

## CRITICAL MEASURES OF TRANSIT SERVICE QUALITY IN VARIOUS CITY TYPES

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**Abstract:** Finding critical measures of transit service suitable to a certain types of cities is very important, which is cost-efficient and effective in satisfaction improvements. It is natural that transportation policy of the administration is different from each individual city has its own needs and characteristics. To find critical measures suitable to an individual city, questionnaire method was used on Gyeonggi Province, which has various types of cities and large ratio of bus usage, its own authorization right of bus service license. The customer satisfaction survey at bus service shows that the transportation policy should be varied by city characteristics such as function, location, urbanized level, urbanized area level, population density industrial scale. And this research is expected to help bus schedulers or policy makers to establish efficient transportation plans and to settle new public transportation system in planning a new city.

Key word: Critical measures, Transit service quality, Various city types, Bus service

### 1. INTRODUCE

Finding critical measures of transit service quality is one of the most important studies on transportations. It enables to improve customer's satisfaction cost-efficiently with limited revenue sources by improvements of service attributes focused on customers and their needs. But these customer complaints or needs of individual city are different, so it is necessary to determine service improvements attributes suitable to a certain city's conditions.

To find critical measures suitable to a certain types of cities, peculiarity of each city should be considered such as population and density, land use patterns, industrial structure and scale (including GRP), urbanization level, function and relations with adjacent cities (especially metropolitan), transit service types and so on.

In this study, the difference of critical measure of transit service quality, in various city types, is developed by customer satisfaction research and quantitative analytical techniques. The data collection is specified as followings; 1) Date: 2004. 10. 1 - 11. 30 (2 months), 2) Area: Gyeonggi Province (including 31 cities whose characteristics are different from one another), 3) Samples: 2,397 respondents, who is 16 or older, and has ridden within the past week, 4) Method and contents: a questionnaire (including customer's personal attribute and customer's satisfaction rating for each measure which could be classified into availability, reliability, operator attributes, safety, comfort, plant and equipment, affordability, and 45 bus service characteristics).

This research is expected to help bus schedulers or policy makers to establish efficient plans considering peculiarity of areas that would improve bus service in a certain city, and to settle new public transportation system considering mutual functions and relations with surrounding cities in planning a new city.

## **2. QUANTITATIVE ANALYTIC TECHNIQUES**

### **2.1 Overview**

In a typical quantitative customer satisfaction study, respondents evaluate overall satisfaction, then rate each individual service attribute that customers have defined. A key question for researchers is which attributes are the drivers of overall satisfaction (since not all attributes have equal impact)? When there are 40 to 50 attributes that can impact customer satisfaction, and transit agency resources are limited, how can it be determined which limited number of attributes should be targeted for problem occurrence reduction, in order to produce the greatest possible increase in overall customer satisfaction with transit service?

Researchers have suggested many procedures for dealing with this problem. Several are considered by Green and Tull (1975) and reviewed in The Maritz Marketing Research Report (1993).

Stated importance measures ask respondents to explicitly state their perception of the importance of each attribute, usually using a 10-point scale. The results of this method can be straightforwardly interpreted; however, results can be few, if any, statistical differences among attributes, so the aim of the method — to prioritize attributes — is thwarted.

Derived importance methods rely on the statistical association between individual ratings (predictors) and an overall satisfaction rating. The importance of an attribute is statistically determined from this relationship. These measures can be generally described as follows:

1. Bivariate (Pearson) Correlation: This measure separately tests the strength of the relationship of each independent variable (attribute) with the dependent variable (overall satisfaction). It has the advantages of familiarity and relative simplicity.
2. Multiple Regression Analysis: This approach allows the inclusion of additional independent variables (attributes) when testing the relationship with the dependent variable (overall satisfaction).

3. Factor Analysis: Factor analysis is a statistical technique that is used for many purposes including:
  - revealing patterns of intercorrelations among variables, and
  - reducing a large number of variables to a smaller number of statistically independent variables (dimensions) that are each linearly related to the original variables.

## 2.2 Impact Score Technique

The Impact Score approach determines the relative impact of attributes on overall satisfaction, by measuring customers' relative decreases in overall satisfaction, when a recent problem with an attribute is reported. This makes sense because, within the delivery of quality service framework, the primary way transit agencies can improve customers' overall satisfaction with service is to reduce customers' problematic experience with those attributes which have the greatest negative impact on overall satisfaction. These driver attributes can be identified and prioritized in a three-step process.

