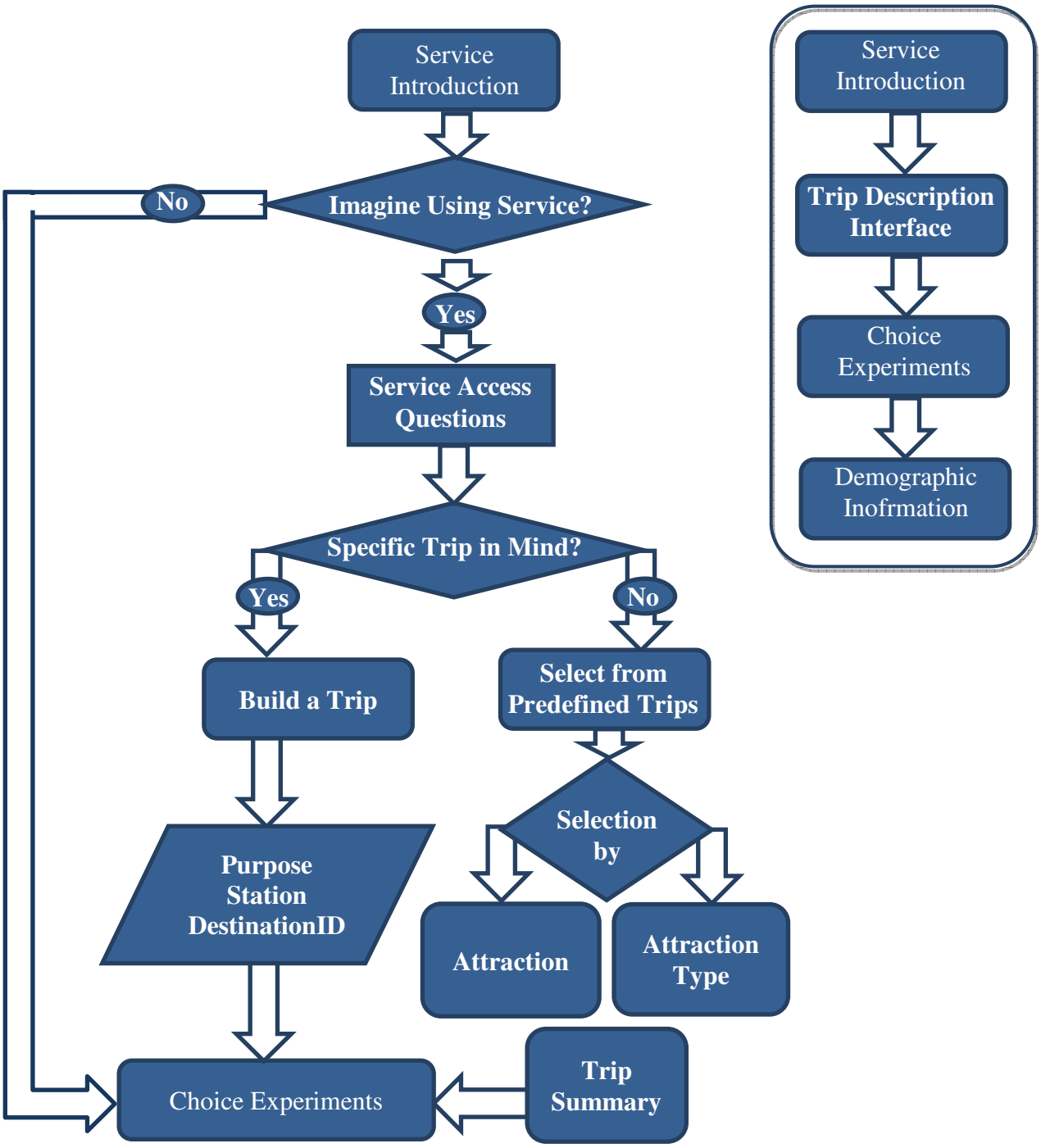


Figure 4.7: Flow Chart of Trip Description Interface

4.3.3.1 *Building a Trip*

To effectively navigate the "Build A Trip" interface, respondents needed to be very familiar with the physical geography between the transit station and their final destination. This option presented respondents with a set of questions intended to elicit total travel times from origin to destination. The "Build A Trip" interface was included in this survey specifically because it is well suited to describe commuter trips. However, it is also a useful tool for respondents who currently use public transit or make frequent trips to a specific destination well suited for public transit. Appendix 1 shows a slideshow of this process.

4.3.3.2 *Selecting from a Set of Predefined Trips*

Predefined trips were intended for respondents who could imagine using the passenger service but were unsure of the type of trip they would make using the proposed service. First, respondents were asked to select a city along the passenger service line and then a specific attraction within that city. If respondents did not like any of the listed attractions, they were asked to select a trip purpose (or attraction type) and a generic trip was described to them. After a destination was selected, a page summarizing important control variables was displayed (time on the passenger service, access time, and the total cost). Appendix 2.25 depicts this process.

4.3.4 Choice Experiments

Once attributes included in the choice experiments and their levels were finalized, an experimental design was developed. The purpose of an experimental design is to determine the appropriate number of and combination of choice sets. Choice sets are scenarios provided for evaluation by respondents in the choice experiments. In this choice experiment the choice sets consisted of two alternative transit projects, project A and B. Each transit project was described by one level of each attribute included in section 4.1.2 of this report. After weighing the alternatives respondents were asked to choose between one of three alternatives: to vote for project A, project B, or neither project. Respondents were asked to vote similarly to the way they would if this were a real, binding, public referendum. An example of the choice questions is shown in figure 4.8

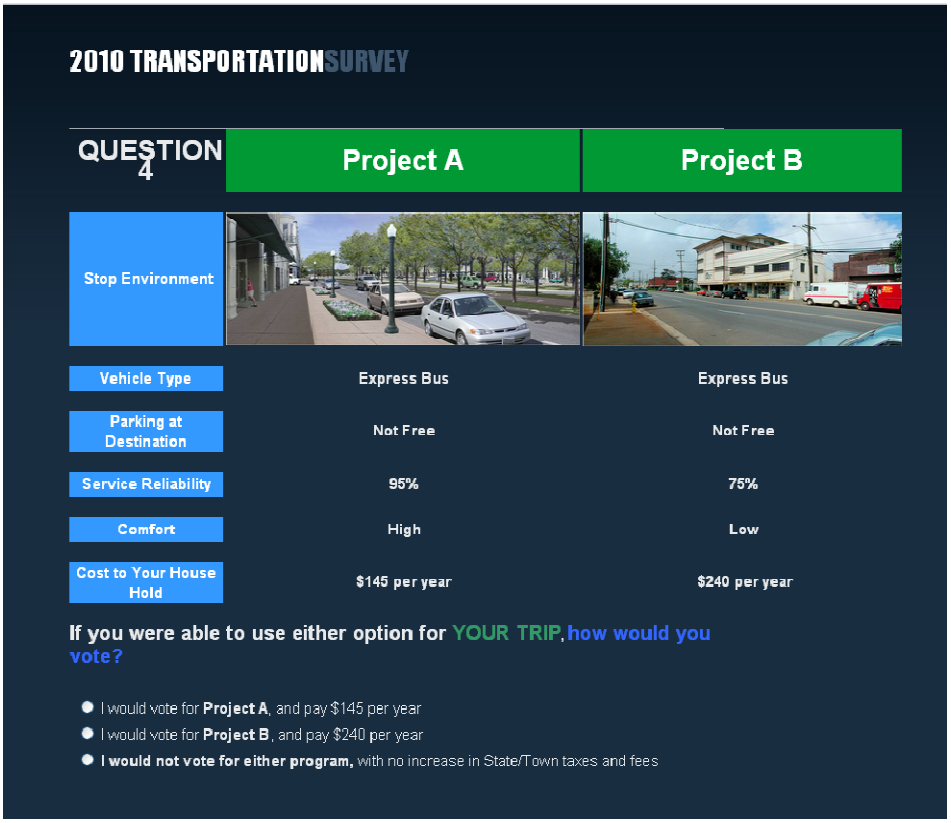


Figure 4.8 Example of Choice Experiment Used In Survey

4.3.4.1 *Experimental Design*

Choice sets viewed by each respondent were developed using an experimental design optimized using a D-efficiency criterion. The experimental design in a Stated Preference (SP) study is to ensure orthogonality and balance among attribute levels, such that parameters may be estimated efficiently with observations over a limited number of choice sets *(Hensher,* 1994*).* In practice, however, some degree of correlation and/or imbalance is usually present due to specifics of the choice context which constrain the design (e.g., some combinations that are infeasible in practice and hence must be excluded from choice sets). D-optimal designs are preferred to standard orthogonal factorial designs because, among other advantages, they can reduce the number of runs of the experimental design *(NIST,2010).* The design was constructed to maintain similar estimation efficiency for the main effects and interactions. A total of 64 choice sets were included in the design. Blocking was achieved by randomly assigning four choice modeling questions to each survey to arrive at a total of 16 unique versions of the survey. Participants in this study were randomly assigned a version of survey which determined the choice questions they answered.

The resulting 16 survey versions present respondents with various combinations of the levels of the attributes. This ensures that respondents are (over the course of several hundred responses) comparing and contrasting many different combinations of attributes – which allows the analyst to estimate the value of these attributes using econometric procedures.

4.4 DATA COLLECTION

Data collection for the 2010 Transportation Survey commenced in May, 2010 and continued throughout November. Data was collected in several communities along the proposed NHHS commuter rail line corridor, including: Wallingford, Meriden, Hartford, Enfield, and Springfield. The primary sites of data collection in these communities were public libraries and grocery stores. Candidate survey locations were chosen based on their proximity to the proposed locations of transit stations for the NHHS commuter rail line and subsequently contacted to obtain permission to administer the stated preference survey on their premises. Data collection typically took place over a period of three days at each location to allow for adequate sample size.

4.5 MODEL ESTIMATION

A total of 299 responses were obtained from the 2010 Transportation Survey. This resulted in a total of 1196 observations, as each respondent was required to answer four choice questions per survey. After collection, the Stated Preference (SP) data was prepared for analysis using LIMDEP v9.0, an econometric analysis software capable of estimating conditional logit models. The conditional logit model is an extension of the multinomial logit model with the basic difference between the two models being that, the conditional logit model uses the characteristics of the alternatives, rather than the attributes of individuals, to model expected utility *(Hoffman and Duncan, 1988).* In the estimation of a conditional logit model, the explanatory variables; the characteristics of alternatives, are not constant but vary across alternatives.

