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Quantifying the Value of Transit Station and Access Improvements for Chicago's Rapid Transit System

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ABSTRACT

The goal of the Congestion Management and Air Quality (CMAQ) program is to improve air quality by reducing auto use and highway congestion. Rapid transit station and pedestrian system improvements are important to Chicago's strategy to meet this goal for its CMAQ funding. The effects of improving transit service by traditional means are generally well understood and are represented in conventional travel forecasting models. Much less understood are how more general improvements in transit stations and transit access affect transit ridership and, ultimately, air quality.

This paper describes work to quantify the effects of potential changes to the Chicago rapid transit system's stations and pedestrian access and to measure the impacts of these changes on rapid transit system ridership, revenue, and auto emissions. The study was based on an in-depth computer-based survey of a sample of people who either currently use rapid transit or who make trips that could reasonably be served. Preference information was collected using hybrid conjoint methods.

The study found that a modernized station provides an equivalent benefit of approximately \$0.23 to \$0.37/trip. Perceived benefits of individual components such as landscaping, security, improved mezzanines and better weather protection were found to vary in value from \$0.02 to \$0.05/trip. Enclosed walkways for downtown stations have an overall value of about \$0.11/trip but this value increases during inclement weather.

Estimated increases in transit ridership and reductions in auto emissions suggest that station modernization and pedestrian programs can be an important component of a regional transportation program such as CMAQ.

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INTRODUCTION

The goal of the Congestion Management and Air Quality (CMAQ) program is to improve air quality by reducing auto use and highway congestion. During the past five years, the Chicago Department of Transportation has received CMAQ funding for design and reconstruction of rapid transit stations and expansion of a central area pedestrian walkway system. Improvements in public transit can reduce traffic volume. The effects of improving transit service by extending service into new areas, reducing travel times, increasing speeds and lowering fares are generally well understood and are represented in conventional travel forecasting models. Much less well understood are how more general improvements in transit stations and access to transit affect transit ridership and, in turn, highway volumes and air quality.

The purpose of this study was to identify the types of changes that could be made to the Chicago Transit Authority (CTA) rapid transit system's stations and pedestrian facilities to improve conditions for existing riders and attract new riders and to quantify the air quality benefits of these programs. The study was based on an in-depth survey of a sample of people who either currently use the CTA rapid transit system or who make trips that could reasonably be served by the system.

Chicago's rapid transit system consists of seven lines and over 140 rapid transit stations along over 200 directional route miles (322 directional route meters). The oldest stations on the line date from before the turn of the century (1897). The newest stations were built in 1993 for CTA's newest lines. In addition, several older stations have been thoroughly rebuilt in the past fifteen years. Many stations in Chicago's central business district are connected to major office buildings and retail centers by a system of grade-separated pedestrian walkways (pedways).

The survey questionnaire collected information about the respondents' current use of transit and about their preferences among a wide variety of transit station features. The preference information was collected by having the respondents compare various combinations of these features, trading off the features as they would when making their actual travel choices.

This paper outlines the approach that was used for the study, the key findings from the survey research that was conducted and calculations of transit ridership/air quality benefits.

THE STUDY'S APPROACH

The benefits that could accrue from improving transit stations depend both on the preferences of travelers and on the current condition of the stations. The focus of this study was on measuring the preferences of travelers but the sampling was conducted in a way that allows differences among stations to be accounted. The results of the survey can thus be applied to the rapid transit stations as they are currently configured as well as to the stations as they are improved.

The survey instrument that was designed for the study used conjoint analysis to measure preferences among transit station features. Conjoint analysis is a type behavioral intention research technique in which individuals trade-off (consider jointly) levels of attributes so that the relative importance, or utility, of the attributes and levels can be determined. There are different types of conjoint analysis and variations on the implementation of the concepts. Two primary types of conjoint analysis, Adaptive Conjoint Analysis (“ACA”) and Choice Based Conjoint (“CBC”) were used in combination in this study, employing advantages that each approach offers.

Adaptive Conjoint Analysis (“ACA”) was developed in the 1980s as a market research tool to estimate consumer preferences among larger numbers of product features (“attributes”) than could be evaluated using the conjoint methods that had been previously developed. (1) ACA is a computer-based method that statistically estimates each respondent’s preferences as the survey progresses and “adapts” the questions in a way that allows the effects of the many features to be measured. ACA is a useful tool for developing information about the relative preferences among many features but it does not measure the interactions among those features.

