# A RESEARCH ON THE USE OFMOBILE MOVE CENTERS SERVICE USING STRUCTURAL EQUATION MODEL (SEM)

Kim Sung-Hoe[a], KimGyeong-Seok[b], Cheon Seong-Sik[c], Cho Yung-Sung[d], Son Seung-Neo[e]

[abc]Kongju National University, Cheon-an, Korea
[de]Intelligent Transportation Society of Korea, An-san, Korea
*Corresponding Email*: gskim23@kongju.ac.kr

## Abstract

Mobile move centre is an institution which helps transportation vulnerable to mobilize in their daily activities. Due to their limited physical or cognitive abilities, vulnerable transportation needs to be equipped with a special transportation system(STS) that is capable of giving them accessibility and convenience. This research used structural equation model(SEM) to analyse the importance-performance indicators based on the views of transportation vulnerable who are using the existing STS. The significant indicators will be prioritized for the improvement of the services provided by the mobile move center, such as vehicle use, convenience and charge system. From the analysis, it was found that the charge system had no influence on overall performance as it shows a higher performance due to its comparative price rather than when using the regular public transportation. Furthermore, it can be known that it is necessary to set the improvement on vehicle use as top priority because it is highly influential on the performance of the transportation system. It will also be necessary to focus on the improvement of variables that showing high importance and low performance such as kindness, punctuality, waiting time and call centre response.

*Keywords:* IPA, Mobile Move Centre, Structural Equation Model(SEM), Transportation-Vulnerable.

## 1. Introduction

Transportation vulnerable refers to a class of persons with limited physical functions or limited cognitive functions which show limited mobility in terms of using means of transportation and walking on a road. To provide travel convenience to transportation vulnerable, most of the local governments in South Korea operate the mobile move center equipped with the Special Transportation System(STS) which is capable of carrying a wheel chair. To enhance the transportation vulnerable's travel convenience, such a mobile move center has been making various efforts to improve its services and increase the number of operating vehicles. However, the mobile move center is faced with some budgetary problems such as vehicle purchase cost and safety system installation cost. In addition, simply increasing the number of operating vehicles without reflecting actual users' feedback may make limited improvement of the service. Accordingly, in this research, the Structural Equation Model(SEM) was used to analyze the importance and satisfaction(performance) based on the opinions of the transportation vulnerable who actually use STS, and the analysis results were used to prioritize the improvement of the following services provided by the mobile move center for the users of the STS, such as: vehicle use, charge system, related service, etc.

## 2. Review of literature
## 2. 1 Review of Thoery

The SEM, also called the Covariance Structure Analysis, is a model for analyzing causal relationship between various latent variables through measurement models and structural models. The SEM is a combination of factor analysis and path analysis. In other words, it is a structural model that grasps the causal relationship between latent variables through factor analysis. Therefore, SEM has the advantage of verifying the causal relationship between observed variables and latent variables or between each latent variables as the most suitable analytical technique to verify the causal relationship set by the researcher. In general, the SEM consists of observed variables, latent variables, errors and residuals, and path coefficients.



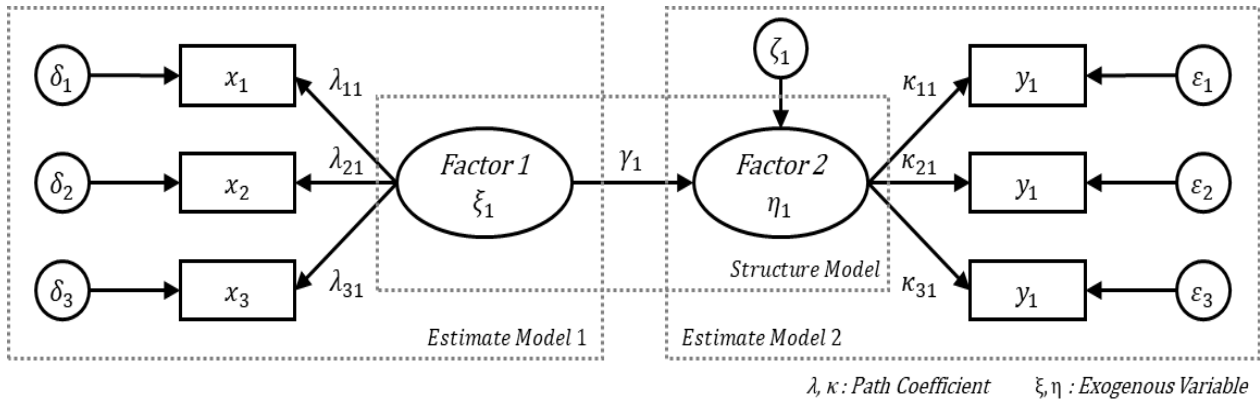$\lambda, \kappa$ : Path Coefficient     $\xi, \eta$ : Exogenous Variable