The estimated conditional logit model assumes that a survey respondent *i*, with a vector of demographic attributes "*X*", faced with a set of alternatives *J,* will choose an alternative $j \in J$ with the maximum utility "U_{ij}" defined as:

$$U_{ij} = U(Z_{ij} C_{ij} D) = V(X_{ij} C_{ij}, D) + \varepsilon_{ij} \qquad (4\text{-}1)$$

Where:

$U(.)$	utility function
C_{ij}	Household cost of alternative *j* for survey respondent *i*
Z_{ij}	vector of attributes of alternative *j* for survey respondent *i*
$\boldsymbol{D}$	vector characterizing community and demographic attributes
$V(.)$	deterministic, estimable part of utility
ε_{ij}	stochastic part of utility modeled as a random error
j	indexes of choice response A,B or Neither

The random component of utility (ε_{ij}) is assumed to be identically and independently distributed across the utilities. It has a standard type I extreme value distribution with a density function given by: $f(\varepsilon_{ij}) = e^{-e^{-\varepsilon_{ij}}}$. The probability that a survey respondent "*i*" chooses an alternative *j* is therefore given by:

$$P_{ij} = \frac{exp(\beta \cdot Z_{ij})}{\sum_{n=1}^{J} exp(\beta \cdot Z_{ij})} \quad (4\text{-}2)$$

Where:

$\boldsymbol{\beta}$ = vector of utility co-efficient or parameters for Z_{ij} attributes.

5.0 FINDINGS

The major findings in phase two of the study are summarized in the following sections under two main topic areas

5.1 CONTINGENT VALUATION OF BUILT ENVIRONMENT

The first analysis used data collected from Meriden and Wallingford in June and July of 2010. The results of the main effects conditional logit estimation with interactions is presented in Table 5.1 and corresponds to the utility specification:

$$V = \beta_{ST} * \boldsymbol{ST} + \beta_{SR} * \boldsymbol{SR} + \beta_C * \boldsymbol{C} + \beta_P * \boldsymbol{P} + \beta_{CH} * \boldsymbol{CH} + \beta_{SN} * SN \quad \textbf{(5-1)}$$
$$+(\beta_{FP} + \beta_{FP*MI} * MI) * \boldsymbol{FP} + (\beta_{VP} + \beta_{VP*R} * OR) * \boldsymbol{VP}$$
$$+(\beta_{GP} + \beta_{GP*MI} * MI + \beta_{GP*HI} * HI + \beta_{GP*ST} * ST + \beta_{GP*OR} * OR) * \boldsymbol{GP}$$

Table 5.1 : Conditional Logit Model Parameter Estimates with Interactions (Initial Data Set)

Variable	Abbreviation	Coefficient (β)	t-stat
Commuter Rail service	ST	0.8471	**3.610**
Service Reliability	SR	-3.1643	**-3.351**
Fair Placemaking	FP	0.7763	**3.091**
Good Placemaking	GP	0.7607	**1.992**
Very Good Placemaking	VP	0.7080	**2.291**
Low Comfort	C	-0.4634	**-3.080**
Parking Fee at destination	P	-0.6889	**-4.472**
Cost to Household	CH	-0.0087	**-6.831**
Alternative Specific Constant	SN	-2.6048	**-7.569**
Good Placemaking * Renter	GP*R	-1.5872	**-2.731**
Very Good Placemaking * Renter	VP*R	-1.1860	**-2.950**
Fair Placemaking * Mid Income Household	FP*MI	-1.3234	**-2.990**
Good Placemaking *Mid income Household	GP*MI	1.1261	**1.879**
Good Placemaking *High income Household	GP*HI	1.4712	**2.317**
Good Placemaking *Commuter Rail	GP*ST	-0.6883	**-1.686**
ρ^2		**0.1635**	
No. of Observations		**452**	

Notes*: All variables included in model significant at 0.95 level, Model significant at 1% level (χ^2=289.433,df=15)*

The willingness of an individual to pay for the service related attributes in a transit system is shown in Figure 5.1. Willingness-to-Pay (WTP) in the context of this choice experiment is the annual increase in taxes and fees an individual is willing to pay for a particular attribute; mathematically it is defined as the ratio of the coefficient of an attribute to the coefficient of the cost to a household.

Figure 5.1: Willingness to Pay for Service Related Attributes in a New Transit System

Determining the existence of public preference for either express bus or commuter rail is an important tool included in the survey instrument. The results of the study reveal that the public does have a statistically significant preference for commuter rail service over express bus service; all other attributes held constant, households were willing to pay $97 more for a commuter rail service. This contrasts what was found in *(Ben-Akiva and Morikawa, 2002)* and (*Yannes et al,. 2010).* This is hypothesized to be a result of how the surveys employed in the studies were structured. Both *(Ben-Akiva and Morikawa, 2002)* and *(Yannes et al, 2010)* structured their studies in the context of respondent's commutes, whilst the 2010 Transportation Survey was not structured around any one type of trip, accounting for all types of users. It is hypothesized that commuters are primarily concerned about travel time and place less importance on other attributes of transit service and that this accounts for the differences between the findings of this study and the two previous studies. . The results to some extent agree with *(Tennyson, 1989)* which found a higher potential ridership attraction for rail transit than equivalent bus service. *(Tennyson, 1989)* found no evidence for this bias from the data used in it, but based on other studies and reports, identified reasons such as the delineated rail transit stops which provided more protection and were stable and the comfort of rail vehicles as possible reasons for the existence of the bias. The 2010 Transportation Survey compliments the bias found by *(Tennyson, 1989)* by incorporating data from potential non-riders. The bias towards commuter rail service over express bus service found by this research implies that there may be intrinsic value to rail services over bus services in communities.

[1] Service reliability relative to 70%

Furthermore, the research shows that for each percent reduction in service reliability, households were willing to pay $3.63 less than they would for a 100% reliable service, and as much as $91 less for a service that was only 75% reliable. This emphasizes the importance of transit service reliability to the public. This has interesting implications for pricing policy in transit systems. The survey tool can be used to estimate the value of service reliability to users in transit systems and justify fare increases for consumers.

Along with service type and service reliability, the comfort of the travel alternative was found to be an important service attribute. The WTP for more comfortable systems was found to be $54 per year per household.

Both residential ownership and total household income were hypothesized to have an influence on individuals WTP for the different levels of placemaking. To test this hypothesis, two demographic variables, household ownership and income, were interacted with the various levels of placemaking. Respondents were categorized as either property owners or renters and their total household income was classified into one of three groups, low, middle, and high. Separating survey responses on the basis of residential ownership and income helped to quantify the value, different subsets of the public placed on the community development potential of public transportation. The WTP for these interactive relationships can be seen in Figures 5.2 and 5.3 and summarized in Figure 5.4.

Figure 5.2 illustrates the effect of income on a household's willingness to pay for placemaking. As one can see, owners considered good placemaking worth $87 more in taxes, while middle and high income households, considered good placemaking worth $217 and $257 more, respectively. Renters exhibited a similar trend. Renters who considered good placemaking worth $95 less in taxes, while middle and high income renters, considered good placemaking worth $34 and $74 more, respectively. The figure suggests that willingness to pay for placemaking increases with income, regardless of whether a household owns or rents their place of residence.

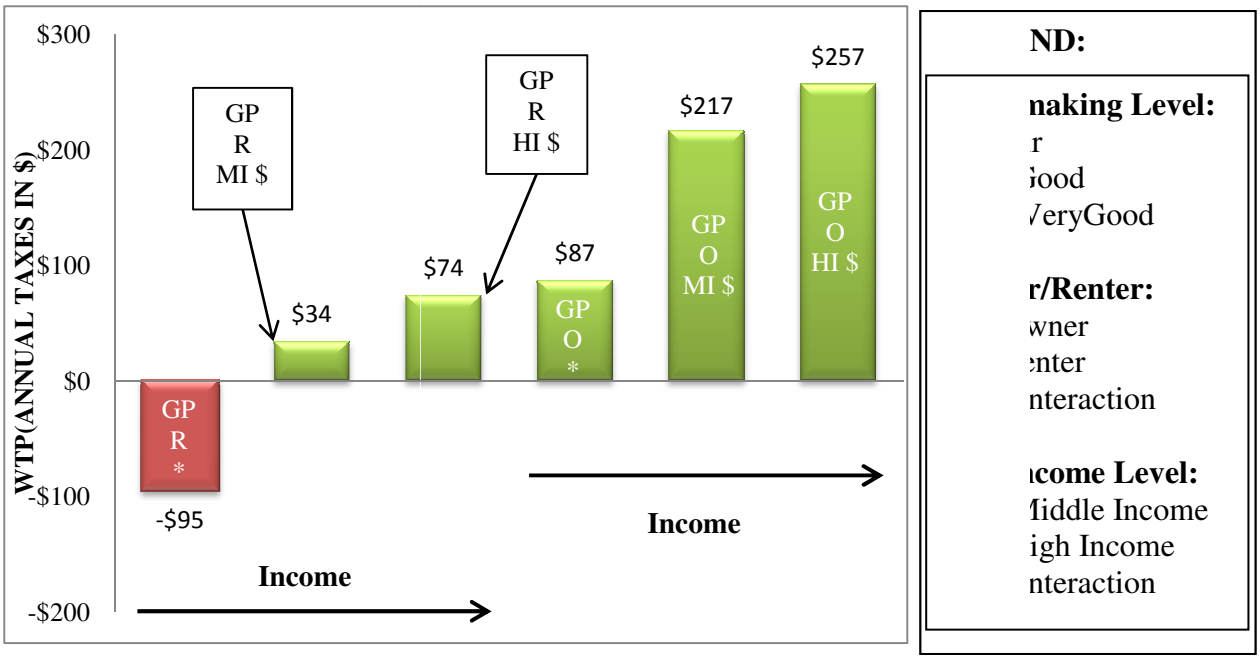


Figure 5.2:An Individual's WTP for a Level of Placemaking Increases with Income[2]

Figure 5.3 suggests that households which own their place of residence are more willing to pay for placemaking while households who rent are less willing to play for placemaking. These results are intuitive because owners may consider good and very good placemaking as part of community development and therefore a profitable investment offering a return on property value. Renters with short term leases would not likely realize the benefits of placemaking in their community.