Choice Based Conjoint (“CBC”) or stated preference methods that have traditionally been used in transportation planning surveys can be used to measure those effects among a smaller number of features. Choice-based conjoint can also be used to estimate interaction effects among attributes and to more accurately predict the utility of price and the dollar value of the features against which it is traded-off. (2)

The survey questionnaire that was developed for this study used ACA to measure respondents’ relative preferences among 14 transit station-related features that were selected for analysis:

- Way of Getting to Another Floor
- Spacious Platform
- Protection from Weather on Platforms
- Active Neighborhood

- Station Area Landscaping
- Bicycle Storage
- Interior and Exterior Lighting
- Security Cameras
- Police Presence
- Real-Time Schedule Information
- Mezzanine Appearance
- Reduced Noise
- Maps and Attraction Information
- Cleanliness

For each of these features, up to five levels were specified. In addition, to quantify air quality benefits requires that the levels of preference for each of these features be related to a service feature that is included in a travel demand forecasting model. For this study, levels of preference for the 14 station features were measured relative to the type of station access and three key transit service variables: transit fare, travel time and train headway. The resulting 18 features is many more than could be measured using the stated preference methods that are most commonly used in transportation planning surveys.

The ACA approach for this study included three parts. First, the rank order of the levels within each attribute was determined. Second, the best and worst levels of each attribute were displayed and the respondent indicated on a five-point scale the importance rating for obtaining the preferred level of that attribute. This rating information is used to determine the importance of one attribute relative to another for each individual respondent. Third, a series of pair-wise trade-off scenarios were presented with two or three attributes shown at a time. In each scenario, respondents were asked to choose between a highly valued level of one attribute and a highly valued level of another attribute (Figure 1). Each highly valued level is paired with a less preferred level of the other attribute. Respondents use a nine-point scale to indicate the pair they prefer and the strength of their preference. Each pair-wise trade-off question is customized using a respondent's answers to previous questions.

After the ACA section, respondents were given information about potential future improvements to the Chicago CTA train stations. The improvements were described as a subset of the station feature improvements that were shown previously in the ACA level descriptions. Most attributes that were tested in the ACA section were included in the definition of a "modernized station" (Figure 2). A separate survey screen expanded the modernized station concept by describing a modernized station with "architectural design", which, as specified in the survey, includes additional features beyond those that make up a

modernized station. These definitions were presented prior to the stated preference trade-off screens, so that the two levels of a hypothetical modernized station could be traded off in the upcoming stated preference section.

FIGURE 1 Example Adaptive Conjoint Trade-Off Screen.

**Which improvements would you prefer for the stations that you use?
(Assume all else about the stations is acceptable.)**

LEFT OPTION				OR					RIGHT OPTION				
Platform area has SOME protection from wind, rain, and snow									Platform area has GOOD protection from wind, rain, and snow and is HEATED				
<i>and</i>									<i>and</i>				
Train arrives every 4 minutes									Train arrives every 8 minutes				
<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4	3	2	1	0	1	2	3	4					
prefer the left option				no preference					prefer the right option				

NEXT Question 1 of 20

FIGURE 2 Definition of Modernized Station and Architectural Design Presented to Survey Respondents.

When Chicago CTA train stations are modernized, they will be completely redesigned and rebuilt. For the next section, assume travel time and time between trains are unchanged and a "MODERNIZED" station includes these potential station improvements you learned about in the previous section:

- Renovated entrance and mezzanine
- Well lit station interior and exterior
- Good protection from wind, rain, and snow on platform
- Graffiti-free surfaces
- Stairway and elevator to a spacious platform
- Reduced noise levels on platform
- Improved information about neighborhoods and attractions
- Well landscaped outside station area

Additional "ARCHITECTURAL DESIGN" features would include:

- Artwork and creative design in mezzanine and platform area
- Restoration of quality historic features or designs
- Creative use of color and lighting

In some cases this "MODERNIZED" with "ARCHITECTURAL DESIGN" station will be one of your choices.

In a second trade-off section, stated preference (CBC) methods were used to measure the overall effects of key service variables, including a package of the 14 station attributes (“modernized station”), pedestrian walkways, weather and the transit service variables of travel time and fare (Figure 3). A total of five attributes (three with three levels and two with four levels) were tested in the CBC trade-off section.

FIGURE 3 Example Stated Preference (CBC) Survey Screen.

The screenshot shows a survey question: "Under the weather condition listed, which option would you prefer for your trip?". The weather condition is "Snow or rain". Two options are presented side-by-side:

OPTION 1	OPTION 2
Weather protected enclosed walkway available for MOST of your route to or from the downtown station	Weather protected enclosed walkway NOT AVAILABLE for your route to or from the downtown station
Travel time on train is 4 minutes LESS than current travel time	Travel time on train is 2 minutes LESS than current travel time
Stations are MODERNIZED	Stations are MODERNIZED
Fare is 25¢/trip MORE than current fare	Fare is 25¢/trip LESS than current fare

Below the options are two radio buttons for selection:

- I prefer Option 1 when the weather is: **Snow or rain**
- I prefer Option 2 when the weather is: **Snow or rain**