Figure 1: Conceptual Diagram of SEM

Importance-Performance Analysis(IPA) analysis is mainly used in the management field to measure user importance and performance of products or services, but recently, it has been widely used in various fields. For the analysis, the questionnaire survey was conducted on a 5 point(or 7 point) scale. Then, the importance variable is set for the vertical axis and the performance variable is set for the horizontal axis, and the importance-performance value for each variable is displayed in the quadrant. Therefore, each variable can be prioritized according to the quadrant.

Each quadrant has attributes according to the location of each quadrant as follows:

- Quadrant 1: Keep up the Good Work Recruitment
- Quadrant 2: Concentrate Here
- Quadrant 3: Low Priority
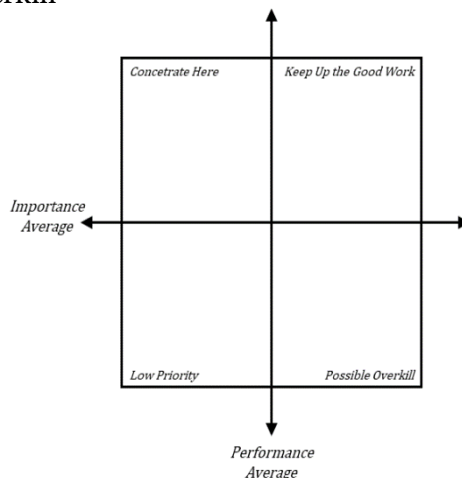- Quadrant 4: Possible Overkill

Asia Pacific Institute of Advanced Research (APIAR)

Figure 2: Conceptual Diagram of IPA

## 2. 2Differentiation and Research Problem Setting

In contrast to the previous researches, which are based on performance questionnaire surveys, this research conducted by user survey and considering the importance and performance by SEM and IPA analysis. In order to purpose the service improvement priority, both the importance and the performance are considered, which makes this research different from the previous researches. The questionnaire survey can be used to investigate the importance and performance at the same time. However, during the survey, respondents cannot distinguish between the two variable and gives a similar score, this can result in low reliability. This research hypothesized that users' performance with Vehicle Use, Convenience, and Charge System service had a positive(+) effect on overall performance, and analyzed the effect of each service on overall performance. Based on the results of the survey and the results of the analysis, we compared the priority of improvement based on the IPA analysis existing performance.

## 3. Methods
## 3. 1 Research Flow

In this research, the research problem was derived from the review of relevant literature, and the questionnaire survey was conducted to collect mobile move center user opinions. The questionnaire survey data was conducted by 'Reliability Analysis' and 'Factor Analysis' using SPSS. After that, the SEM was constructed and analyzed using AMOS, and IPA analysis was conducted based on the importance and performance results. Finally, based on the results of SEM and IPA, the priority of service improvement was suggested to consider both importance and performance.
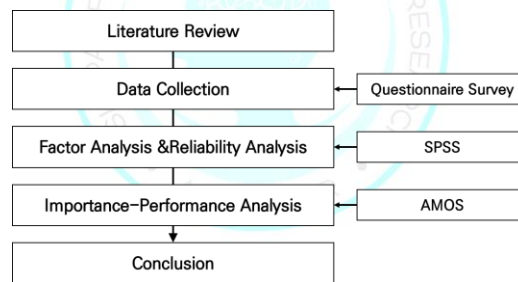


Figure 3: Flowchart

## 3. 2Data Collecting

In this research, questionnaire surveys were conducted for the users and guardians who use STS, and 15 observed variables were used. We used 14 observed variables that would directly or indirectly affect the use mobile move center and used additional observed variables for overall performance. User questionnaire survey was conducted for STS users and guardians in Cheon-an City. Performance was measured using the Likert scale(1 point: worst, 5 point: best). Total survey respondents were 289, including 220 of actual STS users and 69 of guardians.

