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URBAN TRANSPORTATION SYSTEM IMPROVEMENT IN VIEW OF SUSTAINABILITY

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ABSTRACT

The increase of automobile traffic has always caused traffic congestion of downtown areas. This simultaneously generates environmental problem caused by automotive exhausts and an increase in traffic accidents. We should build a new comprehensive scheme of urban transportation based on the quality of life of the inhabitant to solve this problem. To thus end, we propose the phased evaluation system for finding an appropriate plan in terms of quality of life. Firstly, we introduce the method of Conjoint Analysis to build the basic planning concept. In the next stage we design the outline of a downtown transportation plan using the obtained concept. By demonstrating this to the inhabitants we examine its acceptability. Finally the improvement of transportation is analyzed by AHP (Analytic Hierarchy Process) and examined for the possibility of visiting in downtown area. Actually, we applied these methods to the transportation plan for Sapporo, which is located in Hokkaido, Japan. As a result, inhabitants assessed some sustainable transportation measures. The differences and the tendencies in each district are clarified by use of Conjoint Analysis. Consequently, the residents do not all have consistent opinions towards the attributes on the sustainable transportation scheme. However, they preferred the step improvement to the drastic one. Thus, we proposed the new basic plan which we would execute over the period of ten years. Next, we evaluated the acceptability of the inhabitants to the plan in view of quality of life. As a result, the proposed new plan possesses a higher acceptability. In particular, the residents accept the plan in terms of safety against traffic accidents. From this, we estimated that they would be a 34% increase in frequency for visits downtown after scheme is completed.

Keywords: instruction, full manuscripts, camera-ready, Microsoft Word format.

1 INTRODUCTION

In these years it has been popular to discuss a sustainable city or eco-city which is a city designed with consideration of environmental impact, inhabited by people devoting to minimization of required inputs of resources and outputs of waste and polluted loads. Specifically, this point is to create the smallest possible ecological footprint, and to produce the lowest quantity of pollution possible, to efficiently use land, to reduce use of the fossil fuels and so on. In most of Japanese major cities, the increase in automobile traffic has often caused traffic congestion in the downtown area. This simultaneously generates environmental problems due to automotive exhausts and an increase in traffic accident [1]. In order to make the city up as a sustainable city, it is necessary for us to improve the urban transportation system. Therefore, the measures that restrain a travel demand of automobiles have been introduced for sustainable schemes of transport plan [2]. Concretely, it is to control the automobiles which approach to the city center area. Moreover, the introduction the transit mall for the purpose of making the pedestrian space has been considered and is discussed as well.

For instance, Sapporo City, which is located in Hokkaido, the northern island of Japan, proposes the future vision of the transport that emphasizes pedestrian and environment in downtown area. These past years, the inhabitants have ardently requested for better travel demand management in the downtown area. Thus, the attractiveness of the whole city center area should be increased when involving new commercial facilities. However, it becomes indispensable that the understanding of citizens and involved parties are obtained, whenever measures are undertaken in the downtown area that will drastically change travel behaviors. Shopkeepers and parking lot managers are concerned by such measures. That is, it is important to introduce the method of public involvement to the transportation scheme. At the same time, we should discuss the appropriate method to grasp the needs of citizen for new measures [3].

The first purpose of this study is to develop the new method for sustainable schemes for urban transportation [4], [5]. The method is used for arranging the citizen needs and coordinating sustainable measures. The Conjoint Analysis is introduced as an evaluation method [6]. The second objective is to develop an evaluation method of sustainable factors for urban transportation planning. We apply AHP to evaluate the achievement of this objective in view of its attractiveness of each inhabitant.

2. METHODS AND ALGORITHMS

2.1 Procedure of Systematic Approach

In view of urban transportation planning, it is important to improve the traffic flow in the downtown area [7]. This is to reduce traffic congestion and increase efficiently. Therefore, we should promote comprehensive transportation system management.