Figure 5.3: Owners are More Willing to Pay for Placemaking While Renters are Willing to Pay Less

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Figure 5.4 summarizes all significant interactions in the estimated model. It suggests that, overall, renters have a somewhat more negative view of good and very good placemaking. It also reveals that, depending on the income of the household, households are willing to support some features of placemaking in the stop environment and the amount they are willing to pay is closely related to their income. Middle income households were willing to pay $63 less in taxes to support to support systems with fair placemaking. While the very good level of placemaking contains all of the features of the good level in addition to street trees and greenery, individuals of all income levels were willing to pay less in taxes for very good placemaking with everything else being held constant. One viable explanation for this could respondent's perception of street trees and greenery as purely aesthetic and/or lavish in comparison to the features of placemaking which have clear safety implications, like improved lighting, on-street parking and sidewalks. This is further supported by the fact that only owners were willing to pay more for very good placemaking in their community. The public's overwhelming willingness to pay for good placemaking over the other levels suggests that there exists a hierarchy of placemaking features

[2] The interaction labels can be interpreted as follows: the first row contains an abbreviation for the level of placemaking, the second row an abbreviation for whether a household owned or rented their place of residence, and the third row an abbreviation for a household's total annual income.

and that this hierarchy is dependent upon the perceived practical utility of placemaking treatments and less on their aesthetics.

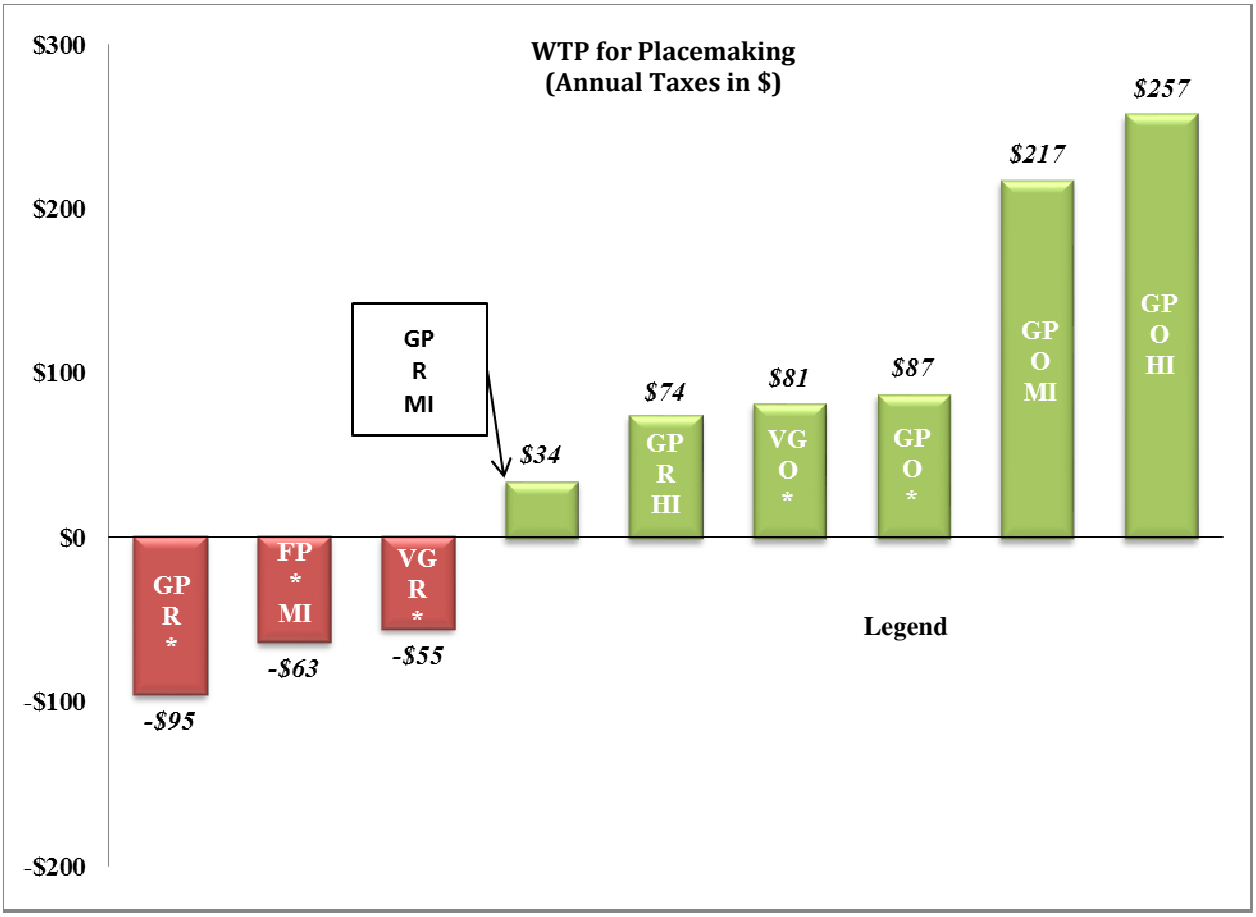

Figure 5.4: The Effect Household Ownership and Income on the Willingness to Pay for Placemaking

The importance of freely available parking was a recurring theme in the research. Focus group participants suggested their patronage of the hypothetical service was dependent on the disincentives of traveling via personal auto. Intuitively, one would expect the unavailability of free parking at the final destination to deter drivers from choosing personal auto, making them more inclined to use public transit. However, the coefficient on the parking variable was negative. From the results, it appears that there was a general misunderstanding of the parking attribute. Two possible explanations for the sign of this coefficient are travelers' general sensitivity to parking fees and the misinterpretation of the parking attribute as the cost of access-end parking. People may have associated the unavailability of free parking as exclusive to a project instead of as an attribute of their destination's built environment, in which case the sign of the coefficient on the parking attribute and its significance are to be expected. The latter suggests that just the existence of parking fees at a transit station results in a reduction in households' WTP by $79. The presentation of this attribute was addressed in the fall data collection sessions.

The SN variable, typically referred to as the Alternative Specific Constant (ASC) captures the systemic, welfare-relevant aspects of policy changes that are not reflected in the presented choice attributes *(Kerr and Sharp 2006)*. In the current model specification, the ASC incorporates effects of omitted levels for a variety of dummy variables (omission was required to avoid the "dummy variable trap")—for example the utility associated with bus transit and high comfort—as well as the utility when no program is selected. The ASC may also imply that respondents may be weighing service attributes and costs not addressed by this survey, though its inclusion in the final model specification is left to the analyst's judgment *(Rolfe, 2006)*. For this reason, there is no single interpretation of the statistically significant coefficient for the ASC, other than as the residual systematic increment to utility when all model variables are set at zero.

5.2 URBAN AND SUBURBAN PERCEPTION OF TRANSIT STOP BUILT ENVIRONMENT

The second analysis uses the complete data set (Data collected from Meriden,Wallingford, Hartford, Enfield and Springfield over the course of six months) to generate a main effects and interacted conditional logit model. The results of the main effects conditional logit model are presented in Table 5.2 and correspond to the following utility specification:

$$V = \beta_{ST} * \boldsymbol{ST} + \beta_{SR} * \boldsymbol{SR} + \beta_{FP} * \boldsymbol{FP} * + \beta_{VP} * \boldsymbol{VP} + \beta_{C} * \boldsymbol{C} + \beta_{P} * \boldsymbol{P} + \beta_{CH} * \boldsymbol{CH} + \beta_{SN} * SN \quad \textbf{(5-2)}$$

Table 5.2 : Main Effects Conditional Logit Model Estimates (Complete Data Set)

Variable	Abbreviation	Coefficient (β)	t-stat
Commuter Rail Service	ST	0.2251	2.009
Service Reliability	SR	1.6376	3.369
Fair Placemaking	FP	0.2806	2.679
Very Good Placemaking	VP	0.1246	1.095
Low Comfort	C	-0.2336	-2.957
Parking Fee at destination	P	-0.4226	-5.420
Cost to Household	CH	-0.0065	-10.059
Alternative Specific Constant	SN	-2.294	-12.985
ρ^2		.07233	
Log Likelihood		-988.8927	
No. of Observations		1023	

Notes*: All variables included in models are significant at 90%, Model significant at 90% confidence level (χ^2=154.204, df=8)*

Figure 5.5 shows the willingness to pay for all attributes in the main effects and helps to illustrate the trade-offs between attributes of transit service. The results of the study again reveal that there is a significant preference for rail service relative to an express bus service supporting the hypothesis that rail has intrinsic value to communities. All else being equal, tax payers were

willing to pay $35 more for a commuter rail service than an equivalent express bus service in the NHHS corridor.

Figure 5.5:Willingness to Pay to for Service Attributes and Attributes of the Built Environment (Complete Data Set)

The results also indicate an increase in utility for transit service with an increase in service reliability relative to its reference level, this agrees with the previous findings. Individuals were willing to pay $63 more per year to guarantee the on-time arrival of transit vehicles. Furthermore, it was found that individuals would be willing to pay $2.51 per unit increase in reliability over 75%.
Both a reduction in comfort and an increase in cost to household resulted in a utility reduction for the transit option. Individuals were willing to pay $36 less in annual tax dollars for transit systems less comfortable than the private auto. It is interesting to note that fair placemaking is worth more to individuals ($43) than high comfort ($36). This suggests individuals place a greater weight on out-of-vehicle comfort than in-vehicle comfort. This parallels how individuals weigh out-of-vehicle and in-vehicle travel time.

The coefficient on parking remained negative; suggesting that the existence of a parking fee at individual's final destination would reduce utility for the transit service and, in effect, their willingness to pay for transit projects. It appears that there was still a misunderstanding of the parking variable by respondents. Yet, this may have significant policy implications. Introducing new transit projects while simultaneously altering parking policy around major destination areas may have adverse effects. New out-of-pocket costs (like parking fees) may inhibit taxpayer's ability to weigh the long-term benefits offered by such transit projects Fair and good placemaking were found to be significant with fair placemaking having a slightly larger marginal effect on utility than very good placemaking. Quantifying the value of placemaking was a major goal of this research. The research establishes that transit is more valuable to individuals when the quality of the stop environment is considered. It was found that individuals were willing to pay a total of $62 more in annual taxes to improve the quality of the transit stop environment in their communities. However, good placemaking was not found to be significant, suggesting that

the public is not willing to pay for some forms of placemaking around transit stops. Individuals were found to place a higher value on fair placemaking than very good placemaking, with a willingness to pay value of $43 compared to $19, further supporting the fact that some forms of placemaking are more valuable than others.

The results of the main effects model suggest that individuals are more willing to pay for features of placemaking, such as wider sidewalks, improved lighting, and on-street parking, that increase safety or enhance individual's perceptions of safety *(Ivan et. al.,2010)*. It is believed that these features account for the higher willingness to pay value for fair placemaking, the level which offers these basic improvements. Policy makers and transportation planners should recognize that transit will accrue greater support if safety elements of placemaking are incorporated into the stop environment.

