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Public Perception of Public Transportation and its Built Environment in the New Haven - Springfield Corridor

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Public Perception of Public Transportation and its Built Environment in the New Haven – Springfield Corridor

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Public Perception of Public Transportation and its Built Environment in the New Haven – Springfield Corridor

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ABSTRACT

Studying and quantifying public perception of public transportation and the built environment in which it operates is crucial to understanding the symbiotic relationship between transportation and land use. This paper presents a choice experiment which places respondents into personalized hypothetical scenarios and examines their preferences for new transit service and the environment in which it operates. The choice experiment survey instrument investigates public response to hypothetical bond referenda to fund new transit projects with particular service and built environment attributes. Service options are characterized by six attributes: service type, service reliability, comfort, stop environment, parking availability at final destination, and corresponding increase in taxes. Open-source survey software is leveraged to design a conditional and branching survey instrument that allows for adaptive context and control variables. The study fits a conditional logit model to this data, allowing for quantitative comparisons between the built environment through the estimation of the public‘s willingness to pay for specific features of the built environment. This research finds that people place a significant value on the quality of public spaces created by transit, captured here through the use of digitally rendered built environments that depict several features of good public spaces: wide sidewalks, greenery, reduced building setbacks, etc, combining different levels to define four distinct groupings of public spaces. It also discovers that an individual‘s willingness to pay for public spaces varies based on geography of their community.

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1.0 INTRODUCTION

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.

Transit managers and professionals have traditionally focused on the mobility and transit's capacity to reduce congestion on the highway, which is problematic for several reasons. Setting these as goals relegates transit as a means to an end and not an end in and of itself and has created many obstacles for transit in the political arena. Measures of transit value solely in terms of mobility and reduction of congestion often result in public transit systems which are poorly integrated into communities and later face challenges realizing their potential. These types of systems are often underutilized and contribute to the perception of transit as last resort mode of travel.

Transit's past treatment solely as a mobility instrument overlooks the substantial source of public value created by public transit, and can result in sub-optimally designed public transportation. Transit systems have been known to foster the creation of high quality public spaces that promote and enhance social interaction and economic activity; a phenomenon referred to as placemaking. Public transit stops have the potential to develop into centers of community life which rejuvenate and strengthen communities. This research looks beyond traditional mobility-centric transportation planning, acknowledging and quantifying the value of good public spaces created and supported by transit. Although many transit managers, transportation professionals, and persons in the industry now recognize the community development and placemaking potential of transit systems, they lack quantitative measures of its value. Worse, many riders, potential riders and even non-riders of transit who are aware of public transit's community development and placemaking potential have no means by which to express its value. Therefore this research presents a systemic measure of transit's value and its attributes, both mobilizing and developmental. It serves to augment communication between citizens and the policy makers. Providing a means to value key mobility and non – mobility attributes of transit is essential as what gets measured gets managed.

A previous study (*Yannes et al. 2010*) investigates the value placed by people on placemaking in a public transit system using choice experiments administered in a stated preference (SP) survey. The survey instrument produced is used to estimate the willingness of the public to pay for a transit system and quantify the tradeoffs made by the public between basic attributes of public transit service and placemaking. Data

gathered from the survey were used to develop choice models to identify the various tradeoffs the public were willing to make for specific transit service attributes.

The work described in this paper is a significant extension and expansion of a previous study (*Yannes et al. 2010*). Like the previous study, this one adopts a SP choice experiment, 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 allows the measurement of willingness to pay in a context that is understandable and plausible to the survey respondent. However, this study employs an in-person, intercept survey using mobile electronic delivery devices. The electronic delivery method allows for personalized scenario building, resulting in overall better estimates of control service parameters. It also improves the reliability of results by increasing the plausibility of the hypothetical scenarios presented to respondents. Lastly, two new service attributes, "service reliability" and "parking at the final destination", supplanted others in the experimental design. Conditional logit models are then estimated using data obtained from the survey and the models are subsequently used to identify the tradeoffs the public is willing to make for specific transit service attributes.

This paper will first review the applications 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 framework for good placemaking and subsequently a review of the empirical evidence supporting a relationship between transportation and land use. It provides segue to the work of Yannes et Al. (2010) and a comprehensive

analysis of the sampling frame for refinement of future survey instruments. Next the methodology and results of a hypothetical bond referendum state preference choice study and estimates of logit model parameters are presented. Lastly, the conclusions are discussed and recommendations for future research are made.

2.0 PREVIOUS WORK

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 the relationship between the environments in which it operates, 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 of 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 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 YANNES ET AL., 2010

Yannes et al., formally pilot tested the use of choice experiments in the form of stated preference surveys and validated the use of public preference models to quantify the value of key mobility and non – mobility related attributes of public transit. 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 which asked respondents to consider a hypothetical bond referendum in which they would be making a choice between two proposed transit service alternatives that would directly impact their community. In this experiment respondents 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 served to validate the choice of transit service attributes. Respondents were shown several transit service alternatives characterized by varying levels of six attributes; fare, travel time, placemaking, comfort, cost to household and service type. The attributes were carefully selected and tested through several focus groups. Data collected from this study was used to estimate preference models from which willingness to pay for the service attributes was computed.

In this study placemaking was characterized by two levels, "good" and "bad," which were interacted with home owners/renters and potential riders/stated non-riders of

the hypothetical transit service. The study found travelers were willing to pay for good placemaking as part of a new transit service and that their willingness to pay was largely dependent on their propensity to the ride the hypothetical transit services and whether they were homeowners or renters in their communities.

Yannes et al. established that the general public, on average, is willing to pay for enhancements to the transit stop environment (placemaking) in conjunction with service improvements, propensity to ride and demographic characteristics affect an individual's willingness to pay for placemaking, stated preference surveys are a useful tool for evaluating placemaking's value, and that visual stimuli (images of places) are better suited than textual descriptions to communicate the application of placemaking techniques. Yannes et al. identified several areas in which their experiment could be improved. They suggested removing choice experiment attributes which were found to be insiginicant in the final models, in order to enhance the accuracy of results and alterations to the survey design to increase survey respondent's confidence. They also recommended obtaining larger sample sizes that are more demographically representative of their sample populations. This is expected to increase the capacity of models to estimate the interactions between transit system and built environment attributes and population demographics. The next section contains an analysis of the data collected by (Yannes et al., 2010) to help identify potential areas in which the survey could be improved and obtain a more demographically representative sample in future implementations.

3.1 SURVEY SAMPLING FRAME ANALYSIS

This section contains an analysis of the Meriden, Connecticut survey sample collected as part of the (*Yannes et Al., 2010*) "Operationalizing Placemaking in a Choice Experiment Context". This analysis was conducted to review the demographic and survey feedback data portions of (*Yannes et al., 2010*) pilot survey and 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 future survey distributions. The 590 households to which the survey were sent were demographically representative of Meriden's 2000 census data – the responding households in some cases, were not. This section contains several graphics to help identify potential areas for the pilot survey to be improved and collect a more demographically representative sample in future distributions. 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 this analysis contains descriptive statistics, histograms and cross tabulations of survey respondent demographic and socio-economic characteristics as well as ideas for sampling improvement.

3.1.1 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 3.1: 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 3.1 and 3.2 summarize the feedback on survey design collected by question 5. Table 3.1 presents the raw numbers of responses for each question, while Table 3.2 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 3.2, 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 3.2 : 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. Many of the respondents were retired with no regular commute schedule or worked from home and were therefore 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 the 2010 Transportation Survey [1]either locate a greater percentage of commuters 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, efforts of the

[1] The survey is referred to by its field name "2010 Transportation Survey" throughout the text, which was specifically chosen to limit the potential for self selection bias.

2010 Transportation Survey focused on reducing the overall length of the survey, it was considered to reduce the number of choice questions and/or possibly 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 (*Yannes et al.* 2010) to alter the design by moving the blank pages located at the beginning of the survey to the end.

3.1.2 Question 6: Respondent Priorities

Question 6 asked the survey respondents to identify the importance of several aspects of a public transit system. Tables 3.3 and 3.4 summarize the respondents' prioritization of these aspects. Table 3.3 presents the raw numbers of responses to each question, while Table 3.4 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[2] 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 the most as it had the highest variance at 1.21.

[2] Taxes to be paid by a household was presented (Yannes et al. 2010) as the annual increase in taxes and fees required to pay for the construction and operation of new bus or train facilities.

Table 3.3 :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 3.4: 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

A potentially significant interaction would be one 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 the 2010 Transportation Survey.

3.1.3 Respondent Characteristics

A final concern that arose during the analysis is the very low response rate of segments of the population, which resulted in age, commute mode, and transit usage response rate distributions that were not representative of Meriden 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.

3.1.3.1 *Age Distribution*

The age distribution of the sample reveals a significant overrepresentation of older individuals. Tables 3.5 and 3.6 summarize the age distribution of the survey sample and census information for the City of Meriden. Table 3.5 summarizes descriptive statistics, while Table 3.6 displays age distributions of the survey sample and Meriden. This overrepresentation introduces a significant potential for bias in (Yannes et al., 2010) 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 Meriden's population mean of 38.3 years (Census 2000). 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 higher values, but the distribution skewed in that direction as well. Stratified sampling was one consideration for the 2010 Transportation Survey sampling plan to obtain a more representative age distribution.

Table 3.5: 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 3.6 and Figure 3.1, 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, it is expected that there would be 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 Yannes et al. (2010) sample.

Table 3.6: 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%

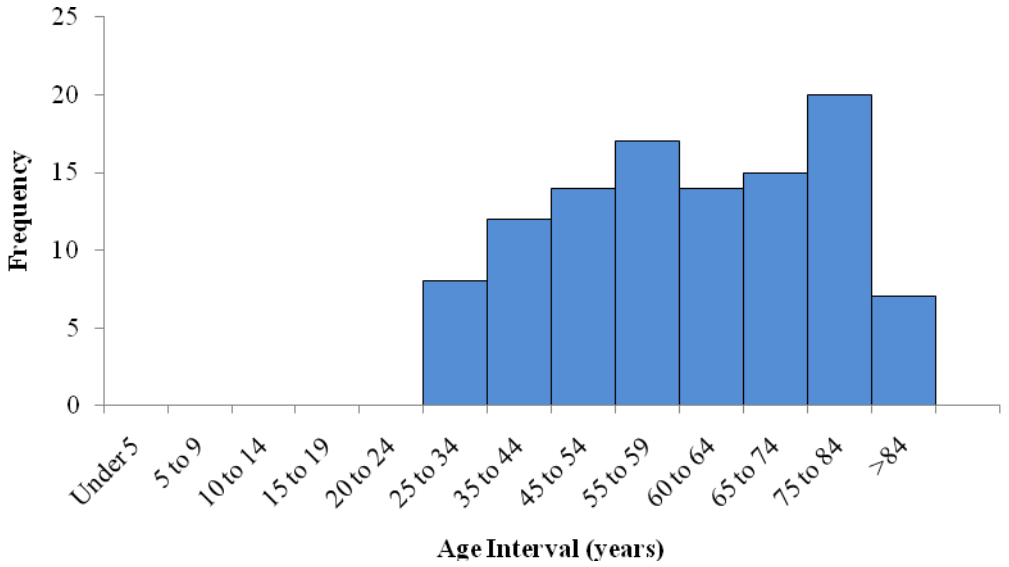

Figure 3.1: Survey Sample Age Distribution

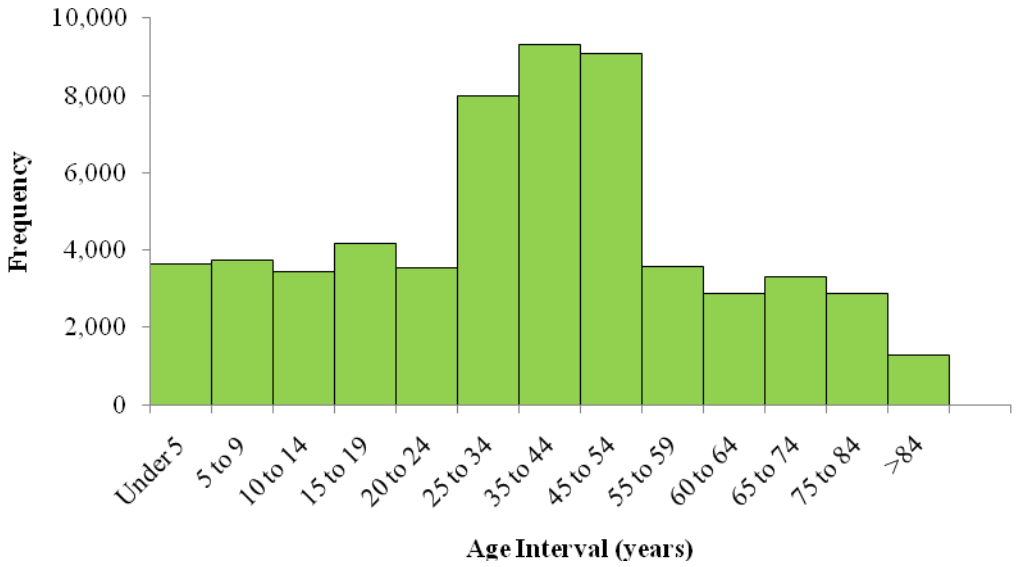

Figure 3.2: Meriden's Age Distribution (Census 2000)

3.1.3.2 *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 Yannes et al. (2010) 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 3.7 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 3.7: Age vs. Income

Age	HH Income Level							
Interval	< $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

3.1.3.3 *Gender Interactions*

Figure 3.3 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.

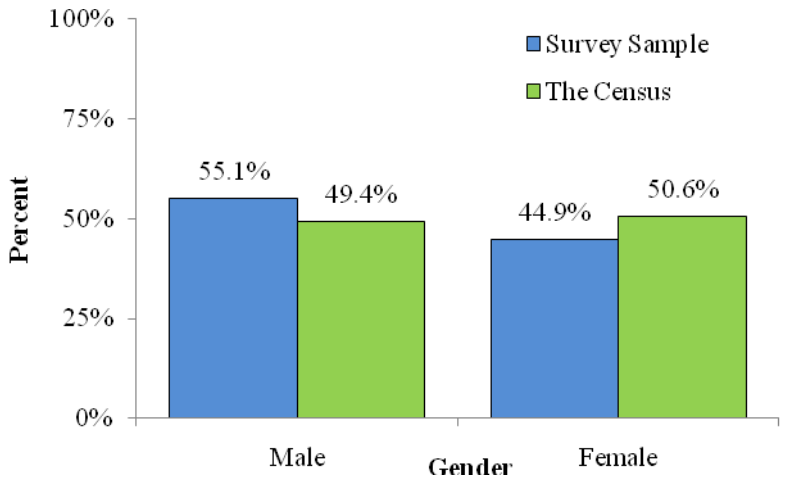

Figure 3.3: Gender Distribution

There appeared to be some differences between genders, their potential ridership, and the importance of safety in the sample. Table 3.8 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 3.8 : Gender vs. Potential Ridership

	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 3.9 and 3.10 show gender vs. vehicle safety and station safety, respectively. Table 3.9 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. Table 3.10 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 household's willingness to pay for placemaking.

Table 3.9: Gender vs. Vehicle Safety

	Vehicle Safety (Likert Scale)					
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 3.10: Gender vs. Station Safety

	Station Safety (Likert Scale)				
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%

3.1.3.4 *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 3.11 and 3.12 summarize the household income of the survey sample and Meriden. Table 3.11 presents summary descriptive statistics, while Table 3.12 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. As a result, categorical options for household income in the 2010 Transportation Survey were 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 the 2010 Transportation Survey.

Table 3.11: 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	>100,000	>200,000

Table 3.12: HH Income Distribution (in thousands)

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 3.11 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 3.4 and 3.5 present the household income distribution for the survey sample and Meriden, respectively. Together Table 3.11, Figure 3.4, and Figure 3.5 show discrepancies 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 households (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, though the response rate for lower income households must be increased to obtain a representative sample. One possible solution for this is to oversample renters within the 2010 Transportation Survey 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 the 2010 Transportation Survey will measure 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.