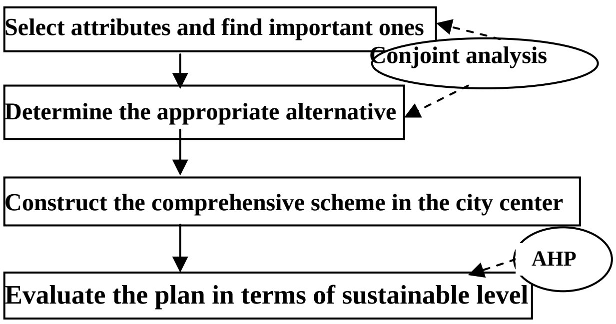

Figure 1 Analytical procedure of this study

First of all, we think of several attributes to make alternatives and then find the important ones in terms of Conjoint Analysis. Next we combine the appropriate alternatives. Then, based on the alternative plan, the comprehensive plan in the downtown area is proposed. Furthermore, we evaluate the comprehensive transportation system management in such a case. First of all, we discuss several attributes to make alternatives and find the important attributes in terms of Conjoint Analysis. Next we composed the appropriate alternative. And then, based on the alternative plan, the comprehensive plan in the downtown area is proposed. Furthermore, we evaluate that plan for sustainable level in view of its attractiveness to inhabitants. AHP is used for this evaluation. The procedure is represented in Figure 1. Although some methods examine the value like willingness to pay (WTP) as economical evaluation, the main aim is to discuss the appropriate plan in terms of the alternative evaluation here. Therefore, the method for evaluation of WTP was not adopted. Conjoint Analysis finds out the most appropriate solution combining a level with some factors. The appropriate combination of a level with each element is determined by the obtained solution. Then we consider the sustainability is proper for the local residents. AHP was adopted to evaluate the performance level in terms of the improved transportation planning. I other words, it was also introduced for indicating the comprehensive effects due to sustainable transportation planning.

2.2 Application of Conjoint Analysis

The conjoint analysis is one of the techniques by which the evaluated objects consisted of multiple factors and analyzed the multiple levels. It is a research technique used to predict people’s choices for future products and services. The Conjoint Analysis was created in 1960’s in the field of the psychometrics [8]. Afterwards, this technique was advanced in the marketing research field. Here, the alternatives handled in this study were composed of the multiple traffic measures. Each service level was also considered from various categories. The conjoint analysis is applied to planning fields, environment economics, etc. in these years. The analysis procedure is summarized in the following manner:

1) Evaluated Attributes: First of all, several attributes are introduced to determine the value of plans. Each attribute consists of several levels. The alternatives are a combination of the multiple transport measures to reduce traffic congestion. Each attribute is evaluated in terms of its utility value to inhabitants. The evaluated levels of each selected attribute are then categorized.

2) Comprise Profiles: The card called a profile is prepared and used. The profile is the lattice of the factors composed of a series of attributes. Each attribute value (partial value) is evaluated in terms of presenting this profile to the respondent, and asking the overall utility of the profile,.

3) Analyze the Obtained Data: Equation (1) represents an estimate of the overall utility.

$$\hat{r}_i = \hat{\beta}_0 + \sum_{j=1}^{p} \hat{u}_j(k_{ji}) \quad \text{(i=1,2,…,n)} \qquad (1)$$

Here, $\hat{u}_j(k_{ji})$ is an estimate of the partial utility of the level k_{ji} in the attribute j in the profile i. $\hat{\beta}_0$ is an estimate of the constant parameter β_0, and $\hat{r}_i$ is an estimate of the evaluation γ_i for the evaluation object (profile) and n is a total number of the profiles, and p is a total number of the attributes.

Moreover, importance score of attribute j for indicating the relative importance of each factor is shown in Equation (2). Here, RANGE is a difference between maximum and minimum of utility value of attribute j in Equation (3).

$$IMP_j = 100 \frac{RANGE_j}{\sum_{j=1}^{P} RANGE_j} \qquad (2)$$

$RANGE_j$ =[maximum of $u_j(k_{ji})$, minimum of $u_j(k_{ji})$] (3)

The remarkable advantage of Conjoint Analysis is in estimating how the value changes, when it rearranges the value element of alternative plan, and when it adds the new value element. Namely, it is not only to clarify in which part there is a problem within the whole plans but also to estimate the variation of when it measures the value by the decomposition of the whole plans at the moment. Some transport plans are considered as the alternatives in the city center. Based on the approach, the preference measure of the citizen was surveyed in terms of the Conjoint Analysis. The profile with whole concepts was presented to the respondents.

2.3 Application of AHP

We introduce AHP to quantitatively indicate the attractiveness of the downtown area. The general procedure is outlined below:

1) Compose the hierarchical figure by analyzing a problem.
2) Assess the importance of factors in each level and make a matrix. The interrelation is examined from an upper level to a lower level orderly with a pair comparison [9].
3) Compute the weight of factors and consistency index (CI) in each pair of matrix.

