A Quantitative Measurement of Automobile User Value from Intuitively Evaluated Value of Automobile and Transit Service

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Abstract: This study aims to suggest reasonable method of analyzing automobile users' empirical cognition on travel mode choice. This study defines the concept of Automobile User Value (AUV) as, the ratio of transportation service that automobile users acquire to cost that they pay. The analysis frame is developed by considering Customer Value and Service Quality (SERVQUAL) method. AUV is divided into expected value and perceived value, and evaluated by SERVQUAL method. The analysis indicates that the AUV score is 4.6 times higher in automobile than transit. Path analysis shows that the effectiveness of automobile's motive to transit's motive was low. Various policy alternatives for modal shift have been made to relieve transportation problems. But the auto’s mode share has increased mainly due to ignorance in policies about automobile user value. In order to improve transportation systems in metropolitan areas, it is strongly recommended that AUV should be surveyed and analyzed in more detail.

Key Words: AUV (Automobile User Value), SERVQUAL (Service Quality), Expectancy-Value Theory, IPA (Importance Performance Analysis)

1. INTRODUCTION

Governments have been aggressively pursuing transit-oriented policies to relieve traffic congestion and to make transportation systems more efficient. Although these policies have been implemented for long period, outcomes have not been significant. Since 1996, governments have constructed 125km of urban railways in Sudokwon. Sudokwon, population 24 million, is a metropolitan name in Korea and includes Seoul, Inchon and Gyunggi. Transit mode share, however, decreased 1.6% while auto’s mode share increased 5.1%. One of the main reasons of increasing of auto mode share is that users are more sensitive for automobile’s attractiveness than for travel time and travel cost. The mode choice decision is caused by empirical experience except rational judgment. This empirical cognition can be understood by considering perceived or expected usefulness of mode. But until now, there were few research studies on empirical cognition of mode that can be applied to policy. The mode choice model only includes travel time and cost, excluding the empirical element of usefulness, which is the main reason for not making the persuasive choice model. To relieve this problem, the automobile user expectancy or contents should be reflected in transportation planning. Hence, the methodology of automobile user’s empirical cognition has to be developed in order to enhance the reality of policy and estimation of the transportation market. This study aims to suggest reasonable methods of analyzing automobile user’s empirical cognition on travel mode choice and suggest transportation policy alternatives by applying AUV (Automobile User Value). The data for this study was surveyed during 10days May 2008 at Sudokwon in Korea.
The general ideas of customer value and service quality are applied to develop the methodology of AUV. Based on this methodology, this study quantitatively measured the AUV intuitively evaluated by automobile users. The following sections describe the concept of AUV considering customer value and the process of AUV measurement, the data surveying and equations of AUV developed in this study. Then, we evaluate the service quality of transportation mode and calculate the AUV per mode. We next analyze the motive of automobile choice using expectancy-value theory and AUV between modes using path analysis. Finally, conclusions and implications are discussed.

2. THE CONCEPT OF AUTOMOBILE USER VALUE (AUV) AND FRAME ANALYSIS

The 21st century is a 3C era: change, customer-oriented and competition in quality. The transportation policy in this 3C era needs to control the user's satisfaction by maintaining a certain level of transportation service quality. The control of traveler value is not managing the traveler’s themselves, but in the management of user satisfaction. This is the main reason why we need the concept of AUV. The Concept of AUV is derived by the mode choice right and the customer value (CV). This study corresponds to an empirical study because of developing a new concept of AUV and measuring of it. The purpose of the empirical study is first, to subject the concept postulated above to a rigorous empirical examination and second, to test the robustness of itself by conducting a case study. In this process, AUV is defined as follows:

What is the Automobile User Value (AUV)?
The ratio of transportation service that a user acquired to the cost that user paid.

