Comparative Study of Pedestrian Travel Culture in Different Cities in Japan

Hiroshi TSUKAGUCHI
Professor
Department of Civil Engineering
Ritsumeikan University
1-1-1 Noji-higashi, Kusatsu, Shiga
525-8577, Japan
Fax: +81-77-561-3418
E-mail: tsukaguc@se.ritumei.ac.jp

Upali VANDEBONA
Senior Lecturer
School of Civil and Environmental Engineering
University of New South Wales
Sydney 2052, Australia
E-mail: u.vandebona@unsw.edu.au

Kuang-Yih YEH
Professor
College of Planning and Design
National Cheng Kung University
No.1 Ta-Hsueh Road, Tainan 70101,Taiwan
E-mail: z7302005@email.ncku.edu.tw

Hao-Ching HSIA
PhD candidate
College of Planning and Design
National Cheng Kung University
No.1 Ta-Hsueh Road, Tainan 70101,Taiwan
E-mail: spacemake@yahoo.com.tw

Hun-Young JUNG
Professor
Department of Urban Engineering
Pusan National University
Jangjeon-dong, Keunjeong-gu, Pusan, Korea
E-mail: huyjung@pusan.ac.kr

Abstract: Attitudes and preferences toward walking in different urban areas have been investigated to understand differences among pedestrian travel culture. The study team distributed ten thousand questionnaires altogether in 10 cities and achieved a 23.5% average response rate. Analysis revealed attitude toward walking has a statistically significant difference among different age groups with relatively old age groups expressing positive responses. Car ownership of respondents did not contribute to a significant difference in attitudes although the public transport usage showed an impact. Preferences related to walking space also showed a significant difference between respondents who use and do not use public transport. Analysis also showed that citizens in large cities who use public transport consider pleasant walking environment in their route choice behavior even at the cost of making a detour. Walking behavior, particularly the pedestrian signal compliance at traffic signals, is found to be different between many city pairs considered in the analysis.

Key Words: *pedestrian travel culture, image of walking, Attitudes of pedestrians, EASTS IRG05.*

1. INTRODUCTION

Walking is an indispensable transport mode and walking as a means of mobility has been important since the beginning of the human history. In the modern day, importance of walking is recognized as societies strive to become sustainable and attempt to decrease stresses on the environment. Walking is also an integral part when creating seamless transport systems. Safe and user oriented pedestrian facilities play a key role in achieving these goals. This paper explores a framework that accounts for the outlook toward walking in a community and the particular sociological background to understand pedestrian travel behavior.

Traditionally pedestrian issues have been investigated from a mathematical and engineering point of view, largely to contribute to planning of pedestrian facilities. However, pedestrian traffic is a complex phenomenon that should be and could be approached from various fields of academic research. A useful contribution to this multidisciplinary nature of understanding the pedestrian activity was provided by Nagayama (1989) who investigated the difference of pedestrian attitudes and behavior in several Japanese cities from the psychological point of view. His work and other researchers who have looked at impacts of gender and ethnicity (for example, Seedat et al., 2006; Lawson and Edwards, 1991) have indicated the need to understand the cultural significance in the context of pedestrian safety. Similarly, the influence of the regional culture has been mentioned in the context of aesthetics of pedestrian facilities (Hughes, 1988).

Pedestrian traffic behavior is a composite outcome of infrastructure, individual characteristics and societal attributes. For example, awareness and attitude toward walking affect the lifestyle and outlook of people in a given area. Conversely, this particular mind-set has an effect on pedestrian behavior. Thus, understanding of pedestrian behavior is incomplete without an appreciation of the societal perspective. The challenge in this work is to include lifestyle elements in pedestrian facility planning without probing into personal life. It is the lifestyle related outlook that is referred to as the 'pedestrian travel culture' in this paper (a more complete definition is provided at the end of section 2.2). Groundwork for this approach was documented by Sugihara and Tsukaguchi (2005) as well as Hsia and Yeh (2006). Tsuakguchi et al. (2007), in follow up work, made initial observations about comparisons among selected Japanese and Taiwanese cities from the view point of pedestrian travel culture. The above study focused on development of a methodology to identify similarities and dissimilarities of attitudes and preferences of pedestrians, as a means of understanding the outlook toward walking in different localities. The study showed the usefulness of spider-web graphs for making comparisons among different communities.

There are two main benefits anticipated from the study of pedestrian travel culture. They are:

(1) A behaviorally meaningful manner of planning for pedestrian space and establishing suitable planning standards become possible when specific regional characteristics based on historical, cultural and lifestyle characteristics can be taken into consideration. This would reduce the need for a community to bow to fit and live with standardized trite planning. In the long-term, the community can develop a greater appreciation of their urban space when the built environment fits natural character of inhabitants.