(Two kinds of pair comparisons)

i)A pair comparison in each level and ii) a pair comparison of alternatives in every evaluated factor shown .

(Calculation of weights)

i) geometry mean of each factor and ii) weight based on geometry mean formulated as Equation 4 and Equation 5.

$$A_i = \sqrt[n]{a_1 a_2 ......a_n} \qquad (4)$$

$$W_i = \frac{A_i}{\sum_{i=1}^{m} A_i} \qquad (5)$$

where a_n : surveyed importance of sample n, A_i : average importance of factor i in all respondents, W_i : weight of factor i.

(Consistency index CI) consistency index is formulated as Equation 6.

$$CI = \frac{\lambda_{\max} - m}{m-1} \qquad (6)$$

where $\lambda_{\max}$: maximum eigen value, m: number of factors.

4) Compound weights from the result of a pair comparison analysis and obtain the comprehensive weight of an alternative.

3. URBAN TRANSPORTATION PLANNING

3.1 Sustainable Transportation Planning

In many cases, the sustainable development at least in connection with transportation is argued that changes of travel behavior to minimize an impact of transportation on its environment. Here, the sustainable transportation planning mainly aims at high amenities for travelers in the area. Therefore, it has not considered a direct expense, direct administrative and maintenance expenses, etc. However, it includes some measures which can e carried out within expenditure of a supplier. The visitors or travelers also know such information beforehand and determine their thinking using it.

The changes here include encouraging travelers to change from single-occupant vehicles to shared car, transit or non-automobile measure of transportation. Moreover, those also include new vehicle technology such as the reduced fuel consumption and the use of alternative, non-petroleum-based resources. The concept of a specific sustainable development-oriented transportation planning is based on the following viewpoints:

1) The underlying basic idea involves neither a network analysis nor a traffic flow theory, but ecological or system theory.
2) The viewpoints of planning or investment adopt neither existent economical development nor correspondence with a sprawl but the traffic capacity corresponding to environment, redevelopment in the existing developed area, and the reduction of a single-occupant vehicle.
3) The governmental economical policy is to promote neither new development on new land nor economic policy focuses on productivity but reuse of infrastructure developed previously and economic policy integrated with an environmental policy.
4) The technical analysis is not to examine trip-making and system characteristics between origins and destinations and benefits defined in economic terms but consider the relationship among transportation, ecosystem, land use, economic development, and community social health. That is, it is grasp secondary and cumulative impacts.
5) The technical role is to promote not individual mobility but travel substitution and to consider the total life cycle to determine real costs, and more effective use of existing system.
6) As an economical issue, it is not to perform subsidies to transportation users but to consider societal cost pricing including environmental cost accounting and transportation priced value as utility.
7) Therefore, the types of strategies include maintenance of the existing system, traffic calming and urban design, integration of transportation and land use, travel demand management, and education mainly.

Here, the sustainable measures of transportation in a downtown area were composed of expansion of the road for pedestrians including a transit mall, expansion of tram route, introduction of a bicycle track, improvement of underground walk space, automobile regulation of main streets, automobile regulation of the road which intersects the main roads, etc. based on the concepts of sustainable development orientation.

3.2 Construction of Alternatives

(1) The Range of City Centre Area

The city center area in this study was defined as an area of approximately 1 km from north to the south and 1.1km from east to west in Sapporo City.

(2) Establishment of Alternatives

In this study, two main methods, namely, a continuous pedestrian space improvement and a transit mall in terms of extensively expanding the tram car system made the sustainable transport plan in the city center.

The specific attributes of the plan were the following five factors:

1) Traffic for Pedestrian: The introduction of an extension of pedestrian space in the Central Avenue Park known as Ohdori in order to have the synergistic effect with the extension of the tramcar line to the Station Avenue as shown in the next attribute. Ohdori is the main thoroughfare bisecting the city from east to west, and the Station Avenue correspondingly bisects from the north to the south.

2) Extension of the Tramcar (Light Rail Transit): The tramcar in the transit mall was considered and 2 levels of extension to "South 4 Jo from the Sapporo Station Square" and to "South 4 Jo from the Ohdori Avenue" was established. Simultaneously, an improvement of the spaces for handling of freight in the short time was carried out in order to reduce the affect on vehicles for business and physical distribution.