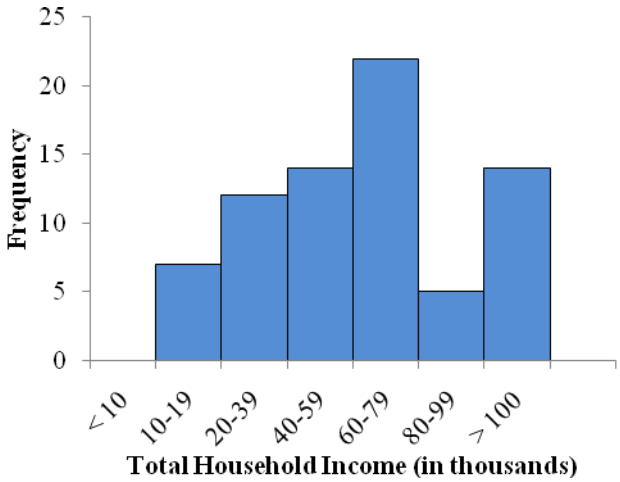

Figure 3.4: Sample Household Income

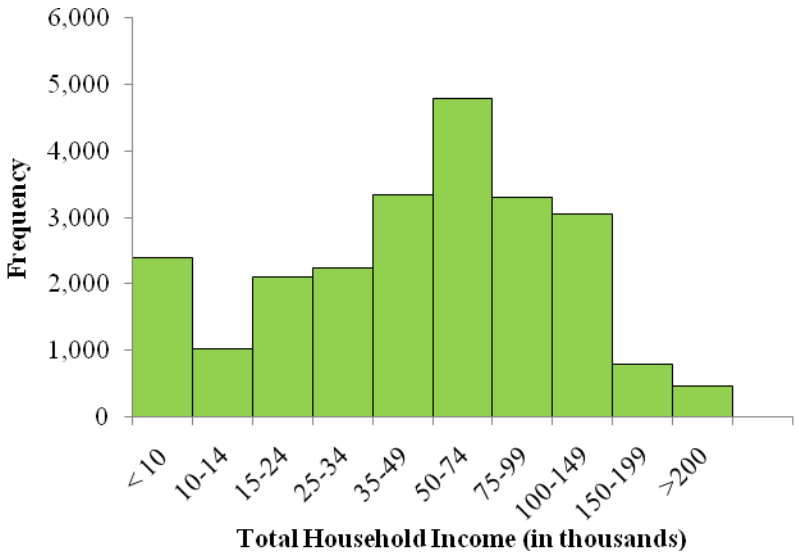

Figure 3.5: Meriden Household Income Distribution

3.1.3.5 *Educational Attainment*

The educational distribution of the sample reveals a bias towards individuals with high levels of education. Figure 3.16 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.

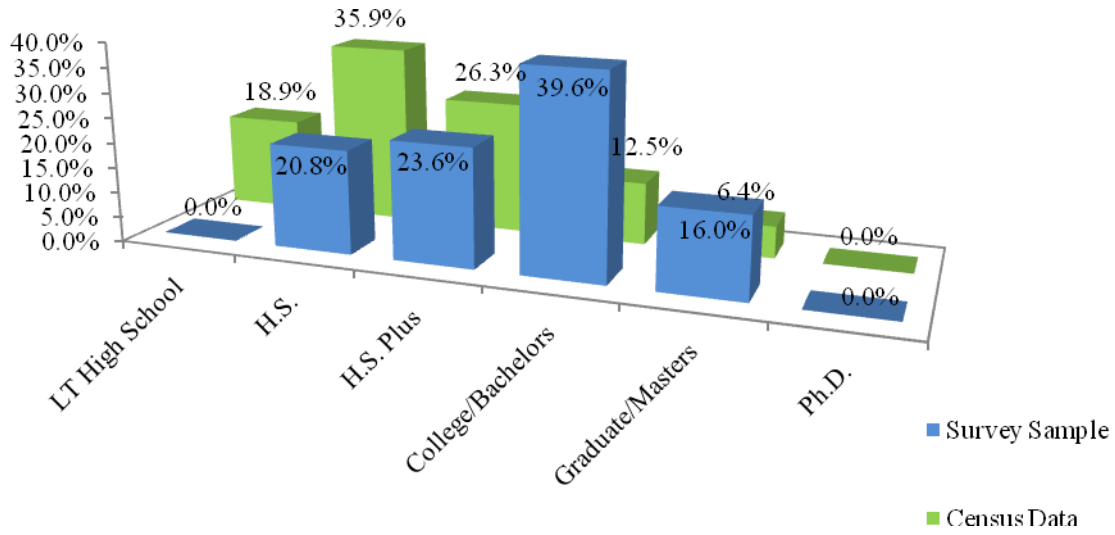

Figure 3.6: Distributions of the Levels of Educational Attainment in Meriden

3.1.3.6 ***Home Ownership Interactions***

The sample distribution between home owners and renters revealed a bias towards owners. Figure 3.7 shows the sample distribution of owners and renters to census data for Meriden. The sample population overestimates the number of property owners by 22%.

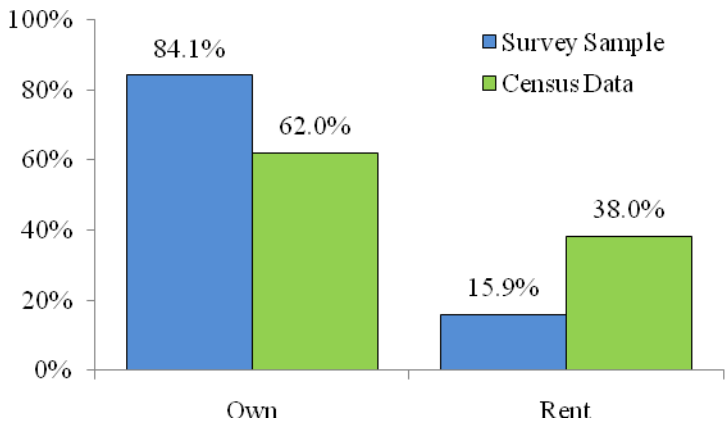

Figure 3.7: Home Ownership Distributions

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 3.13a and 3.13b 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 3.13b. 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 be addressed in the 2010 Transportation Survey, at least in part, by a sampling plan designed to correct the owner/renter bias.

Table 3.13: Household Ownership vs. Education (Count)

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

Table 3.14: Household Ownership vs. Education (Percentage)

	Level of Education				Grand
Owner/Renter	HS or =	HS + Tech	College or B.S.	Grad or Masters	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 3.14 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 2010 Transportation Survey would help mitigate household size bias.

Table 3.15: Household Ownership vs. Household Size

	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 3.15 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 2010 Transportation Survey. The original phrasing limited the positive response to work-based commute trips as opposed to trips of any purpose. An important part of the 2010 Transportation Survey 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 2010 Transportation Survey would have secondary effects – such as producing a sample with a larger portion of respondents willing to consider transit.

Table 3.15: Household Ownership vs. Consideration for Transit

	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 3.16 shows the frequency distribution of property ownership to household income. Table 3.16 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 3.16: 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 3.17 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," "Do renters choose to live in the vicinity of their workplaces," and "How does this affect their willingness pay for to the attributes of transit?" 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 2010 Transportation Survey. This would effectively provide respondents with more plausible scenarios and as a result produce more realistic responses.

Table 3.17: 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 3.18, 3.19, and 3.20 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 in the 2010 Transportation Survey to accommodate other attributes, they became important context and control variables in the survey redesign.

Table 3.18:Household Ownership vs. Cost to Ride

	Fare (Likert Scale)					
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 3.19:Household Ownership vs. Cost of Time

	Travel Time (Likert Scale)					
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 3.20: Household Ownership vs. Cost to Household

	Taxes (Likert Scale)					
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%

3.1.4 Conclusions

While age was the largest bias in pilot survey results of Yannes et al. (2010), income, education, and property ownership were also shown to exhibit significant biases. To achieve a representative age distribution for the 2010 Transportation Survey 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.

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 addition of front matter also comes at a cost. 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. For example in a paper-based survey, controlling for fare and travel time in the corridor would require 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 the 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. The following methodology describes the synthesis of these recommendations into a final survey design, the 2010 Transportation Survey.

4.0 2010 TRANSPORTATION SURVEY METHODOLOGY

The 2010 Transportation Survey is a significant extension and expansion of the pilot study conducted by Yannes et al. (2010) and required re-design of the survey instrument and additional focus group testing. The pilot study was useful in design, as it was structured around respondent's commutes. However, this design alienated segments of the population, such as people who are unemployed, retired, do not work, or work from home. For such respondents, concepts such as time in vehicle (defined relative to respondents' current commute) became irrelevant and confusing. The 2010 Transportation Survey seeks to overcome this shortcoming by allowing respondents to select the kind of trips they would most likely make using the service. Other significant improvements over (Yannes et al., 2010) pilot 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
- Description of a hypothetical transit service

The remainder of this chapter provides the methodology behind these components, in addition to implementation, data collection, and econometric modeling process.

4.1 CATEGORIZATION OF PLACEMAKING

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. Component variables were chosen in accordance with the principles of new urbanism. 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 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. Figure 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

4.1.2 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

4.1.3 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

4.1.4 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

4.2 SELECTION OF THE ATTRIBUTES FOR THE CHOICE EXPERIMENTS

As fare was found to be insignificant in (Yannes et al., 2010) 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 (Yannes et al., 2010) 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. Note the zero or baseline levels are used to represent the scenario in which individuals vote for neither transit project. In the context of this choice experiment the baselines make it possible to identify systematic utility for or against transit projects. 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	0	**Express Bus**
	1	**Commuter Rail**
Placemaking	0	**Poor**
	1	**Fair**
	2	**Good**
	3	**Very Good**
Parking	0	**Free**
	1	**Not free**
Reduction in Service Reliability	0	**0**
	1	**0.01**
	2	**0.05**
	3	**0.15**
	4	**0.25**
Comfort	0	**High**
	1	**Low**
Cost to Household	0	**$100 per year**
	1	**$175 per year**
	2	**$240 per year**
	3	**$275 per year**

4.2.1 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 equivalent. 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.

4.2.2 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.

4.2.3 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

4.2.4 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.

4.2.5 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.

4.3 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 attributes to be used in the choice experiment 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.

4.3.1 Task 1: Survey Delivery Method Evaluation

The purpose of the first task was to obtain feedback regarding the 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.

4.3.2 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 are the 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.

4.4 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.

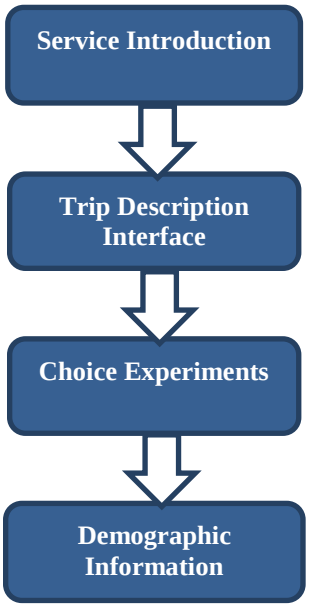

Figure 4.6: Flow Chart of the 2010 Transportation Survey

4.4.1 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, speeds the delivery of a survey, and greatly facilitates data analysis. 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. LimeSurvey 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 computer. 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.

4.4.2 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.

4.4.3 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.

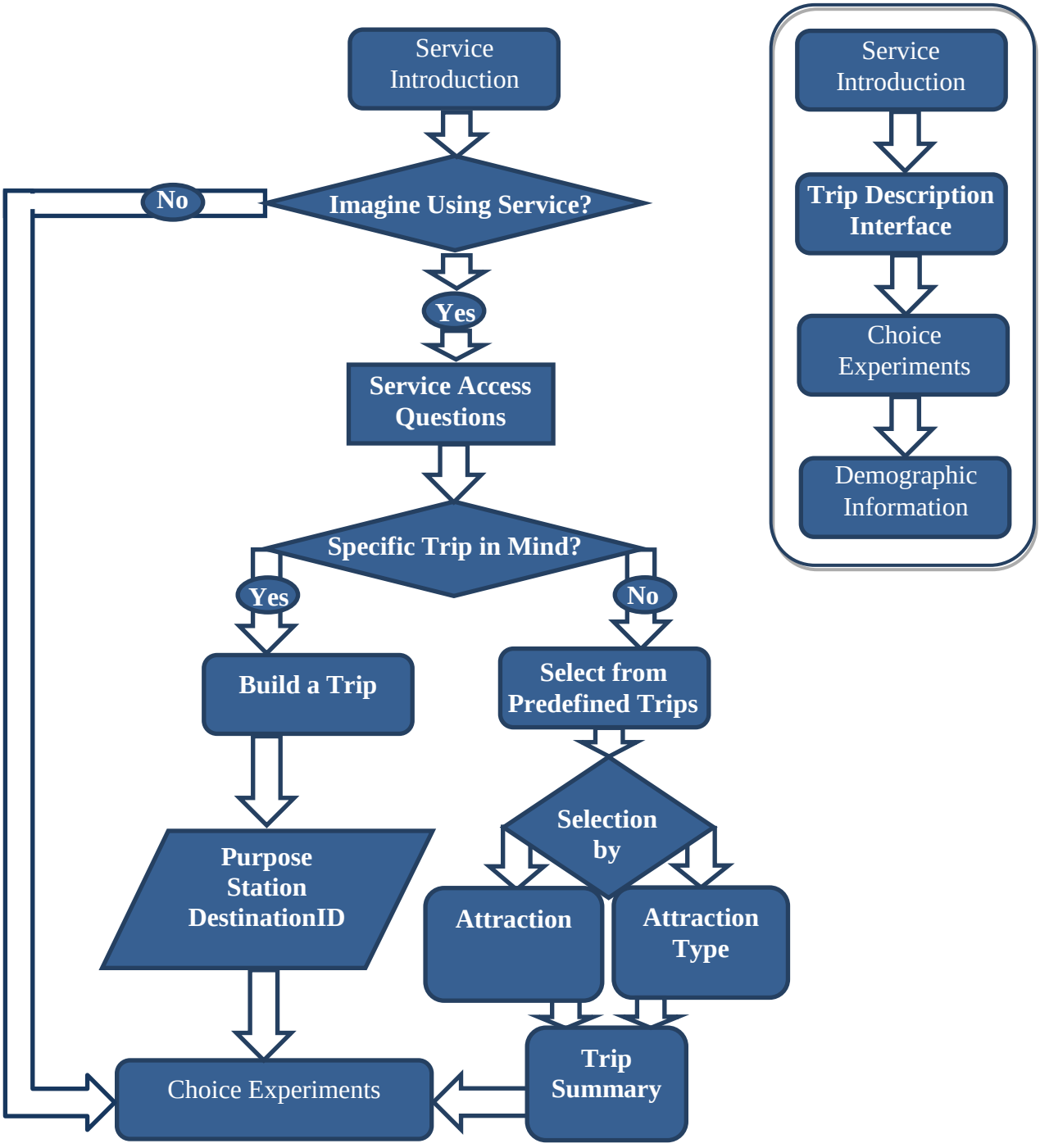

Figure 4.7: Flow Chart of Trip Description Interface

4.4.3.1 *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 A-2 shows a slideshow of this process.

4.4.3.2 *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 A-2 depicts this process.

4.4.4 Choice Experiments

Once the attributes to be 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 4.2 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. The use of this technique helps to eliminate the bias commonly associated with more common ridership-centric stated preference surveys. An example of the choice questions is shown in Figure 4.8.