(2) Planners and decision makers can set targets and priorities that are a close fit to the community they serve. Although they can use concepts handed down from national and international planning agencies, it is necessary to fine tune to local needs. On the other hand, planning agencies at higher levels of the hierarchy should provide adequate means and freedom to allow community level fine-tuning. Research is required to uncover the degree of specificity of the pedestrian culture so that appropriate protocols can be introduced to planning and engineering disciplines.

This paper provides a description of the pedestrian travel culture in the context of Japan by comparing 10 cities, as a part of a much larger international collaborative program to compare different countries in the region. The methodology followed will be explained in Section 3. The next section explains attributes considered in this paper in an attempt to quantify the pedestrian travel culture for the purpose of analysis presented later.

2. STUDY FRAME-WORK OF PEDESTRIAN TRAVEL CULTURE

The final goal of this study is to provide evidence of the existence of the concept of pedestrian travel culture and to propose the direction which applies to pedestrian planning. In order to achieve this goal, it is necessary to briefly explain key elements of the pedestrian travel culture and their inter-relationships. The research framework shown in Figure 1 is a simplified illustration of the connectivity among elements that contribute to the pedestrian travel culture. It is acknowledged that this diagram has been modified from the framework previously presented in Tsukaguchi et al., (2007). The upper portion of the Figure 1 indicates regional characteristics. The regional or system characteristics include infrastructure available and properties of the urban environment and citizens. Only a selected number of attributes are mentioned in the figure to ensure brevity.

Level of service of the urban system refers to the standard of the built environment. This includes service characteristics of street network operation, side walk system, bicycle paths, transit system and transport interchanges. Regional environmental properties cover climate, topographical features as well as marks left by human impact on the land. Attributes of local inhabitants include properties that explain the life style, the stage of life, demeanor, way of thinking, outlook toward society as well as traits acquired from history and culture.

The lower portion of the Figure 1 refers to the pedestrian characteristics, explained in the next section.

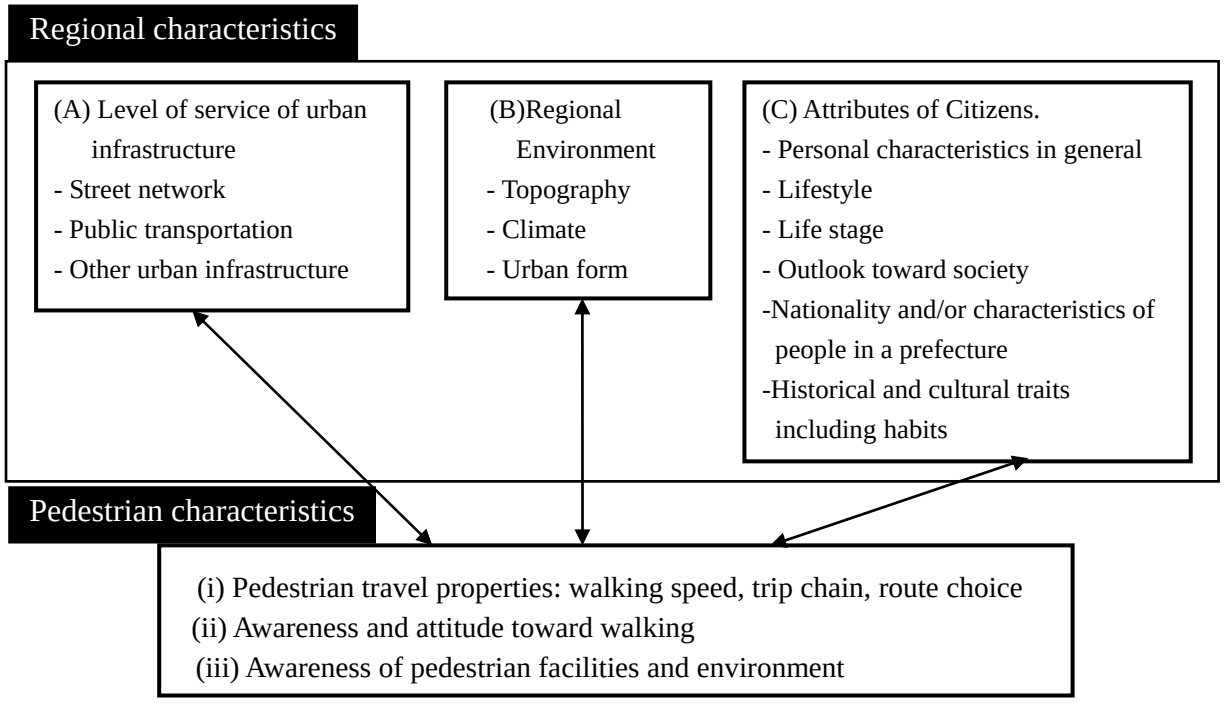


Figure 1 Study framework of pedestrian travel culture

2.1 Characteristics of pedestrian traffic / travel

Pedestrian characteristics cover three types of features in Figure 1. The first category covers physical properties considered in traditional traffic sciences. The second category covers emotional aspects of the person. The third category refers to the degree of acquaintance with the urban system.