3) Cyclist Traffic: In the exiting state, bicycle travel in the city centre area is difficult. Therefore, bicycle users have much dissatisfaction. Thus, new roads exclusive to cyclists are constructed in order to improve cyclic traffic as one of the measures in city center area.

4) Underground Space Improvement: A measure is based on the large number of citizens who desire the improvement of pedestrian space in the underground of the Station Avenue (between Ohdori and South 4 street), the underground pedestrian space is also established as a kind of the alternatives. By improving the level ("underground opening" with "shopping mall (underground arcade) is laid") of underground space, the evaluation of the pedestrian measure in the aboveground seems to be different.

5) Regulation of the automobile traffic: The prohibition of all vehicle traffic due to the policy of a transit mall is compared with existing state (all vehicle traffic can passed). In addition, "the prohibition is released during the morning in weekday" "only the business vehicles are not

Table 1 Factor and level of the alternatives

Measure	Level				Place
Extension of pedestrian space	None	Ohdori Avenue			
Extension of tramcar line	None	Station Avenue	Station Avenue		
Cyclic exclusive area improvement	Existing Condition	Improvement			Station & Ohdori Avenues
Underground pedestrian space improvement	Only underground path	Underground shopping mall			Station Avenue
Regulation of automobile passage	Whole vehicles Navigable	Whole vehicles navigable in the morning of weekday	Commercial vehicles navigable in the morning of weekday	Whole vehicles unnavigable All day	Station Avenue
Regulation of automobile crossing	Existing Condition	Whole vehicles Crossable in the morning of weekday	Only commercial vehicles crossable in the morning of weekday	Prohibition of crossing	Station & Ohdori Avenues

physical distribution. Finally, the measure of "extension of the pedestrian space" is introduced in the Station Avenue with automobile regulation.

6) Regulation of automobile crossing: The prohibition of all vehicles crossing over the Station Avenue is compared with the existing state (all vehicle traffic can cross over). In addition, as same as the case of automobile passing, "the prohibition is released during the morning weekday" and "the only business vehicle is not prohibited during the morning weekday" is added and as an alternative for avoiding the interference to business and physical distribution. These are summarized as Table 1. The outline of traffic regulation is also represented in Figure 2.

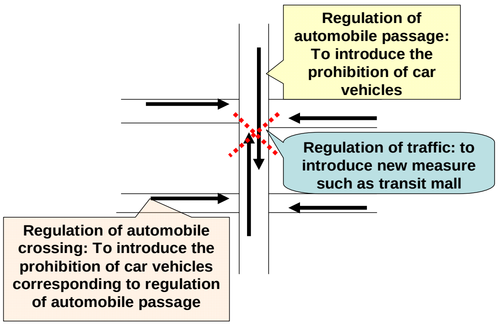

Figure 2 Conditions for regulation of traffic

3.3 Preparation of the Profiles

16 kinds of profiles were prepared in order to apply the Experimental Programming Method. It separately generates the holdout card except the above-mentioned profiles. Here, though the examinee is made to evaluate the holdout card, it is not using it as a profile for the calculation of the part utility value. This is also used in order to check the reliability of the estimate in comparison with the calculated value using estimated part utility value and the evaluated value of the examinee. The computation was executed by SPSS as a software package of statistics.

3.4 Results of Survey and Analysis

(1) Outline of Survey

The examinees were selected from some of the inhabitants in tree areas as the area along the North-South underground line and Fukuzumi district with underground terminal and East-Naebo district without underground system. The survey was made in terms of visiting for distribution, and then collecting by mail. The questionnaire recovered with distribution number of sheet is shown in Table 2.

The investigation contents include sex, ages, occupations, and distance from home to city centre as attributes of each examinee and score for gaining the evaluation of the profile.