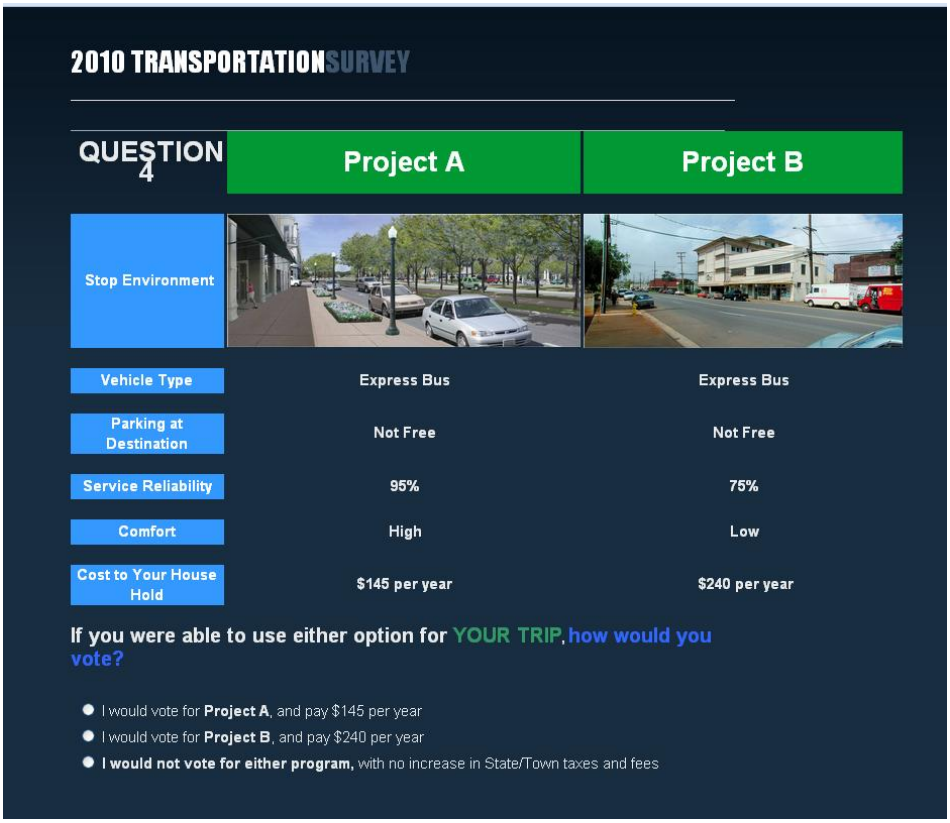

Figure 4.8 Example of Choice Experiment Used In Survey

4.4.4.1 *Experimental Design*

To accommodate the different forms of public transit, multiple attribute configurations were incorporated into the design in the form of choice sets, allowing public preference models to be estimated. 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.

4.5 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. A counting rule was applied to the selection of survey participants; stop every fifth person or group of people after a successful intercept and every third person or group after a failed intercept.

4.5.1 Sample Characteristics

The sample obtained was largely representative of the study populations. Figure 4.9 shows the survey sample and Census 2010 age distributions and Figure 4.10 shows the survey sample and 2010 Census household income distributions for each study location. The samples do not reveal any significant age or income biases in the data.

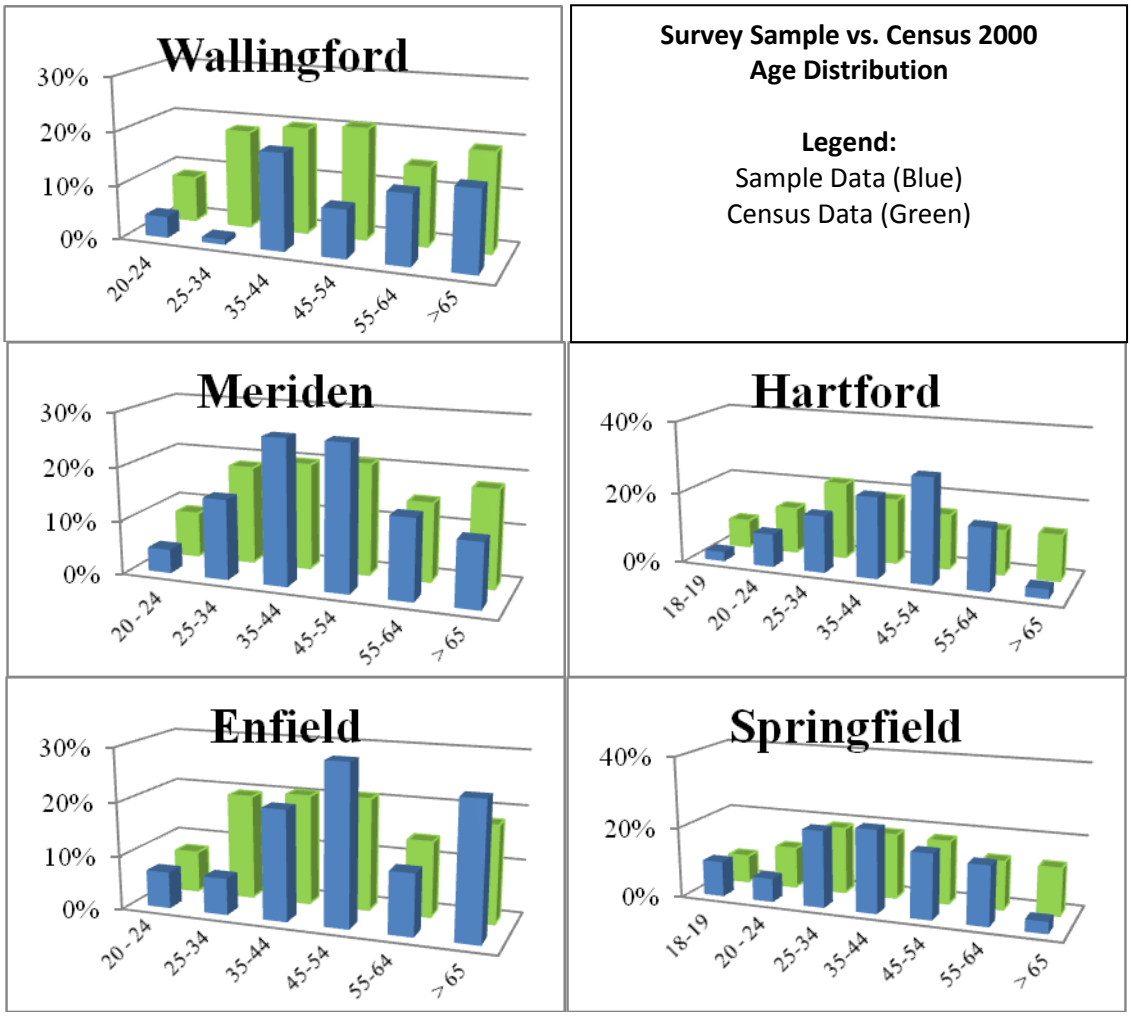

Figure 4.10: Survey Sample (blue) and Census 2010 (green) Age Distributions

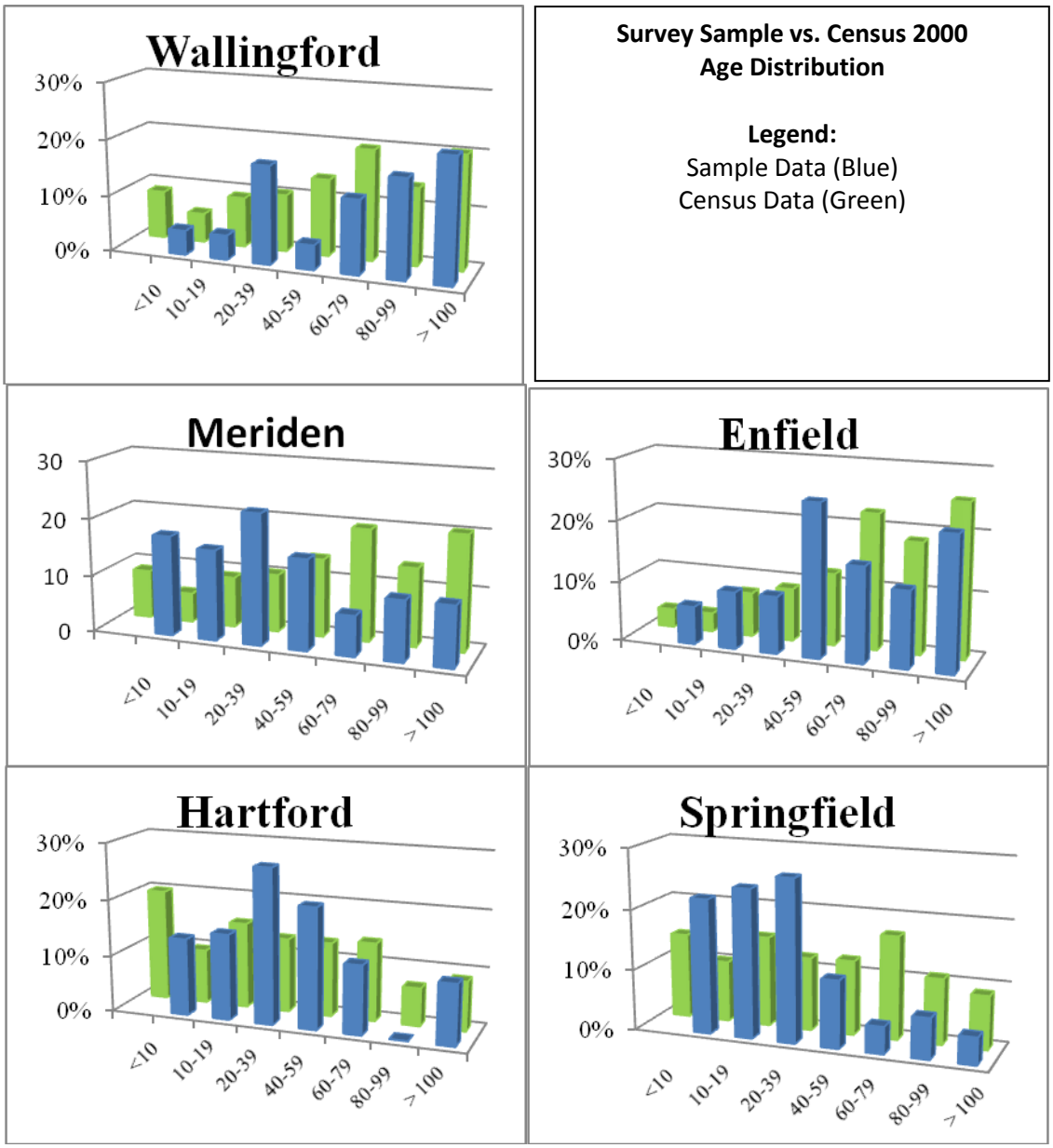

Figure 4.10: Survey Sample (blue) and Census 2000 (green) Household Income Distributions (in 1000s)

4.6 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:

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

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*
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 from the study are summarized in the following sections under two main topic areas. A final section synthesizes the findings within the two main topic areas and presents the most salient findings.

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:

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

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. For example, the willingness-to-pay for a commuter rail service can be found as follows:

$$\frac{\beta_{ST}}{|\beta_{CH}|} = \frac{0.8471}{|-0.0087|} = \$97.36$$

Table 5.1 : Conditional Logit Model Parameter Estimates with Interactions (Meriden-Wallingford)

Variable	Abbrev.	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)*

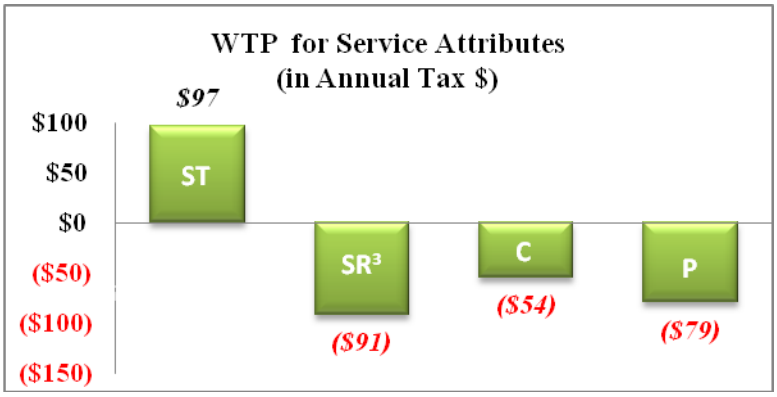

Figure 5.1: Willingness to Pay for Service Attributes in a New Transit System[3]

[3] WTP for a 25% reduction in service relative to a 100% reliable service.

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 found no evidence for this bias from the data used, 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.

Furthermore, the research shows that for each percent reduction in service reliability, households were willing to pay $3.63[4] less on average per percent reduction of service reliability, 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

[4] The percent reduction in service reliability was modeled as a continuous variable and calculated as an average reduction. It is acknowledged that the value of each percent reduction in reliability is likely not a linear relationship.

$217 and $257 more, respectively. Renters exhibited a similar trend. Renters 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.

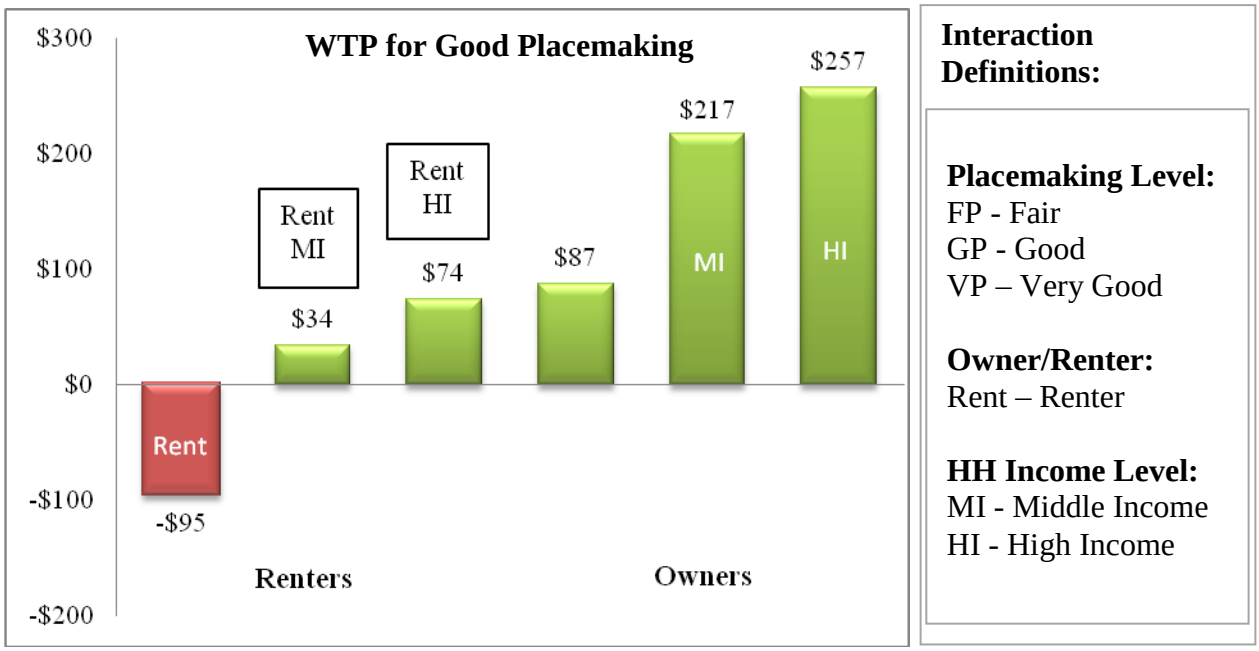

Figure 5.2: An Individual's WTP for a Level of Placemaking Increases with Income[5]

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.

[5] 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.