The traveler could be categorized into two groups. One is a choice rider, who has the right of choice in traffic mode and the other is captive rider, who has no right of choice except transit. In this paper, captive rider means not a weak traveler who has a handicap for trip but a traveler who has no private automobile and strongly depends on bus or subway for trip. Automobile user corresponds to choice rider getting a dominant position compared with transit rider. For a positive analysis of AUV, the analysis frame for AUV was developed by considering customer value (CV) and the SERVQUAL method. Customer value is the ratio of acquired service to the cost paid in acquiring service (Heskett 1997). The following is a simple formula of CV which was created to express the concept of CV by Heskett.

\[
CV = \frac{\text{Quality of Output Result} + \text{Process Quality}}{\text{Cost of Product} + \text{Cost of Acquisition Service}}
\]  

(1)

In this formula, the quality of output result is a product purchased by a customer or the service provided to the customer and the process quality is the service quality in the purchasing process. The SERVQUAL method is a measurement tool of service quality that is defined as, the result of the comparison that customers make between their expectations about service and their perceptions of the way in which the service is performed (Parasuraman et., 1988). This method is an empirically derived method which may be used by a service organization to improve service quality. This method can be used for performing a gap analysis between customer's perceived service and expected service. When perceived service (PS) is less than expected service (ES), a customer will rationalize unacceptable service quality resulting in an increased discrepancy between ES and PS. Otherwise when perceived service (PS) is greater
than expected service (ES), a customer will rationalize ideal service quality, resulting in an increased discrepancy between ES and PS. Figure 1 shows the concept of SERVQUAL, in measuring the service quality gap between customer's perception and expectation suggested by PZB (Parasuraman, Zeithaml, and Berry, 1990).

Using the concept of CV and the data surveying method of SERVQUAL, this study developed a method of measuring AUV. This method starts with an identification of the construction element of AVU. This element can be developed after canvassing the relevant literature, consulting a SERVQUAL professional and using experimental knowledge. AUV is largely composed of two elements: one is a transportation service quality (TSQ) and the other is the cost of acquiring transportation service. TSQ is subdivided into the outcome of travel and the process quality in travel and cost is subdivided into the fare of transit and the price of gas for the automobile. To further process this study, definition of a reliability and convenience of transportation mode need to be made. Reliability of mode means arriving at the destination (office, school, etc.) at exactly the time that travels are expected. For example, when one travels to the office by automobile in the morning, one departs from home 20 minutes earlier than usual to arrive on time to compensate for traffic congestion. In this case, if one arrives on time at the office, the service quality of reliability is satisfactory because one is willing to put up with the effort of early departure and traffic congestion. There are several sub-items of convenience, however for this paper; convenience of mode will be divided into three items: access, transfer and waiting. The first item is the convenience of access to transit, under consideration of its relationship with the automobile. The second item is the convenience of transfer between transit points, under consideration of its relationship with the automobile. The third item is the convenience of waiting time at the departing station, under consideration of its relationship with the automobile. These three items show clear distinction between transit and automobile from the users view and in important in showing the elements of needed improvement in the transportation policy. Table 1 shows the elements of AUV and the results of Table 1 described at Figure 5, 6 in section 3.
After defining the AUV element, that the automobile user has a right to choose from each mode (automobile and transit), it is measured by a numerical expression. In naming the numerical expression of the AUV equations, AUV equations can measure each mode; the AUV of automobile and the AUV of transit. In process quality of travel, there is no need for access, waiting and transfer with the automobile, but these are essential to transit. For this reason, they are reflected as discomfort elements in the transit equation. The satisfaction of each transportation mode's service items are calculated by multiplying each item weight and perceived or expected item satisfaction. The measurement method of AUV is explained by the survey method of input data and AUV equation. Data is acquired by surveying automobile user's perceived and expected satisfaction on each mode, as they do in the SERVQUAL r.

### Table 1 Elements of AUV

<table>
<thead>
<tr>
<th>Elements of Customer Value</th>
<th>Transportation Service Items</th>
<th>Elements of AUV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of outcome results</td>
<td>Reliability</td>
<td>Automobile</td>
</tr>
<tr>
<td>Process quality</td>
<td>Convenience</td>
<td>Transit</td>
</tr>
<tr>
<td>Price of product</td>
<td>Economical burden</td>
<td></td>
</tr>
<tr>
<td>Cost of acquisition service</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

After these initial discussions clarify the research constructs, the analysis method is defined as data collection and data analysis. The data collection is conducted by adapting the SURVQUAL method and AUV equations developed in this study which is used to analyze the surveyed data to measure AUV by mode. Following is the methodology of AUV developed in this study.