(2) Attributes

The examinees' attributes in the each area are

Table 2 Number of respondents

	Number of distribution	Number of recovery	Ratio of recovery
District along the subway line	600	317	52.8%
Fukuzumi district	300	158	52.7%
East-Naebo district	300	132	44.0%
Total	1200	607	50.0%

observed. To begin with, in the case of the age, the share of respondents over 60-year-old generation in the subway side districts is as much as 48%. In Fukuzumi and East-Naebo, there was no bias in the extreme age so much. In the Districts along the North and South Subway Line and Fukuzumi the most of people used subway to go to city centre, while in the East-Naebo the most people used the bus up to there. This is because of the difference of the easiness to access to the subway station, as Fukuzumi has a subway station within its district. Also, in all the 3 districts the next transport measure is automobile and its share in the district along to the subway is 39.3%, Fukuzumi has 58.3%, and the East Naebo is occupied by 55%.

(3) Importance of each factor

Table 3 shows the importance of each attribute in each region. The attribute on the regulation of the automobile passing and crossing totally is more important than any other attributes. However, the same importance is not so high in Fukuzumi district, because the dependence for the automobile in Fukuzumi is lower than in the East Naebo.

Table 3 Importance of each factor

Factor of measures	District along the subway line	East-Naebo	Fikuzumi
Extension of Pedestrian space	4.83	15.76	23.46
Extension of tramcar line	21.25	15.94	16.9
Bicycle excusive space improvement	0.45	11.77	5.6
Underground pedestrian space improvement	22.98	0.35	12.82
Regulation of automobile passage	19.62	16.58	22.6
Regulation of automobile crossing	31.05	39.6	18.61

(4) Partial Utility of Each Attribute

Table 4 shows the obtained partial utility of each attribute in the target districts. The results are summarized as follows:

1) The respondents in every district viewed the extension of pedestrian space, the measure underground space improvement as high utilities.

Table 4 Partial utilities of transport measures in terms of Conjoint Analysis

Attribute	Level	Districts along Subway line	Fukuzumi	East-Naebo
Extension of pedestrian space	None	-0.371	-4.063	-2.851
	Ohdori Avenue	0.371	4.063	2.851
Extension of tramcar line	None	1.7308	-3.465	3.356
	Station Avenue (S)	-0.0484	1.075	-2.413
	Station Avenue (L)	-1.6764	2.390	-0.942
Cyclic exclusive area improvement	Existing condition	0.036	0.970	-2.130
	Improvement	-0.036	-0.970	2.130
Underground pedestrian space improvement	Only underground path	-1.839	-2.220	0.063
	Underground shopping mall	1.839	2.220	-0.063
Regulation of automobile passage	Whole vehicles navigable	-1.083	-3.141	4.688
	Navigable in the morning	0.109	4.688	-1.697
	Commercial vehicles navigable in the morning	2.067	-2.681	-1.928
	Whole vehicles restriction all day	-1.083	1.135	-0.447
Regulation of automobile crossing	Existing Condition	3.016	3.635	9.168
	Whole vehicles crossable in the morning	0.865	-2.813	-5.159
	Commercial vehicles crossable in the morning	-1.926	1.839	-1.601
	Prohibition of crossing	-1.955	-2.681	-2.409

However, they were opposition to the regulation of automobile crossing.

2) On the other hand, in the case of extension of tramcar line and cyclic exclusive area improvement, the respondents in each district have different opinions. They have more complex opinions towards regulation of automobile use in the supposed transit mall.

3) In view of the characteristics of districts, the differences between the district with better public transport and the district without it are remarkable. For example, in the case of regulation of automobile passing, the respondents in East-Naebo made much of the measure of vehicle passing but those in Fukuzumi respected the measure of conditional vehicle passing.

4) More complex opinions exist for the attribute utility; therefore it is important to discuss the measure of sustainable transport plan.

5) Now though the Sapporo Municipal Office proposes the extensions of underground path and tramlines as its long-term plan, citizen in the City cannot spotlight it at present. In particular, the inhabitants do not highly evaluate the extension of the tramline, as opposed to those with commercial interests in the city center. They also significantly resist the policy of automobile traffic regulation, even though they recognize the necessity of the control of the automobile traffic. Such a tendency is marked in the districts where the underground is not utilized easily.

6) There are some discussions on the measures and the levels. For example, two kinds were considered about extension of a tram line. Therefore, the attribute of a tram line extension is composed of two levels. Some respondents do not necessarily agree about large-scaled extension. This is because they had some problems on the increase in cost and demand. Moreover, the hierarchical level is also set up in traffic restriction. This attribute has four levels. However, in this case, since it is not a continuous hierarchy, a high level has not necessarily obtained high evaluation. By such reason, confusion was seen a little about each level.