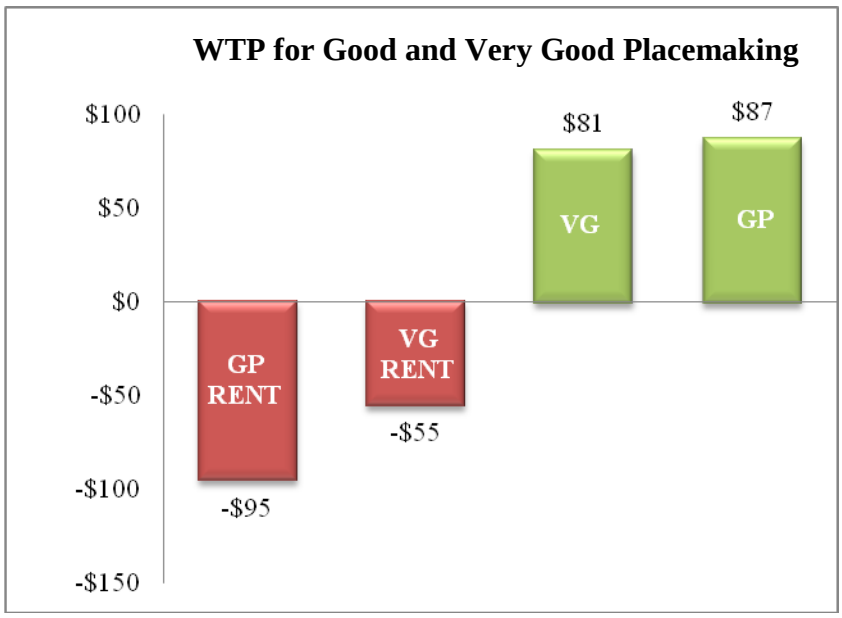

Figure 5.3: Owners are More Willing to Pay for Placemaking While Renters are Willing to Pay Less

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

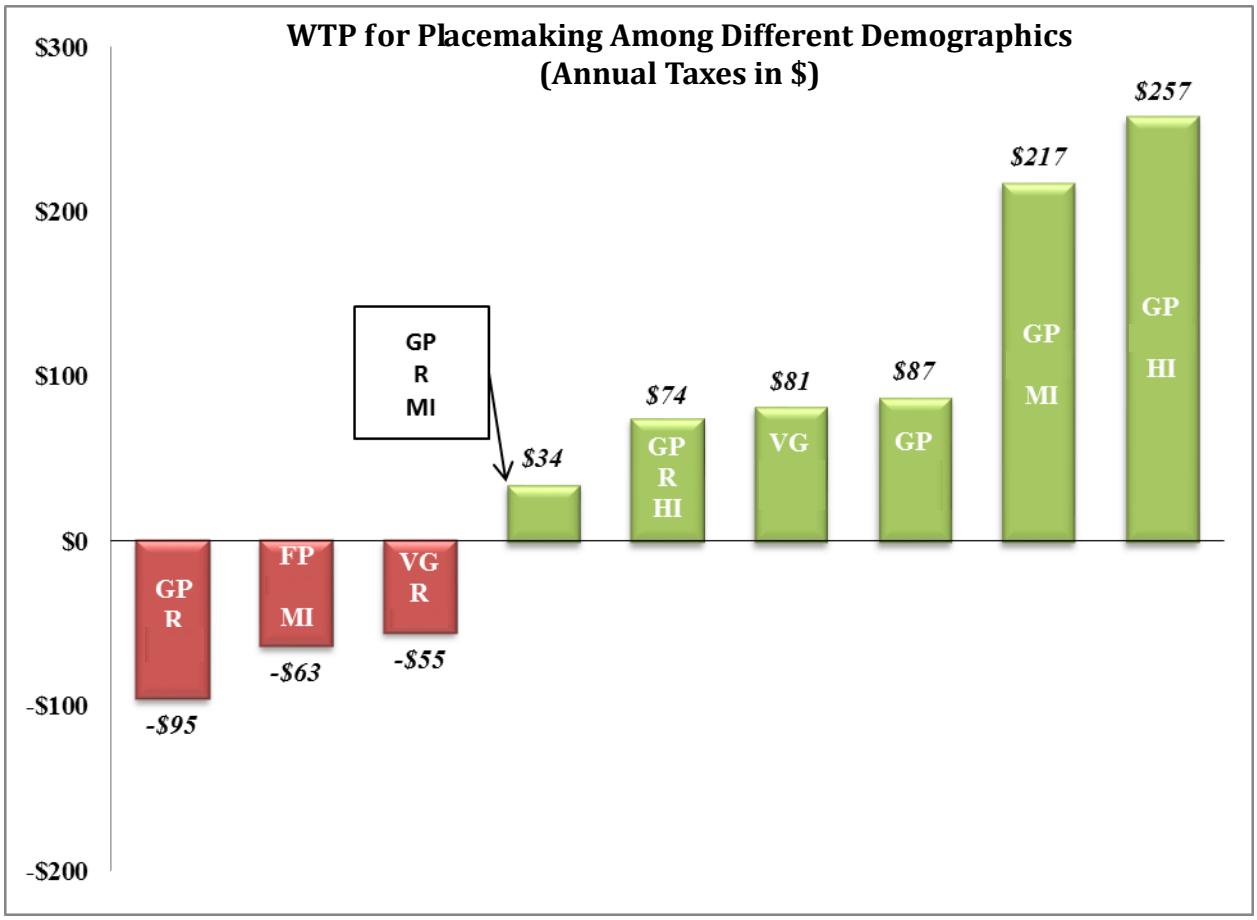

Figure 5.4: The Effect Household Ownership and Income on the Willingness to Pay for Placemaking

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. A negative and statistically significant coefficient estimate associated with the ASC on no plan indicates that respondents have negative baseline utility when all attribute values are set to zero. This negative utility is eliminated when one engages in any policy, and is hence added to compensating surplus (welfare) estimates. All else being equal there is a systematic preference *against* no project. 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:

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

$$+ \beta_{CH} * \boldsymbol{CH} + \beta_{SN} * SN$$

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

Variable	Abbreviation	Coefficient (β)	t-stat
Commuter Rail Service	ST	0.224	1.992
Service Reliability	SR	1.663	3.421
Fair Placemaking	FP	0.390	3.115
Good Placemaking	*GP*	*0.207*	*1.613*
Very Good Placemaking	VP	0.222	1.713
Low Comfort	C	-0.249	-3.120
Parking Fee at destination	P	-0.440	-5.578
Cost to Household	CH	-0.007	-10.124
Alternative Specific Constant	SN	-2.227	-12.266
ρ^2		.0736	
Log Likelihood		-987.855	
No. of Observations		1023	

Notes*: Italics = significant at 80% level, Non italicized variables are significant at the 90% level. Model significant at 10% level (χ^2=156.819, df=9)*

The model has a likelihood ratio index (ρ^2) of 0.0736, which is in the lower range for the index. The final model presented in this study was however chosen after

estimation of a number of preliminary models based on measures of model fit including the likelihood ratio index. The model proved to be significant at 90% confidence level and superior to other models that were estimated.

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 $34 more for a commuter rail service than an equivalent express bus service in the NHHS corridor.

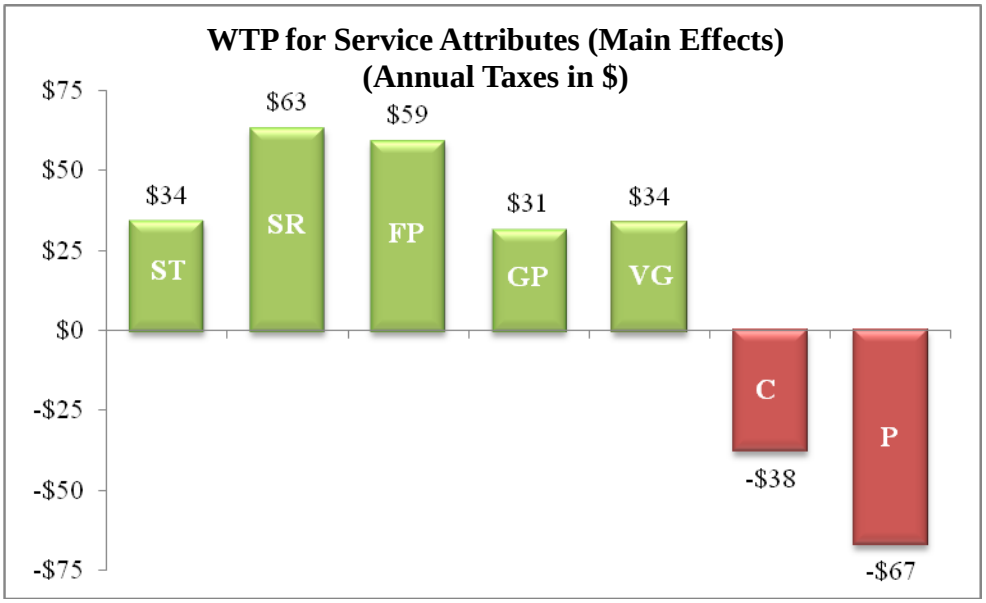

Figure 5.5:Willingness to Pay to for Service Attributes (Complete Data Set)

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 $2.52 on average 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 $38 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 ($59) than high comfort ($38). 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 either a misinterpretation of the parking variable by respondents or that respondents were attempting to keep their options for car or transit open. It is possible that users in considering a new transit service wanted to preserve their existing travel options. Regardless, this may have significant policy implications. Introducing new transit projects while simultaneously altering parking policy at 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.

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. Fair and very good placemaking were found to be significant at the 90% level while good placemaking was found to be significant at the 80% level. Fair placemaking was found to have a larger marginal effect on utility than the good and very good levels of placemaking. The research establishes that transit is more valuable to individuals when the quality of the stop environment is considered.

Individuals were found to place a higher value on fair placemaking than the good and very good placemaking levels, with a willingness to pay value of $59 compared to $31 and $34, respectively. This further suggests 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. The public placed the least value on good placemaking, the level which includes reduced building setbacks in addition to the previously mentioned elements. Individuals may not as readily perceive the benefit of reduced building setbacks as they do benefits of wider sidewalks, improved lighting and on street parking. It is also possible that this feature is not believable or desirable among communities along the NHHS corridor. Individuals' willingness to pay for very good placemaking (the addition of street trees and greenery to good 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, good placemaking (the first level including reduced building setbacks) was found to be less significant in the final model. 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 the features of 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, household ownership 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.

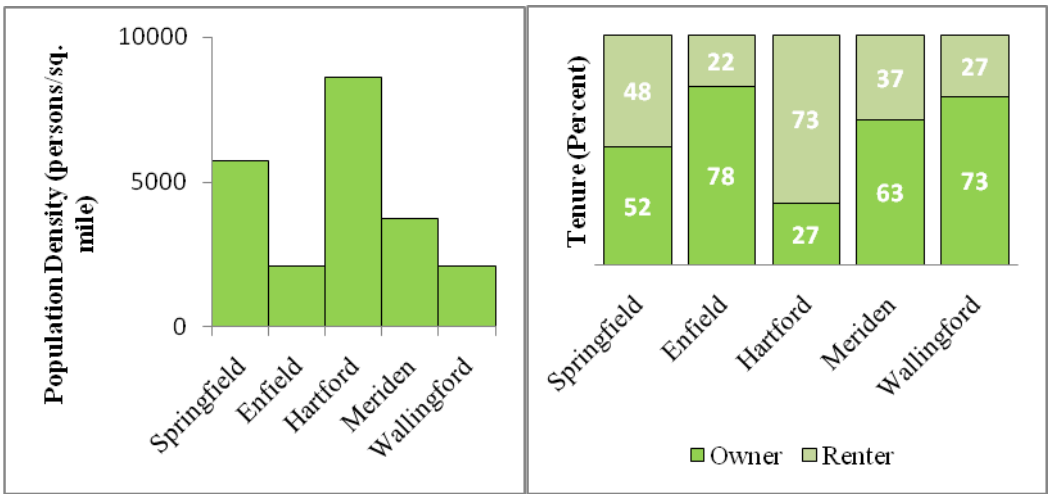

Figure 5.6: Population Density (Left) & Household Ownership (Right) for Study Locations

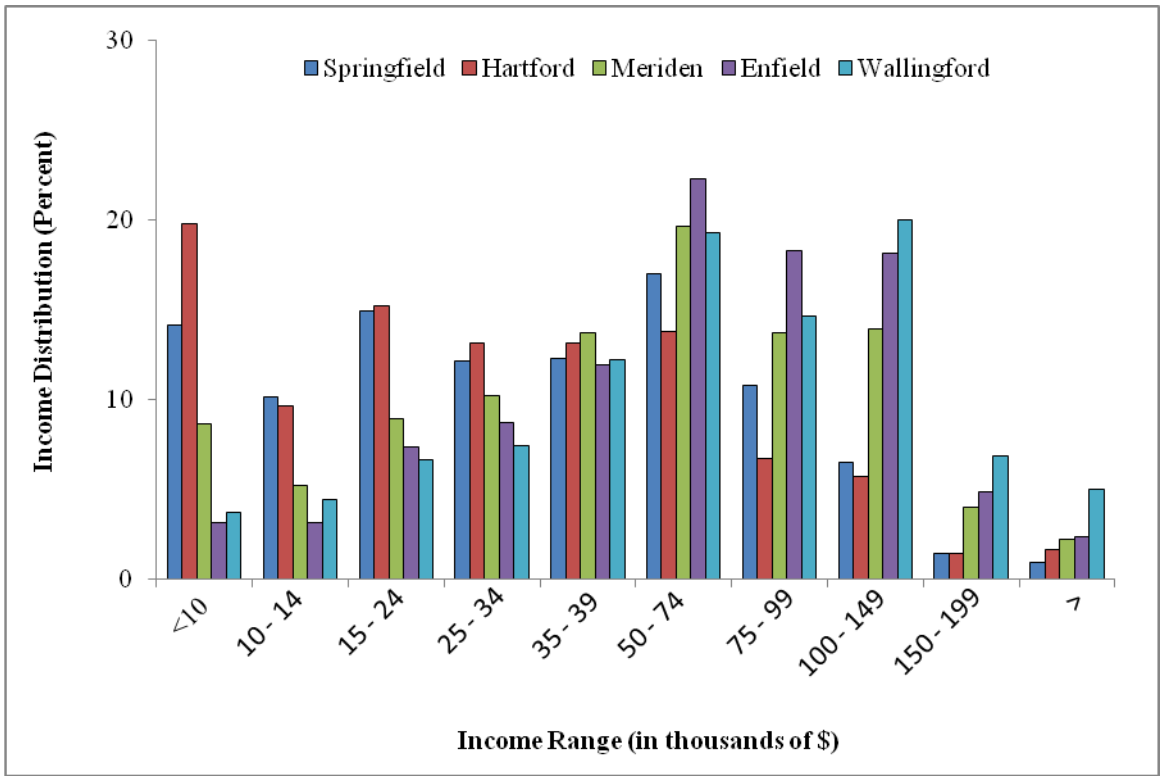

Figure 5.7: Income Distributions for Study Locations

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 same 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.

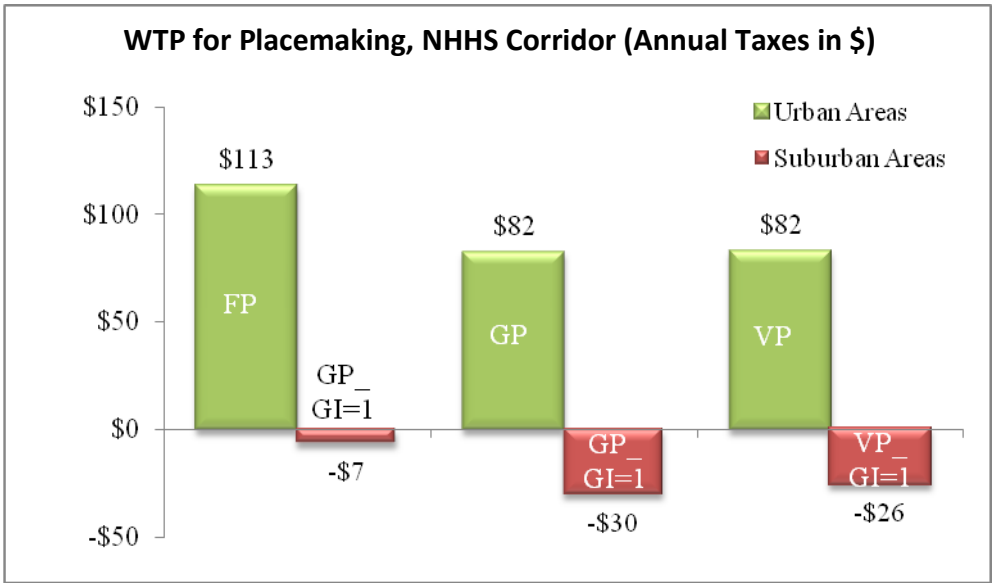

Figure 5.8: An Individual's Willingness to Pay for the Levels of Placemaking in Urban and Suburban Areas

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 of the study locations. This may explain the insignificance of the 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.