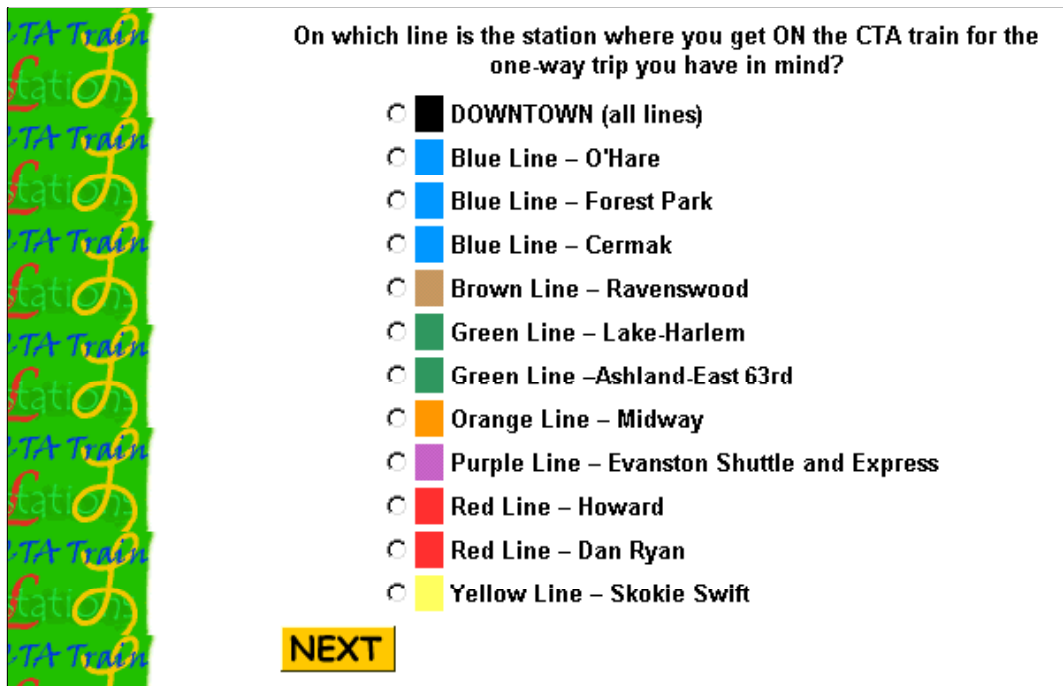
At the bottom left is a yellow "NEXT" button, and at the bottom right is the text "Question 1 of 8".

The stated preference section relied primarily on a two-choice fixed fractional factorial experimental design, with a randomized component. The orthogonal design, which allows collection of the most information possible with the fewest questions, included three or four variables, depending on the respondent’s origin and destination stations. Respondents whose trip did not include a station within the downtown area were not presented with the pedestrian walkway attribute. For the weather attribute, a random one of the four levels was selected for each screen and applied to both options shown on the screen at that time. The 16-experiment design was presented to respondents in randomized combinations and order on eight survey screens. The stated preference responses were used to compute the fare and travel time equivalents of the station features.

The questionnaire collected information about respondents’ use of the CTA rapid transit system, such as the stations where they get on and off the train (Figure 4), the amount of time they spend making the trip,

how they get to and from the stations, and the frequency with which they ride the train. Additional background data included gender, age, employment status, zip code, and income. This current trip information and background data can be used to segment the survey sample.

FIGURE 4 Example Background Questions Screen.



The screenshot shows a survey question screen. On the left side, there is a vertical green banner with a repeating pattern of the text 'TA Train Station' in various colors (yellow, red, blue). The main content area is white and contains the following text:

On which line is the station where you get ON the CTA train for the one-way trip you have in mind?

- DOWNTOWN (all lines)**
- Blue Line – O'Hare**
- Blue Line – Forest Park**
- Blue Line – Cermak**
- Brown Line – Ravenswood**
- Green Line – Lake-Harlem**
- Green Line – Ashland-East 63rd**
- Orange Line – Midway**
- Purple Line – Evanston Shuttle and Express**
- Red Line – Howard**
- Red Line – Dan Ryan**
- Yellow Line – Skokie Swift**

At the bottom left of the question area, there is a yellow button with the text **NEXT**.

The instrument that was used to administer the questionnaire was a computer-assisted self interview ("CASI"). The questionnaire was programmed so that it could be administered on stand-alone laptop computers or over the Internet. Clusters of laptop computers, including some with touchscreens for those unfamiliar with computers, were set up in a variety of locations within the CTA rapid transit system service area. Two or three survey staff attended each cluster. Potential respondents were screened and recruited to complete the questionnaire on the computers or, for those with access, over the Internet.

The survey was administered over a 12-day period in September 1999 to a total of approximately 500 travelers.

SUMMARY OF FINDINGS

Transit Service Effects

The primary purpose of the study was to determine how changes in transit stations would benefit travelers. One indicator of this is the amount that travelers are willing to pay for station-related features.