(6) Evaluation of alternative plans

Here, five alternatives were arranged at the bottom, and the utility was obtained in respect of the measures in which the Sapporo City Authorities proposed as their new vision for the traffic in the city center.

The value of Case 5 was by the sum total of the estimated utility values the highest, because the case did not control automobile traffic in comparison with the other cases. Next, the value of Case 2 was evaluated as the second highest, and these two alternatives will be effective if the automobile is controlled.

3.5 Results of Main Plans for Transportation

In this study citizens assessed some sustainable transport measures. The difference and the tendency in each district were clarified by conjoint analysis. Consequently, the citizens do not have the same opinions towards the attributes on sustainable transport scheme. It is necessary to discuss and to coordinate the different point of view on the transport in the city center.

Table 5 The Alternatives for Evaluation of Total Utility

Case	Extension of pedestrian space	Extension of tramcar line	Cyclic exclusive area	Underground pedestrian space improvement	Regulation of automobile passage	Regulation of automobile crossing
1	Ohdori Avenue	Station Avenue	Existing	Only underground path	Whole vehicles unnavigable All day	Prohibition of crossing
2	Ohdori Avenue	Station Avenue	Existing	Only underground path	Whole vehicles crossable in the morning	Only commercial vehicles crossable in the morning of weekday
3	Ohdori Avenue	Station Avenue	Existing	Only underground path	Commercial vehicles crossable in the morning	Whole vehicles crossable in the morning of weekday
4	Ohdori Acenue	Station Avenue	Existing	Only underground path	Commercial vehicles crossable in the morning	Existing condition
5	Ohdori Avenue	Station Avenue	Existing	Only underground path	Existing condition	Existing condition

Table 6 Estimated Utility Values

	Case 1	Case 2	Case 3	Case4	Case5
District along underground line	55.510	58.678	61.469	59.521	60.480
East-Naebo	57.402	56.728	53.171	53.402	73.498
Fukuzumi	62.768	63.492	58.821	66.189	64.808
Average	58.560	59.633	57.820	57.248	66.282

Based on these results, we introduce the new measure of transportation planning as follows:

1) The basic ideas of improvement are comfortable pedestrian environment and smooth vehicle transportation. To realize such a system in the downtown area, the transportation functions are shared into traffic and access functions. The traffic functional roads provide the smooth vehicle run and the access functional roads give comfort to pedestrian as much as possible.

2) In particular, the spaces of pedestrians are extended and roads which lower the speed of vehicles to within 30km/hour are established simultaneously.

3) The continuous pedestrian space is constructed in Ohdori Avenue.

Figure 3 shows the provisional improvement plan of the streets in the downtown area after factors composed of the street function were evaluated and the appropriate plan was discussed. Using this plan, we indicate the degree of improvement on attractiveness in the downtown area.

3.6 Evaluation of Attractiveness Due to Transportation Improvement Plan

(1) Attractiveness as the quality of life

The citizens usually have different views in terms of *intimateness* with the downtown area. Thus the downtown area should sustain its attractiveness to the citizens continuously. As points of attractiveness have diversified recently, we should execute a comprehensive evaluation to promote not only urban planning but also the urban transportation scheme.

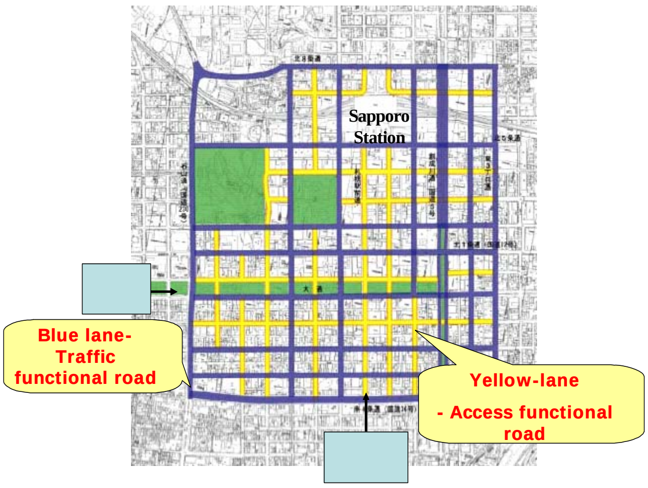

Figure 3 Improvement plans for streets in the downtown area of Sapporo

In this study we try to grasp the attractiveness of transportation in the downtown area with regard to the quality of life. First of all, we choose the points pertaining to the quality of life and make their hierarchy structure. Here, AHP was applied to evaluate the improvement measures of transportation by comparison with the existing case. As a result, we can understand the progress of attractiveness in the quality of life by implementation of transportation measures.