Individuals' willingness to pay for very good placemaking (the addition of reduced building setbacks and street trees to fair placemaking components) suggests that individuals place some value on the addition of aesthetic features to the built environment. This suggests that apart from elements that can be perceived as providing safety at the transit stop, the public cared about certain aesthetic elements which could make their travel to and time spent at the transit stop more comfortable and relaxing.

Interestingly, the public did not place significant value on good placemaking (the first level including reduced building setbacks.) This somewhat contradicts what was found in the first analysis. It is possible that individuals did not perceive the safety benefit of reduced building setbacks, however after further analysis, subtle differences were found between the original and complete data sets. The original data set was comprised of choice experiment data collected from residents of Wallingford and Meriden, two communities with comparable geographies. The complete data set added choice experiment data collected from residents of Enfield, Hartford, and Springfield to that of Meriden and Wallingford. The urban form of even the most downtown areas of Meriden and Wallingford differ greatly from that of Hartford and Springfield. This led the research team to believe geography, and more specifically the urban form of communities played a role in individual's willingness to pay for placemaking. It is possible that good placemaking, a level which includes fair placemaking in addition to reduced building setbacks, would not be valuable to individuals who live in Hartford and Springfield as many of the buildings are already adjacent to the street.

As previously mentioned, individual's geographic location was hypothesized to have a significant effect on the utility of and willingness to pay for placemaking in a transit stop environment. Communities were categorized as urban or suburban, based on the population density (persons per sq. mile) in the vicinity of proposed transit stops. The population density of the survey location was used as proxy to measure the urbanity of the area in vicinity of the transit stop or the area over which placemaking was being valued by a community, because it was readily available and could be easily interpreted. A closer analysis of the distribution of demographic variables specifically, population density in survey locations, income, tenure (renters versus ownership of homes) and gender was conducted using census data (*US Census Bureau 2010*) , to determine if the geographic indicator variable was possibly capturing the variation in these demographic variables across the survey locations. These are displayed graphically in figure 5.6 and 5.7.

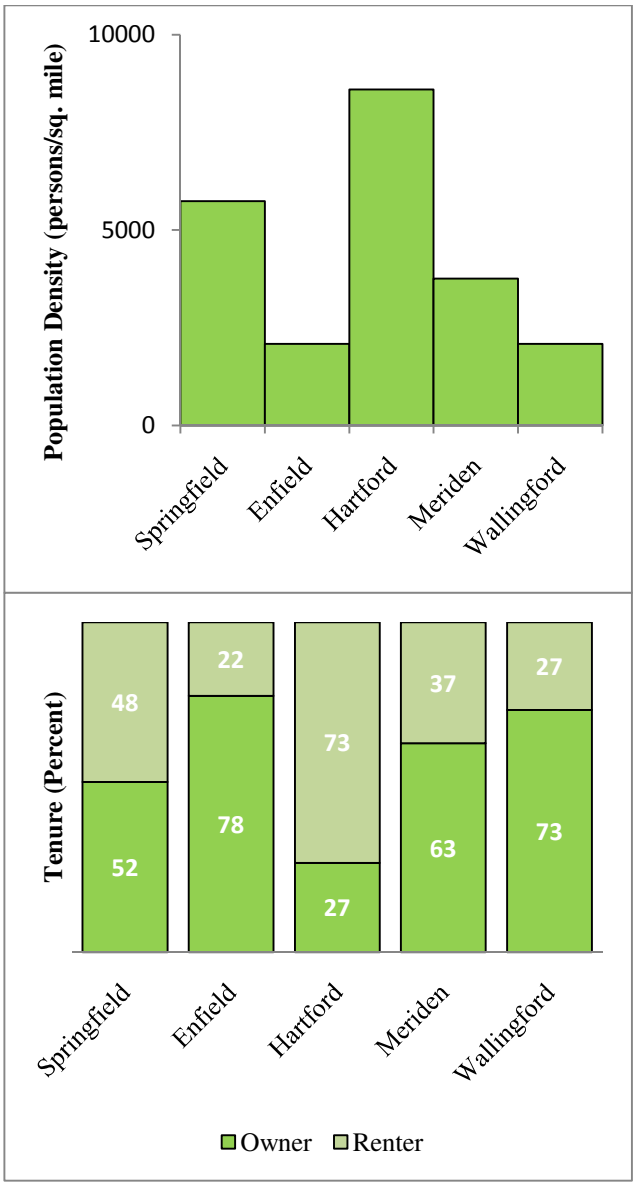

Figure 5.6: Population Density (Left) & Household Ownership (Right) for Study Locations

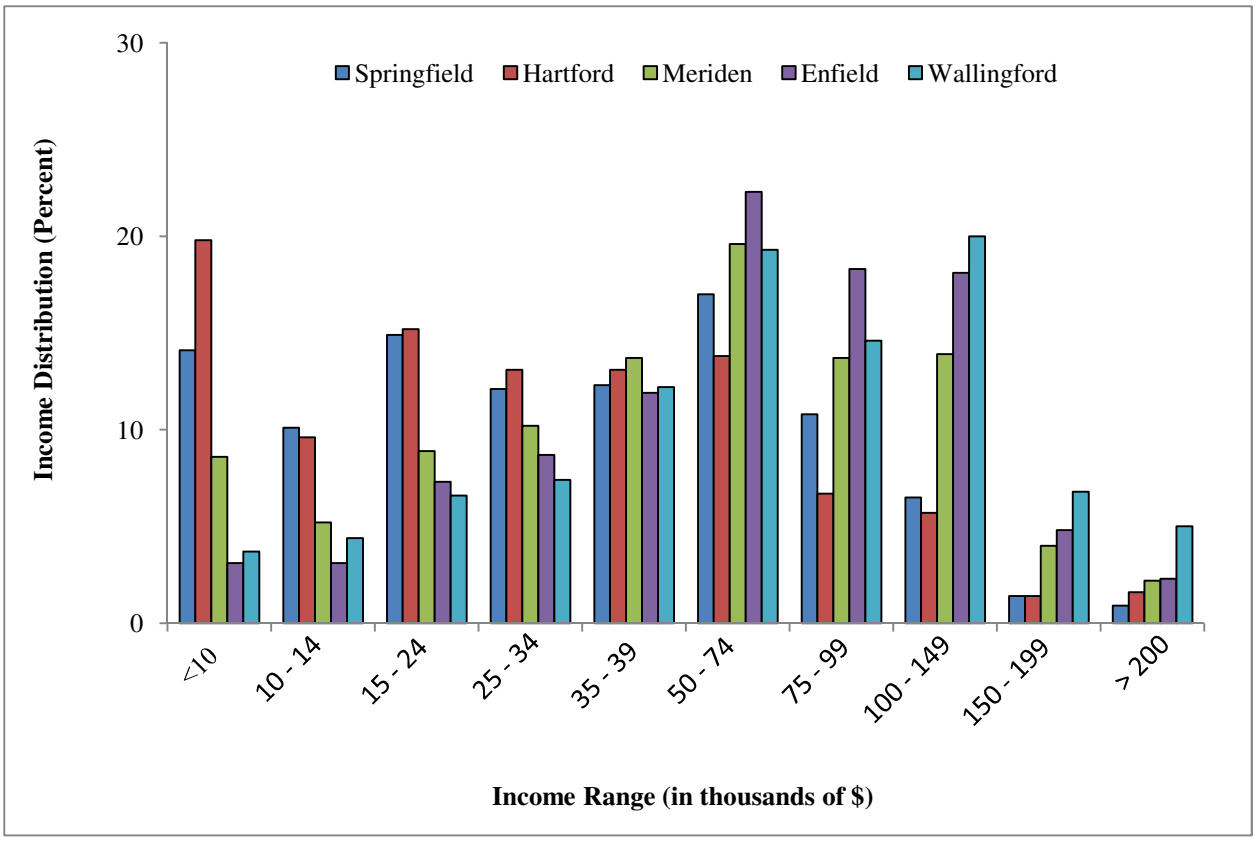

Figure 5.7: Income Distributions for Study Locations

The population density appears to be relatively similar in Springfield and Hartford, while Enfield, Meriden and Wallingford display similarities in density. The distribution of owners of homes in Enfield, Meriden and Wallingford also looks to be higher than that in Hartford and Springfield locations. The gender distribution from the census appeared to be the similar from city to city with very little variation. Similarly for income distribution, the three cities; Meriden, Wallingford and Enfield seem to have very close income distribution which varies from that in Springfield and Hartford. Based on these results, Meriden, Enfield and Wallingford were categorized as suburban whilst Springfield and Hartford were classified as urban locations.

Table 5.3 summarizes the levels of the geographic indicator variable used in the estimation of the interaction model and its corresponding utility specification shown below this table. The results of the estimation of interaction variable are summarized in table 5.4.

Table 5.3: Summary of Geographic Indicator Variable

Interaction Variable	Abbreviation	Level	Description
Geographic Indicator	GI	0	Urban
		1	Suburban

Notes: 0 = Reference Level

$$V = \beta_{ST} * \boldsymbol{ST} + \beta_{SR} * \boldsymbol{SR} + (\beta_{FP} + \beta_{FP*GI} * GI) * \boldsymbol{FP} + (\beta_{GP} + \beta_{GP*GI} * GI) * \boldsymbol{GP} \quad \textbf{(5-3)}$$

$$+(\beta_{VP} + \beta_{VP*GI} + \beta_{VP} * GI) * \boldsymbol{VP} + \beta_C * \boldsymbol{C} + \beta_P * \boldsymbol{P} + \beta_{CH} * \boldsymbol{CH} + \beta_{SN} * \boldsymbol{SN}$$

Table 5.4: Interaction Conditional Logit Model with Geographic Indicator Variable

Variable	Abbreviation	Coefficient (β)	t-stat
Commuter Rail Service	ST	0.2342	2.07
Service Reliability	SR	1.6656	3.40
Fair Placemaking	FP	0.7553	4.83
Good Placemaking	GP	0.5491	3.43
Very Good Placemaking	VP	0.5519	3.35
Low Comfort	C	-0.2597	-3.23
Parking Fee at destination	P	-0.4497	-5.65
Cost to Household	CH	-0.0067	-10.28
Alternative Specific Constant	SN	-2.2842	-12.42
FP * Geographic Indicator	FP*GI	-0.8004	-3.905
GP * Geographic Indicator	GP*GI	-0.7534	-3.55
VP * Geographic Indicator	VP*GI	-0.7237	-3.26
ρ^2		0.0854	
Number of Observations		1023	
Log likelihood at convergence		-982.7087	

Note: All parameters significant at 90%.Model significant at 90% confidence level (, χ^2=182.249, df=12)

The results of the model show a disutility for placemaking in suburban environments relative to that of an urban environment. However it is worth mentioning that the reductions in the marginal effects of the geographic interactions terms on placemaking cannot be interpreted alone but must be interpreted along with the main effects of placemaking variables found in the interaction model. The willingness to pay chart in figure 5.8 suggests that individuals in urban communities are much more willing to pay for the benefits of placemaking than those in suburban communities. Individuals who live in urban communities are more likely to use non-motorized modes to access transit stops and therefore would be expected to place a greater value on the built environment than individuals accessing it by automobiles.