This “willingness to pay” can be determined by having travelers compare options that involve different fares and features, as was done in the conjoint portions of the survey. The stated preference conjoint measured relative preferences among different levels of transit fare, travel time, walkway extent and overall station design. This analysis indicates that the surveyed travelers, on average, value their travel time at about \$0.10/minute. They also value each minute of reduction in train headways at about the same level – \$0.10/minute. Since average wait times are approximately one-half of the headway, this means that the effective value of average wait time is about twice that of travel time. These values of time are within the range of what is typically found in travel demand models and they are consistent with the findings of other studies that have been conducted in the Chicago area.

Overall Station Renovation

The stated preference responses show that travelers place an overall value on the full package of station improvements of about \$0.23/trip¹. This is the average value of the package of station features described on the survey screens where the “modernized station” was defined. Respondents value improved architectural design in conjunction with station improvements at an additional \$0.02/trip, so a modernized station with architectural design would be worth \$0.25/trip on average. The utility of a modernized station would be approximately equivalent to 2.3 minutes of travel time savings without the architectural design and 2.5 minutes with the architectural design.

The average value of a modernized station varied somewhat depending on which CTA train line the respondent travel on. Respondents who boarded the train in downtown valued a modernized station at about \$0.20/trip and architectural design provided little additional worth, whereas, for example, respondents whose trip originated along the Blue Line – O’Hare (from O’Hare Airport to downtown) indicated that a modernized station would have a value of about \$0.27/trip and architectural design would be worth an additional \$0.05/trip.

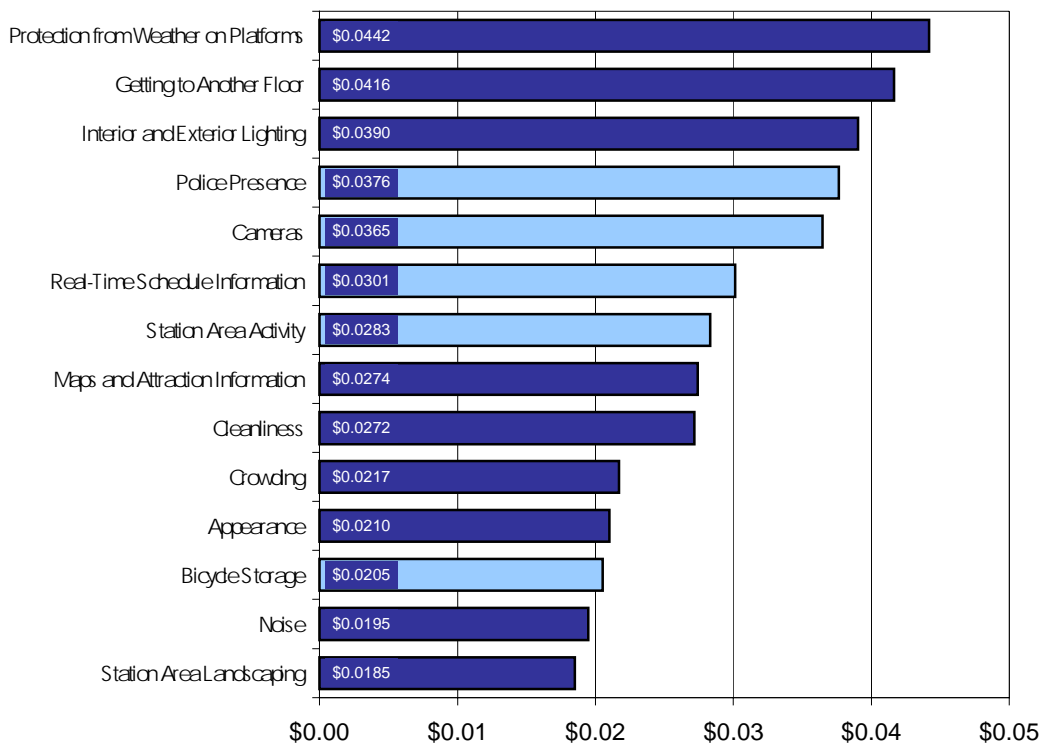
Individual Station Features

The relative values for individual features of a “modernized station” were estimated using adaptive conjoint and scaled so that the total value of the ACA levels that comprise the modernized station (Figure 2) equaled the value for all of these features together as estimated from the stated preference responses. The

values of the additional attributes tested were scaled relative to the values of the basic station renovation components of the “modernized station.”

The chart below (Figure 5) shows the values that were computed for each of the station features tested. In several of the cases, more than one level of the feature was tested and, for these, the values shown here are for the most highly valued among those levels. The dark colored bars represent the attributes whose values are included in the scaling adjustment, and the lighter colored bars indicate the attributes that were not part of the modernized station concept.

FIGURE 5 Value of Station Improvements.