More precisely, the pedestrian travel behavior discussed here includes; pedestrian speed, average walk trip distance, maximum feasible walking distance, route choice characteristics for walk trips, coefficients of the trip generation and modal split of pedestrian traffic, and observance of traffic rules related to pedestrians.

In this research project the consciousness and attitude toward walking is measured by asking members of the community their agreement or disagreement to a series of questions in a scale of 0 to 4 as explained later. The subjects were asked to respond to following 10 statements:
(a) I like walking.
(b) Walking is smart (clever).
(c) I am willing to walk for a short distance in daily life.
(d) I like to walk and stroll.
(e) I prefer a street with good scenery for walking.
(f) I prefer a street with good surroundings (neighborhood), even if a little detour is necessary.
(g) I prefer a street with some people, even if a little detour is necessary.
(h) I prefer the shortest route when the surroundings (neighborhood) are not pleasant.
(i) I walk faster than others.
(j) I usually cross a road during a red signal if there is no traffic.

In addition, awareness of pedestrian facilities and environment was measured by posing following questions. However, analysis of this part of the survey is not covered in this paper.
1) Perceived level of service of transportation system, including that of public transportation,
2) Perceived and actual distance to the nearest railway station and bus stop and a sense of distance,
3) Description of perceived street environment on the way to railway station or bus stop,
4) Acceptable walking distance to the railway station and bus stop when street environment is good.

The subjects were asked to rate the statements using five levels (0 to 4). Complete agreement with the statement was indicated by a value of 4.0, while strong disagreement with the statement was indicated by a value of 0.0. Statements that received a response greater than 2.0 were considered to be positive.

2.2 Relationship between pedestrian travel characteristics and regional characteristics

In order to clarify pedestrian travel characteristics in an area, it is useful to explore the relationship between pedestrian travel characteristics and the regional characteristics shown in the upper section of Figure 1. As mentioned earlier, regional characteristics are constituted of (A) Conditions of the urban infrastructure and level of service of the transportation system, (B) Regional environment, and (C) Attributes of citizens.

The relationship between these regional characteristics and pedestrian characteristics described earlier can be used to develop a classification scheme to explain the influence of external factors on formation of pedestrian characteristics as shown in Figure 2. This figure retains most of the structural shape previously seen in Figure 1, although our intention here is to classify pedestrian characteristics. Pedestrian characteristics can be classified according to the contribution from the regional elements. In this scheme, we can define Type A pedestrian characteristics as those with most influence from built system properties, Type B as characteristics with influence from the environment and Type C as characteristics with the greatest influence from fellow citizens. For completeness, we may define a Type D that does

not belong to any of the above categories. Different analyses may be necessary to model these relationships.