## 3. 3Factor Analysis & Reliability Analysis

Factor Analysis analyzes an object composed of isometric or ratio scales. Factor analysis analyzes the interrelationships between variables using covariance and correlation among variables. Based on the results, it is an analytical technique that grasps the correlation and structure between the variables and the variables and derives them as a few factors. In this research, factor analysis was performed on 14 observed variables excluding overall performance

in order to derive the factors. Since the questionnaire survey is assessed by respondents on subjective standards, the data needs to be verified for reliability. Therefore, reliability analysis was conducted as a process of evaluating the reliability of the factor analysis results. As a result of factor analysis, it was derived from three variables: Vehicle use, Convenience, and Charge system. From the reliability analysis of the three variables derived from the factor analysis, the minimum Kronbach alpha coefficient was 0.864, more than the minimum value of reliability which is 0.6

Table 1:Results of Factor Analysis &Reliability Analysis

| Variables | Factor | | | Cronbach's α |
|---|---|---|---|---|
| | Vehicle Use | Convenience | Charge System | |
| Punctuality | .874 | .033 | .061 | .910 |
| Kindness | .861 | .147 | .209 | |
| Call Center Response | .833 | .213 | .157 | |
| Waiting Time | .775 | .219 | .175 | |
| Safety | .760 | .031 | .245 | |
| No. of Vehicles | .745 | .180 | -.117 | |
| Reservation Method | .120 | .866 | .281 | .864 |
| Means of Reservation | .094 | .861 | .266 | |
| Boarding Method | .285 | .628 | .405 | |
| Vehicle Size | .461 | .580 | .309 | |
| Additional Charge | .098 | .214 | .882 | .917 |
| Out-of-town Surcharge | .098 | .220 | .866 | |
| Basic Charge | .191 | .272 | .849 | |
| Charge Payment Method | .145 | .376 | .758 | |
| KMO(Kasiser-Meyer-Olkin) | | | | .875 |
| Bartlett's Test of Sphericity | | | Chi-Squre | 3121.28 |
| | | | df(p) | 91(.000) |

## 3. 4Methods of Importance-Performance

The methodology for the importance-performance analysis of this research is shown in the [Fig 4]. The research model and the hypothesis were set up, and the 'Model Setting' was performed to set the SEM, variables, and errors.

In addition, a 'Model Evaluation' was performed to determine the significance of each variable and a final SEM was derived through 'Model Modification' to modify the fit of the model. Finally, IPA analysis was conducted as a result of the importance of the final SEM and performance of the questionnaire survey and the priority was derived.
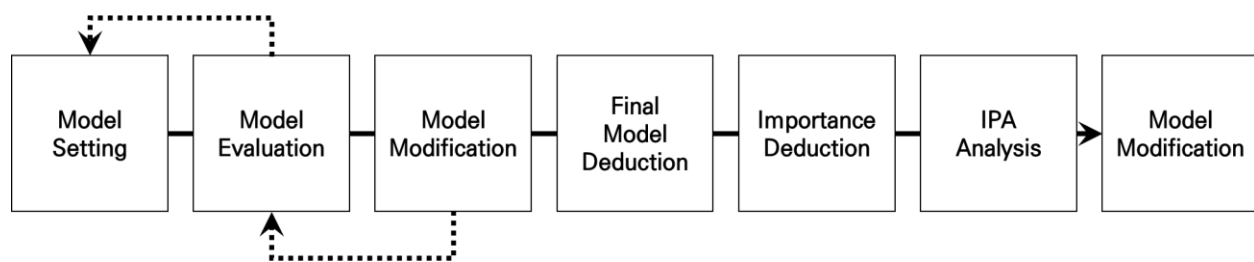


Figure 4: Analysis Flow

Asia Pacific Institute of Advanced Research (APIAR)

# 4. Results
## 4. 1 Derivation of SEM

The analysis was conducted using AMOS, a SEM Analysis Program(Fig 5.).

However, as a result of verifying the reliability of the SEM, it was found that the charge system, latent variable related to overall performance was unable to satisfy the critical ratio(C.R.≥±1.96).