### Table 2 Equations of AUV

<table>
<thead>
<tr>
<th>Mode</th>
<th>Alternatives of choice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Automobile (using mode)</td>
</tr>
<tr>
<td>Concept</td>
<td>Outcome travel + Process quality</td>
</tr>
<tr>
<td></td>
<td>Purchasing cost + Gas cost</td>
</tr>
</tbody>
</table>

\[
\begin{align*}
(AW_i^m \cdot AM_i) + \sum_{k=1}^{n} AW_i^k \cdot AC_i^k &= (AW_i^m \cdot AP_i) + (AW_i^p \cdot AG_i) \\
TW_i^m \cdot TM_i + \left( \sum_{k=1}^{n} TW_i^k \cdot TC_i^k / n \right)^{-1} &= TW_i^p \cdot TP_i \\
TW_i^m : Reliability Weight on Transit \\
TM_i : Reliability Satisfaction on Transit \\
TW_i^k : Convenience Weight on Transit \\
TC_i^k : Convenience Satisfaction on Transit \\
TW_i^p : Transit Fare Weight \\
TP_i : Transit Fare Satisfaction \\
i : User i \\
k : Convenience Item k
\end{align*}
\]

After these initial discussions clarify the research constructs, the analysis method is defined as data collection and data analysis. The data collection is conducted by adapting the SURVQUAL method and AUV equations developed in this study which is used to analyze the surveyed data to measure AUV by mode. Following is the methodology of AUV developed in this study.
3. EVALUATION OF TRANSPORTATION SERVICE FOR AUV ANALYSIS

3.1 DATA Collection
The analysis of AUV and service quality is based on the development of a suitable survey instrument. The relevant questionnaire was generated as a detailed analysis of the AUV entity and used the survey method of SERVQUAL. To achieve this, various survey methods of SERVQUAL were examined, based on transportation service. The previous section developed the measurement method of AUV. Before this method is adopted, some further discussion is needed, especially regarding expected service of transportation and perceived service, to enhance the design of the questionnaire. The survey is designed for automobile users having experience of the transportation service. Their satisfaction of transportation service could be divided into two types- expected satisfaction, that is to say the level of performance desired-and perceived satisfaction, the performance level that has been experienced. Satisfaction scores were measured on a 5-point Likert scale. According to the research of LaBarbera and Mazursky (1993) and Mittal et al (1998), the use of multi scale decreases the measurement validity rather than enhance it. Therefore, in this study, all questionnaires are asked in 5-point Likert scale to enhance reliability of results. The survey was conducted during 10 days in May, 2008 at Sudokwon Metropolitan in Korea. Respondents were selected at random among travelers who periodically go to work by automobile. A total of 363 people (120 in on-line survey via Internet, and 243 in off-line survey) were given the questionnaire (that had undergone pre-test to ensure comprehension). Each individual was assured that his/her responses were treated confidentially. The response rate was 91.6% in on-line survey and 87.7% in off-line survey. Of the total 363 participants, 78.7% of respondents were male and 21.3% were female. Just over half of the respondents said they use their automobile 5-6 times per week to go to work, and pay $150-300 a month in gas fees.

3.2 Traveler behavior analysis
Nearly two out of ten respondents said they did not prefer transit because of longer travel time than automobile. This is the greatest reason that automobile users do not use transit when going to work. Just over 10% of respondents said they did not prefer transit because of disliking other's intervention and social position. This means that nearly one of ten people use automobile for privacy reasons. Nearly four out of ten respondents said they do not use transit due to discomfort, such as waiting time, transfer and difficulty of access at transit station. This means that it is possible for automobile users to choose transit by improving transit frequency and transfer facilities without constructing additional rail.
Respondents were asked the degree of satisfaction for gas and automobile price to examine the economic burden for the automobile. This survey was conducted on a scale 1 to 5 with 1 being of no satisfaction and 5 being of very satisfied. Nearly 60% of the respondents indicated they are not satisfied with gas price, but 41% of the respondents said that they are satisfied with purchasing price. Because of high gas prices ($110-140/bar) during survey period, respondents said that gas price is more of a burden than the purchasing price of an auto. The June 2008 average gas price in Korea was $1.44; the price shoots up 8% over one month.

This study analyzed the change of gas price elasticity of automobile demand to examine the possibility of modal shift from auto to transit during a 4 month time lag (May-Sep). To do this, surveys were conducted twice, once in May and once in September. Across the two periods, the same question was asked. At these times, gas price was similar at $1.34/lit. The consciousness of modal shift was examined by asking the automobile user's intention to use transit when the gas price increases by 5%-25%. Table 3 is the questionnaire of elasticity.