The values for individual station features range from about \$0.02/trip to almost \$0.05/trip. In general, the highest values are given to features that affect physical comfort (weather protection, moving between floors) and personal security (lighting, police, security cameras). However, some of the other features have perceived values that could, plausibly, be reasonably high when compared to the costs of the station improvements required to accrue the benefits. These values can be converted into equivalent travel time

¹ The value of the full package of station improvements of \$0.23/trip assumes that improvements are made at both the

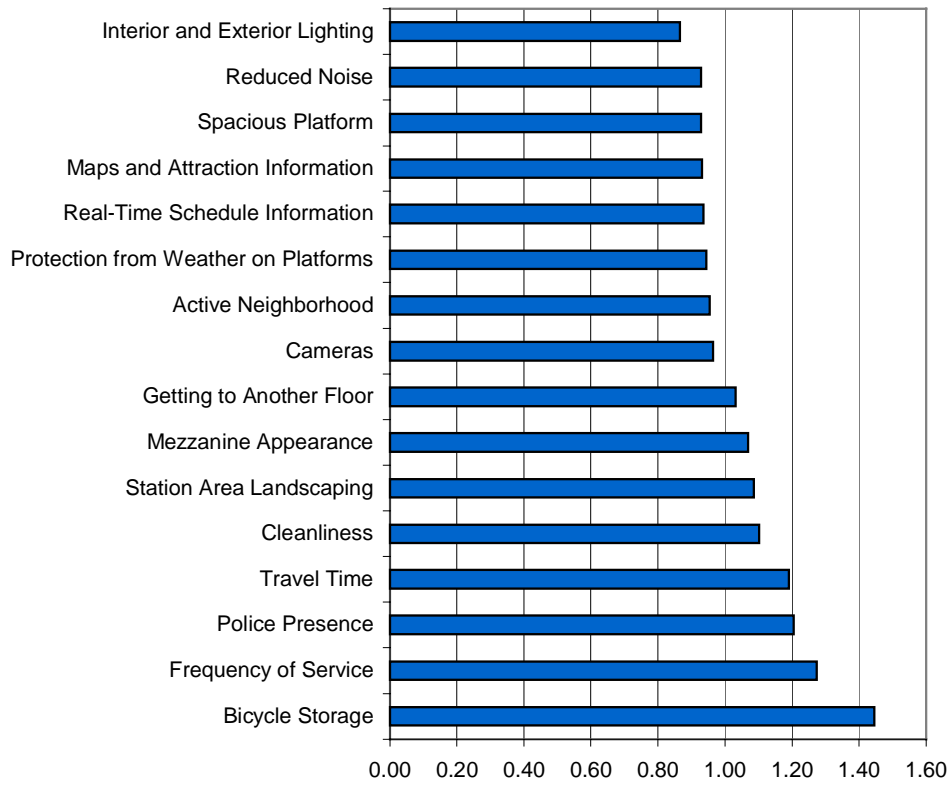
benefits by dividing them by the computed value of travel time, which is about \$0.10/minute. For example, a value of \$0.05 would be equivalent to a half-minute travel time savings.

While the modernized station concept is valued at \$0.23/trip overall, the value of any other set of station improvements could be computed as the sum of the values of the individual components. For example, providing a “modernized station” plus a security camera would increase the total value by \$.04 to about \$0.27/trip. The sum of the values of all the station features presented in the survey is about \$0.40/trip.

