

## A Study of the Factors Involved in Improving the Satisfaction of the Segway Tour

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**Abstract:** In this paper, survey questionnaires were conducted to quantify the participants' satisfaction level of the Segway tours held on the Funabashi Campus of Nihon University. Using the obtained data in this research, the relationship between the satisfaction level and the determination factors were ascertained by structural equation modeling. From the results of the initial tour, the time of the Segway ride. By comparing these cases, not only the shift of participants' satisfaction level caused by the time change but also how it relates to the determination factors were investigated.

**Keywords:** Segway, Personal Transporter, Campus Tour, Mentality, Satisfaction, Structural Equation Modeling

### 1. INTRODUCTION

In recent years, the Segway, an automatic two-wheeled personal transporter (PT), has been attracting attention as a new means of transportation for short distances. In Europe and the United States, the PT is already in use on public roads as a way of traveling throughout an entire city on sightseeing tours and patrolling by security guards. In Japan, the PT has been used on private property for the purposed of security patrols and sightseeing tours, and also on golf courses, but its use on public roads is not permitted due to regulatory and safety issues.

In a study of the Segway, Miller et al. (2008) analyzed its behavior: the obstacles were set at the end of curve where a rider could not predict the situation in advanced. Emori et al. (2009) examined the characteristics of movement behavior, assuming the Segway is sharing a space with pedestrians. Nishiuchi et al. (2010) analyzed the travel area necessary for the Segway in comparison with a bicycle, and also the eye movement of a Segway rider according to pedestrian density. Another study clarified why the Segway was chosen as a means of transportation.

Potential factors, such as personal perception and psychological factors that are difficult to quantify, affect a person's choice of transportation. Nor Ghani et al. (2007) said potential factors are statistically significant, and should not be ignored when choosing a means of transportation. As a study to clarify the factors that result in selecting the Segway as a means of transportation, Saito et al. (2011) used a virtual tourist destination to understand the choice made among the Segway, the bicycle and walking under various circumstances. Li et al.

(2011) and, Ando and Li (2012) analyzed the operability, acceptability and effectiveness of two-wheeled personal mobility vehicles. These studies focused on the Segway itself from the technical perspectives, and have revealed the usefulness of the Segway.

However, the factors to define the level of satisfaction with the Segway tour have not been clarified in the previous studies. None has shown the other important factors for implementing the Segway tour. By clarifying these factors and understanding the relationship among the factors, the improvement of the Segway tour will be achieved.

The aim of this paper is to examine the relationship between the satisfaction and determination factors, and to see how different the structures of consciousness are from before the Segway and walking tours. In this examination, the satisfaction of the tours is defined by five factors and a structural equation model (SEM) is built for them. By using the constructed model, the structure of consciousness of the participants is found out. In addition, as extending the time of the Segway ride, changes brought about by the extension are revealed in the level of satisfaction, which leads to understand the relationship between satisfaction and the determination factors.

## 2. SURVEY METHOD

### 2.1 About the Segway Tours

Five Segway tours were organized in 2011 and 2012. The first three, which were held on October 30, November 12, and December 2 in 2011, were defined as the “initial tours.” These tours were used to compare the structure of consciousness of the Segway and walking. The fourth and fifth tours were named the “rearranged tours,” having a longer ride distance and their time was doubled. Overviews of each tour are shown in Table 1 and Table 2. The reason for focusing on riding distance and time duration is because the result of a survey of standard tours showed participants wanted to extend the ride time. A questionnaire survey about the impression of the tour was conducted after each tour.

Table 1. Overview of initial tours

Date	Oct 30th, 2011 / Nov 12th, 2011 / Dec 2nd, 2011
Weather	Sunny
Time	10:00-16:00 (an hour/tour)
Place	Funabashi Campus of Nihon University
Maximum number of participants for each course	10
The contents of the guide	Outline of the facilities at Funabashi Campus Refer to the HP of the Nihon University
Flow	1. Fill in the consent form: 10 minutes 2. First tour (Segway or Walk) : 30 minutes 3. Second tour (Segway or Walk) : 30 minutes 4. Fill in the questionnaire: 10 minutes

Table 2. Overview of the rearranged tours

Date	Nov 3rd, 2012 / Dec 2nd, 2012
Weather	Sunny
Time	10:00-16:00 (an hour/tour)
Place	Funabashi Campus of Nihon University
Maximum number of participants for each course	5
The contents of the guide	Outline of the facilities at Funabashi Campus Refer to the HP of the Nihon University
Flow	1. Fill in the consent form : 10 minutes 2. Tour (Segway) : an hour 3. Fill in the questionnaire : 10 minutes

### 2.1.1 Configuring the Routes

#### Initial tour routes

As shown in Figure 1, two routes, Route A and B, were designed for this tour. Each of the routes has 1 km in distance, which is equivalent to 30 minutes' walk. The participants of each gathering were divided into two groups: riding Segway in Route A and walking in Route B, or walking in Route A and riding Segway in Route B. When riding Segway, they had 15 minutes' training before 15 minutes' ride: the total time of each Segway tour is 30 minutes. Each route has two places to visit: the Surveying Center (A1) and the Advanced Materials Science Center (A2) in Route A, and the Sports Hall (B1) and the Large-Structure Testing Center (B2) in Route B. All of the places above, the distinctive facilities in Funabashi Campus of Nihon University, were selected owing to Hasegawa et al. (2011).