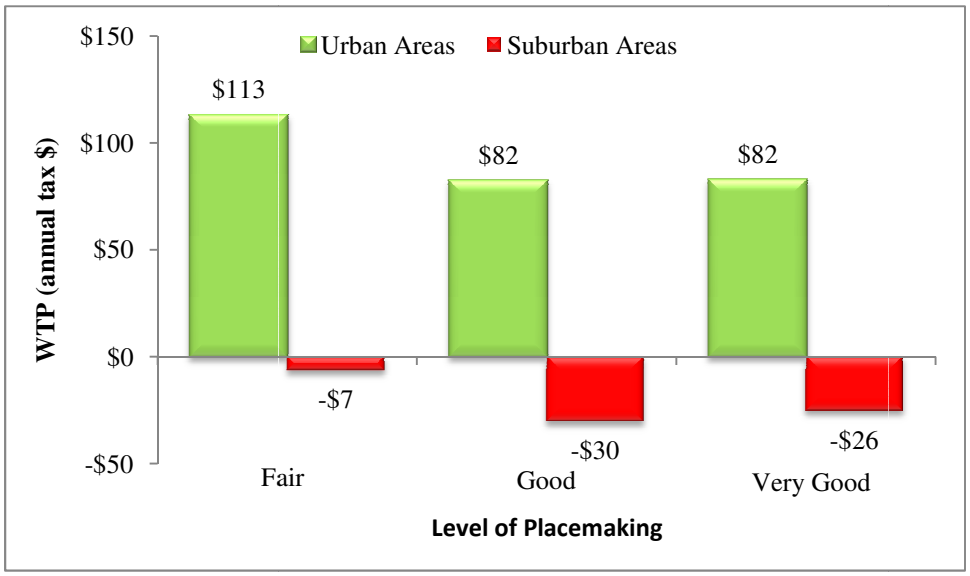

Figure 5.8: An Individual's Willingness to Pay for the Levels of Placemaking in Urban and Suburban Areas

The geographic indicator interaction led to a negative coefficient for all levels of placemaking, suggesting that suburban communities will, all else being equal, consider placemaking a much less important consideration than their urban counterparts. Several variations of the logit model were run with interactions between the geographic indicator variables and socio-demographic variables, including household income, household ownership, and age. These interactions were found to be insignificant, suggesting that the geographic indicator may be capturing the effects of household income, household ownership, age, and population density the study locations. This may explain the insignificance of aforementioned interactions with the geographic indicator variable. The negative effect disagrees with expectations based on previous work *(Yannes et al., 2010*) where it was shown that home ownership and higher income tended to increase the value put on placemaking.

6.0 CONCLUSIONS & RECOMMENDATIONS

Educating people about the indirect benefits of a well-established transit system can help attract investors as well as raise community support for transit projects. It is difficult to define an index or metric for quantifying the benefits of placemaking, however, this survey provides practitioners with a tool for identifying which elements of the built environment individuals in a community value most. Phase I found that the public places a significant value on good placemaking in a transit system. The second phase of the study further categorizes placemaking into its component variables and finds that the public are willing to pay for some combinations of placemaking features and place a higher value on these combinations of placemaking features than others, implying a hierarchy of placemaking features. The study finds that the WTP for what public transit users perceive as safety improvements (like improved lighting, wider sidewalks, on-street parking,) is higher than that for what they perceived as aesthetic improvements (trees and greenery). This study also finds that users in an urban environment have a higher willingness to pay for placemaking relative to users in a suburban environment. This result is expected, in that placemaking initiatives are likely to be perceived as more plausible in urban environments than in suburban. The results of the study also reveal that the public places a high value on reliable and comfortable transit systems which minimize the cost to their household.

A logical next step would be to use images of a particular community with custom placemaking modifications to solidify the plausibility of the placemaking options and better control the variable in model estimation. Additional work is required to refine the electronic survey delivery method, specifically its ability to personalize hypothetical scenarios and control extraneous variables. Customizing options to present plausible placemaking alternatives for urban and suburban respondents would allow analysts to identify more specific elements that differentiate the WTP for aspects of transit systems and the built environment.

There are several areas in the research and study methodology that need further treatment:

- The survey delivery method can be improved to increase its ability to personalize hypothetical scenarios and control extraneous variables, presenting customized options with plausible placemaking alternatives for urban and suburban respondents.

- There is a need to communicate destination-end parking to respondents so that they do not perceive this variable as fee associated with availability of parking at the transit station but rather as a motivator to use the transit service .

- Additional efforts should be made to capture a demographically representative sample of the study population. A variety combination of delivery methods (intercept, email, paper) could be used to achieve this.

- The trip description interface of the survey can be expanded and improved for easier comprehension and interpretation by respondents.

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Appendix A

A-1 Pilot Survey

Connecticut Public Transportation Survey
2009 Survey of Residents

University of Connecticut

Funded by the Center for Transportation and Urban Planning

Introduction

Across the country, state and town officials like those in Connecticut are considering different ways to improve and maintain transportation in their city, town, or state.

Researchers at the University of Connecticut are investigating the most important features of public transportation – both buses and trains, and the environment in which they operate.

This survey will present you with a number of different transportation alternatives for your town, and ask you to vote for the ones you prefer.

Your taxes often pay for a portion of public transportation, so it is very important to know what types of services you support.

Your opinions in this research are important.

All information you provide is anonymous. Please do not put your name or other personal information on the survey.

We appreciate your help with this important effort.

CENTER FOR TRANSPORTATION and URBAN PLANNING
University of Connecticut

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Instructions

Each question in this survey will ask you to choose between two public transportation options that could be used in your community. The choices are based on realistic situations.

Two types of information are provided for each transportation option:

1. A table of service qualities
2. A picture of the station or stop environment that would be nearest your home.

We recognize that these are not pictures of your neighborhood – these pictures are meant to give a general feel for the stop or station environment.

Your responses to this survey may influence real policy decisions. **Please answer all questions the same way you would if this were a real, binding vote in your community.**

Please consider each question separately. **Do not add up costs across different questions.**

The following **apply to both projects in each of the questions**:

- The service is available for **your commute** to/from work
- It takes **15 minutes or less** to **walk or drive** to the stop **from home**
- You can **comfortably walk** to/from the stop to work.
- **Parking is freely available** at the stop near home.
- There are **no transfers** on the bus or train trip
- The **maximum wait time** at the stop **is 10 minutes**.

We know that not everyone's commute is that same – we ask that you think of **your commute** when answering the questions.

A completed example can be seen on the following pages

Example: *This example describes how to answer the questions in this survey. Please review and begin the survey on page 5.*

Assume the following two public transportation options were proposed in your community.

Project A Stop Environment

Project B Stop Environment

	Project A	Project B
Vehicle Type	Bus	Train
Time in Vehicle	15 minutes longer than current commute	5 minutes shorter than current commute
Fare (One way)	$1.00	$2.00
Comfort	Low	High
Cost to Your Household	$175 per year (Increased State/Town Taxes and Fees*)	$275 per year (Increased State/Town Taxes and Fees*)

*Taxes and fees required to pay for construction and operation of new bus/train facilities.

High comfort is equivalent to comfort in a car, while *Low* comfort is less comfortable than a private car.

If you were able to use either of the option to commute to and from work, **how would you vote?** Please check **one**:

- ☐ I would vote for **Project A**, and pay $175 per year
- ☐ I would vote for **Project B**, and pay $275 per year
- ☐ **I would not vote for either program**, with no increase in State/Town taxes and fees

Put an 'X' in the top box if you prefer Option A, in the middle box if you prefer Option B and in the bottom box if you would vote for neither

Survey

Question 1: Assume the following two public transportation options were proposed in your community.

Project A Stop Environment

Project B Stop Environment

	Project A	Project B
Vehicle Type	Bus	Bus
Time in Vehicle	5 minutes shorter than current commute	30 minutes longer than current commute
Fare (One way)	$0.50	$0.50
Comfort	Low	Low
Cost to Your Household	$100 per year (Increased State/Town Taxes and Fees*)	$100 per year (Increased State/Town Taxes and Fees*)

*Taxes and fees required to pay for construction and operation of new bus/train facilities.

If you were able to use either option to commute to and from work, **how would you vote?** Please check **one**:

- ☐ I would vote for **Project A**, and pay $100 per year
- ☐ I would vote for **Project B**, and pay $100 per year
- ☐ **I would not vote for either program**, with no increase in State/Town taxes and fees

Question 2: Assume the following two public transportation options were proposed in your community.

Project A Stop Environment

Project B Stop Environment

	Project A	Project B
Vehicle Type	Bus	Bus
Time in Vehicle	15 minutes longer than current commute	15 minutes longer than current commute
Fare (One way)	$1.00	$1.00
Comfort	High	Low
Cost to Your Household	$275 per year (Increased State/Town Taxes and Fees*)	$240 per year (Increased State/Town Taxes and Fees*)

*Taxes and fees required to pay for construction and operation of new bus/train facilities.

If you were able to use either option to commute to and from work, **how would you vote?** Please check **one**:

- ☐ I would vote for **Project A**, and pay $275 per year
- ☐ I would vote for **Project B**, and pay $240 per year
- ☐ **I would not vote for either program**, with no increase in State/Town taxes and fees

Question 4. Assume the following two public transportation options were proposed in your community.

Project A Stop Environment

Project B Stop Environment

	Project A	Project B
Vehicle Type	Train	Train
Time in Vehicle	30 minutes longer than current commute	15 minutes longer than current commute
Fare (One way)	$0.50	$1.50
Comfort	Low	High
Cost to Your Household	$175 per year (Increased State/Town Taxes and Fees*)	$275 per year (Increased State/Town Taxes and Fees*)

*Taxes and fees required to pay for construction and operation of new bus/train facilities.