- Step One is to determine which attributes have the most impact on overall customer satisfaction. For each attribute, the sample is divided into those respondents who have had a recent problem with the attribute and those respondents who have not recently experienced a problem with the attribute. The difference between the two mean overall satisfaction ratings is called the "gap score". Gap scores are computed and the attributes are then ordered by the size of their gap scores.
- Step Two lists the attribute problem incidence rate for each attribute in a column next to its gap score.
- Step Three creates a composite index by multiplying the attribute's overall satisfaction gap score by the attribute's problem incidence rate. The result is an attribute "impact score".

To summarize, impact scores are computed as shown in the following example:

Table 1. Impact Score Approach

Classification	A	B	C	D	E
	Had Problem* Mean Overall Satisfaction Rating	No Problem* Mean Overall Satisfaction Rating	(B-A=C) Gap Score	Reported Problem Occurrence Rate**	(C*D=E) Impact Score
Attribute 1	6.5	Mean Overall	2	0.548	1.096
Attribute 2	6.3	Satisfaction	1.9	0.442	0.8398
Attribute 3	5.3	Rating	2.8	0.173	0.4844

\* within the past week

\*\* percent of customers experiencing a problem with the service attribute within the past 30 days

Thus this paper firstly used quadrant analysis for easy recognition of the target area, secondly used impact score analysis, delphi and brain storming to determine the target area and target travel environment elements.

### 3. CUSTOMER SATISFACTION MEASUREMENT

#### 3.1 Data

Gyeonggi Province environs SEOUL Metropolitan, a capital of KOREA shown as figure 1, and has various types of 31 cities whose characteristics are different from one another; 1) some cities have a population more than 0.5 million, on the other hand, some cities have only 50 thousand, 2) urbanized level of some cities are 100%, but there are cities less than 40%, 3) some cities has 33 times of industrial scale than another. And the ratio of bus usage of all traffic modes is so high (about 33%) that people have a lot of concerns at bus service. Moreover the authorization right of bus service license is taken not to Gyeonggi Province but to 31 individual cities. Thus each city can draw up and practice its own transportation policies, and in practice, popular complaints of cities are different from one another.

These reasons make Gyeonggi Province as analysis zone, which is suitable for determination of critical measures in bus service improvements by various city types. The method to collect data is questionnaire including customer's personal attribute and customer's satisfaction rating for each measure that could be classified into availability, reliability, operator attributes, safety, comfort, plant and equipments, affordability, and information.

The data for the bus service coverage area estimation is collected as followings; 1) Date: 2004. 10. 1 - 11. 30(2 months), 2) Area: Gyeonggi Province, KOREA (including 31 cities whose characteristics are different from one another), 3) Samples: 2,397 respondents, who is 16 or older, and has ridden within the past week, 4) Method and contents: a questionnaire.

And a questionnaire have 3 parts as followings; 1) personal details (place of residence, sex, age, occupation, income, car ownership), 2) general bus service (frequency of using bus, reason of using bus, bus types, hour of use, purpose, transfer, access mode, 3) bus service characteristics (importance level (1-10), experience problem (O, X), satisfaction level (1-10)

Table 2. Statistical Characteristics of Samples

Classification	1	2	3	4	5	6	7
Sex	44%	56%					
Age	14%	21%	28%	22%	8%	7%	
Employment status	27%	4%	17%	6%	21%	24%	1%
Income	47%	25%	18%	7%	2%	1%	
Car ownership	42%	58%					
Frequency of use	28%	20%	16%	6%	9%	14%	7%
Trip purpose	23%	15%	7%	8%	8%	30%	9%
Access mode	88%	2%	2%	4%	4%		

Notes: SEX: 1.Male 2.Female, AGE: 1. 15-19 2. 20-29 3. 30-39 4. 40-49 5. 50-59 6. 60-, EMPLOYED STATUS: 1. Employed full-time 2. Employed part-time 3. Business on one's own account 4. Unemployed 5. Student 6. Housewife 7. Retired, INCOME PER MONTH: 1. less than 1 million won 2. 1 million won to less than 2 million won 3. 2 million won to less than 3 million won 4. 3 million won to less than 4 million won 5. 4 million won to less than 5 million won 6. 5 million won or more, CAR OWNERSHIP: 1. yes 2. no, FREQUENCY OF USE PER 1 WEEK: 1. 1 time 2. 2 times 3. 3 times 4. 4 times 5. 5 times 6. 6 times 7. 7 times, TRIP PURPOSE: 1. Work 2. School 3. Shopping 4. Recreation 5. Visiting 6. Personal business 7. Other, ACCESS MODE TO BUS STOP: 1. Walking 2. Bicycle 3. Carpool 4. Car 5. Other