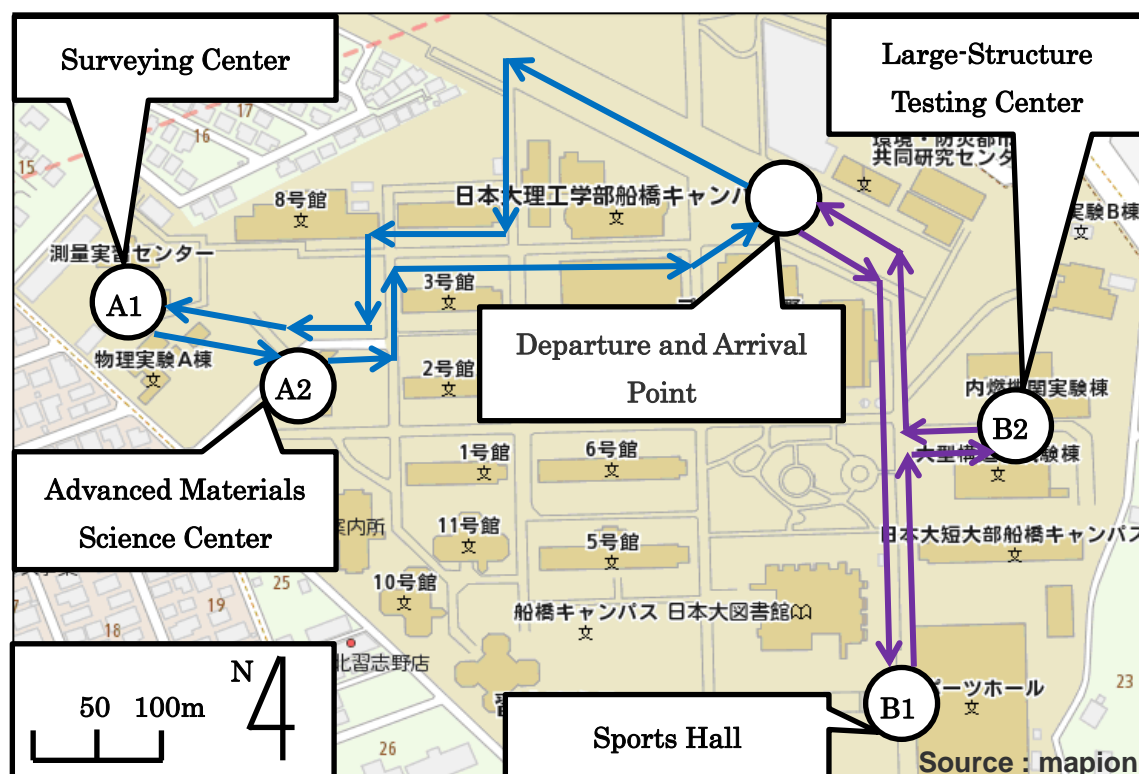


Figure 1. Standard tour courses (routes A and B)

## Rearranged tour route

The route of the rearranged tour, doubling the distance and time of the initial tour, is shown in Figure 2. Unlike the initial tour, participants traveled only by Segway, riding from the departure point through 1, 2, 3 and 4 to the arrival point as shown in the figure.