5.3 SIGNIFICANT FINDINGS

This section presents the most salient findings of this research. Several excerpts of the models, tables, and figures are used to illustrate significant findings.

5.3.1 The Value of the Survey Instrument as a Planning Tool

Full scale implementation of the survey instrument served dual purposes, to collect data to estimate individual's willingness to pay for key mobility and non-mobility attributes of new transportation services and to determine the suitability of the survey instrument as a planning tool. Both studies revealed a significant preference for commuter rail over express bus, ceteris paribus (Figure 5.9). The findings suggest that the survey instrument should be employed in potential transit corridors before making basic service type decisions.

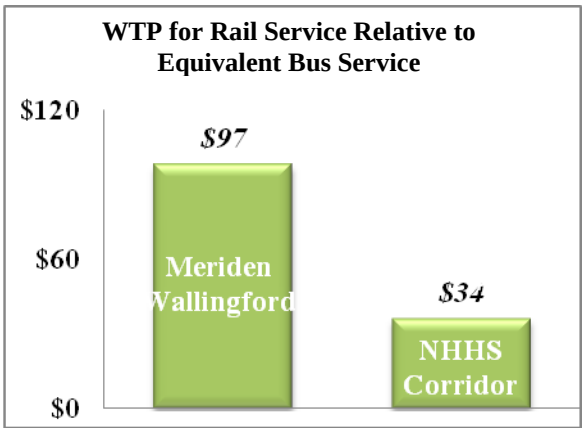

Figure 5.9: WTP for Rail Service Over Equivalent Express Bus Service

The survey instrument can also be used to determine whether new transportation services are more valuable to communities when the quality of stop environments is considered. Figure 5.10 illustrates the value of placemaking to the NHHS. Successful planning should incorporate systems that foster these types of environments.

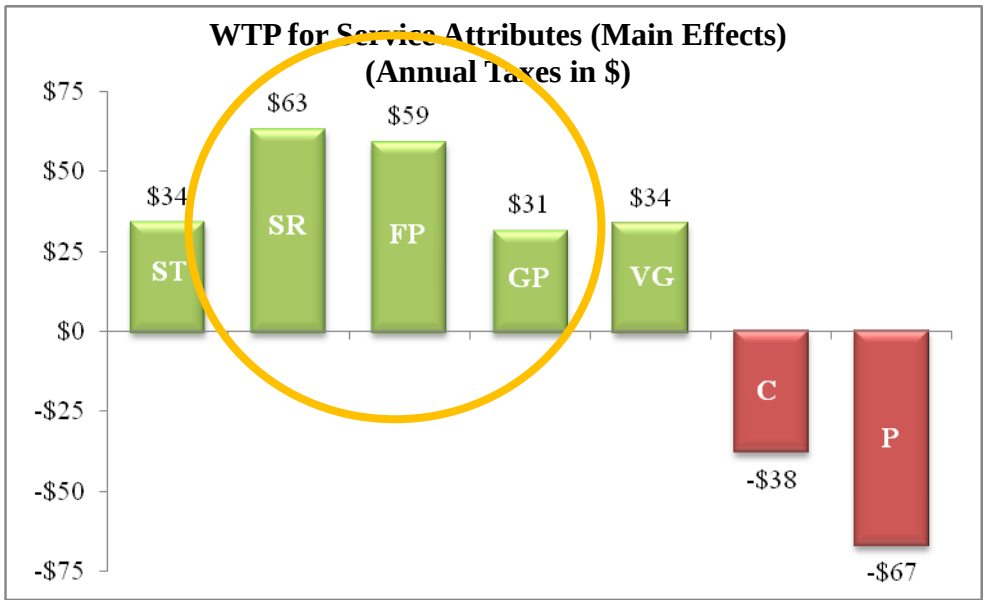

Figure 5.10: The Value of Placemaking to the NHHS Corridor

5.3.2 Communities Differ in Their Willingness to Pay for New Transportation Systems

In the analysis of Wallingford and Meriden SP data income and household ownership were found to have an effect on an individual's willingness to pay for placemaking. Figure 5.11a and 5.11b illustrate the effect of income on renters and homeowner's willingness to pay for the good level of placemaking. As one can see from the figures, higher income has a positive effect on willingness to pay for both segments of the population. A similar relationship was found to exist between income and willingness to pay for the other levels of placemaking. Figure 5.12a and 5.12b depict the effect of household ownership status on the good and very good levels of placemaking, respectively. The figures reveal that property owners are more willing to pay for placemaking than renters in their community.

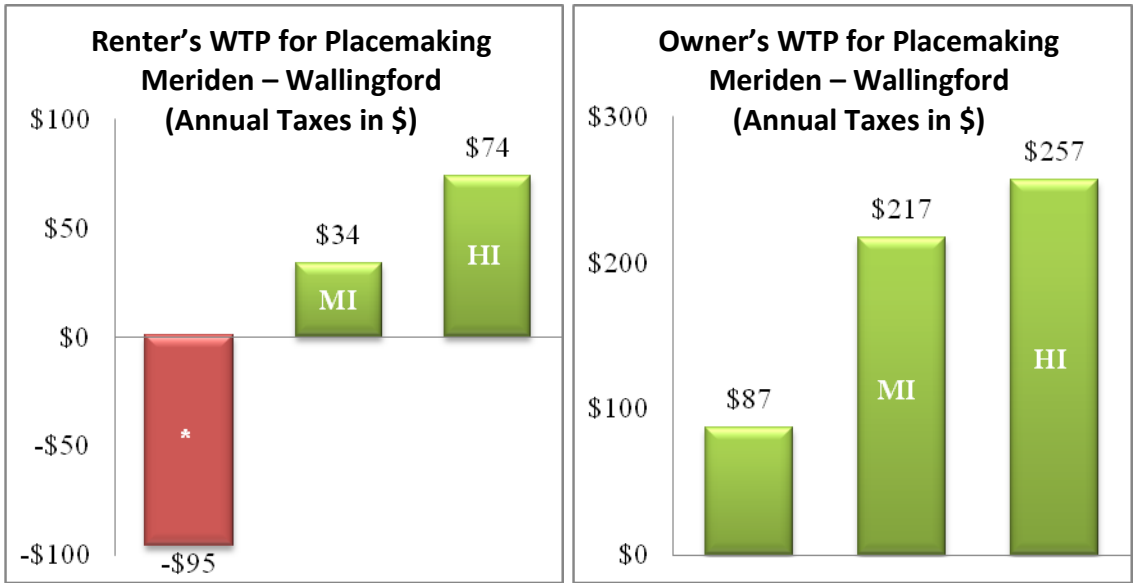

Figure 5.11a,b: The Income Effect on the WTP of Renters (left) and Owners (right) for Good Placemaking

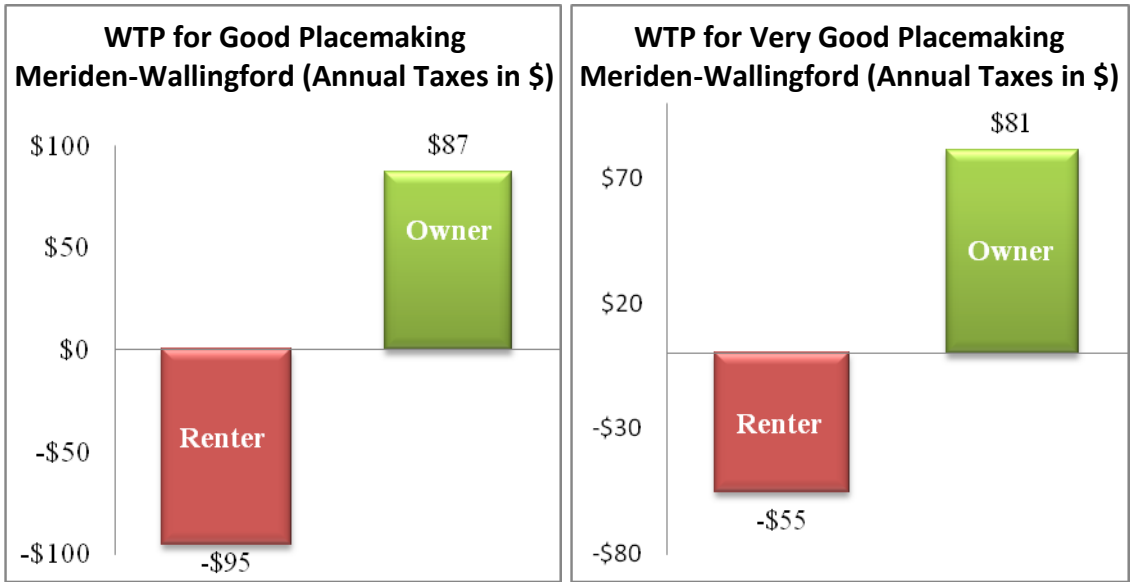

Figure 5.12a,b: The Household Ownership Effect on WTP for Good (left) and Very Good (right) PM

In the larger, complete data set the income and household ownership variables were only found to be significant when interacted individually, however when included together in the same model their significance was lost. The initial data set included the towns of Meriden and Wallingford which are adjacent to each other and share much more in common than cities in the larger data set such as Hartford and Springfield. When

classified on the basis of urbanity, urban populations were found to be much more willing to pay for placemaking than rural populations. In the selected study locations the level of urbanity appeared to capture both the household income and household ownership effects, suggest that the urbanity of communities is an important factor governing individual's willingness to pay for placemaking.

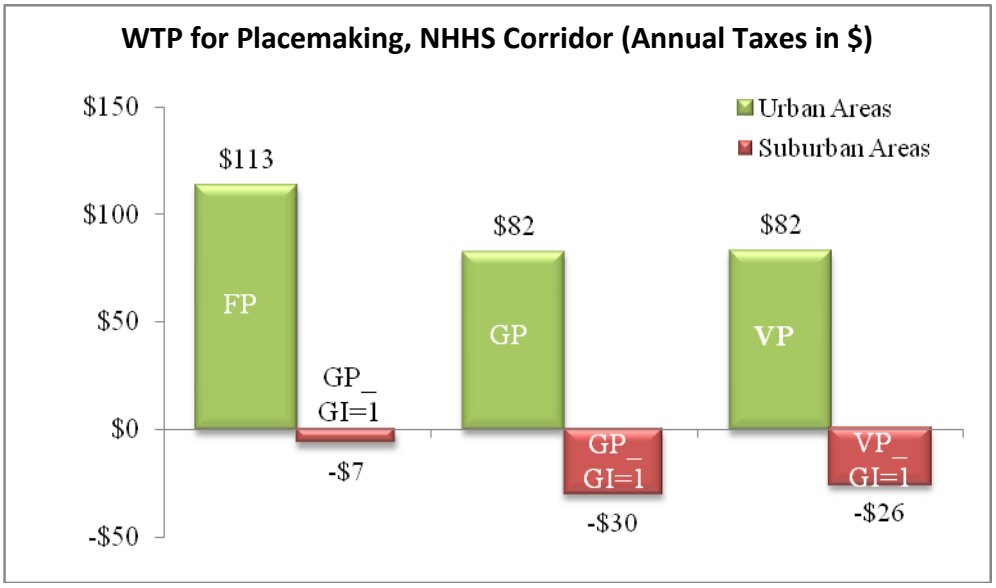

Figure 5.13: The Effect of Urbanity on Willingness to Pay for Placemaking

5.3.3 Some Forms of Placemaking are More Valuable than Other

The primary purpose of expanding the pilot studies "good" and "bad" categorization of placemaking was to determine if some forms of placemaking are more valuable than others. While all levels of placemaking were found to be significant in the interacted models, some levels of placemaking had higher positive coefficients suggesting that the public was more willing to pay for that level. Figure 5.14 shows the willingness to pay of residents of Meriden – Wallingford and suggests that, overall, good placemaking (improved lighting, on-street parking, wider sidewalks, and reduced building setbacks) is most valuable.

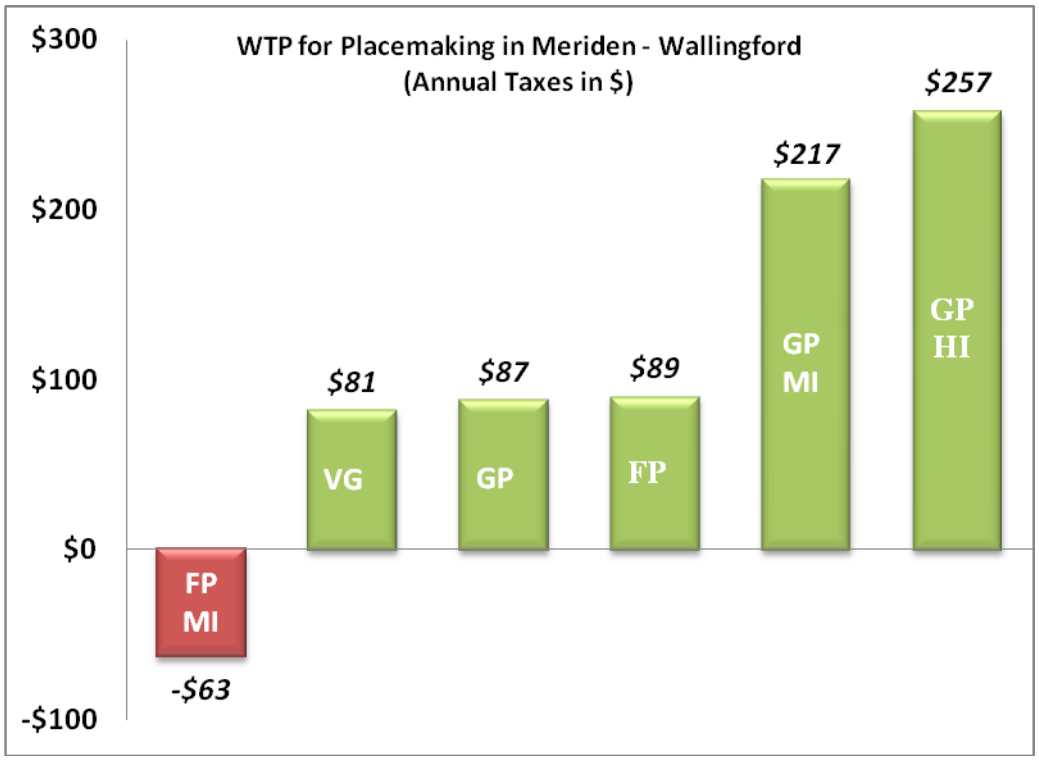

Figure 5.14:WTP for Placemaking Among Different Segments of the Population in Meriden and Wallingford.

However, Figure 5.15 illustrates how segments of the population (in this case owners and renters) value the levels of placemaking differently. Owners of all income levels are willing to pay less for very good than they are for good placemaking. Low income owners were willing to pay slightly less for good than fair placemaking. It is important to note the effect of income on willingness to pay for the good level of placemaking. Middle and high income owners exhibited a significantly greater willingness to pay for the good level of placemaking. Similar to owners, renters also exhibited less willingness to pay for very good than good placemaking, however they exhibited a greater willingness to pay for systems with fair rather than good placemaking. The disparity in preference for placemaking between owners and renters suggests that while the public values the placemaking potential of transit systems, it values it to different degrees. It appears that renters are more willing to pay for fair placemaking

because it is the level which offers basic safety improvements to the stop environment. Renters may be more likely to be patrons of new transportation systems, use the transit facilities of placemaking and therefore place greater importance on safety treatments. Owners were found to be more willing to pay irrespective of potential ridership for the good level of placemaking, which in addition to the features of fair placemaking includes improved storefronts situated closer to the roadway. The good level of placemaking really emphasizes the community development potential of public transportation and it is hypothesized that owners have a vested interest in the development of their community.