Table 7 represents the evaluation standards and their contents obtained due to brain storming in our laboratory. At the same time, the hierarchical structure was obtained as shown in Figure 4 [10].

Table 7 Evaluation standards and their contents

Evaluation standards	contents
convenience	Accessibility for downtown and smooth activity in the downtown
excitement	Gathering into the downtown and enough space for loitering
richness	High-grade commercial system and massive downtown
safety	Safe traffic system like separated pedestrian and vehicle roads

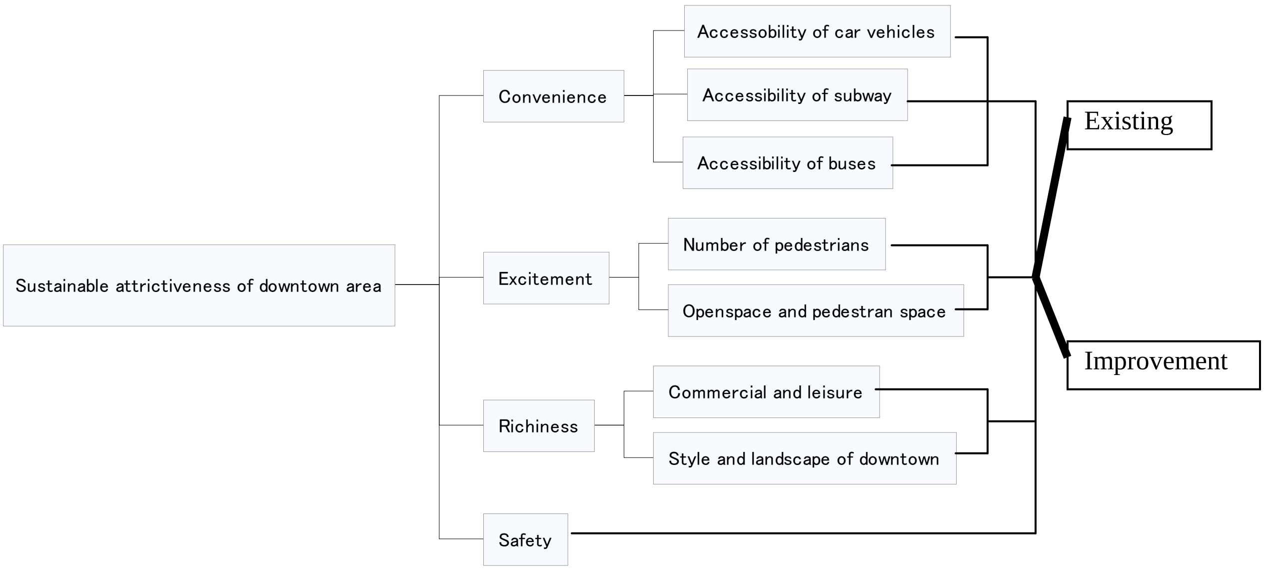

Figure 4 Hierarchical diagram of before or after improvement for AHP

We surveyed the increased attractiveness level due to the improvement of transportation and transportation behavior of inhabitants in the downtown area. The questionnaire sheets were distributed among 1,000 samples. 449 were returned and from them and the answers of 307 were effective to use for the method of AHP.

(3)Change of attractiveness in the downtown area before and after improvement

In Table 8, the increase in attractiveness in the case of implementation of the new measures compared with the existing case is shown. In particular, the standard of safety increased more remarkably than the other standards. The following standards such as number of pedestrians, style and landscape of downtown and accessibility of buses were more effective comparatively. Reversely, the accessibility of the subway was particularly increased due to the new measures. These evaluations reflect the expectations towards the improvement of transportation in downtown area.