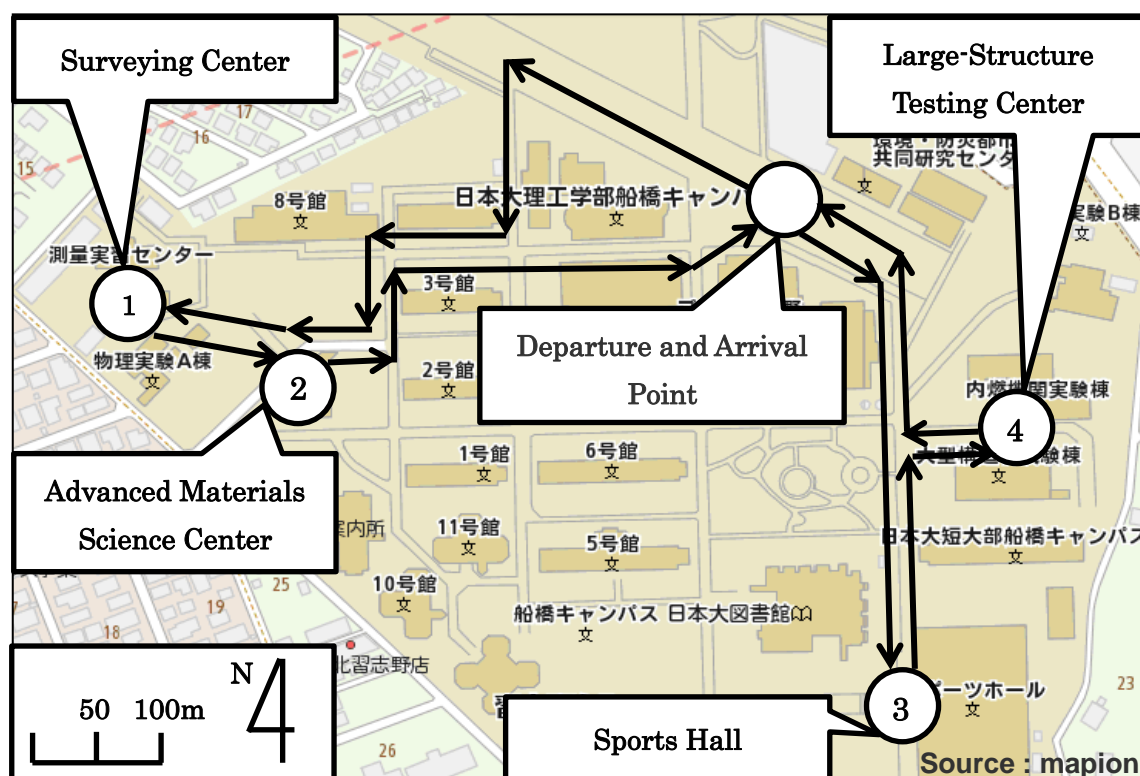


Figure 2. Rearranged tour course

## 2.2 About the questionnaire

### 2.2.1 Overview of the questionnaire

An overview of the questionnaire survey is shown in Table 3. The purpose of the questionnaire is to understand the psychological impact of the tour in terms of satisfaction. Impressions of the tours were evaluated in five stages from the observation items: very good (5 points), good (4 points), neither (3 points), bad (2 points) and very bad (1 point). Survey items of the questionnaire were divided into three broad areas, impression of the Segway, impression of the tour, and personal attributes.

Table 3. Overview of questionnaire

How to responses	Respond directly	
Number of effective responses	2011 : 58 (97%)	
(Effective response rate: %)	2012 : 48 (96%)	
Survey items	Items	Contents
	Individual attribute	Gender, Age, Occupation, Frequency of coming to university
	Impression of the tour	19 items (Reference : Table 4)
	Impression of the Segway	4 items (ex : Terms of ride)

### 2.2.2 Characteristics of the respondents

Table 4 shows the personal characteristics provided by the questionnaire survey of 2011 and 2012. The items of the personal characteristics are sex, age, occupation and frequency of coming to Funabashi campus of Nihon University.

The first item is Gender. The result of 2011 and 2012 shows that the ratio of male is approximately 70% and female is approximately 30% each year.

The second item is Age. The result of 2011 shows that the 10's and 20's account for about 70% of all data and the 60's or over is about 10%. The result of 2012 shows the 10's and 20's is approximately 60%. The 60's or over is 2% and the lowest ratio. The 30's and 50's ratio of 2012 is higher than 2011. The reason is that an acquaintance family had cooperated. The 60's or over ratio of 2011 is higher than 2012. As the reason, the tour targeting the elderly (60's or over) was held in November 12, 2011.

The third item is Occupation. The results of 2011 and 2012 show the ratio of the student are the highest. And office worker have the second highest ratio. It may be said that the student is main occupation. The result is considered that the tour participants were mainly composed of family or friends.

The final item is Frequency of coming to Funabashi Campus of Nihon University. The results of 2011 and 2012 show First time is the biggest ratio. The people who visited Funabashi Campus for the first time were mainly students of other universities. The reason why this group is focused on is that it covers the first-time visitors of Funabashi Campus or beginners of Segway. In the result of 2011, the people who selected 10 times over were concerned of Nihon University.

Table 4. Characteristics of the people who replied the questionnaire

Characteristics		2011 (N=58)	2012 (N=48)
Gender	Male	<b>40</b> (69%)	<b>33</b> (69%)
	Female	<b>18</b> (31%)	<b>15</b> (31%)
Age	10's	<b>24</b> (41%)	<b>12</b> (25%)
	20's	<b>16</b> (27%)	<b>18</b> (37%)
	30's	<b>1</b> (2%)	<b>5</b> (10%)
	40's	<b>5</b> (9%)	<b>6</b> (13%)
	50's	<b>5</b> (9%)	<b>6</b> (13%)
	60's or over	<b>7</b> (12%)	<b>1</b> (2%)
Occupation	Office worker	<b>14</b> (24%)	<b>15</b> (31%)
	Student	<b>32</b> (55%)	<b>23</b> (48%)
	Homemaker	<b>6</b> (10%)	<b>6</b> (13%)
	Self-employed	<b>2</b> (4%)	<b>0</b> (0%)
	Other	<b>4</b> (7%)	<b>4</b> (8%)
Frequency	First time	<b>32</b> (55%)	<b>31</b> (65%)
	Once	<b>5</b> (9%)	<b>4</b> (8%)
	A few times	<b>7</b> (12%)	<b>7</b> (15%)
	5 times over	<b>3</b> (5%)	<b>2</b> (4%)
	10 times over	<b>11</b> (19%)	<b>4</b> (8%)

### 2.2.3 Contents of the assumed factors

Detailed questions to understand the factors for explaining the level of satisfaction of the tour are shown in Table 5. In this study, there are five factors that define the degree of satisfaction. They are: to enjoy the tour “Conversation factor,” to feel safe “Risk factor,” to experience participant fatigue “Burden factor,” to evaluate the content of the tour “Tour contents factor” and to represent the charm of the tour “Interest factor.”

Table 5. Contents of assumed factors

Factors	Question items
Conversation	Ease of conversation with the guide Ease of conversation with participants
Risk	Distance to pedestrians Distance to a vehicles Fears of slope The width of the passage Condition of the road surface
Burden	Distance of the tour Time of the tour Tiredness by the tour
Tour contents	Clarity of explanation of the guide Views of the campus Understanding of the facilities that have been described Recognition of the facility that was passed
Interest	Willing to rejoin the tour Attractiveness of undergraduate Attractiveness of campus

## 3. METHOD

### 3.1 Structural equation modeling

SEM was used because this method can incorporate the many variables in this study. The structure of consciousness is easily understood. This method is suitable for exploring the potential factors for explaining satisfaction. Two types of variables are used in this method: observed and latent variables.