If you were able to use either option to commute to and from work, **how would you vote?** Please check **one**:

- ☐ I would vote for **Project A**, and pay $175 per year
- ☐ I would vote for **Project B**, and pay $275 per year
- ☐ **I would not vote for either program**, with no increase in State/Town taxes and fees

Question 5: Indicate how strongly you agree with the following statements. Check one box for each.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The survey provided enough information for me to make informed choices	☐1	☐2	☐3	☐4	☐5
I feel confident about my answers	☐1	☐2	☐3	☐4	☐5
Information in the survey was easy to understand	☐1	☐2	☐3	☐4	☐5
I would vote the same way in an actual public vote or referendum	☐1	☐2	☐3	☐4	☐5

Question 6: When considering a bus or train service in your community, how important is each of the following? Check one box for each.

	Not at All Important ← Moderately Important → Very Important				
Safety in vehicle	☐1	☐2	☐3	☐4	☐5
Comfort	☐1	☐2	☐3	☐4	☐5
Cost to ride	☐1	☐2	☐3	☐4	☐5
Commute Time	☐1	☐2	☐3	☐4	☐5
Taxes Paid by my household	☐1	☐2	☐3	☐4	☐5
Safety around stop or station	☐1	☐2	☐3	☐4	☐5
Vehicle Appearance	☐1	☐2	☐3	☐4	☐5

Question 7: Personal Information

The following information is important in helping us to analyze responses and to make sure that all groups in your town are fairly represented by our survey. **All of your responses are anonymous and strictly confidential.**

1. What is your age? _____ years

2. What is your gender? ☐ Male ☐ Female

3. What is the highest level of education that you have completed?

   ☐ Less than high school
   ☐ High school or equivalent experience
   ☐ High school plus technical experience
   ☐ College experience or Bachelor's Degree
   ☐ Graduate experience or a Master's Degree
   ☐ Doctorate Degree

4. How many people live in your household? _____

5. Do you currently own or rent your place of residence?

   ☐ Own ☐ Rent

6. How long have you lived in Meriden? _____ years

7. Would you ever consider using a bus or train for your commute to work?

   ☐ Yes ☐ No ☐ Maybe

Question 7 continued

8. What category is closest to your total household income?

- ☐ $ 9,999 or less
- ☐ $10,000 to $19,999
- ☐ $20,000 to $39,999
- ☐ $40,000 to $59,999
- ☐ $60,000 to $79,999
- ☐ $80,000 to $99,999
- ☐ $100,000 or more

9. How many cars are in your household?

- ☐ None
- ☐ One
- ☐ Two
- ☐ Three or more

10. How do you usually commute to work?

- ☐ Drive alone
- ☐ Carpool
- ☐ Do Not Work
- ☐ Walk
- ☐ Bus
- ☐ Work from Home
- ☐ Train
- ☐ Bicycle

11. How often in an average week do you currently use public transportation (bus and/or rail)?

- ☐ Less than 5 trips
- ☐ Between 5 and 9 trips
- ☐ Between 10 and 19 trips
- ☐ 10 trips or more

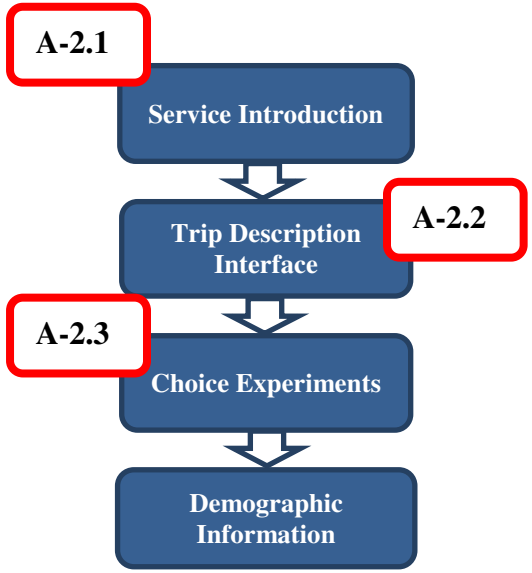
12. How long is your current commute to work?

- ☐ Less than 10 minutes
- ☐ Between 10 and 20 minutes
- ☐ Between 20 and 30 minutes
- ☐ Between 30 and 45 minutes
- ☐ 45 minutes or more

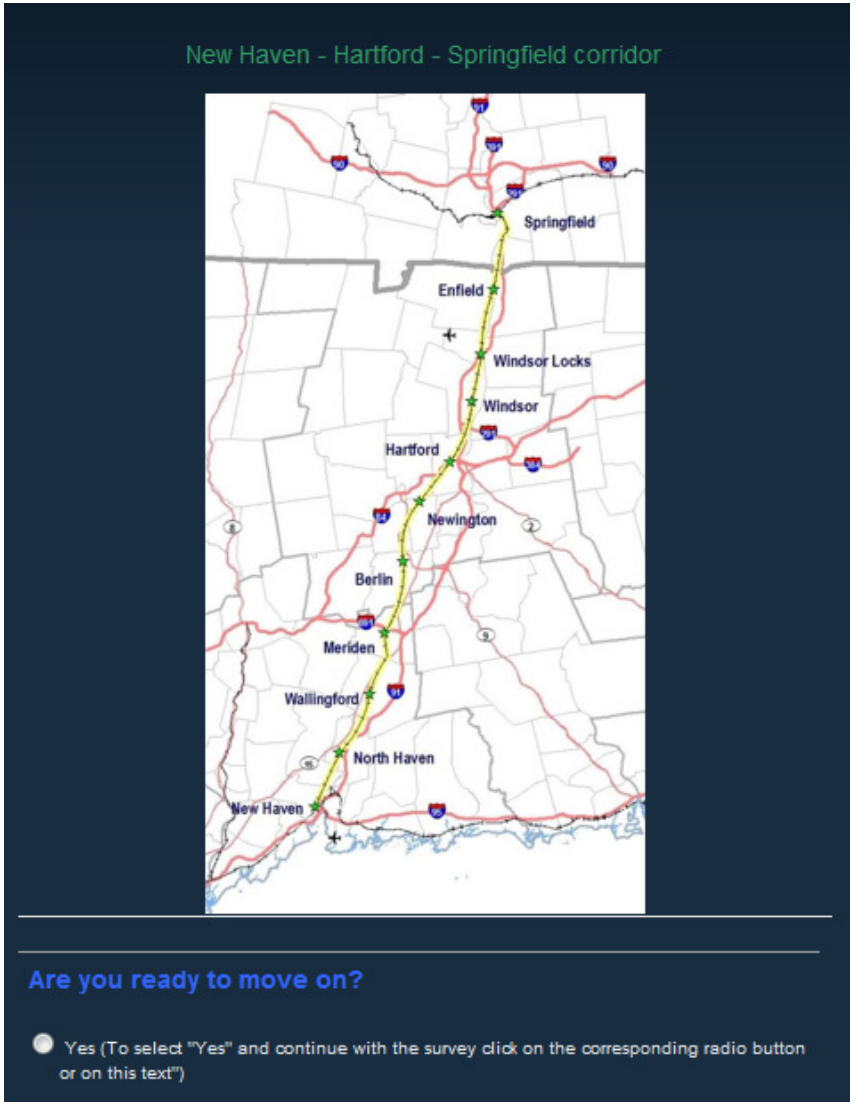
Comments

If you have any comments or would like to explain your answers to a particular question please use the space provided below. Please provide the question to which you are referring.

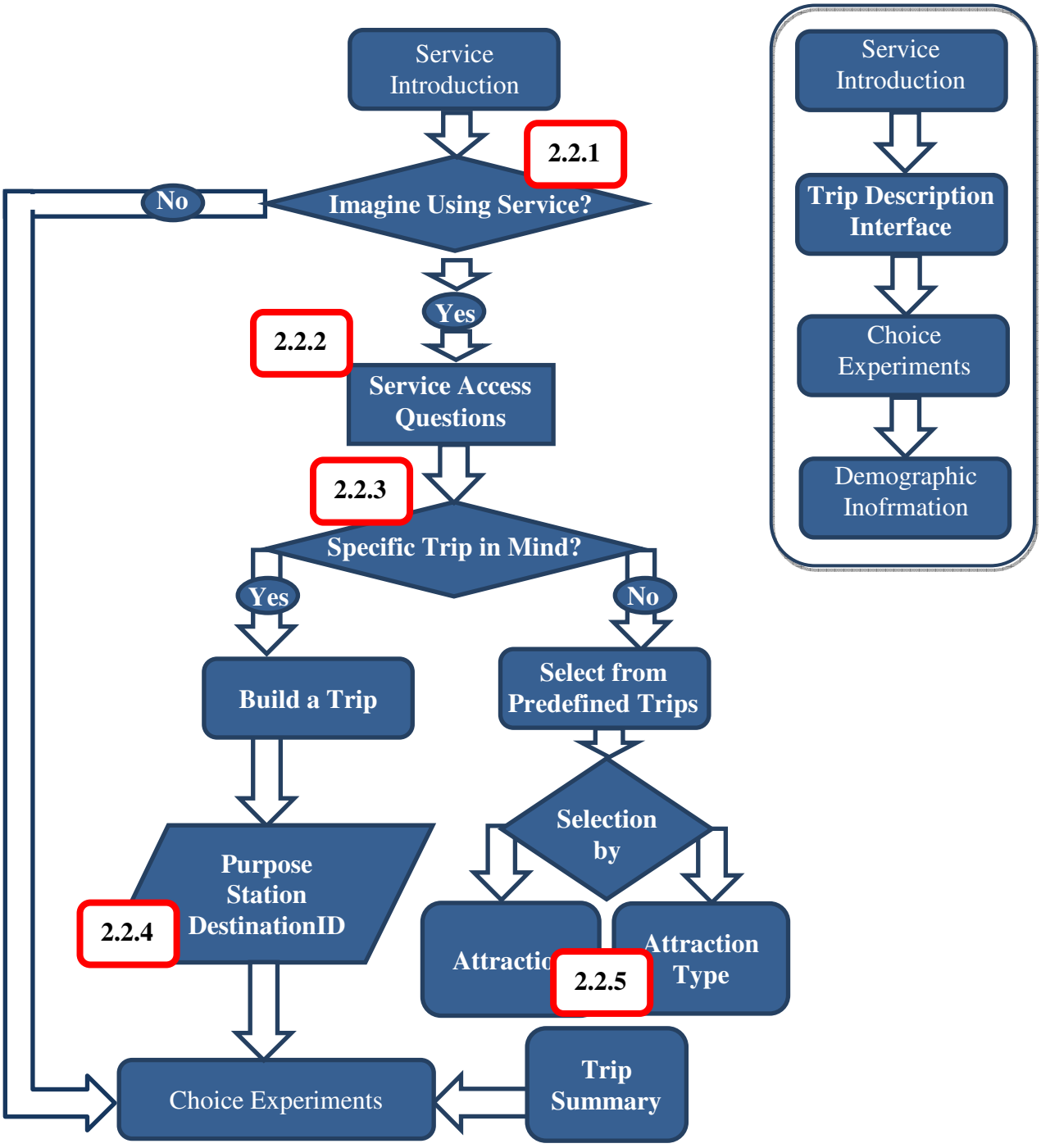
A-2: 2010 Transportation Survey Flowchart