Figure1. Analysis Zone

Table 3. Bus Customer Satisfaction Survey Attributes

1	Reliable trains/buses that come on schedule	24	Having station/stop near one's home
2	Smoothness of ride and stops	25	Explanations and announcements of delays
3	Ease of opening doors when getting on/off	26	Safety from crime on trains/buses
4	Cost effectiveness, affordability, and value	27	Clear and timely announcements of stops
5	Fairness/consistency of fare structure	28	Freedom from nuisance behaviors of riders
6	Ease of paying fare, purchasing tokens	29	Trains/buses that are not overcrowded
7	Friendly, courteous, quick service from personnel	30	Display of customer service number
8	The train/bus traveling at a safe speed	31	Route/direction information visible on trains/buses
9	Safe and competent drivers/conductors	32	Quietness of the vehicles and system
10	Transit personnel who know system	33	Availability of seats on train/bus
11	Attitude of driver about smoking or cellular phone call	34	Comfort of seats on train/bus
12	Accessibility to persons with disabilities	35	Cleanliness of interior, seats, windows
13	Availability of schedule information by phone/internet	36	Availability of handrails or grab bars
14	Station/stop names visible from train/bus	37	Frequency of delays from breakdowns/emergencies
15	Absence of graffiti or offensive odors in bus	38	Cleanliness of train/bus exterior
16	Absence of graffiti or offensive odors at stops	39	Temperature on train/bus- not hot/cold
17	Availability of schedules/maps at stops	40	Physical condition of vehicles and infrastructure
18	Posted minutes to next train/bus at stations/stops	41	Connecting bus service to main bus stops
19	Safety from crime at stations/stops	42	Frequency of service on weekday
20	Cleanliness of stations/stops	43	Hours of service during weekdays
21	Bicycle keeping facility at stations/stops	44	Having station/stop near one's destination
22	Availability of shelter and benches at stops	45	Availability of transfer discount
23	Frequency of service on Saturdays/Sundays		

### 3.2 Survey Analysis Results of Gyeonggi Province

The target areas are determined by each approach of quadrant analysis and impact score analysis for customer satisfaction survey about bus service at Gyeonggi Province. And priority of travel environment elements is also determined by delphi and brain storming about 45 bus service attributes.

Firstly the target area attributes, which are important but not satisfied, shown as Figure 2 for Gyeonggi Province as determined by quadrant analysis are as followings: [12] Accessibility to persons with disabilities, [9] Safe and competent drivers/conductors, [8] The train/bus traveling at a safe speed, [1] Reliable trains/buses that come on schedule, [7] Friendly, courteous, quick service from personnel, [19] Safety from crime at stations/stops, [26] Safety from crime on trains/buses, [25] Explanations and announcements of delays [29] Trains/buses that are not overcrowded [35] Cleanliness of interior, seats, windows [28] Freedom from nuisance behaviors of riders [45] Availability of transfer discount [11] Attitude of driver about smoking or cellular phone call etc.

And target area attributes as determined by impact score, which are displayed in Table 4, approach are as followings: [4] cost effectiveness, affordability, and value, [17] availability of schedules/maps at stops, [1] reliable trains/buses that come on schedule, [30] display of customer service number, [3] ease of opening doors when getting on/off, [35] cleanliness of interior, seats, windows, [27] clear and timely announcements of stops, [20] cleanliness of stations/stops, [37] frequency of delays from breakdowns/emergencies, [31] route/direction information visible on trains/buses, [45] availability of transfer discount, [18] posted minutes to next train/bus at stations/stops, [12] accessibility to persons with disabilities of all 45 attributes.

When impact score results are compared with quadrant analysis results, some significant changes appear. There are several problems in quadrant analysis as addressed previously, thus this paper takes the results of impact score analysis as real target attributes.