C.R. Value is interpreted as having the same meaning as the t value of SPSS because it can test the significance of the regression coefficient.

This was analyzed as a meaningful result in factor analysis and reliability analysis, but it was analyzed as meaningless in the SEM. Therefore, a new SEM is derived in this research.

A new SEM was constructed with the exception of the charge system service, and a new SEM was established. From the feasibility test, all the variables were found to be reliable.

Table 2:Validity Verification Results for Previous SEM

| Variables | C.R. | Variables | C.R. |
|---|---|---|---|
| Call Center Response<Vehicle Use | 17.685 | Punctuality<Vehicle Use | 16.251 |
| Waiting Time<Vehicle Use | 15.571 | Performance<Convenience | 3.403 |
| Safety<Vehicle Use | - | Performance<Vehicle Use | - |
| No. of Vehicles<Vehicle Use | 11.803 | Out-of-town Surcharge<Charge System | 17.049 |
| Means of Reservation<Convenience | 13.045 | Additional Charge<Charge System | 17.553 |
| Reservation Method<Convenience | 13.583 | Basic Charge<Charge System | 17.476 |
| Boarding Method<Convenience | 14.908 | Charge Payment Method<Charge System | - |
| Vehicle Size<Convenience | - | Performance<Charge System | 0.118 |
| Kindness<Vehicle Use | 19.025 | | |

Table 3:Validity Verification Results for Modified SEM

| Variables | C.R. | Variables | C.R. |
|---|---|---|---|
| Call Center Response<Vehicle Use | 15.067 | Boarding Method<Convenience | 15.954 |
| WaitingTime<Vehicle Use | 14.787 | Vehicle Size<Convenience | - |
| Safety<Vehicle Use | 13.445 | Kindness<Vehicle Use | 16.49 |
| No. of Vehicles<Vehicle Use | - | Punctuality<Vehicle Use | 16.197 |
| Means of Reservation<Convenience | 9.864 | Performance<Convenience | 6.537 |
| Reservation Method<Convenience | 10.658 | Performance<Vehicle Use | |
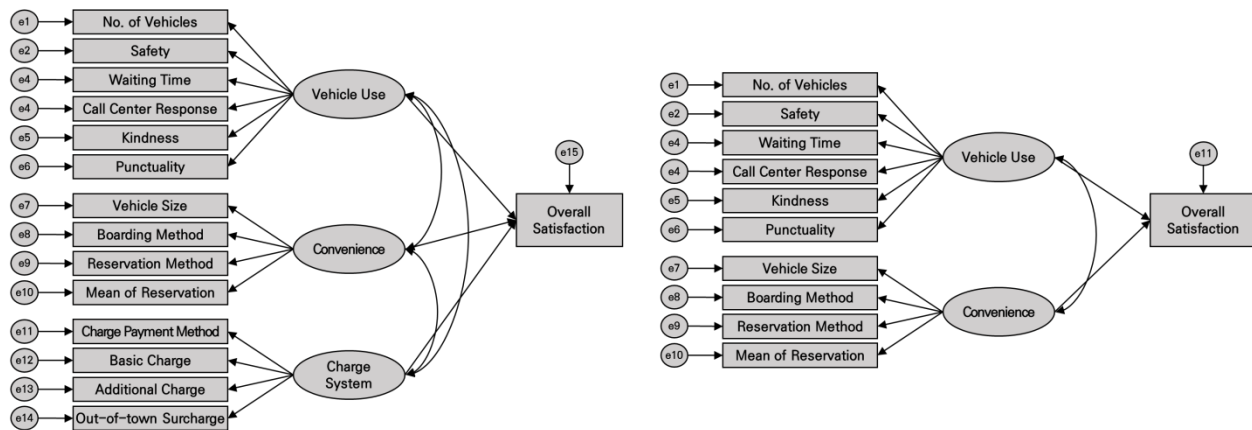
Figure 5: Previous Model(Left) & Modified Model(Right)

## 4. 2MIbased Model Modification

In order to goodness-of-fit test of a new model, a compatibility evaluation should be performed as it will determine the adoption or rejection of the model.

Absolute Fit Indices used in the conformity assessment of the SEM include GRI(0.9~), CFI(0.9~), NFI(0.9~), RMR(~0.5), and RMSEA(0.05~0.08).