A-2.1: Travel Corridor of the Passenger Service

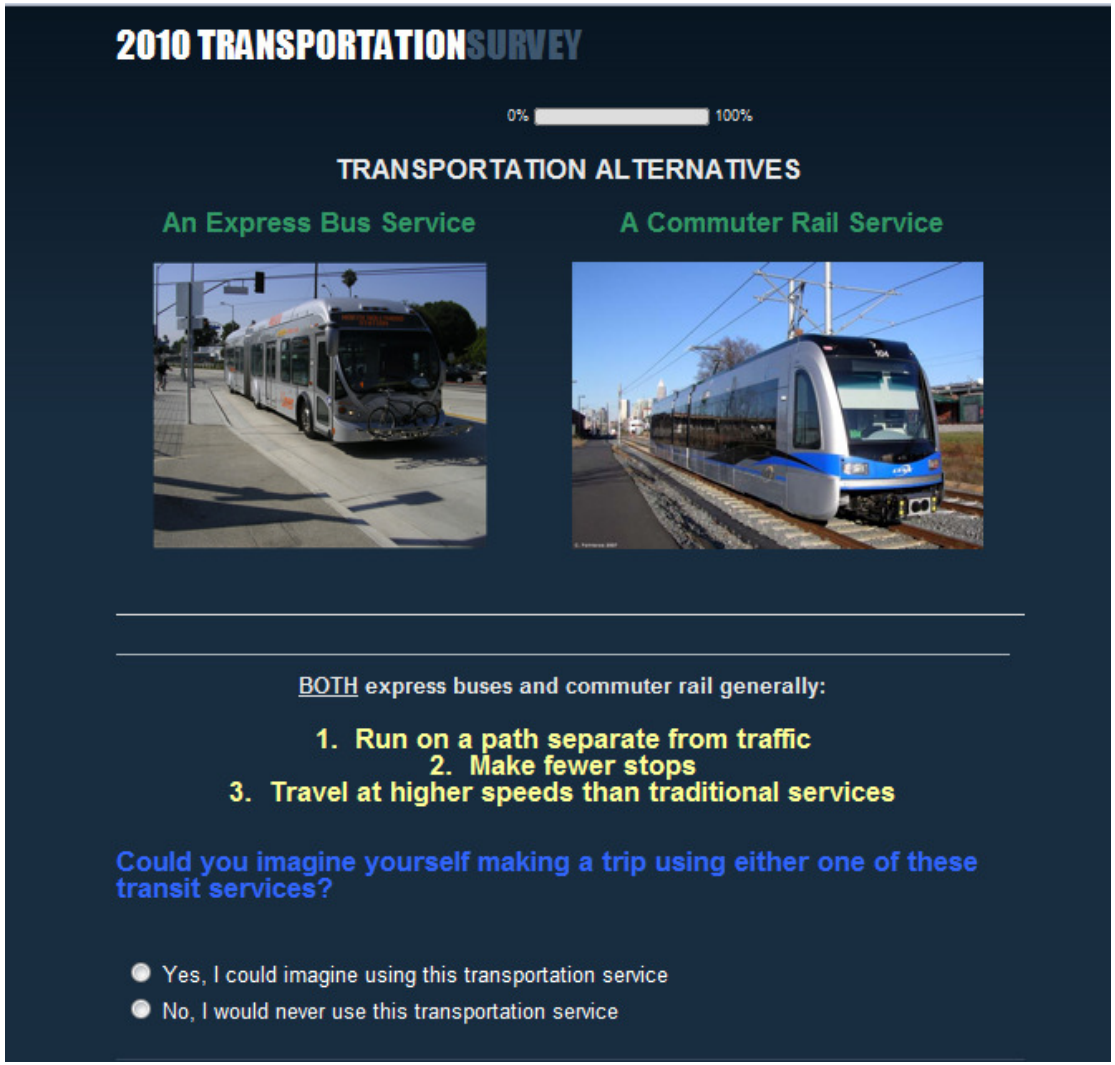


A-2.2: Trip Description Flowchart



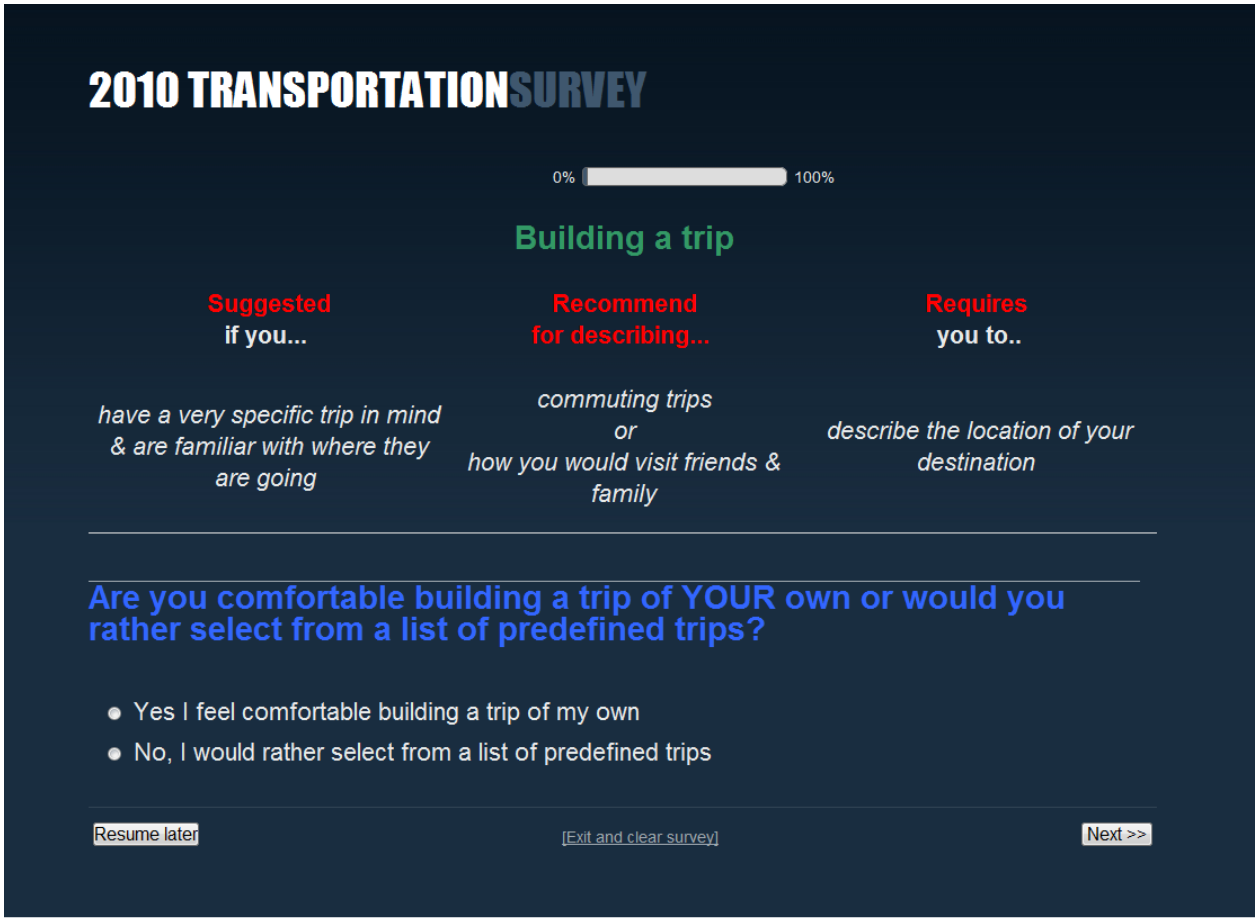
Flow Chart of Trip Description Interface