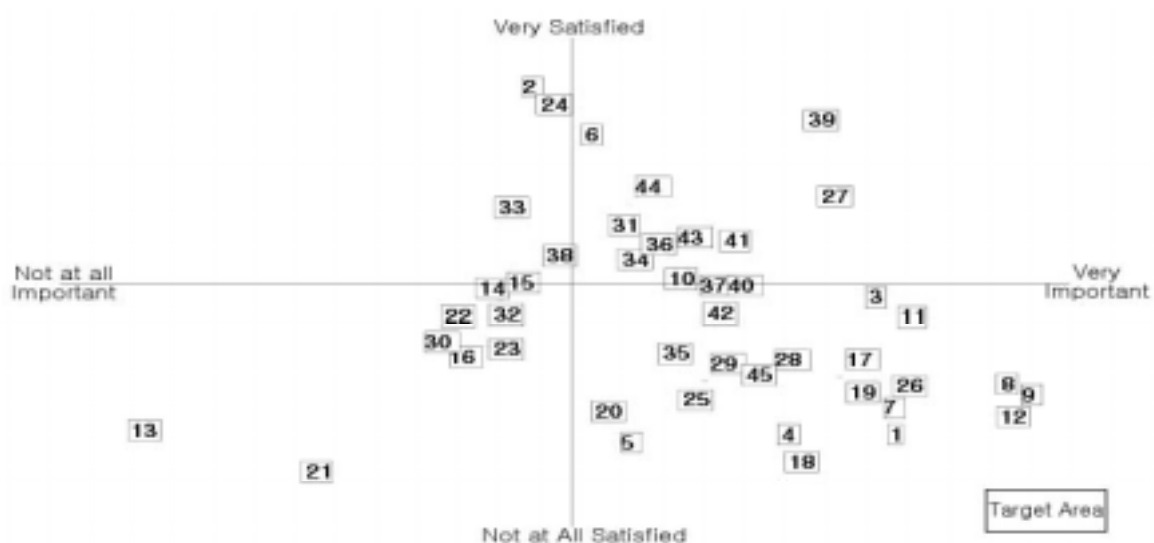


Figure 2. Quadrant Chart and Priority of Travel Environment Elements

Table 4. Bus Service Characteristics Ratings

Target: Gyeonggi Province (total 2,397 respondents) Scale: 1=Poor, 10=Excellent		Importance	Satisfaction	Impact Score	
1	Reliable trains/buses that come on schedule	9	2	0.909	A
2	Smoothness of ride and stops	3	10	0.372	D
3	Ease of opening doors when getting on/off	9	6	0.849	A
4	Cost effectiveness, affordability, and value	7	2	0.985	A
5	Fairness/consistency of fare structure	4	2	0.774	B
6	Ease of paying fare, purchasing tokens	4	10	0.154	F
7	Friendly, courteous, quick service from personnel	9	3	0.599	C
8	The train/bus traveling at a safe speed	10	3	0.752	B
9	Safe and competent drivers/conductors	10	2	0.431	D
10	Transit personnel who know system	6	7	0.321	E
11	Attitude of driver about smoking or cellular phone call	9	5	0.334	D
12	Accessibility to persons with disabilities	10	2	0.818	B
13	Availability of schedule information by phone/internet	1	2	0.273	E
14	Station/stop names visible from train/bus	2	7	0.610	C
15	Absence of graffiti or offensive odors in bus	2	6	0.421	D
16	Absence of graffiti or offensive odors at stops	2	4	0.088	F
17	Availability of schedules/maps at stops	8	3	0.936	A
18	Posted minutes to next train/bus at stations/stops	8	1	0.728	B
19	Safety from crime at stations/stops	9	3	0.524	C
20	Cleanliness of stations/stops	4	2	0.758	B
21	Bicycle keeping facility at stations/stops	1	1	0.347	D
22	Availability of shelter and benches at stops	2	6	0.165	F
23	Frequency of service on Saturdays/Sundays	2	4	0.054	F
24	Having station/stop near one's home	3	10	0.083	F
25	Explanations and announcements of delays	6	2	0.068	F
26	Safety from crime on trains/buses	9	3	0.024	F
27	Clear and timely announcements of stops	9	9	0.879	A
28	Freedom from nuisance behaviors of riders	7	3	0.758	B
29	Trains/buses that are not overcrowded	6	3	0.068	F
30	Display of customer service number	2	5	0.876	A
31	Route/direction information visible on trains/buses	4	9	0.770	B
32	Quietness of the vehicles and system	2	5	0.366	D
33	Availability of seats on train/bus	2	9	0.268	E
34	Comfort of seats on train/bus	5	8	0.237	E
35	Cleanliness of interior, seats, windows	5	4	0.809	B
36	Availability of handrails or grab bars	5	8	0.644	C
37	Frequency of delays from breakdowns/emergencies	6	7	0.892	A
38	Cleanliness of train/bus exterior	3	8	0.766	B
39	Temperature on train/bus-not hot/cold	8	10	0.483	D
40	Physical condition of vehicles and infrastructure	6	7	0.089	F
41	Connecting bus service to main bus stops	7	8	0.177	E
42	Frequency of service on weekday	6	6	0.094	F
43	Hours of service during weekdays	5	8	0.720	B
44	Having station/stop near one's destination	5	9	0.701	B
45	Availability of transfer discount	7	3	0.796	B