The observed variables are data from the questionnaire. Latent variables are composed of multiple observed variables. Variables are connected by arrows called “paths.” Each arrow indicates a causal relationship between variables. If the absolute value of the path is greater, they have a stronger relationship. This value can be compared only within one model. If it represents a correlation between variables, it is indicated by a double-headed arrow. The validity of the model is determined from a plurality of the fit index.

As studies using covariance structural analysis, Hoshino et al. (2012) analyzed the factors that affect student satisfaction in university classes. It was revealed by students with a negative attitude that teaching is greatly influenced by the level of understanding of the lesson. The SEM can reveal the causal relationship between the factors. And Moriyama et al. (2005) have been used SEM to consider measures to improve the convenience and comfort of

transport services.

Therefore, it can be said that a reasonable analysis to understand the relationship between determinants and satisfaction. This analysis can reveal the factors that improve the satisfaction of Segway tour. So, we will be able to consider measures to improve the Segway rider's satisfaction.

### 3.2 The concept of built campus tour satisfaction

In this paper, based on the factors in Table 5, campus tour satisfaction was constructed of latent variables, which were five determinants, to define the overall satisfaction of the tour, and the observed variables were obtained by a questionnaire survey. Figure 3 shows the assumptions model used in this study.

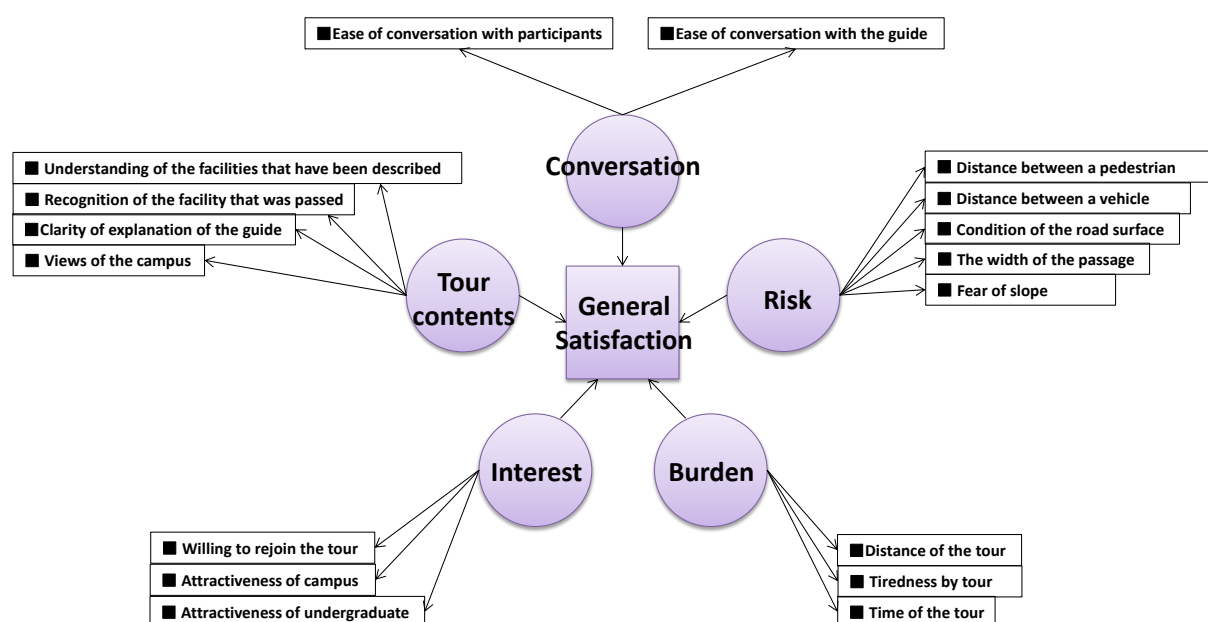


Figure 3. Assumption model of campus tour satisfaction

## 4. RESULTS

### 4.1 Result of basic aggregation

#### 4.1.1 Comparison of average scores of observed items (Segway and walking)

This section presents the results of comparing the average score of the Segway and walking. Table 6 shows the average scores of the Segway and walking. In the five items classified as risk, walking had the higher average score of all items. In the three items classified as rejoining, the Segway scored higher in the average score of all items.

A t-test was performed to reveal whether there is an average score for each item for a significant difference. The results are shown in Table 7. There was a significant difference in 12 items of the 18 items. In particular, "Willing to rejoin the tour" and "Fears of slope" was rejected at the 1% significance level on both sides. As for tour participants, the Segway engenders more "Fears of slope" than walking. But it is understood that the Segway was better for "Willing to rejoin the tour" than walking.

Table 6. Results of the Segway and walking average scores

Factors	Question items	Average Score		
		Segway	Walking	Gap (Segway- Walking)
Conversation	Ease of conversation with the guide	4.24	4.41	-0.17
	Ease of conversation with participants	3.84	3.88	-0.04
Risk	Distance to pedestrians	3.72	3.84	-0.12
	Distance to a vehicles	3.78	3.97	-0.19
	Fears of slope	3.59	4.14	-0.55
	The width of the passage	4.02	4.22	-0.2
	Condition of the road surface	3.36	3.53	-0.17
Burden	Distance of the tour	4.22	4.22	0
	Time of the tour	4.34	4.09	0.25
	Tiredness by the tour	3.67	3.88	-0.21
Tour contents	Clarity of explanation of the guide	4.28	4.14	0.14
	Views of the campus	4.26	4.34	-0.08
	Understanding of the facilities that have been described	4.02	4.10	-0.08
	Recognition of the facility that was passed	4.05	4.05	0
Interest	Willing to rejoin the tour	4.41	4.21	0.2
	Attractiveness of undergraduate	4.14	4.09	0.05
	Attractiveness of campus	4.19	4.05	0.14
General Satisfaction		4.57	4.43	0.14