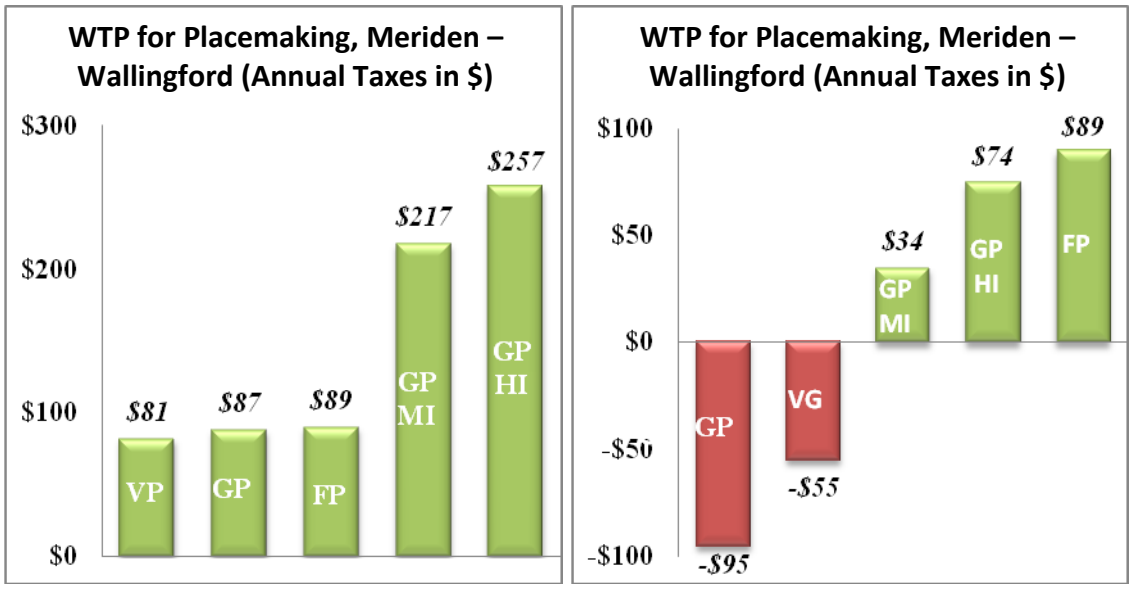

Figure 5.15:WTP for Placemaking Among Owner (left) and Renter (right) Segments of the Population in Meriden and Wallingford

Figure 5.16 shows the willingness to pay for placemaking of urban and suburban communities in the NHHS corridor. Placemaking features that increase or enhance individual's perceptions of safety appear to be most valuable to urban communities. Suburban areas appear to have a slight disutility for safety features. Residents of suburban areas may benefit less from these features as they are more likely to access transportation through kiss and ride or park and ride services.

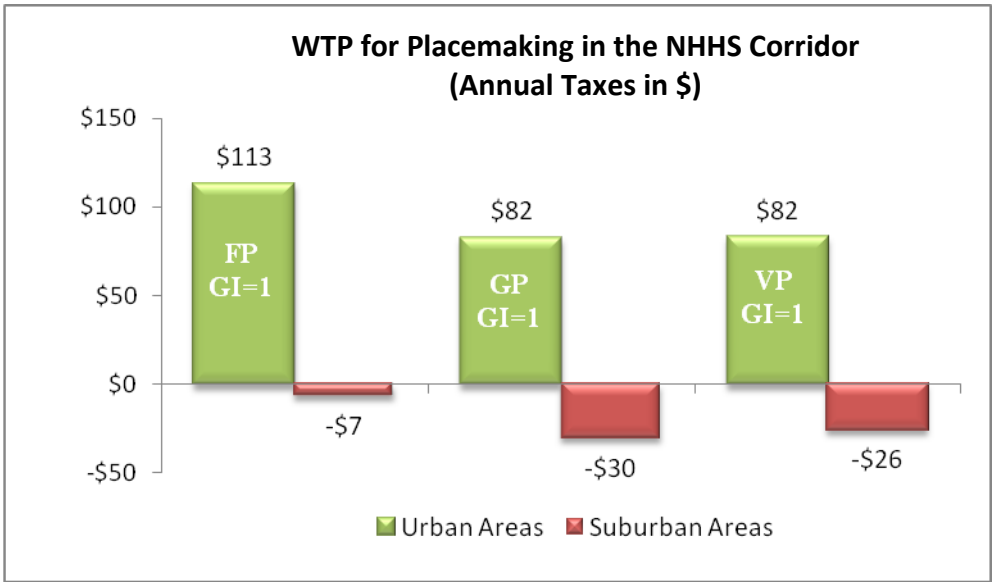

Figure 5.16: Geographic Effect on WTP for Placemaking in the NHHS Corridor

6.0 CONCLUSIONS

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. This study further categorizes placemaking into its component variables and finds that the public is willing to pay for placemaking and place a higher value on some 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 perceive 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.

The survey instrument developed by this research can be used to support a wide array of planning decisions, such as: What type of transit vehicle should be integrated into a community? How important is in-vehicle comfort relative to alternative modes? What are the expectations for on-time performance of transit vehicles in the study corridor? Are people willing to pay for community development and if so to what extent? How do different segments of the population value (low, middle and high income property owners and renters) value these developmental aspects of transit? How can demographics help funding new transportation systems? Is transit oriented development even desired in suburban communities?

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.

7.0 RECOMMENDATIONS

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

7.1 SURVEY DELIVERY

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. For maximum effect, actual images should be taken from communities in study and improved through means of digital rendering to ensure plausible environments. It has also been acknowledged that some features of placemaking are more plausible in the context of urban or suburban environments. Special care should be taken to ensure placemaking treatments are applied to images in a realistic fashion. Architectural treatments, such as improved store fronts closer to the roadway and reduced building setbacks may not be believable in suburban stop environments.

7.2 COMMUNICATION OF PARKING POLICY

Communicating the idea of destination-end parking policy to respondents is a difficult task. The availability of destination-end parking was included as an attribute because it was believed that the existence of parking fees at traveler's final destination would increase traveler's propensity to ride and correspondingly their willingness to pay for transit services which provide alternative to access their destinations. However, incorporating this variable into new transportation projects in the choice experiment may

have led to some confusion among survey respondents as well as the interpretation of the coefficient.

It is worth structuring the parking attribute as a context and control variable. It could be explicitly stated in the service introduction that individuals making commute and shopping trips now have to pay for parking in towns along the corridor if they choose to drive. The variable could then be interacted with another variable in the choice experiment. The presentation of the parking attribute as a variable outside of the choice experiment may make the concept more clear, increase the reliability of results, and ease the interpretation of the variable and is something that could easily be incorporated into the survey design.

7.3 SAMPLING FRAME

Additional efforts should be made to capture a demographically representative sample of the study population. A combination of delivery methods (intercept, email, paper) could be used to achieve this. With minor adjustments and multi-lingual support the survey is well positioned to collect data over the web.

7.4 TRIP DESCRIPTION INTERFACE

The trip description interface of the survey can be expanded and improved for easier comprehension and interpretation by respondents. Focus groups participants confirmed that the description of hypothetical trip making behavior is not a trivial task. However, the hypothetical trip description interface created for this survey (Selection from Predefined Trips) proves that hypothetical trip making behavior can be collected in a very simple and intuitive manner. Future internet based surveys can leverage geographic information programs (I.e. Google Earth) to collect a wealth of information in

an efficient manner. For example, the hypothetical trip description interface can be improved by allowing respondents to describe their trip making behavior by simply pointing to locations on a map. Respondents might select the approximate location of their home, the station closest to their home, the station closest to their final destination, and the approximate location of their final destination to describe their hypothetical trip making behavior with four touches of their finger. This information can then be used to return context sensitive questions to the respondent. A dynamic trip description interface similar to the one described here would be of great use to transportation planners.

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9.0 APPENDICES

A-1: YANNES ET AL., 2010

This section of the appendix contains the survey feedback and demographic portions of *(Yannes et al., 2010)* pilot survey.

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

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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

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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?

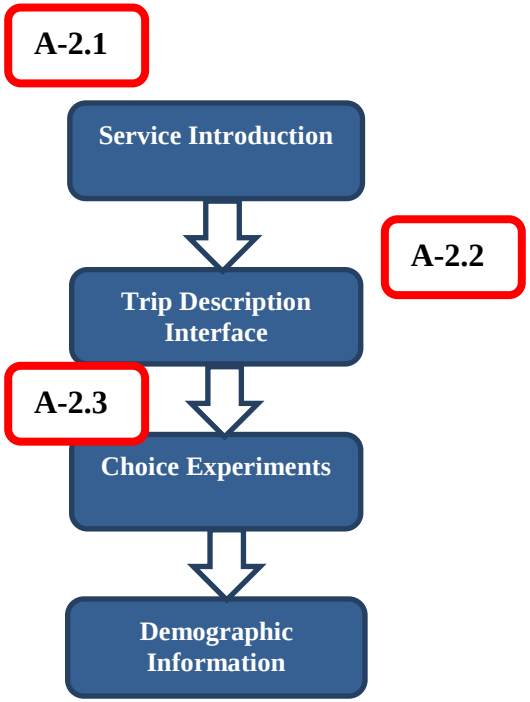
- ☐ Less than 10 minutes
- ☐ Between 10 and 20 minutes
- ☐ Between 20 and 30 minutes
- ☐ Between 30 and 45 minutes
- ☐ 45 minutes or more

Comments

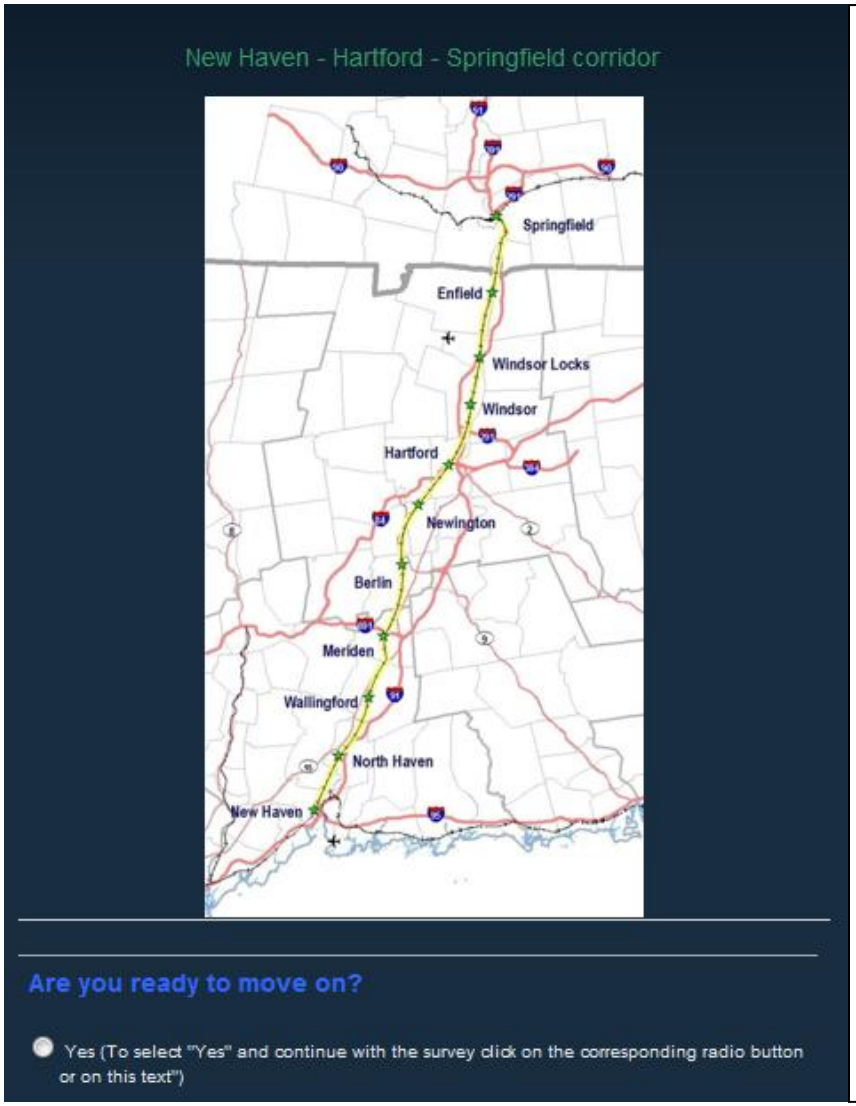
If you have any comments or would like to explain your answers to a particular question please use the space provided below. Please provide the question to which you are referring.

A-2: 2010 TRANSPORTATION SURVEY

This section contains screen captures of the survey and their corresponding narratives to help to help the reader follow along.



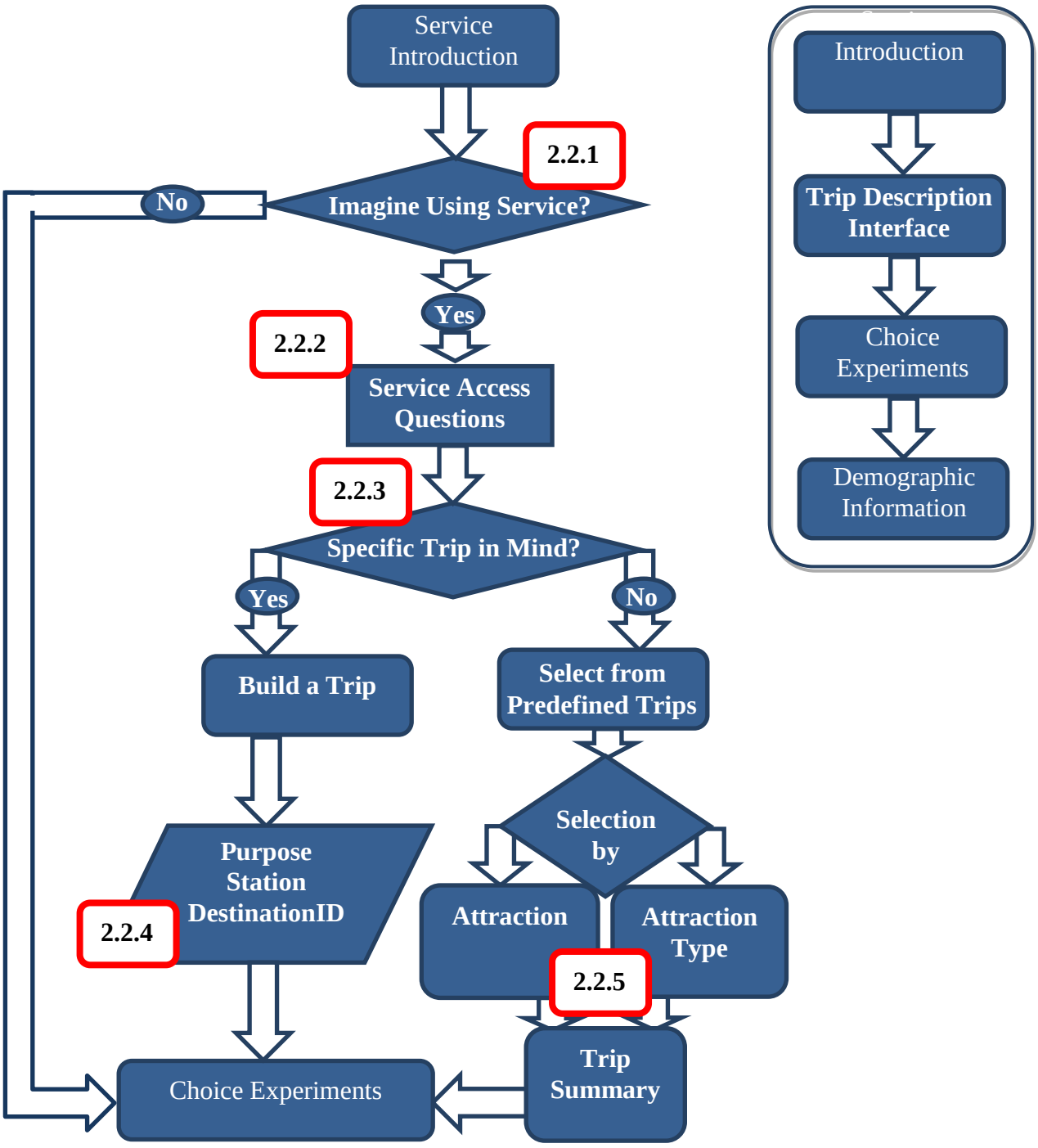
A-2.1: Travel Corridor of the Passenger Service



"This is a map of a passenger service that will operate along the New Haven-Hartford-Springfield Corridor.