Table 8 Change of the comprehensive standard and each sub standard

Evaluation	A .Existing	B. After	B/A
Accessibility of vehicles	0.022	0.047	2.152
Accessibility of subway	0.062	0.072	1.167
Accessibility of buses	0.015	0.043	2.808
Number of pedestrians	0.020	0.069	3.486
Open space and pedestrian space	0.012	0.028	2.359
Commercial and leisure	0.032	0.084	1.974
Style and landscape of downtown	0.026	0.084	3.277
Safety	0.028	0.318	11.357
Comprehensive evaluation value	0.274	0.728	2.657

As a future study, the simulation of traffic flow will be examined and the possibility of travel demand management using the transit mall measure will be confirmed quantitatively. Moreover some alternatives should be prepared based on the agreement of inhabitants.

In other words, it is indispensable to assess the needs and concerns of the inhabitants to the alternatives in order to compose an appropriately sustainable plan for the future.

Next, we constructed the model of traffic behavior in terms of the visit frequencies to the downtown area using the same surveyed data. Here it was supposed that the ratio of frequency after the improvement of transportation depends on the difference between the utility levels. Thus, we introduced the attractiveness of transportation in the downtown area as an explanatory variable. As a result, the evaluated values of the accessibility of vehicles, the accessibility of buses, open space and pedestrian space, style and landscape of downtown area and safety were introduced into the utility model of traffic behaviour. The explanatory variables were influenced by such factors as the bus lane, increased open space, the improvement of landscape and the separation system between pedestrian and vehicle. The results in Table 9 were calculated by the maximum likelihood method.

By applying the result of this table, we can estimate the increase in frequency of visits to the downtown area as in the following calculation:

Improvement/existing = $(199 + 101 \times 2)/300 = 1.34$ (7)

Equation (7) represents the ratio between the improvement and the existing of transportation system. We computed the estimates by using the changes in visiting frequency among respondents after the improvement of transportation. We found an increase of 34%, when the new measure would be introduced.

Explanatory variable	coefficient	T value	Ratio of fitness
X_1 : Accessibility of vehicle	a: 4.014	3.106	77.7%
X_2 : Accessibility of subway	b: 6.235	3.898	Rate of likelihood
X_3 : Open space and pedestrian space	c: 2.108	2.586	0.230
X_4 : Style and landscape of downtown area	d: 2.174	2.556	Number of samples
X_5 :Safety	e: 2.720	2.624	307
f : Constant	f: -3.080	-8.358	

Table 9 Model building for the utility due to the explanatory standards

Utility function

$$V_{after} - V_{before} = aX_1 + bX_2 + cX_3 + dX_4 + eX_5 + f$$

4. CONCLUDING REMARKS

First of all, inhabitants evaluated some sustainable transportation measures as a future policy of transportation. Moreover, the difference and the tendency in each district were revealed by means of conjoint analysis. Consequently, they do not have the same opinions towards the attributes on the sustainable transportation scheme. They seem to accept the substantial improvement measures of transportation. However, they preferred the step by step improvement over the drastic one. It is also necessary to discuss the specific plans on transportation system in terms of sustainability governance.

Thus, we proposed the new basic plan which we would execute for over a period of ten years. Next, we evaluated the acceptability to the inhabitants for the plan in view of attractiveness in quality of life. As a result, the proposed new plan possesses a high-grade acceptability. In particular, they accept the plan in terms of safety against traffic accidents. Using such ideas, we estimated the increase of frequency for visits to the downtown after the completed scheme.

In conclusion, it is effective to evaluate the quality of life in transportation schemes in a phased method combined with conjoint analysis and AHP. We propose the new methodology of sustainable urban transportation in terms of the application of such dialogue based approaches. It will be fundamental to promote the sustainability governance which can be considered as the whole stage for every level of organization and every level of stakeholder in making policy, plan and program on transportation.

As future subjects of the study, the simulation of traffic flow will be examined and the possibility of travel demand management using the transit mall measure will be confirmed quantitatively. Furthermore, the alternative should be prepared with the agreement of inhabitants.

It is indispensable to assess the needs and concerns of the inhabitants to the alternatives in order to compose an appropriately sustainable plan in the future. Here, the most appropriate alternative plan is extracted by not only the temporary travelers or visitors but also the periodic ones. In this case, the comprehensive evaluation was tried by using the sustainability indexes for the visitors if the alternative plan was carried out. A result here was to think the evaluation method due to the combination of these methodologies. It was also to establish the effective technique for building the transportation system in the downtown area corresponding to sustainability for future generations. Therefore, this is not to evaluate a mere planning but to form the large-scaled and flexible theory which includes such as a comprehensive discussion.

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