Table 7. Results of the t-value between the Segway and walking average scores

Factors	Question items	t value	significance level
Conversation	Ease of conversation with the guide	0.006	**
	Ease of conversation with participants	0.568	
Risk	Distance to pedestrians	0.040	*
	Distance to a vehicles	0.266	
	Fears of slope	0.004	**
	The width of the passage	0.000	**
	Condition of the road surface	0.013	*
Burden	Distance of the tour	1.000	
	Time of the tour	0.001	**
	Tiredness by the tour	0.044	*
Tour contents	Clarity of explanation of the guide	0.017	*
	Views of the campus	0.024	*
	Understanding of the facilities that have been described	0.024	*
	Recognition of the facility that was passed	1.000	
Interest	Willing to rejoin the tour	0.000	**
	Attractiveness of undergraduate	0.004	**
	Attractiveness of campus	0.182	
General Satisfaction		0.020	*

\*: 5%

\*\*: 1%



#### 4.1.2 Comparison of average scores of observed items (changing the conditions for the Segway)

Table 8 shows the average scores of initial and rearranged tours. By doubling the ride distance and time in the Segway tour, the mean value was higher in 12 out of 18 items. “General satisfaction” rose by 0.1 point. Three items classified into burden, which was felt during each tour, had higher average points. It followed that the participants did not feel any burden at the time of movement. However, “conversation among participants” dropped by 0.6 point.

As a result of the t-test shown in table 9, a statistically significant difference was found only with respect to conversation among participants. It was considered that there was no significant difference in “General Satisfaction.”

Table 8. Results of the initial and rearranged tours average scores

Factors	Question items	Average Score		
		2012	2011	Gap (2012-2011)
Conversation	Ease of conversation with the guide	4.38	4.24	0.14
	Ease of conversation with participants	3.23	3.84	-0.61
Risk	Distance to pedestrians	3.71	3.72	-0.01
	Distance to a vehicles	3.69	3.78	-0.09
	Fears of slope	3.90	3.59	0.31
	The width of the passage	4.04	4.02	0.02
	Condition of the road surface	3.63	3.36	0.27
Burden	Distance of the tour	4.27	4.22	0.05
	Time of the tour	4.42	4.34	0.08
	Tiredness by the tour	3.38	3.67	-0.29
Tour contents	Clarity of explanation of the guide	4.46	4.28	0.18
	Views of the campus	4.40	4.26	0.14
	Understanding of the facilities that have been described	4.15	4.02	0.13
	Recognition of the facility that was passed	3.94	4.05	-0.11
Interest	Willing to rejoin the tour	4.38	4.41	-0.03
	Attractiveness of undergraduate	4.21	4.14	0.07
	Attractiveness of campus	4.10	4.19	-0.09
General Satisfaction		4.67	4.57	0.1

Table 9. Results of the t-value between the standard and rearranged tours average scores

Factors	Question items	t value	significance level
Conversation	Ease of conversation with the guide	0.377	**
	Ease of conversation with participants	0.007	
Risk	Distance to pedestrians	0.565	
	Distance to a vehicles	0.059	
	Fears of slope	0.419	
	The width of the passage	0.146	
	Condition of the road surface	0.242	
Burden	Distance of the tour	0.782	
	Time of the tour	0.613	
	Tiredness by the tour	0.472	
Tour contents	Clarity of explanation of the guide	0.234	
	Views of the campus	0.316	
	Understanding of the facilities that have been described	0.272	
	Recognition of the facility that was passed	0.399	
Interest	Willing to rejoin the tour	0.786	
	Attractiveness of undergraduate	0.620	
	Attractiveness of campus	0.563	
General Satisfaction		0.360	

\*: 5%

\*\*: 1%

#### 4.2 Comparison of breakdown of general satisfaction

Figure 4, the General satisfaction was broken down and compared. The ratio of participants who choose five points rose by 7% for the tour that had twice the ride distance and time, and the participants who chose two points disappeared. There was not a meaningful difference, but a tendency that general satisfaction improves is seen statistically.