Each of the stars represents a town where the service will stop."

A-2.2: TRIP DESCRIPTION INTERFACE



Flow Chart of Trip Description Interface

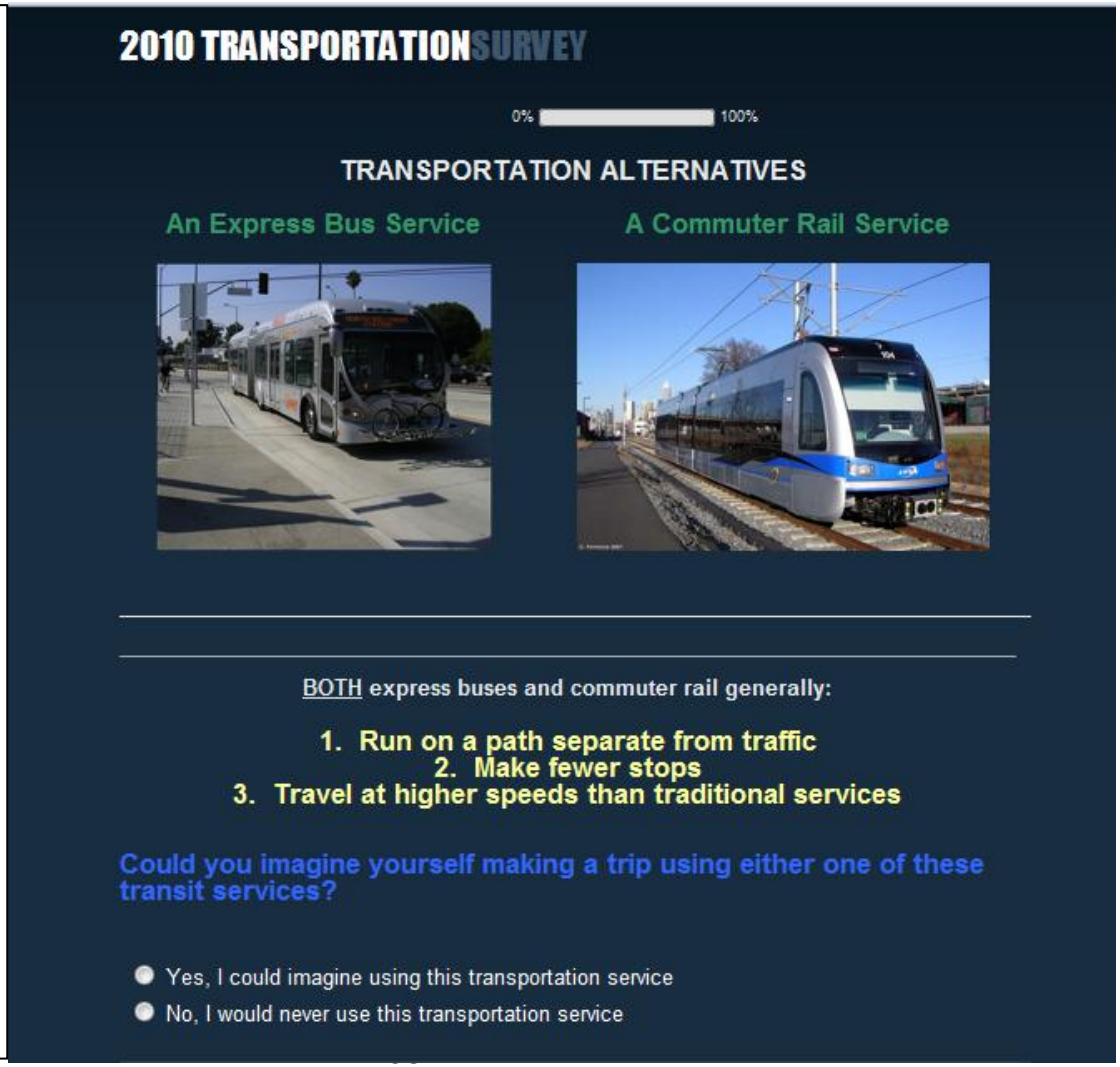
A-2.2.1: Identifying Potential Riders

"These are the two passenger services currently under consideration.

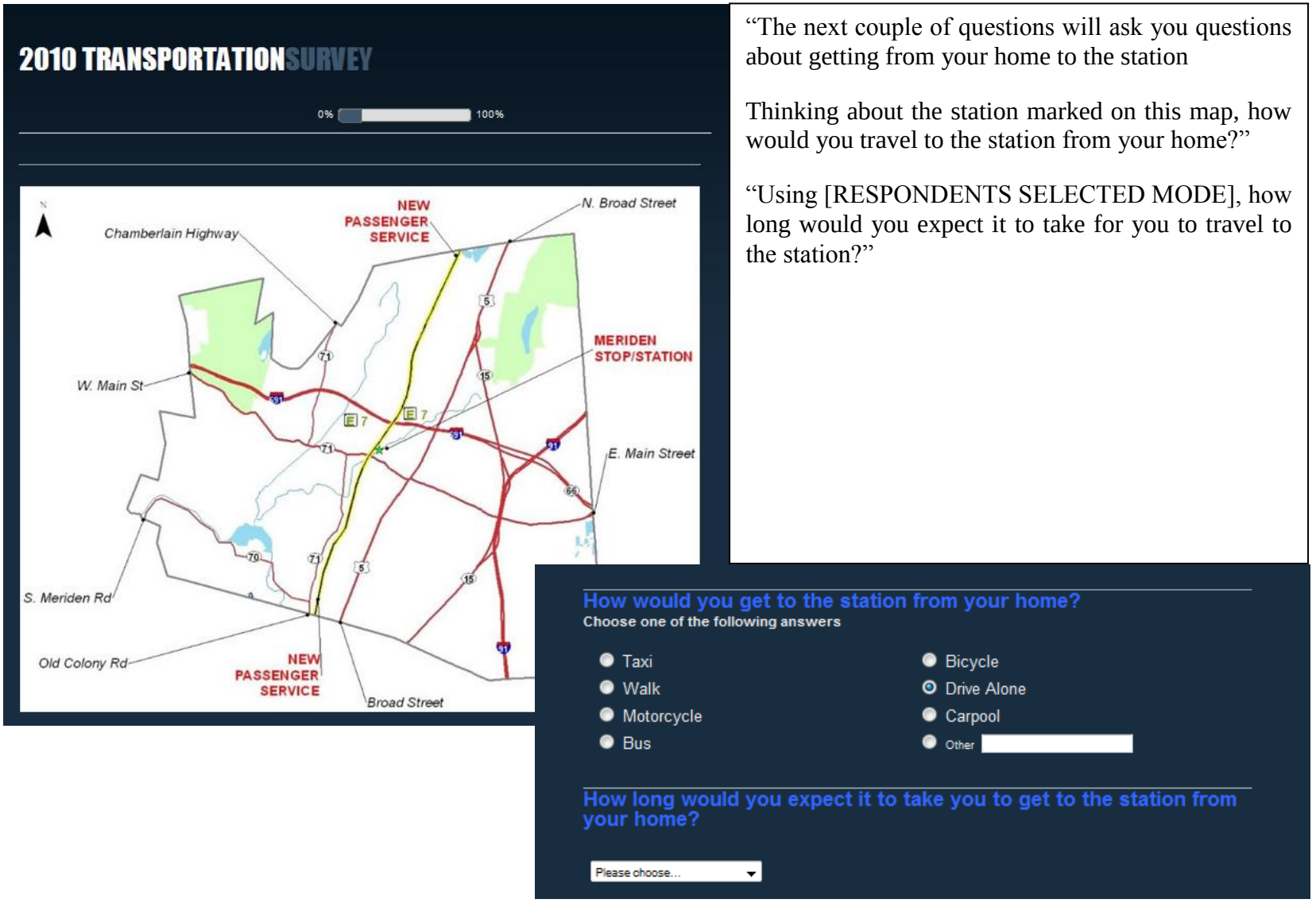
This is an express bus service. Typically, express buses are larger than city buses and, unlike other bus services, express bus services do not share the road with other vehicles.

Both the express bus service and the commuter rail service operate apart from regular traffic, make limited stops, and operate at higher speeds.

Could you imagine yourself making a trip using either one of these transit services?"



A-2.2.2: Service Access Questions



"The next couple of questions will ask you questions about getting from your home to the station

Thinking about the station marked on this map, how would you travel to the station from your home?"

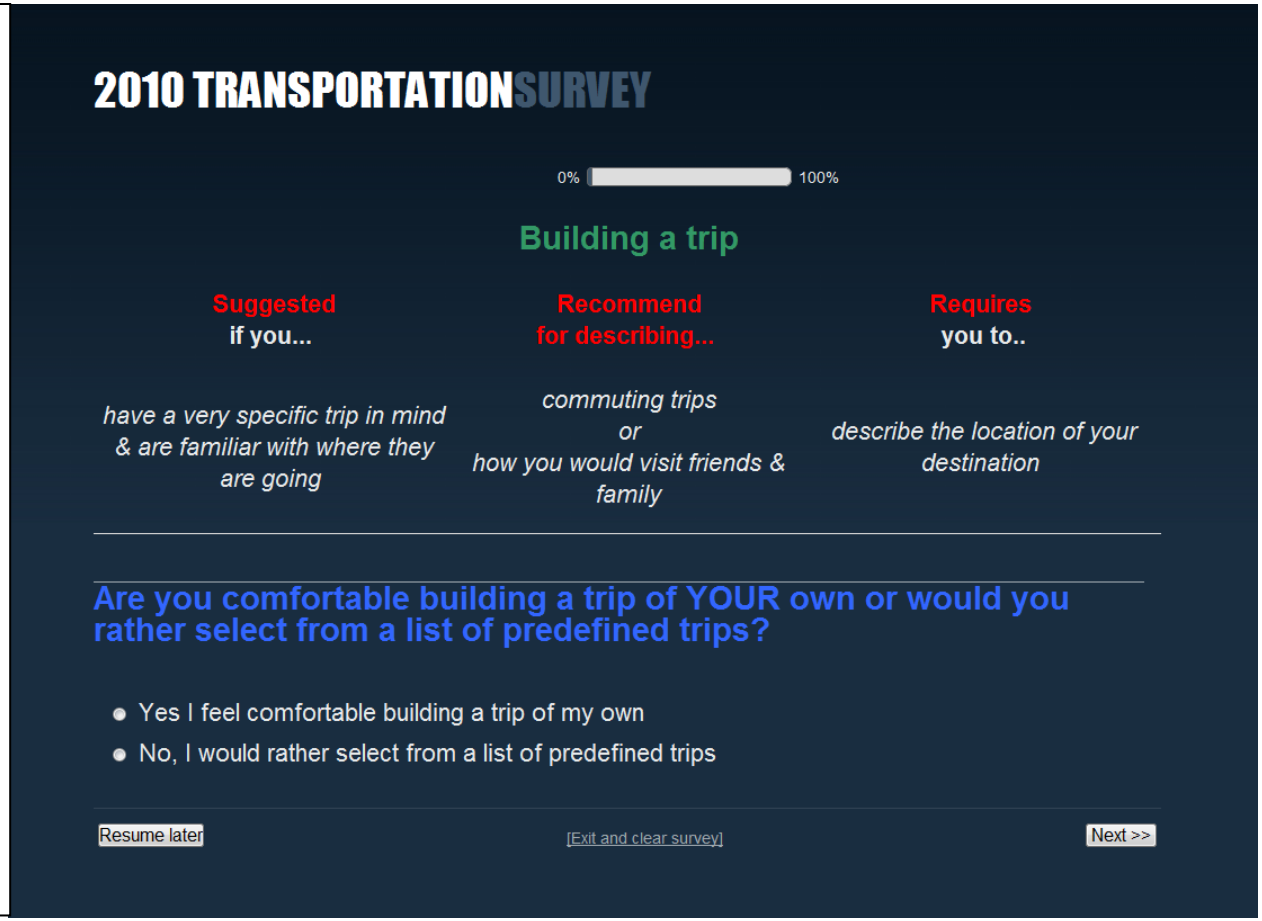
"Using [RESPONDENTS SELECTED MODE], how long would you expect it to take for you to travel to the station?"

A-2.2.3: Screening Respondents for their Trip Description Interface

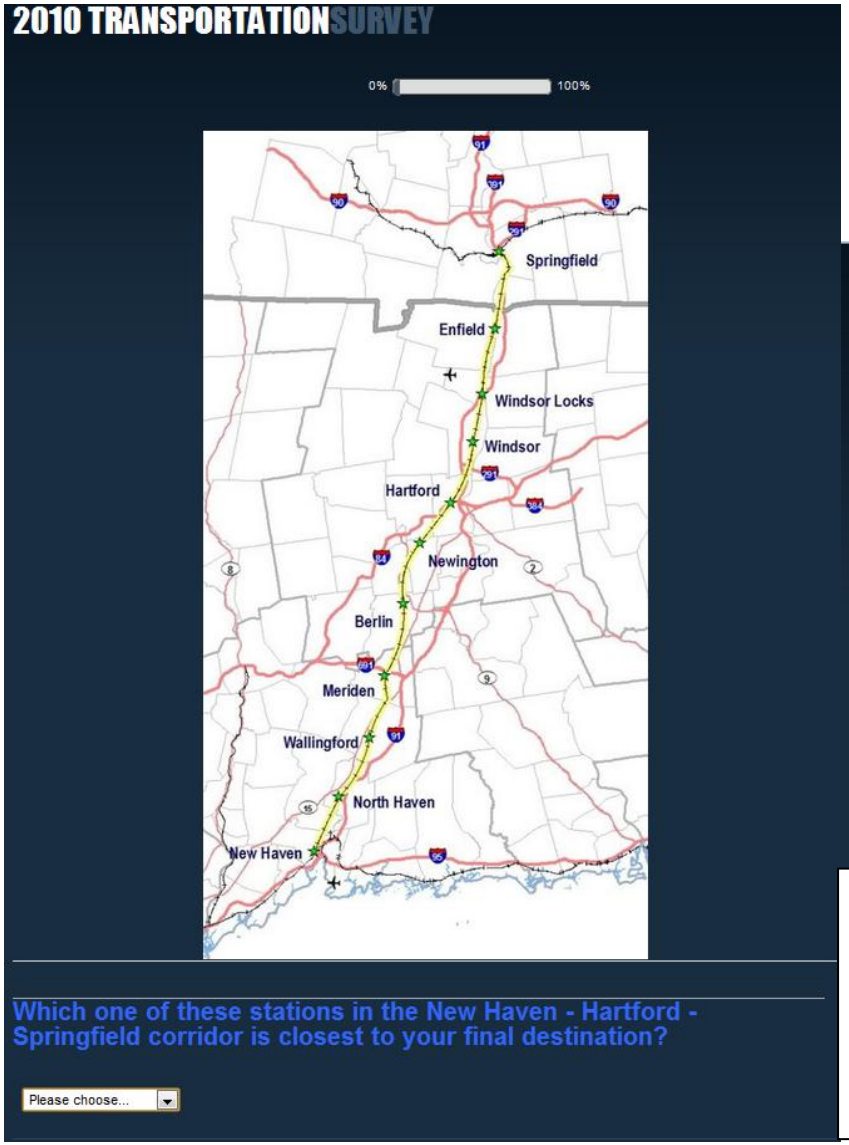
"The next question asks if you are comfortable building your own trip. It is suggested that you build a trip if you have a very specific trip in mind you would make using this transit service or would use this service to commute to work or visit friends and family.