Differences In Preferences

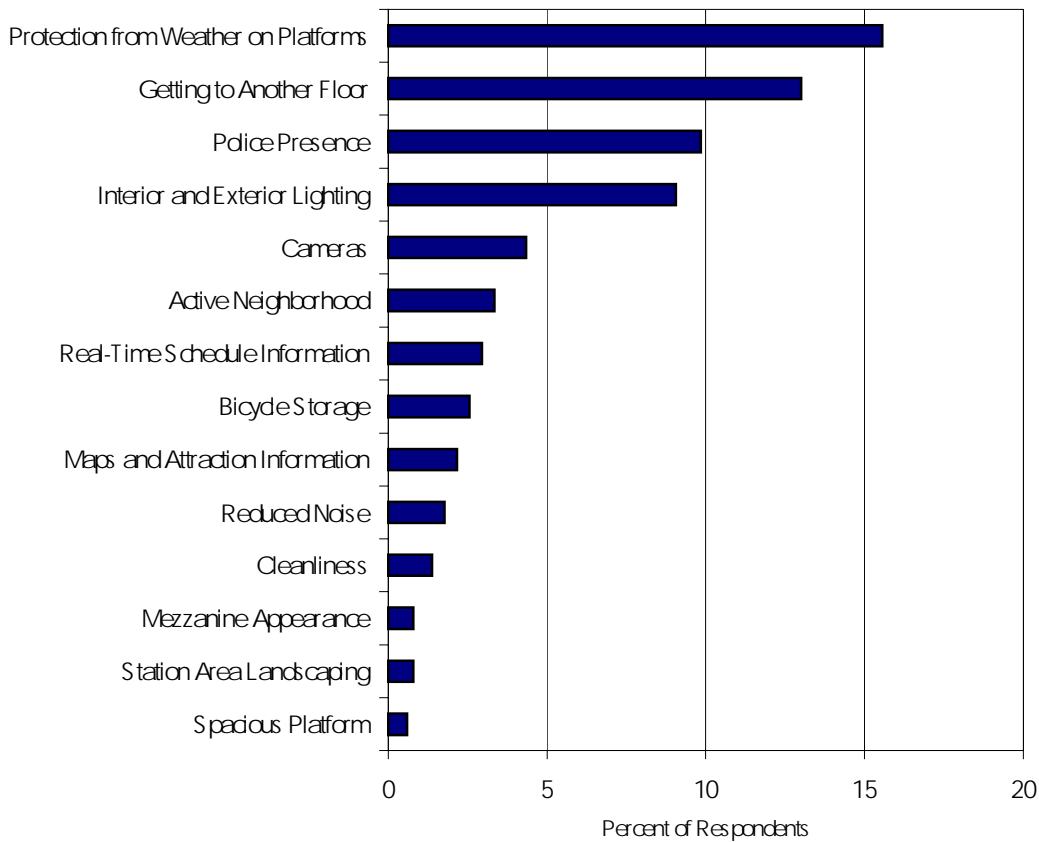
The overall values assigned to various station features vary considerably across the respondents who completed the questionnaire. The relative levels of variation across the features can be represented by the “coefficient of variation”, which is computed as the ratio of the standard deviation of the value divided by its mean value. Figure 6 below shows the coefficients of variation computed for each of the station features included in the survey. The features are sorted with those having the least variation (most agreement) among the respondents to those with the greatest variation (least agreement).

FIGURE 6 Variation in Average Feature Value.



The feature with the greatest variations in value is bicycle storage, which has a relatively low value when averaged across all travelers. This high variation is likely due to the high values assigned by those who use, or might use, bicycles versus the complete absence of value attributed by those who do not have an interest in using bicycles to access to transit. The relatively large variations in values for generally higher-valued features such as service frequency, police presence and travel time come similarly from the natural differences in preferences that exist among travelers. Values for lighting and weather protection are high on average but they have low degrees of variation, indicating a general agreement among the respondents in the values of these features. Figure 7 shows the percent of respondents who place the highest value on each station feature.

FIGURE 7 Single Most Important Station Attribute.



The ordering of attribute importance using this criterion is similar to the ordering based on average value of station improvements. Each of the station features is the most important one for some people. Although spacious platform has an average value of over \$0.02/trip, it has the lowest proportion of respondents who value it most. While bicycle storage has a relatively low value overall, there is a group of people who value it highly.

Some of the variations in values are a result of the travel characteristics and demographics of the traveler. For example, the survey sample included Chicago-area travelers who used the CTA rapid transit system very frequently as well as those who used it very infrequently or not at all. The values for each of the station features were compared among three groups distinguished by frequency of rapid transit system use. The analysis found that the three groups are actually fairly similar overall in their valuation of station features. The largest differences are that those who rarely use the CTA rapid transit system value the type

of activity around stations more highly while valuing protection from weather and vertical circulation less than more frequent users.

The differences among groups can be used to develop improvements targeting the features that would most benefit the users at a given station or targeting particular high-priority traveler segments. While it is possible to identify differences among traveler segments feature-by-feature, the values placed on some subsets of these features tend to be highly correlated. A factor analysis² was performed to identify such subsets. The features whose values tend to be correlated fall into four groups:

1. *Group A* – Vertical circulation, weather protection, real-time train information;
2. *Group B* – Landscaping, mezzanine appearance, cleanliness, reduced noise, spacious platform;
3. *Group C* – Lighting, cameras, police, station activity, bicycle storage, maps;
4. *Group D* – Travel time, service frequency and enclosed walkway.

Cluster analyses³ were conducted using travelers' values for the features in each subset. First, the sample was clustered based on their full preference profile (i.e., considering all features). Two overall segments were identified: one whose primary drivers are the security-related features, comprising about 20% of the total and the other (80%) having more average preferences across all features. Those for whom the security features have higher values than the other station features are predominantly younger, lower income, female, less frequent CTA rapid transit system riders.

The clusters that were identified for the Group A category of station features include a small group (3% of the sample) for whom escalators have a very high value. This group is largely lower-income, female, more frequent CTA rapid transit system users. A second group (63%) places slightly lower-than-average values on these features; this group is also generally average across the demographic and travel variables tabulated. The third group (34%) places a high value on weather protection. This group is slightly more female, younger and lower income than the average.