AMOS provides Modification Indices(MI) to improve the compatibility of the analyzed SEM. In this research, MI was used to increase the compatibility of the SEM. As a result, the Absolute Fit Indices standard of the SEM was met.

Table 4:Goodness-of-Fit Test Results Based on Modification Index

| Category | RMR | RMSEA | GFI | CFI | NFI | RFI |
|---|---|---|---|---|---|---|
| Before M.I | 0.079 | 0.160 | 0.817 | 0.863 | 0.848 | 0.805 |
| After M.I | 0.050 | 0.075 | 0.939 | 0.973 | 0.957 | 0.939 |

## 4. 3Results of SEM & IPA

As a result of the analysis of the importance of SEM, it was analyzed that the performance of vehicle use and convenience service affects positively on overall performance. The adoption of the final SEM was determined by the C.R. value of the regression weights for the latent variables and C.R. value between the variables was more than 1.96, which was analyzed to be significant in the 95% confidence interval.

The importance of each latent variable was analyzed as 0.66 for vehicle use and 0.27 for convenience. The importance of vehicle use variable 'Call Center Response' was analyzed highest at 0.90 and that of convenience variable 'Vehicle Size' was analyzed highest at 0.91.

Table 5: Results of Standardized Regression Weights

| Variables | Estimate | S.E. | C.R. | p |
|---|---|---|---|---|
| Call Center Response<Vehicle Use | 0.803 | 0.074 | 15.067 | *** |
| WaitingTime<Vehicle Use | 0.781 | 0.074 | 14.787 | *** |
| Safety<Vehicle Use | 0.726 | 0.077 | 13.445 | *** |
| No. of Vehicles<Vehicle Use | 0.697 | - | - | - |
| Means of Reservation<Convenience | 0.559 | 0.063 | 9.864 | *** |
| Reservation Method<Convenience | 0.595 | 0.06 | 10.658 | *** |

Asia Pacific Institute of Advanced Research (APIAR)

| | | | | |
|---|---|---|---|---|
| Boarding Method<Convenience | 0.829 | 0.055 | 15.954 | *** |
| Vehicle Size<Convenience | 0.914 | - | - | - |
| Kindness<Vehicle Use | 0.900 | 0.075 | 16.49 | *** |
| Punctuality<Vehicle Use | 0.836 | 0.078 | 16.197 | *** |
| Performance<Convenience | 0.273 | 0.057 | 6.537 | *** |
| Performance<Vehicle Use | 0.661 | - | - | - |

***: p<0.001

As a result of the IPA analysis, the significance average was 0.76 out of 1.00 and the performance average was 3.26 out of 5.00(Table 6.). 'Concentrate here' were analyzed on the Punctuality, kindness, waiting time, and call center response, and 'Keep Up the Good Work' was analyzed by vehicle size and boarding method. Also, 'Low Priority' was analyzed by the number of vehicles and safety, and the 'Possible Overkill' was analyzed by reservation method and reservation method(Fig 7.).Therefore, the priorities derived through SEM and IPA were determined as 'Concentrate here', which was determined to be Punctuality, Kindness, Waiting Time and Call Center Response. However, if only the performance is considered, priority was determined by the Number of Vehicles, Punctuality, Waiting Time, and Kindness, and it is analyzed that there is a slight difference from the method that considering the Importance-Performance.

Table 6:Results of Importance & Performance

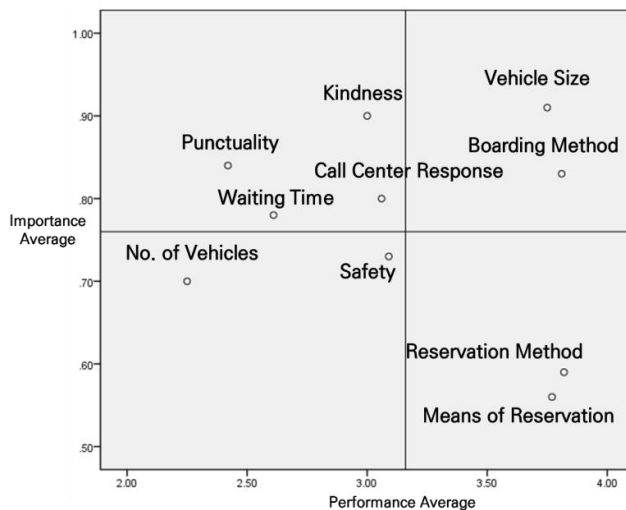| Variables | Importance | Performance |
|---|---|---|
| Punctuality | 0.84 | 2.42 |
| Kindness | 0.90 | 3.00 |
| Call Center Response | 0.80 | 3.06 |
| Waiting Time | 0.78 | 2.61 |
| Safety | 0.73 | 3.09 |
| Reservation Method | 0.59 | 3.82 |
| Means of Reservation | 0.56 | 3.77 |
| Boarding Method | 0.83 | 3.81 |
| Vehicle Size | 0.91 | 3.75 |
| No. of Vehicles | 0.70 | 2.25 |
| Mean Value | 0.76 | 3.16 |