<table>
<thead>
<tr>
<th>Question</th>
<th>May</th>
<th>The range of gas price</th>
<th>September</th>
<th>The range of gas price</th>
</tr>
</thead>
<tbody>
<tr>
<td>If how much gas price rise, do you willingly use transit?</td>
<td>5% □</td>
<td>1.42</td>
<td>10% □</td>
<td>1.49</td>
</tr>
<tr>
<td></td>
<td>15% □</td>
<td>1.55</td>
<td>20% □</td>
<td>1.62</td>
</tr>
<tr>
<td></td>
<td>25% □</td>
<td>1.69</td>
<td>1.39</td>
<td>10% □</td>
</tr>
<tr>
<td></td>
<td>15% □</td>
<td>1.52</td>
<td>20% □</td>
<td>1.59</td>
</tr>
<tr>
<td></td>
<td>25% □</td>
<td>1.66</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Following, is a simple formula used to calculate the percentage change in automobile demand as per the percentage change in price by 5%-25%.

\[
\frac{\Delta Q}{Q} / \frac{\Delta P}{P} = E
\]

(2)

Where, Q: Auto demand, P: Gas price, E: Elasticity

Price range at which most responded to change to "use of transit" is $1.6/lit (Sep) from $1.5/lit (May). The price elasticity of $1.4/lit in May was 4.98, changing to a low 2.44 in September. The price elasticity 4.98 means that the 4.98% of respondents have the intention to use transit per 1% increasing at the price range of 1.4$/lit. The change of elasticity from 4.98 to 2.54 indicates that the impact absorption of increasing gas price was increased. The experienced price range of $1.4-1.5/lit was decreased while no experienced price range of $1.6/lit was increased. This indicated that the automobile demand might be inelastic with a small increase in gas price. As a result, the price policy for demand control might be effected shortly in the transportation market.

<table>
<thead>
<tr>
<th>The change ratio of gas price</th>
<th>Willingly use transit (%)</th>
<th>Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Survey May</td>
<td>Survey Sep</td>
</tr>
<tr>
<td>Experienced price ($1.39-1.55)</td>
<td>0%</td>
<td>-</td>
</tr>
<tr>
<td>5%</td>
<td>25%(25%)</td>
<td>13%(13%)</td>
</tr>
<tr>
<td>10%</td>
<td>12%(37%)</td>
<td>14%(27%)</td>
</tr>
<tr>
<td>15%</td>
<td>27%(64%)</td>
<td>13%(40%)</td>
</tr>
<tr>
<td>Non experienced price ($1.59-1.69)</td>
<td>20%</td>
<td>11%(75%)</td>
</tr>
<tr>
<td>25%</td>
<td>25%(100%)</td>
<td>32%(100%)</td>
</tr>
</tbody>
</table>

( ): cumulation percentage

3.3 The evaluation of service quality by transportation mode

Before evaluation of service quality, correlation between perceived value and expected value in each mode was analyzed to identify how strongly pairs of value are related. Table 5 shows the result of correlation of expected value and perceived value of each mode’s service quality. When automobiles are used, there is no need for transfer or waiting at a station, thus automobile’s convenience item are not analyzed. All correlation coefficients are positive. It means that as expected value gets larger perceived gets larger in transportation service. The highest coefficient is 0.744 between subway’s reliability perceived and expected value. And the lowest coefficient is 0.462 between bus’s convenience perceived and expected value.
Automobile user satisfaction on transit and automobile service was evaluated by SERVQUAL method that divides satisfaction into perceived and expected. Following Figure 5, is a result of reliability in each mode. The survey of satisfaction on reliability of each mode was conducted by the perfect score of 10. In the results of the survey, the rank of satisfaction on reliability indicated subway 6.60, automobile 6.11 and bus 6.02. Because the automobile or bus experience traffic congestion on the road where the subway has its own rail with no traffic congestion, the subway was ranked first. For this reason, it is not easy for the bus or automobile to reach its destination within the desired time. Thus, it is possible to draw inference that automobile users do not choose automobile just for travel reliability, there might be other reasons to choose automobile. The perceived service quality of reliability was higher than expected service quality in all modes.