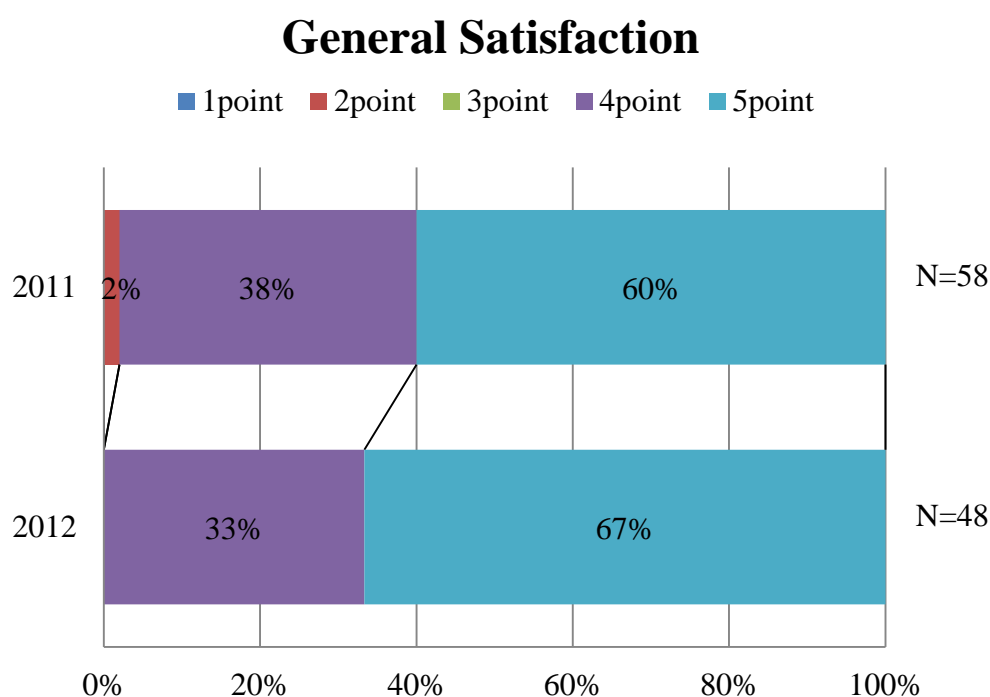


Figure 4. Comparison of general satisfaction breakdown

## 4.3 Result of SEM

### 4.3.1 Comparison between the Segway and walking

The structure of consciousness that present the relationship between general satisfaction and factors is shown in Figure 5 (the Segway and walking).

For the Segway, the Burden factor was 0.68. This value had the greatest impact on general satisfaction. The Talk factor was -0.17. Although this value had at most a small effect on general satisfaction, it was characteristic that conversation was not a factor to improve satisfaction for the persons who ride the Segway for the first time. There are two possible causes: participants were distracted by the unfamiliarity of operating the Segway, or the fact that a distance had to be kept between the Segways to ensure safety making it difficult to talk.

On foot, the Tour Constituent factor was 2.83. This value had the greatest impact on general satisfaction. The Burden factor was -1.51 and this had the greatest negative impact on general satisfaction. It was characteristic that the influence of these two potentiality variables was exceptional.

A comparison of the structure of consciousness of the Segway and walking reveals a difference in the influence that the potentiality variable Talk factor, Burden factor and Interest factor have on general satisfaction. The Talk factor has already been considered the cause for a negative influence on general satisfaction for the Segway. Therefore, the Burden factor and the Interest factor are considered here. The Burden factor and Interest factor have an equilateral influence on general satisfaction for the Segway. But, the Burden factor and the Interest factor have a negative influence on walking. It is considered that participants who travel on foot do not have an intention to rejoin the tour because the physical burden is larger than for the Segway.

All the parameters related to the General Satisfaction did not show the statistical significance. This result will be discussed in 4.3.3.

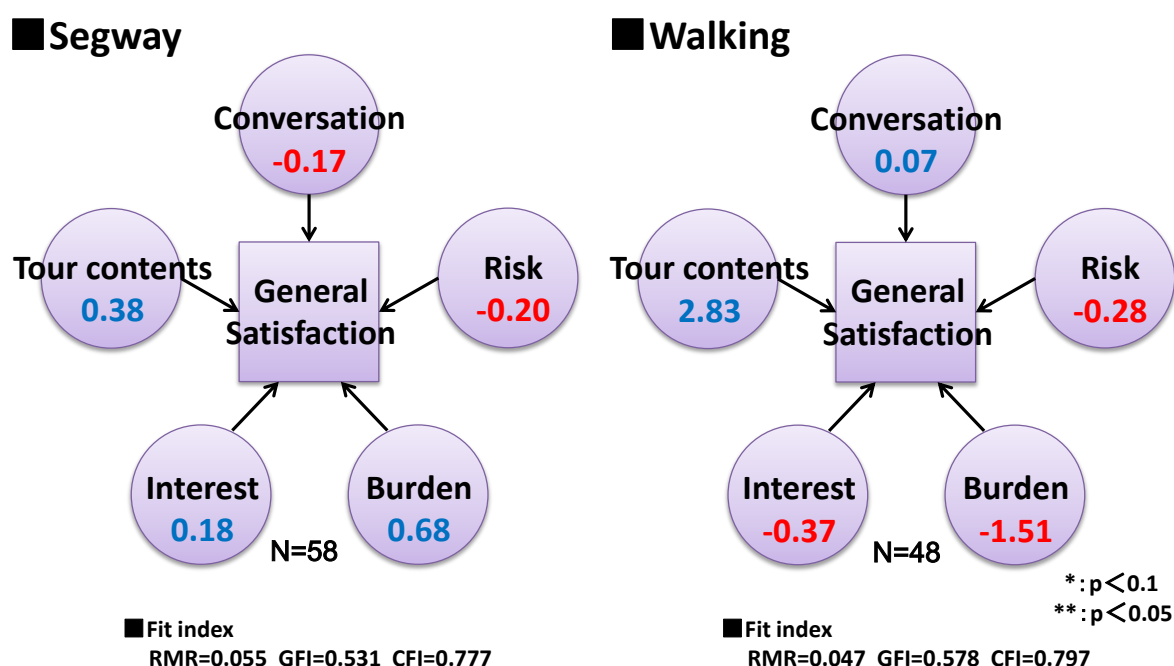


Figure 5. Result of SEM (comparison between the Segway and walking)

For the path in the model of Figure 6, it was analyzed whether there was a significant difference in the size of the path that corresponds to the Segway and walking. As a result, a t-test was performed on the size of the path, and it was found that there was a significant difference (5% rejection region) in the five paths between the Burden factor and the observed items, and the Constitutive factor tour and the observed items. The path is determined to be a significant difference, as shown in Figure 6. The description given by the guide was set as the reference line in the Tour Contents factor. Distance was set as the reference line in the Burden factor. The reference value was 1. From this result, the Segway is shown as reducing the burden on movement as opposed to walking, and that participants enjoyed traveling by Segway but were less interested in the tour itself was understood.