Figure 6: Results of IPA

## Conclusion

In this research, the SEM was used to analyze the importance of the mobile move center for the transportation vulnerable, and the importance and performance drawn and examined through the analysis and questionnaire survey, respectively, were used to propose the IPA results that take into consideration such importance and performance at the same time.

As far as the hypotheses set up in this research are concerned, it was found that vehicle use and convenience had a positive(+) influence on overall performance, and that charge system had no influence on overall performance since charge system itself showed high performance due to its low charge compared to public transportation.

Accordingly, it was determined that, to improve the mobile move center for the transportation vulnerable, it would be necessary to apply the improvement of vehicle use highly influential on overall performance as top priority, as well as to focus on the improvement of variables that showing high importance and low performance such as kindness, punctuality, waiting time and call center response.

However, as this research was only conducted to the users and guardians of special transportation in Cheon-an city, there are limitations in considering different rate systems and the penetration rate of STS among local governments in South Korea. In the future, it is necessary to carry out a Importance-Performance survey on transportation vulnerable in the whole country to make up for the limitations and it can be utilized as basic data for construction of a wide-area mobile move center and facility improvement through the constructed data.

## References

i. Ahn, W.-Y. & Choi, L.-R., 2014. Importance Factor Analysis on Mobility Facilities for the Transportation Disabled by Using Structural Equation Model,. *Journal ofthe KoreanSociety of Civil Engineers,* 34(3), pp. 939-945.

ii. John, A. M. & John, C. J., 1977. mportance-PerformanceAnalysis,. *Journal of Marketing,* 41(1), pp. 77-79.

iii. Kim, H.-C., 2015. Customer Satisfaction Analysis for Urban Railway Service Quality by IPA Analysis. *Journal of the Korean Society for Railway,* 18(5), pp. 502-511.

iv. Kim, W.-C., 2015. Exploring Factors Influencing the use of Intercity-bus Services by means of a Structural Equation Model - Focusing on Intercity-bus Users in Chungcheongnam-do Province. *The Journal of The Korea Institute of Intelligent Transport Systems,* 14(6), pp. 100-109.

v. Lee, C.-H., Kim, M.-S. & Jo, K.-N., 2014. A Study on the Improvement of Pedestrian Facilities by the Use of Importance-Performance Analysis. *Journal of Korean Society of Transportation,* 32(6), pp. 628-637.

vi. Lee, H.-S. & Lim, j.-H., 2015. *Structural Equation Model with Amos 22,* s.l.: Jiphyunjae.

vii. Lee, S.-H., 2009. A Study on the Transportation Policy for the Mobility Handicapped Using Satisfaction Level. *Seoul Studies,* 10(1), pp. 197-208.

viii. Nho, K.-S., 2014. *A well-known analysis of thesis statistics: SPSS & AMOS 21,* s.l.: Hanbit Academy.

ix. Rim, C.-W., 2016. *Analysis on Factors of Business Vehicle's Traffic Accident Using Structural Equation Model by Sectors,* Hongik University: M.S. diss.,.

x. Yu, J.-P., 2013. *Structural Equation Model(SEM) Concepts and Understanding,* s.l.: Hannarae Academy.

xi. Yun, D.-S. & Shin, G.-S., 2011. Study on Transportation Handicapped's Satisfaction Level of Transportation Facilities - A Case Study of Gyeongsan City. *Journal of Regional Studies,* 19(1), pp. 85-107.

## Acknowledgement