The Group B clusters include one very small group (1%) for whom these features have very high value. This group is predominantly female, older very frequent CTA rapid transit system users. A second group (75%) places relatively low value on these features. This group is very close to average across the

² Factor analysis is used to identify underlying variables, or factors, that explain the pattern of correlations within a set of observed variables. Factor analysis identifies a small number of factors that explain much of the variance in a larger number of observed variables.

³ Cluster analysis identifies groups of the population that are relatively homogeneous across a set of observed variables.

demographic and travel variables. The third group (24%) places moderate value on these features. This group is slightly younger and rides the CTA rapid transit system less frequently than the average.

The Group C clusters include a small group (4%) for whom police presence and security cameras has a very high value; these are largely younger, lower income females who use the CTA rapid transit system less frequently but make longer trips than the sample average. A somewhat larger group (66%) gave much lower value to this set of features. This group is comprised more of older, higher income males. The final group (30%) placed relatively high values on all of the features in this set, including lighting, station activity, bicycle storage and maps. This group is slightly younger and more female than the sample average.

Some in the sample (10%) placed noticeably higher values on the travel time, service frequency and access variables that are include in the Group D clusters. These are generally older, more affluent peak-period CTA rapid transit system riders.

DOWNTOWN PEDESTRIAN WALKWAY ACCESS

In addition to the value of the station features, the value of the type and extent of walkway access is of direct interest to this study. A pedestrian walkway attribute was included in both the Adaptive Conjoint Analysis (ACA) and the Choice-Based Conjoint (CBC) sections of the survey. In both cases the survey was dynamically customized so that only respondents who either boarded or alighted the CTA train using a downtown station were presented with the covered pedestrian walkway (pedway) attributes.

The value of having a covered pedestrian walkway (pedway) available for none, most, or all of the walk to or from the downtown station was tested in the stated preference section. These three levels were tested along with levels of fare, travel time, and station modernization, attributes. A weather attribute was also included so that the interaction effects between the weather conditions and pedway extent could be determined. In the ACA trade-off section an attribute that measured the importance of having retail service along the pedway was included.

In non-increment conditions, the value of an enclosed walkway along all or most of the route to the station is about \$0.11/trip. The value of a walkway with no retail along it is about one-half the value of one with retail facilities (or approximately \$.06/trip). The value of a pedway along the full route to or from the

station increases to a maximum of about \$0.35/trip in cold weather (below freezing) and \$0.28 during rain or snow.

These values for walkways were developed based only on responses from travelers who used downtown stations, as it would be difficult to develop enclosed walkways at outlying stations. A walkway either all or most of the way could provide additional value for a trip that uses a station in downtown. This value is supplemental to the value of other station features that could be added or improved, and the degree of value varies depending on the extent of the pedway and the weather conditions. If the weather is moderate about half the time, hot about one fifth of the time, raining or snowing another one fifth of the time, and below freezing the remaining ten percent of the time, the approximate overall value for a walkway most of the way would be about \$0.16/trip. Providing the walkway all of the way would increase the value to \$0.17/trip. Changing the weather assumptions would affect the overall value.

USING THE RESULTS

The values derived from this study can be interpreted directly to determine the overall value of station and access improvements. The computed dollar benefits represent the amounts by which fares could be increased while retaining the same overall attractiveness to users. If fares were increased by this amount, there would be no net benefit to existing users and no inducement to others to use the system – the improvements would be a “wash”. If fares were increased by an amount less than the estimated benefits for an improved feature, the additional benefits would become “consumer surplus” – making the system overall more desirable to existing users and more desirable to potential new users.

Assuming that improvements were made in one or more of the features, and that fares were not adjusted to exactly compensate for those improvements, there would be some increase in estimated ridership. The ridership increase can be calculated using existing travel demand models by representing the improvements as an effective fare decrease to a particular station. The effective fare decrease would be calculated as the total benefit value of the improvements minus the amount of any actual fare increase.

PRELIMINARY ESTIMATES OF TRANSPORTATION IMPACTS

Using the values of station renovation derived from the survey preliminary estimates were developed of the impact that station modernization and pedway expansion would have on CTA transit ridership. (3) The ridership estimates were prepared using the nested logit network model for work trips used by the

Northeastern Illinois Regional Transportation Authority, adapted into a spreadsheet-based incremental logit application. This model was applied to a database of the 1990 U.S. Census Journey to Work records for the CTA service area and the transit station features were represented as equivalent changes in price. The ridership estimates were in turn used to calculate impacts on auto use, air quality, and long-term revenues. Information concerning the development and application of this model is presented in *Using an Incremental Model to Evaluate the Benefits of Transit Station and Pedestrian Walkway Improvements*, Parsons Transportation Group, June 2000. The model was used to test six scenarios:

1. Modernize all stations
2. Modernize all stations with amenities: architectural design, real-time train arrival information, escalators, better weather protection, security cameras, and bicycle racks
3. Modernize stations in Central Area
4. Modernize stations in Central Area with amenities: architectural design, real-time train arrival information, escalators, better weather protection, security cameras, and bicycle racks
5. Modernize stations in neighborhoods
6. Central Area pedway expansion

Overall, the estimated increase in rapid transit work trips is in the range of 6% to 11% for the stations that are improved. As expected, modernizing all stations with amenities results in the largest increase in ridership. Increases in ridership for the other scenarios are also reasonably large. Although results vary by scenario, approximately half of the estimated diversions are from auto and the other half are from transit modes – bus and commuter rail – that also serve Chicago’s neighborhoods.