Impact Score above is expectation value of standard normal cumulative distribution and policy

A:  $\geq 0.833$ , B:  $\geq 0.667$ , C:  $\geq 0.5$ , D:  $\geq 0.333$ , E:  $\geq 0.167$ , F:  $< 0.167$

#### 4. BUS SERVICE PRIORITY BY VARIOUS CITY TYPES

##### 4.1 Classification Of Cities

Gyeonggi Province has 31 cities whose characteristics are different from one another. For example, Suwon that has the provincial office belongs to the big city (has a population more than 0.5million) and is highly urbanized, densely populated and also industrial. But Yeoncheon is low urbanized, sparsely populated and its industrial scale is small. To determine critical measures of bus service improvements suitable to a certain city, the criterion to classify city types are selected as followings: 1) location, 2) urbanized level, 3) population density 4) industrial scale.

Table 5. Classifications of 31 Cities and Counties of Gyeonggi Province

Classification	Location	Urbanized Level	Population Density	Industrial Scale
SUWON	MEDIUM	HIGH	HIGH	HIGH
SEONGNAM	CLOSE	HIGH	HIGH	HIGH
BUCHEON	CLOSE	HIGH	HIGH	HIGH
GOYANG	CLOSE	HIGH	MEDIUM	HIGH
ANYANG	CLOSE	HIGH	HIGH	HIGH
ANSAN	MEDIUM	HIGH	MEDIUM	HIGH
PYEONGTAEK	FAR	MEDIUM	LOW	HIGH
UIJEONGBU	CLOSE	HIGH	MEDIUM	MEDIUM
DONGDUCHEON	MEDIUM	MEDIUM	LOW	LOW
GWANGMYEONG	CLOSE	HIGH	HIGH	MEDIUM
GWACHEON	CLOSE	HIGH	MEDIUM	LOW
GURI	CLOSE	HIGH	MEDIUM	LOW
NAMYANGJU	CLOSE	MEDIUM	LOW	MEDIUM
OSAN	FAR	HIGH	MEDIUM	LOW
SIHEUNG	CLOSE	HIGH	MEDIUM	HIGH
GUNPO	CLOSE	HIGH	HIGH	MEDIUM
UIWANG	CLOSE	HIGH	MEDIUM	LOW
HANAM	CLOSE	HIGH	MEDIUM	LOW
YONGIN	MEDIUM	MEDIUM	LOW	HIGH
PAJU	MEDIUM	LOW	LOW	MEDIUM
ICHEON	FAR	MEDIUM	LOW	HIGH
ANSEONG	FAR	LOW	LOW	MEDIUM
GIMPO	CLOSE	LOW	LOW	MEDIUM
YANGJU	CLOSE	LOW	LOW	LOW
YEOJU	FAR	LOW	LOW	LOW
HWASEONG	FAR	LOW	LOW	HIGH
GWANGJU	MEDIUM	LOW	LOW	MEDIUM
YEONCHEON	FAR	MEDIUM	LOW	LOW
POCHEON	FAR	LOW	LOW	LOW
GAPYEONG	FAR	LOW	LOW	LOW
YANGPYEONG	FAR	LOW	LOW	LOW

Location: distance to SEOUL Metropolitan, CLOSE: <25km, MEDIUM: 25km - 50km, FAR: >50km

Urbanized Level: population in urbanized territory over total population: HIGH: >90%, MEDIUM: 70% - 90%, LOW: <70%

Population Density: persons/km<sup>2</sup>, HIGH: >6,000, MEDIUM: 1,000 – 6,000, LOW: <1,000

Industrial Scale: Gross Regional Products, 1\$=1,058Won, HIGH: >5,000 billion won, MEDIUM: 2,000 – 5,000 billion won, LOW: <2,000 billion won