Figure 5 Reliability

What distinguishes the automobile from transit is that transit needs access (to station), transfer and waiting for completing travel. These three items are selected to analyze automobile user's satisfaction on convenience. As a result of this survey, it was indicated that automobile users expected the automobile to be 1.3 times more convenient than transit and perceived the automobile was 1.5 times more convenient than transit in reality. The gap of expected value and perceived value on transit was -1.2 in subway and -0.89 in bus. This result indicated that automobile users thought bus was more convenient than subway. The main reason of subway's convenience score, a low 0.36 compared to bus was caused by the difficulty of subway transfers. The convenience of use on transit should be improved because of the expected value of convenience (7.63) on transit being higher than the perceived value (6.58).

According to the survey results of reliability and convenience, the improvement of convenience on operating transit should be intensively considered in transport policy.
The Importance Performance Analysis (IPA) considers a relationship between importance and performance and theorizes that target levels of performance for particular service attributes should be proportional to the importance of those attributes (Slack 1991). By using a central tendency e.g. mean, median, the importance and performance scores of service items are classified into high or low categories; then by pairing these two sets of rankings, each item is placed into one of the four quadrants of the importance performance grid. Mean performance and importance scores are used as a fiducial point for plotting service items on a two-dimensional matrix as shown in Figure 7. This matrix is used to prescribe prioritization of attributes for improvement and can provide guidance for strategy formulation.

Figure 6 represents where automobile users had the highest importance of auto’s convenience (10.0), followed by bus’s convenience (7.65), subway’s convenience (7.61). With regard to performance, automobile users had the highest performance of auto’s convenience (10.0), same as the result of importance, followed by auto’s pleasantness, subway’s safety. Figure 7 shows which service item should be urgently improved and which to keep up the good service. Transit (bus, subway) convenience fell in second quadrant (i.e., Concentrate here). The importance of transit’s convenience is higher than average and the performance is lower than average. This finding shows that automobile users perceive the convenience of transit as worse than reliable and conceives transit’s convenience to be improved above all. The service items falling in the 3rd quadrant (i.e., Low priority) are transit’s pleasantness, auto safety and bus reliability. In this result, the discomfort of transit such as access and waiting is the main reason for automobile users to choose automobile over other service items such as reliability and pleasantness. The service items in need of improvement are automobile safety, reliability and comfort ability of transit.

3.4 IPA on Service Quality of Transportation Mode
4. The EVALUATION OF AUV (Automobile User Value)

4.1 The Measurement of AUV

The expectancy-value theory was adopted to examine the automobile user’s different preference of each mode and analyze the automobile user’s motivation of mode choice. The expectancy-value theory was created to analyze a motivation of attitudes in social psychology. Psychologist Martin Fishbein created the expectancy-value theory in the early to mid 1970's. This theory states that attitudes are developed and modified based on assessments about beliefs (expectancy) and values (perception). This theory has been used to develop other theories and is still utilized today in numerous fields of study. There are three basic components in this theory, they are beliefs, values and attitudes. First, individuals respond to new information about an item or action by developing a belief about the item or action. Second, individuals assign a value to each attribute that a belief is based on. Third, an expectation is created or modified based on the result of a calculation based on beliefs and values. For example, a student finds out that a professor has a reputation for being humorous. The student assigns a positive value to humor in the classroom; as a result the student has the expectation that their experience with the professor will be positive. When the student attends class and finds the professor humorous, the student calculates that it is a good class. This theory also states that the result of the attitude stems from complex equations that contain many belief/values pairs. Fishbein represented the theory with the following equation. This equation represents that attitudes are a factorial function of beliefs and values. In this equation, if beliefs or values will be close to zero, then attitudes will also be close to zero.

\[ A = \sum_{i=1}^{n} b_i \cdot v_i \]  

(3)

Where, A: attitudes, b: beliefs, v: values

This formula indicates that an individual is motivated by his beliefs as much as he is expected to win, that value being endowed by himself. Each of two elements in attitudes can be adapted.
to the SERVQUAL method. Belief is similar to expected satisfaction and value is similar to perceived satisfaction in the SERVQUAL method. According to this similarity between expectancy-value theory and SERVQUAL method, the motive of automobile use can be explained by the following simple equation.

\[ M_i = P_i \cdot E_i \]  

(4)

Where, \( M \): Motive of automobile use, \( P \): Perceived AUV, \( E \): Expected AUV.