### ■ Comparison (Segway-Walk)

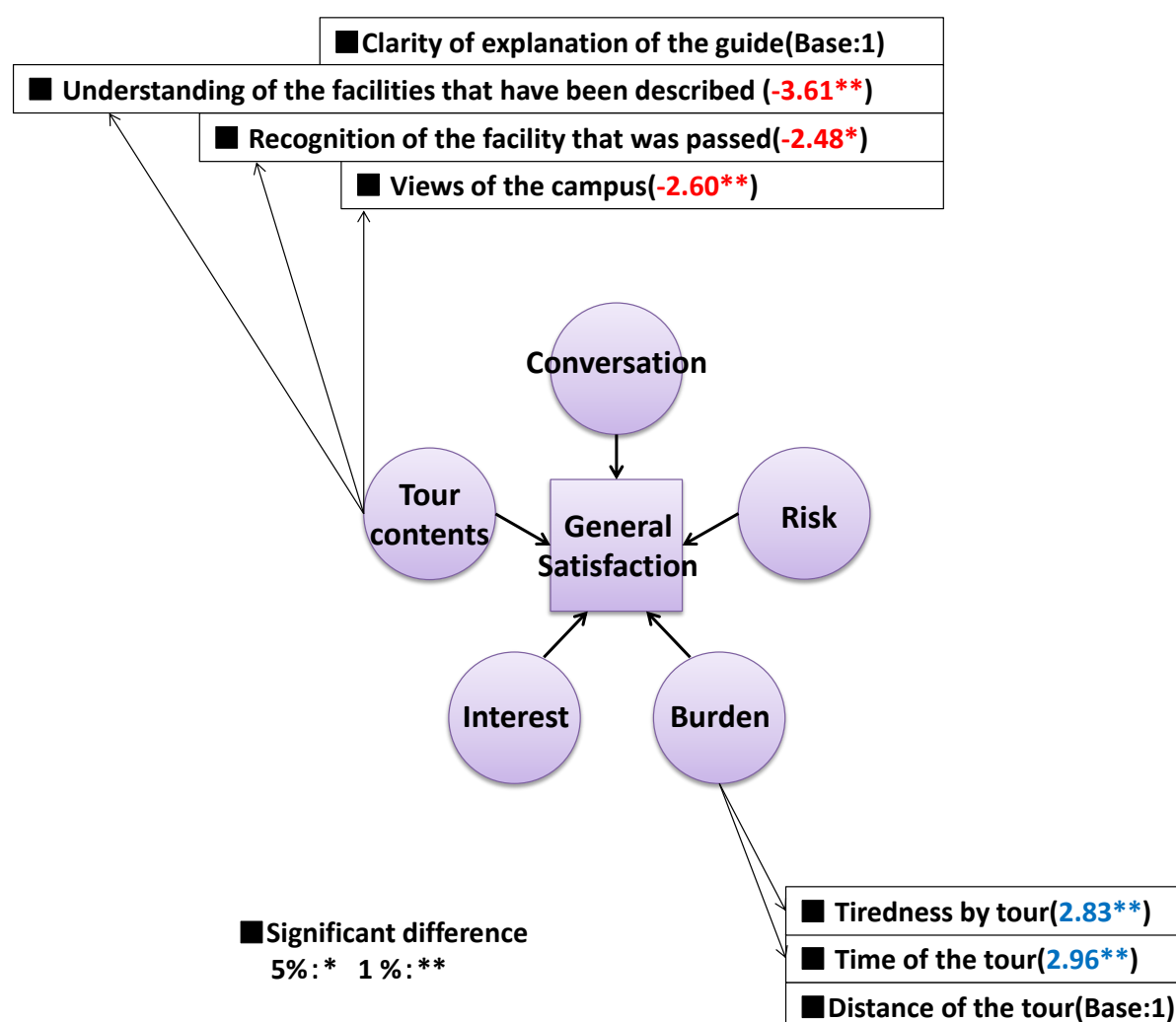


Figure 6. Result of SEM (the difference between the confidence coefficients of the path)

### 4.3.2 Comparison of changing the conditions for the Segway

Figure 7, by doubling the ride time and distance, the effect that defines five factors give a different general satisfaction. The Talk factor and the Risk factor have a positive impact on general satisfaction. It is thought that participants were able to enjoy talking and the sense of risk, because they got used to operating the Segway. But the Tour Contents factor has a negative impact on general satisfaction. It is thought that participants were not interested in the tour itself. The tour was conducted at a safe speed (about 10 km/h), which lasted for 40 minutes. So it is thought that for the participants, the tour had become boring.