A-2.2.1: Identifying Potential Riders

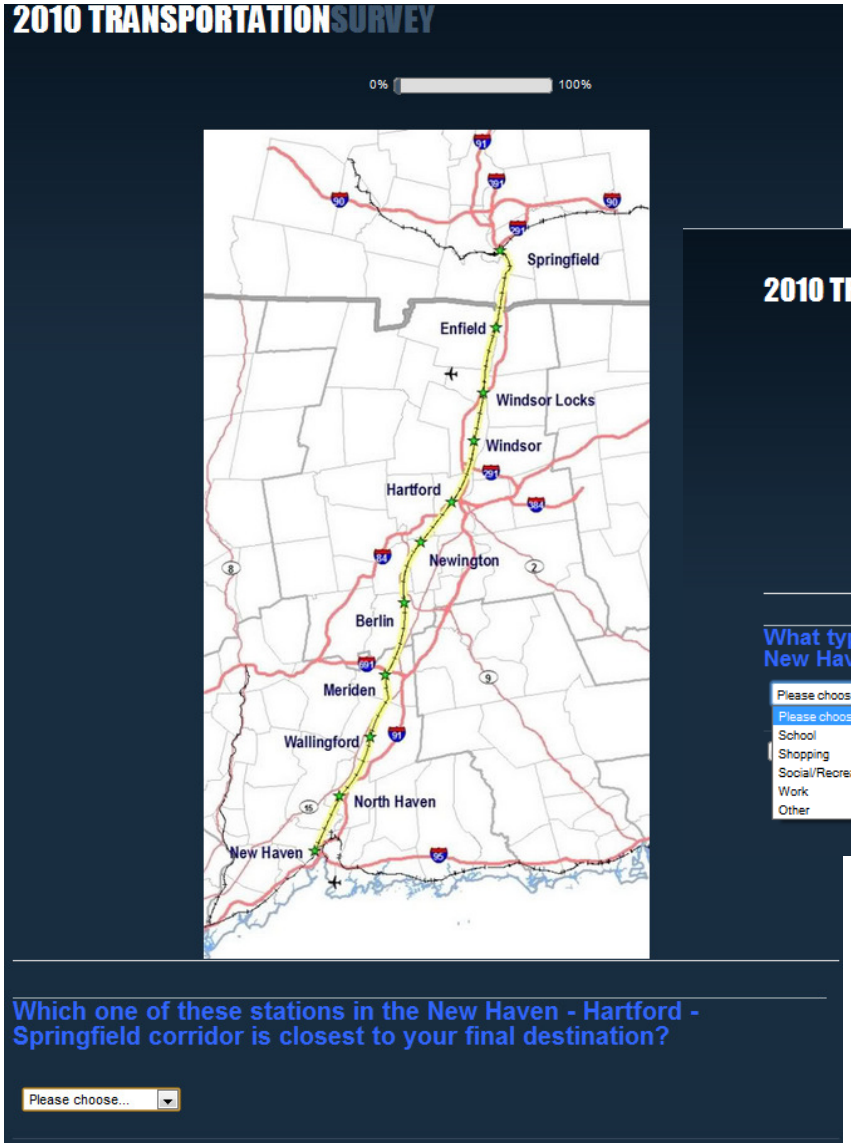


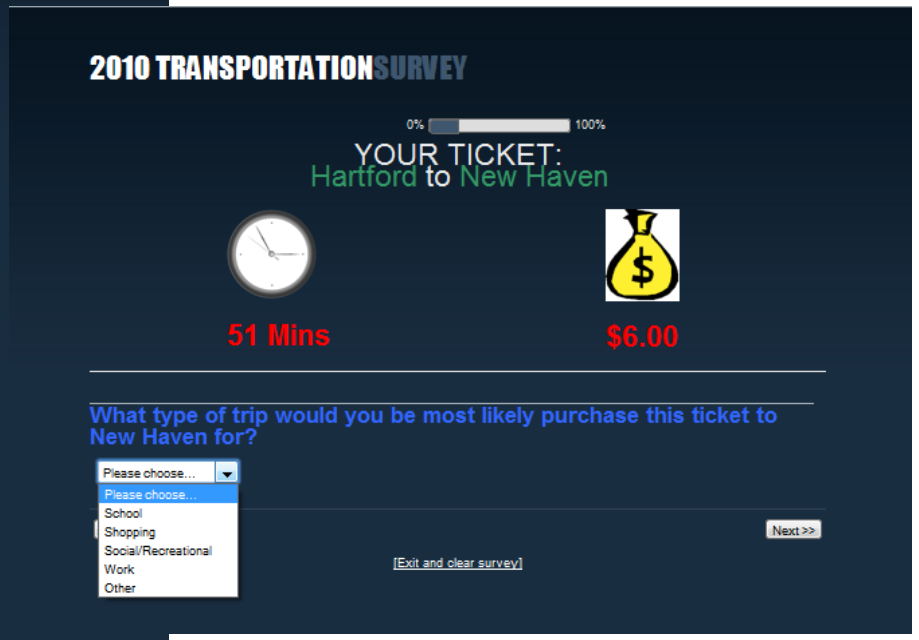
A-2.2.2: Service Access Questions

A-2.2.3: Screening Respondents for their Trip Description Interface

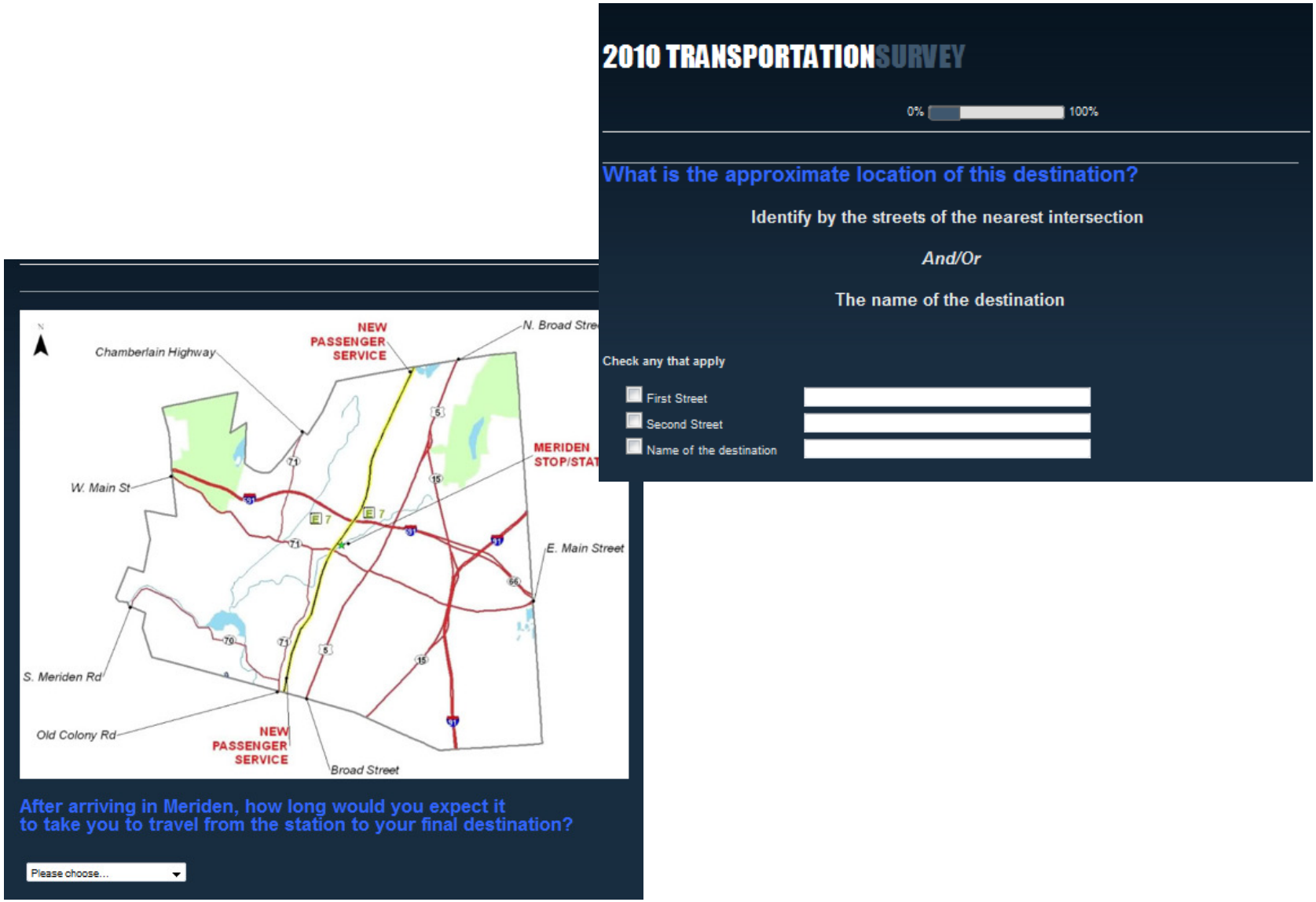


A-2.2.4: Building a Trip

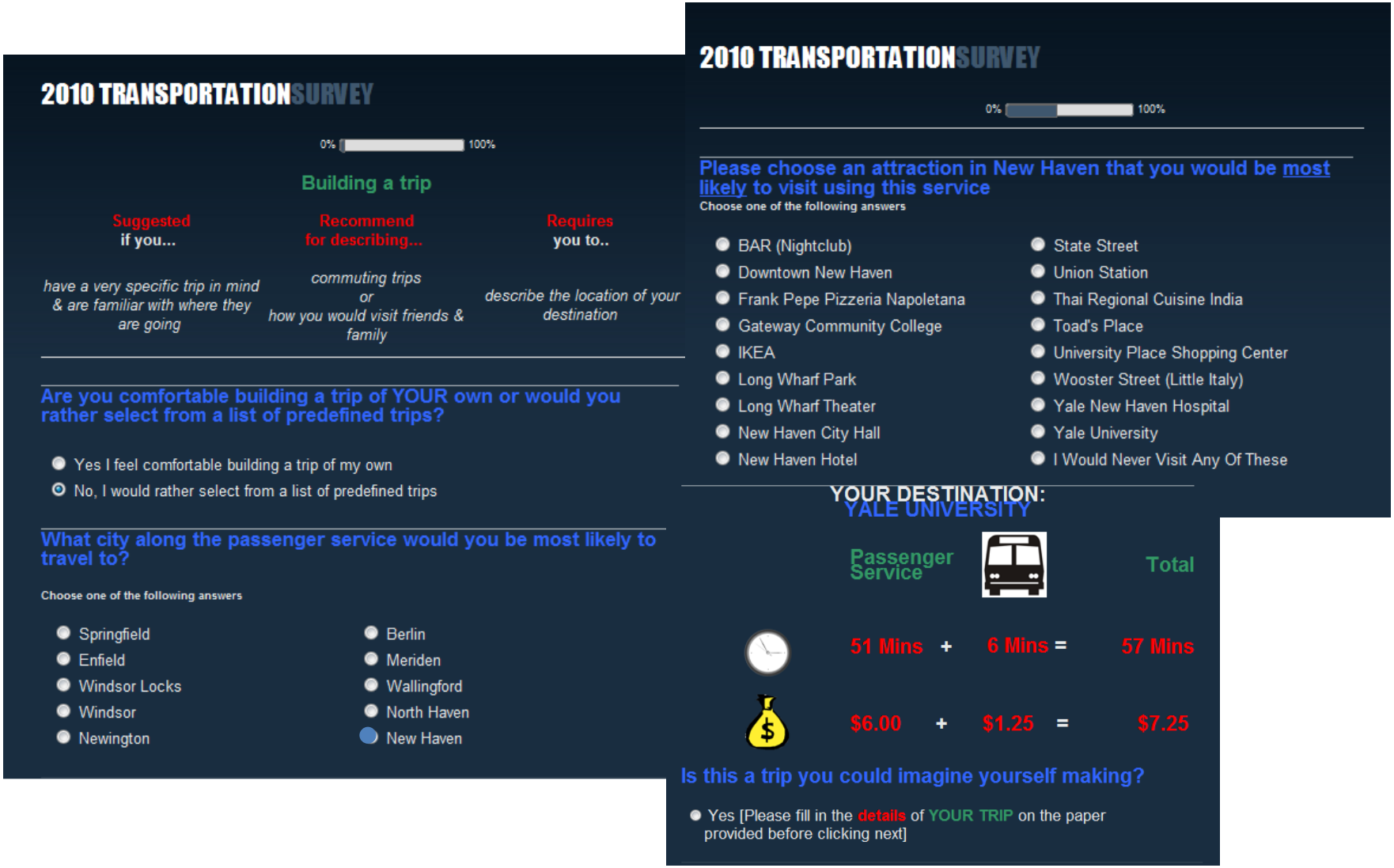




A-2.2.4: Building a Trip (cont)



A-2.2.5: Selecting from a Pre-defined List of Trips



A-2.3: Example Choice Experiment