In this study, AUV is measured by AUV equations. Following, is the result of AUV by each mode. In the case of the automobile, the perceived AUV (1.37) was higher than the expected AUV (1.03), thus the service quality of the automobile was indicated as good. But in the case of the bus, the perceived AUV (0.47) was lower than the expected AUV (0.48) therefore the service quality is in need of improvement. In the case of the subway, the perceived AUV (0.52) was lower than the expected AUV (0.56), thus the service quality should be improved. The 1.37 of automobile's perceived AUV implies that automobile users perceived 1.37 times higher utility per 1 unit cost. And the 0.47 of bus's perceived AUV implies that automobile users perceived a lower utility of 0.47 per 1 unit paid cost.

According to motivation of automobile use explained above, consider the question of how the automobile's motive (attractiveness) is higher than transit motive to an automobile user. The analysis showed that automobile's motive was 1.44, bus 0.28 and subway 0.35. This indicated that automobile's motive was higher than 5.14 times than bus's motive and 4.11 times than subway's motive. In other words, an automobile user is cognitive 4.6 times higher in preferring automobile over transit. This is the most important result of this study, because there is no research to measure the preference of automobile quantitatively with the use of scientific method. The results, quantitatively, show that it is not easy for automobile users to shift modes, from automobile to transit. Before making transit policy to induce modal shift, there should be a need to investigate the AUV to evaluate how much the policy will coincide with the demand of automobile users for transit.

### Table 6 Result of AUV

<table>
<thead>
<tr>
<th>Choice mode</th>
<th>Perceived Value(PV)</th>
<th>Expected Value(EV)</th>
<th>PV-EV</th>
<th>M=PV×EV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto</td>
<td>1.37</td>
<td>1.03</td>
<td>0.34</td>
<td>1.44</td>
</tr>
<tr>
<td>Transit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td>0.47</td>
<td>0.48</td>
<td>-0.01</td>
<td>0.28</td>
</tr>
<tr>
<td>Subway</td>
<td>0.52</td>
<td>0.56</td>
<td>-0.04</td>
<td>0.35</td>
</tr>
</tbody>
</table>

*note: \( M = \left( \frac{\sum PV_i \cdot EV_i}{n} \right) \)*

### 4.2 Path Analysis of AUV between modes

Using path analysis, correlations between transportation modes are examined. In estimation results of the research model (Table 8, 9), the GFI (Goodness of Fit Index) are over 0.9. These values are statistically acceptable. Table 7 shows the result of effectiveness in auto’s expected value and perceived value to automobile using motive\(^1\). Auto EV is an expected AUV and Auto PV is a perceived AUV that is calculated by AUV equation. The effectiveness of

\(^1\) Expected value is a expected AUV and perceived value is a perceived AUV that is calculated by AUV equation.
expected value to automobile motive is 0.422 and the effectiveness of perceived AUV to automobile motive is 1.32, which is 3.1 times greater than expected AUV. All coefficients of this analysis are highly significant, thus proving strong evidence of the following: when the automobile's demand needs to be controlled, it is better to control the perceived satisfaction than the expected satisfaction. In other words, it is more efficient for automobile users to have a difficult experience parking in a CBD (Central Business District) than to publicize using transit.

Table 7 Result of Auto’s Motive Analysis

<table>
<thead>
<tr>
<th>Path</th>
<th>Coefficients</th>
<th>Std. Error</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>x1 ⇒ x2</td>
<td>0.422</td>
<td>0.113</td>
<td>3.730</td>
</tr>
<tr>
<td>x1 ⇒ x3</td>
<td>1.321</td>
<td>0.041</td>
<td>32.582</td>
</tr>
<tr>
<td>x2 ⇒ x3</td>
<td>1.074</td>
<td>0.022</td>
<td>49.552</td>
</tr>
</tbody>
</table>

Note) X1: Expected value, X2: Perceived value, X3: Motive

Table 8 Path analysis of Auto motive

<table>
<thead>
<tr>
<th>Effect</th>
<th>X1→X3</th>
<th>X2→X3</th>
<th>X1→X2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Effect</td>
<td>r13(0.422)</td>
<td>r23(1.774)</td>
<td>r21(1.631)</td>
</tr>
<tr>
<td>Direct Effect</td>
<td>p13(0.422)</td>
<td>p23(1.321)</td>
<td>p21(1.074)</td>
</tr>
<tr>
<td>Indirect Effect</td>
<td>-</td>
<td>p13*p21(0.453)</td>
<td>-</td>
</tr>
<tr>
<td>Spurious Effect</td>
<td>-</td>
<td>-</td>
<td>p13*p23(0.557)</td>
</tr>
</tbody>
</table>