To provide initial estimates of the total impact of station modernization and pedway expansion on transit ridership and air quality, the work trip projections were expanded to all daytime trips. This was done by applying a weight representing the ratio of weekday 1999 rapid transit trips to work trips from U.S. Census data. The weekday estimates were then used to calculate daily and annual changes in system revenues and three categories of auto emissions. The results of this analysis are summarized in Tables 1 and 2.

TABLE 1 Changes in Ridership

SCENARIO	DAILY BOARDINGS AFFECTED	DAILY RAPID TRANSIT RIDERSHIP CHANGES	
Modernize all stations	451,180	29,492	7%
Modernize all stations with amenities	451,180	48,414	11%
Modernize stations in Central Area	155,040	9,646	6%
Modernize Central Area stations with amenities	155,040	15,190	10%
Modernize stations in neighborhoods	290,190	19,729	7%
Central Area pedway expansion	145,690	11,970	8%

TABLE 2 Annual Changes in Ridership, System Revenue and Air Quality

SCENARIO	DAILY NET TRANSIT RIDERSHIP CHANGES	REVENUE ANNUAL CHANGE	ANNUAL AUTO EMISSIONS (TONS)		
			HCO	CO	NOX
Modernize all stations	15,535	\$6,501,230	-26	-221	-37
Modernize all stations with amenities	25,595	\$10,711,591	-37	-364	-58
Modernize stations in Central Area	4,631	\$1,937,990	-5	-63	-11
Modernize Central Area stations with amenities	7,354	\$3,077,733	-11	-100	-16
Modernize stations in neighborhoods	10,839	\$4,536,205	-16	-163	-26
Central Area pedway expansion	5,727	\$2,396,875	-11	-90	-16

In addition to improving air quality by reducing auto use and auto vehicle miles (meters) of travel (VMT), the increase in ridership would bring new revenue to the system. This benefit was calculated by estimating annual revenues (new transit riders * average fare) for the improvement of a fully modernized station. Based on order-of-magnitude estimates of station reconstruction costs, increased revenues over a 20-year span accounted for 12.5% to 15.7% of the total construction cost. These preliminary calculations indicate that station modernization would recover part of the capital cost of a program. Cost recovery for the pedway expansion is calculated to be somewhat higher (close to 50%), but the improvement costs are somewhat more uncertain.

CONCLUSIONS

The survey research and analyses conducted for this study show the benefits that can be derived from a wide variety of rapid transit station improvements. A modernized station that includes key features provides an equivalent benefit of approximately \$0.23/trip. The effects of the individual components of this

modernized station and of other station features were found to vary in value from \$0.02 to \$0.05/trip. A combination of amenities added to the basic station modernization is valued at about \$0.37 per trip.

Expansion of the downtown pedestrian walkway system was also found to have a value to consumers. Transit trips with a pedway linked “most of the way” to the destination has an overall value of about \$0.11/trip but this value increases substantially when respondents consider inclement weather. Assuming that the decision to use transit on a regular basis takes into account year round weather conditions, the value of pedway expansion would be about \$0.16/trip.

The values derived from the survey can be used in a standard network or incremental transportation forecast model to estimate the effects of each of these improvements on transit ridership, auto use, revenue, and air quality. The preliminary results show changes in rapid transit use on the order of 6 - 10% of boardings at renovated stations depending on the degree of renovation and the amenities included. A major expansion of the downtown pedway network is estimated to increase overall transit use at stations to which they are linked by about 8%.

Over half of the new rapid transit riders are those who otherwise would drive. Therefore, a comprehensive program of modernization would increase system revenues and have a significant impact on reducing auto emissions. Estimated reductions in emissions suggest that station modernization and pedway programs can be an important component of a regional transportation program to achieve CMAQ goals that also includes measures as diverse as bicycle trails, coordinated auto traffic measures, new transit vehicles, and traveler information strategies. The financial return estimates suggest that at least some of the cost of station renovation can be derived from increased systems revenues.

Of course, both station modernization and pedway expansion have benefits that have not been examined in this study. Further research would take into account station benefits such as reduced maintenance costs associated with older stations, increased vitality of the neighborhoods surrounding a renovated station, and the overall satisfaction of the community and existing riders. Pedway benefits would include easier pedestrian circulation and enhancing the Central Area as a destination in inclement weather.

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