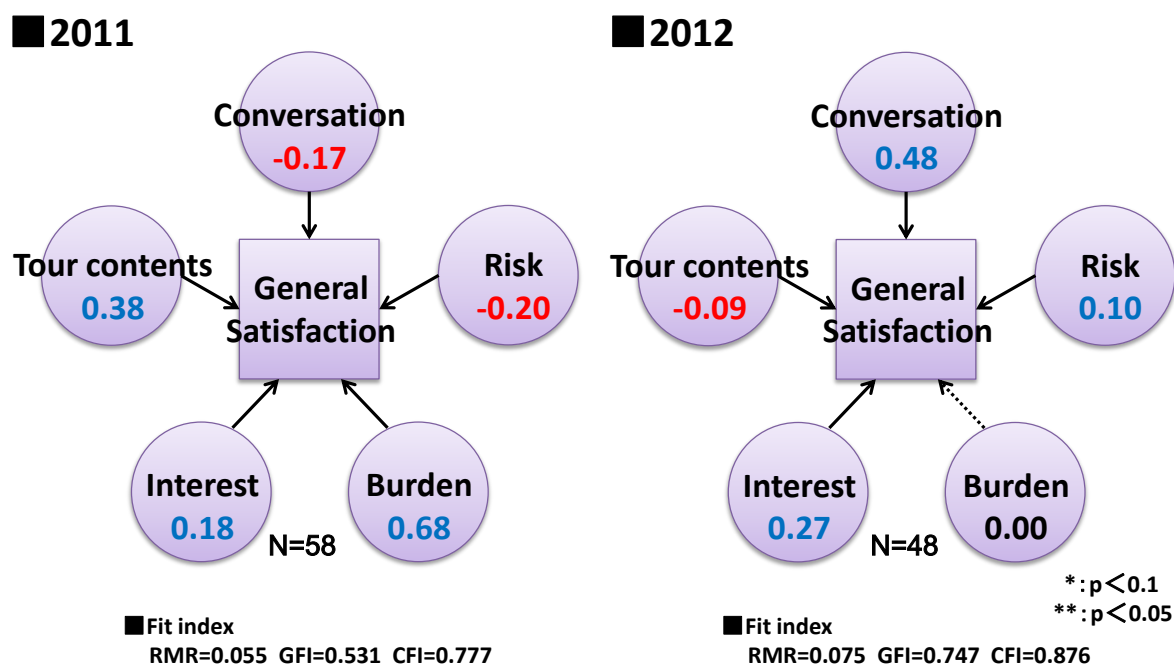


Figure 7. Result of SEM (comparison between last and this year tour)

### 4.3.3 About the statistical significance of the parameters

Three results of SEM (Segway in 2011, 2012 and Walking) show that all the parameters related to the General Satisfaction did not show statistical significance. But, the others indicate statistical significance. Figure 8 show the statistical significance of the parameters. Blue lines were statistically meaningful parameters and red lines were not statistically meaningful parameters. One of the assumed causes is shortage of the samples. The statistical results will need to be seen in much more participants before they can be considered as a valid conclusion.

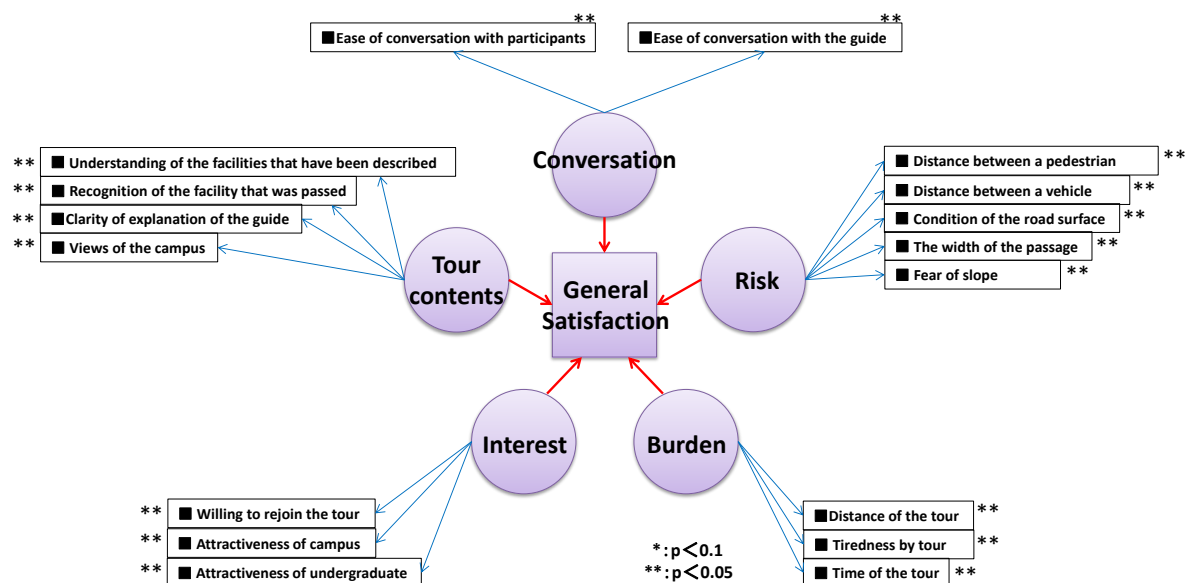


Figure 8. The statistical significance of the parameters

## 5. CONCLUSION

In this study, the structure of consciousness of Segway tours participants and the relationship between general satisfaction and determinants were revealed.

The Segway tour participants tended to lose interest in seeing the sights, compared with the walking tour. The Segway imposes less burden than walking, and burden had the largest positive impact on general satisfaction. Therefore, tours that were double the distance and twice the time were held. As a result, there was no significant difference in the average score of general satisfaction, but general satisfaction tended to improve. In addition, the difference in the impact of determinants that affect overall satisfaction was revealed. The Talk factor and the Risk factor were changed to a positive from a negative influence. The Tour Contents factor was changed to a negative from a positive influence.

As a future work, increasing the number of samples, and a statistically reliable fit index are called for. In addition, a financial factor will be included in the model.

At a general sightseeing spot, whether this satisfaction model is available will be considered.

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