Results of path analysis are given in Table 9 with the accompanying coefficients. The bus’s expected value and perceived value is positively associated with subway’s expected value and perceived value. While the automobile’s expected value and perceived value are little relations with bus’s expected value. In path analysis of expected value and perceived value, t value between automobile and subway has low significance, thus providing no interpretation. The result of path analysis in motive\(^2\) presents that the effectiveness of automobile’s motive to bus’s motive was 0.058 and to subway's motive was -0.044. As a result of this, the signs of coefficients are not important because they are close to zero. This indicates that automobile users have low preference to transit. Thus, it is difficult for automobile users to induce modal shift from automobile to transit. If transit service does not improve, up to the level of automobile user's demand, the modal shift to transit does not happen. This analysis could be applied to rough estimation of modal shift effectiveness in transit's pre-feasibility analysis.

\(^2\) Motive = Expected Value X Perceived Value
### Table 9 Path analysis of between modes

<table>
<thead>
<tr>
<th>Mode Path</th>
<th>Autobus</th>
<th>Autosubway</th>
<th>Bussubway</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
<td>X1→X4</td>
<td>X1→X7</td>
<td>X4→X7</td>
</tr>
<tr>
<td><strong>Total Effect</strong></td>
<td>r41 (0.174)</td>
<td>r71 (0.142)</td>
<td>r74 (0.854)</td>
</tr>
<tr>
<td><strong>Direct Effect</strong></td>
<td>p41 (0.174)</td>
<td>p71 (-0.007)</td>
<td>p74 (0.855)</td>
</tr>
<tr>
<td><strong>Indirect Effect</strong></td>
<td>-</td>
<td>p41*p74 (0.149)</td>
<td>-</td>
</tr>
<tr>
<td><strong>Spurious Effect</strong></td>
<td>-</td>
<td>-</td>
<td>p41*p71 (-0.001)</td>
</tr>
</tbody>
</table>

**Path Diagram**

- **Expected Value (EV)**
  - GFI: 0.907

- **Perceived Value (PV)**
  - GFI: 0.911

- **Motivation (EV × PV)**
  - GFI: 0.924

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**Note1)** PV: Perceived AUV, EV: Expected AUV

**Note2)** Table ( ): path effect, Figure ( ): p value

**Note3)** GFI: Goodness of Fit Index
5. CONCLUSIONS AND IMPLICATIONS

In this study, we defined the concept of Automobile User Value (AUV) by considering customer value and developed the measurement method of Automobile User Value for each mode. This study defines the concept of AUV as the ratio of transportation service that auto users acquire to cost that they pay. This paper will contribute to research of travel value regarding transportation service quality. We have based our analysis on SERVQUAL method in which service quality is measured in two forms. According to SERVQUAL method, AUV by mode is divided into expected value and perceived value. Our empirical result qualitatively shows the difference of cognitions between automobile and transit for automobile users. AUV is in fact an important element of auto user satisfaction on transportation services. Certain aspects of AUV are more important for the process of mode choice. More importantly, there exists a clear difference between auto user’s preference between transit and automobile in expectancy-value theory.

Major findings are summarized as follows. First, the analysis of AUV indicates that the AUV score is higher in auto than in subway and bus. It shows that auto users are cognitive 4.6 times higher in preference to auto than to transit. Second, path analysis is conducted to examine correlation between transportation modes. Path analysis shows that the effectiveness of bus motive to subway motive was high, while the effectiveness of automobile's motive to transit's motive was low. This result shows that it is not easy for auto users to shift from auto to transit. Third, this study also shows the possibility of developing a mode choice model by adopting the qualitative variable of perceived AUV. If this mode choice model builds, the estimation of mode sharing ratio will be more precise than existing Logit model which does not consider user value. Various policy alternatives for modal shift have been made to relieve transportation problems, but the auto's share has increased mainly due to ignorance in policies about auto user value. In order to improve transportation systems in metropolitan areas, it is strongly recommended that AUV should be surveyed and analyzed in more detail.

REFERENCES

Company.