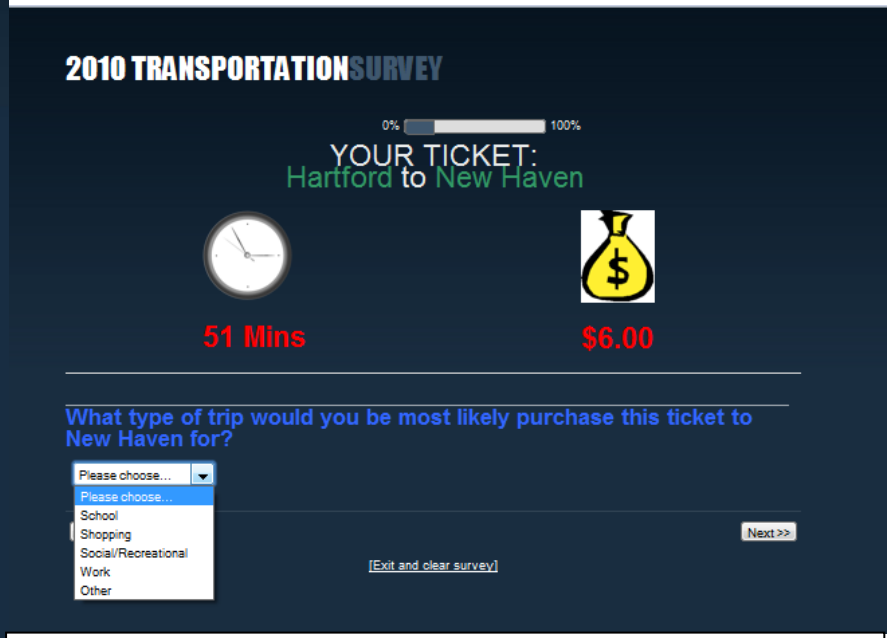
If the respondents says yes…

"Building a trip ask you to describe the location of your final destination. If you are comfortable doing that click the yes button. Otherwise you may choose from a list of predefined trips."



A-2.2.4: Building a Trip

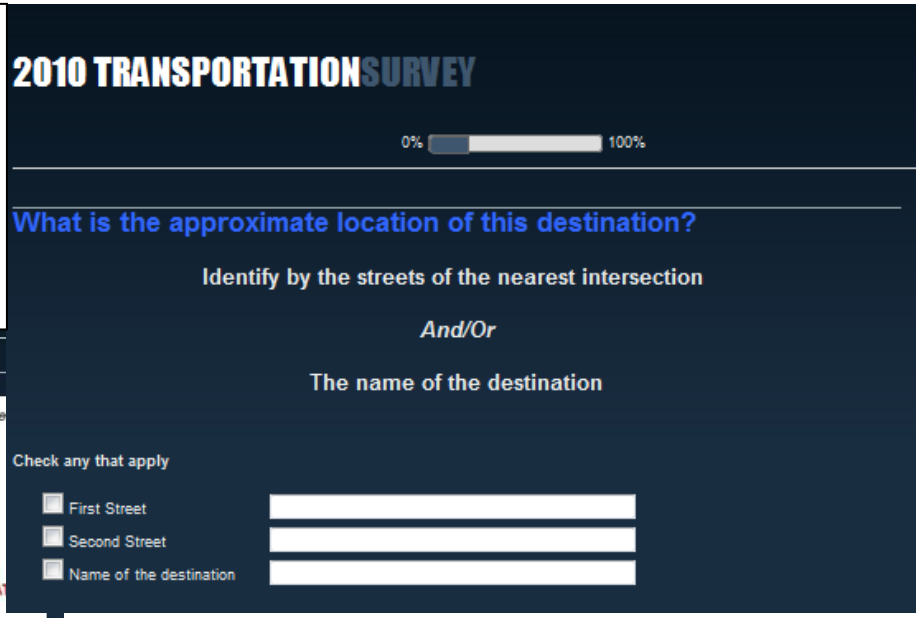


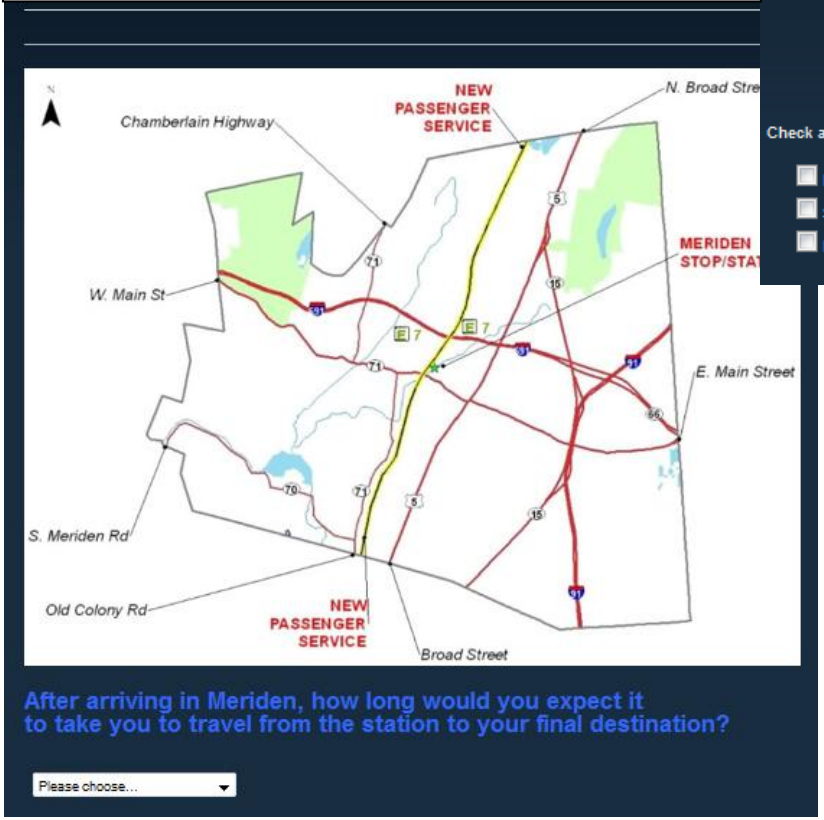


"To arrive at your destination, you will ride the passenger service from [HARTFORD] to [NEW HAVEN] for [51] minutes and it will cost you [6] dollars."

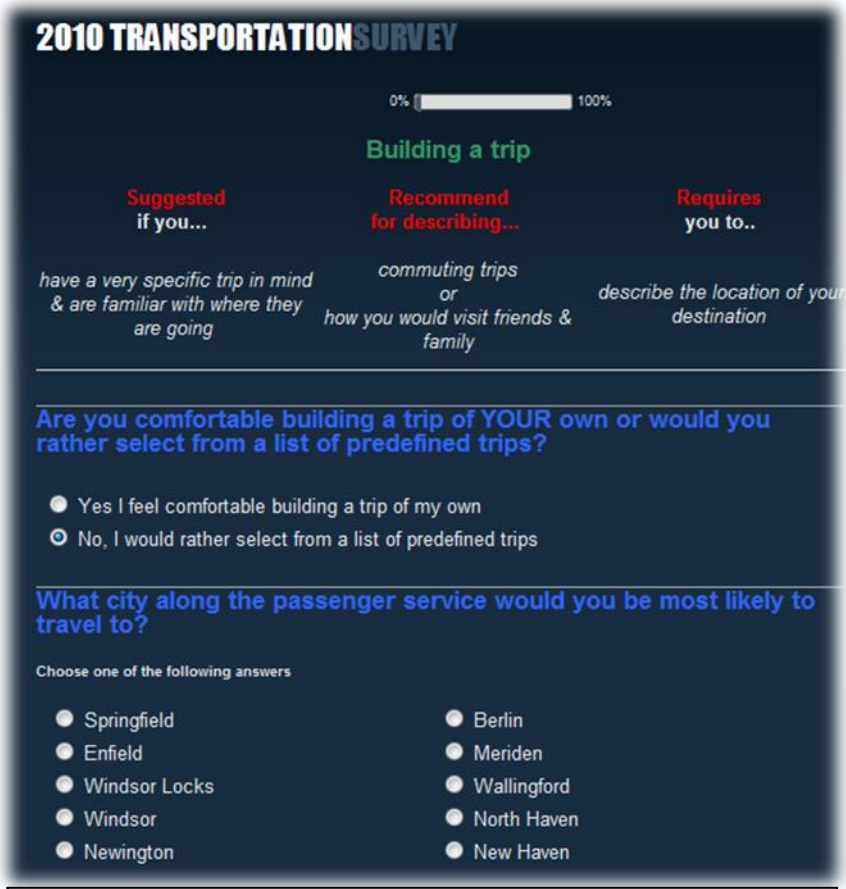
A-2.2.4: Building a Trip (cont)

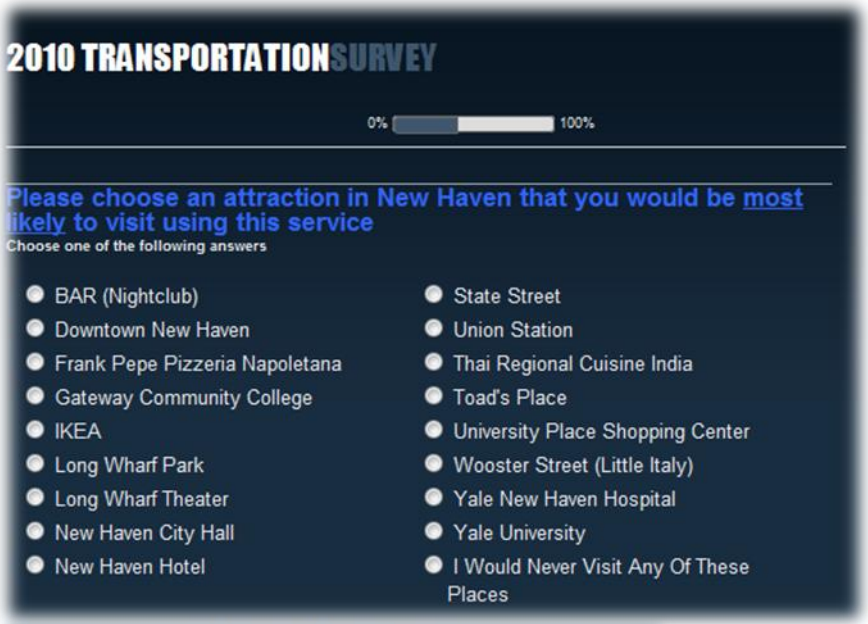
For the approximate location of the final destination ask respondents the place they had in mind so you can help them fill in the name and street information.

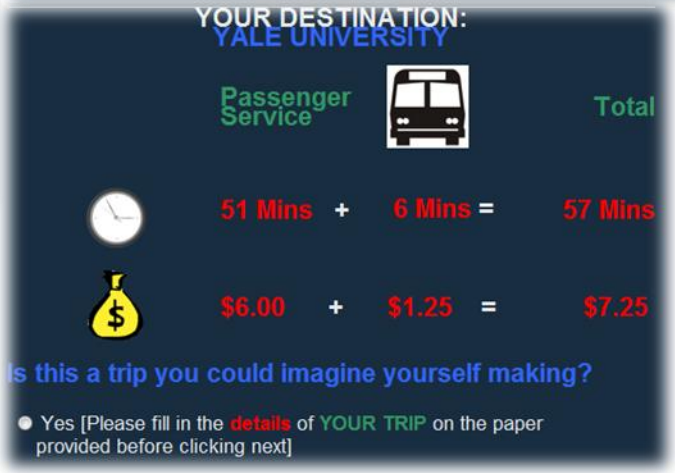




A-2.2.5: Selecting from a Pre-defined List of Trips







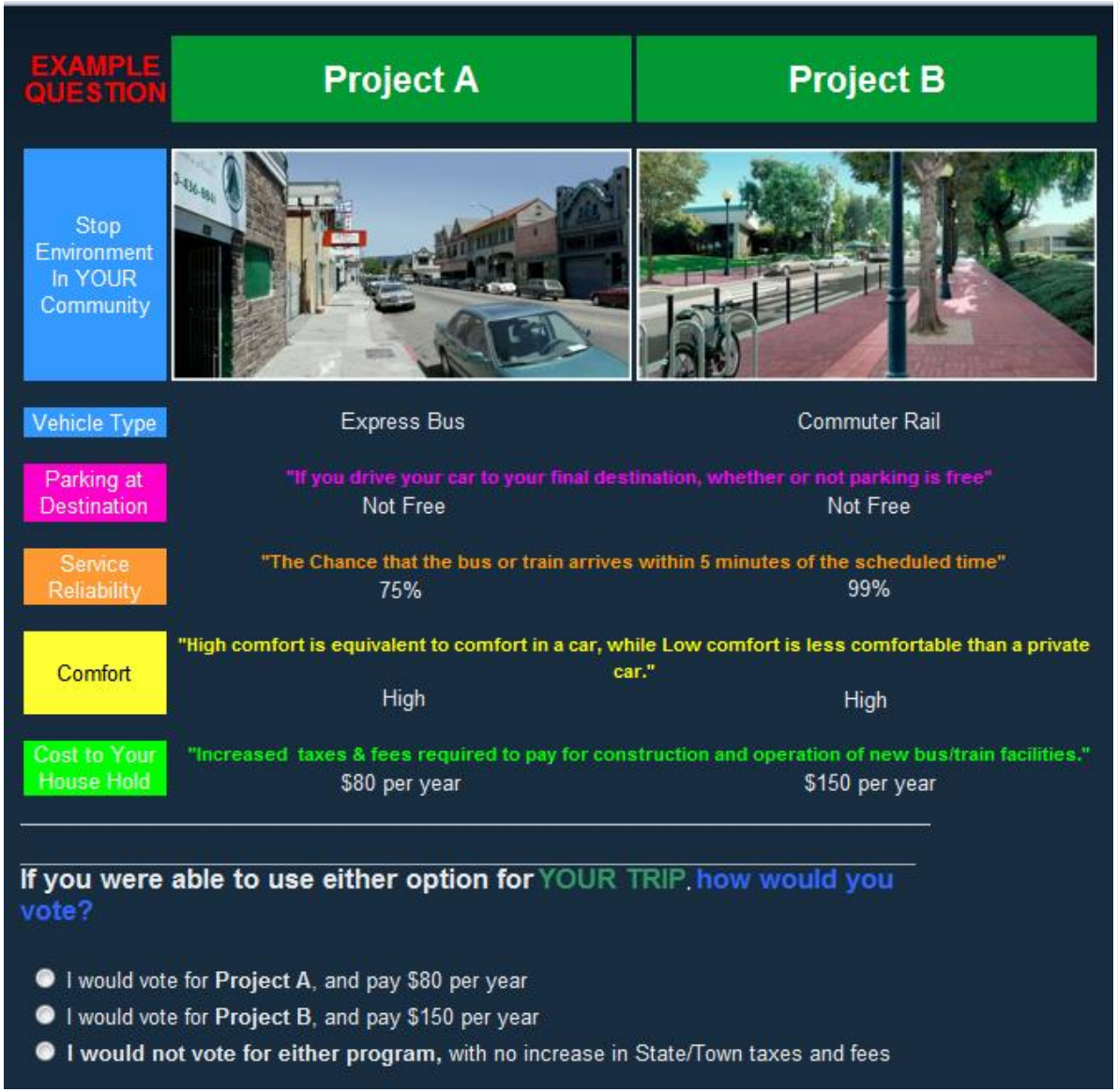
RIGHT

"To arrive at your destination, you will ride the passenger service from Enfield to [NEW HAVEN] for [51] minutes and it will cost you [6] dollars."

"You will then ride a bus from [UNION] station to the [YALE UNIVERSITY]. This will take you an additional [6] minutes and cost you an additional [1] dollar and [25] cents

Is this a trip you could imagine yourself making?"

A-2.3: EXAMPLE CHOICE EXPERIMENT



"We are now moving on to the portion of the survey where you will be asked to choose between different public transportation options.

"This is an example question. You will be given details on two new public transportation options. Once you have considered the options, you will be asked to select whether you would prefer Project A, Project B, or Neither Project.

Explain briefly each choice attribute

"We want to know, if you were able to use either option for your trip, how you would vote. Remember, there are no wrong answers, we are only interested in your opinions."

"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."