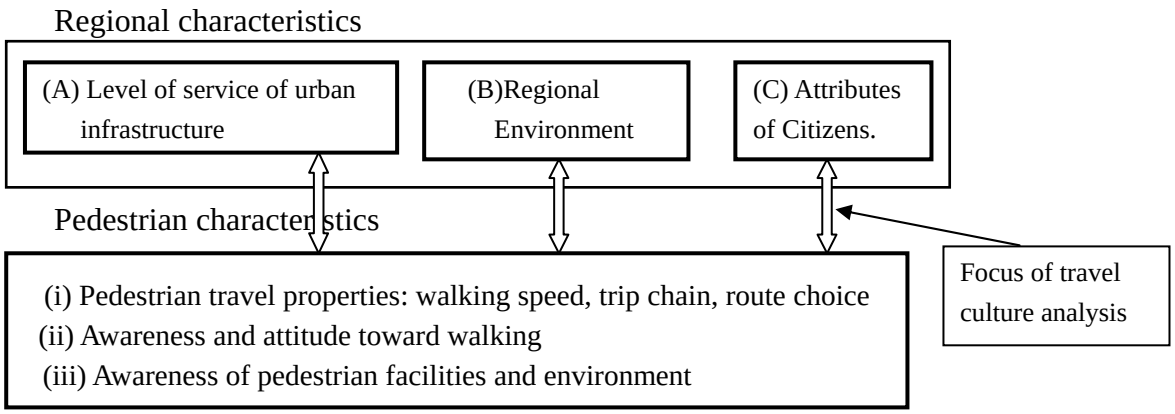


Figure 2 Classification of pedestrian characteristics

As level of service of urban infrastructure and regional environment have strong contribution to pedestrian travel behavior, the types of (A) and (B) pedestrian characteristics are expected to be a significant proportion. For example, the influence of level of service of transportation facilities on pedestrian characteristics has been the subject many conventional research projects. Such works have made useful scientific contribution to the field of pedestrian planning. Anyhow, the analysis related to type (C) pedestrian characteristics may uncover more interesting issues because there is a wide range of unknown factors and possible quantification difficulties. This paper wants to pay particular attention to the relationships centered around historical and cultural traits. This is anticipated to require an investigation of the role of habits, life style, way of thinking, and outlook toward society. Conventional studies on pedestrian travel do not deal with such seemingly 'soft' relationships, but this viewpoint is important to create 'pedestrian centric' environment in downtown areas and residential neighborhoods.

We have defined the pedestrian travel culture as a composite of all of regional and pedestrian characteristics. The pedestrian travel culture is a result of relationships among these features. Impacts from regional characteristics to pedestrian characteristics, and also from pedestrian characteristics to regional characteristics (two-way relationships) form the core of the pedestrian travel culture.

3. DATA COLLECTION METHODOLOGY

Two different data collection techniques were applied during this project. A questionnaire survey was conducted to explore attitudes and pedestrian space preferences. An observational survey was conducted to obtain supplementary data to quantify pedestrian behavior.

The questionnaire survey focused on the image respondents have about walking. As mentioned earlier in section 2.1, ten questions were prepared in relation to walking trips in the daily life of respondents. The mail-back questionnaire survey was completed in December 2004 by residents of 10 cities in Japan.

The cities selected for the study are shown on the map in Figure 3. They belonged to three categories according to the size of population.

Group A: Cities with more than 1.5 million of population. There were three cities (Tokyo, Osaka and Kyoto) located in the extensive Pacific coast megalopolis, considered in this project for this category.

Group B: Cities with population between 1 to 1.5 million. Three cities (Sapporo, Fukuoka and Hiroshima) located in regional metropolitan hubs were selected for this categories.

Group C: Cities with population between 0.3 to 1 million. Four cities were selected in this low population category. These cities were: Sendai, Kanazawa, Matsuyama and Nagano.

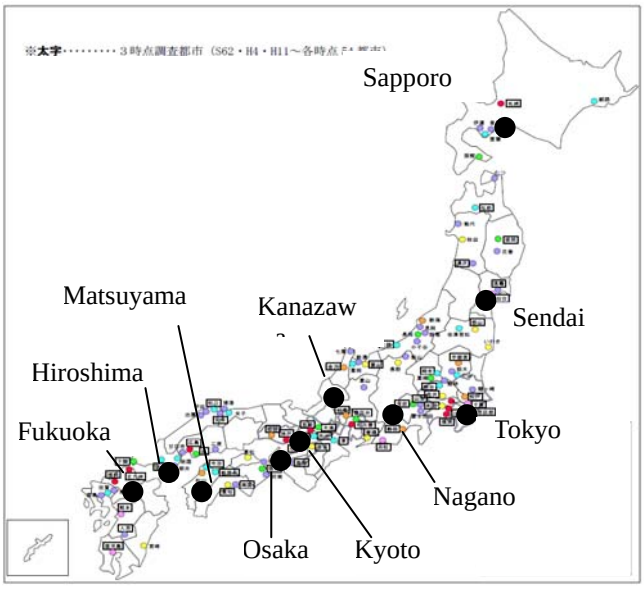


Figure 3 Location of cities surveyed

Figure 3 shows that the selected cities are spread out on the map of Japan. The questionnaire was mailed to 1000 randomly selected citizens in each city irrespective of the city size (see Table 1). The response rate spread from the lowest of 19.4% (in Kanazawa, a type C, i.e. a small city) to the highest 27.5 (in Fukuoka, a type B, i.e. a medium size city). The overall response rate was 24%.

Table 1 Number of questionnaires distributed and returned in each city

	Distributed	Responded
Sapporo	1000	237
Sendai	1000	241
Tokyo	1000	240
Nagano	1000	259
Kanazawa	1000	194
Kyoto	1000	243
Osaka	1000	222
Hiroshima	1000	216
Matsuyama	1000	242
Fukuoka	1000	275
Total	10000	2369

The breakdown of respondents according to gender showed that percentages of males and females were 54% and 46%, respectively. The age composition was tabulated at intervals of 20 years and showed that the percentages of below 20, between 20 and 40, between 40 and

60, and older than 60 were 3.0%, 10%, 37%, 50 % respectively.

Five cities were selected for the observational field study. All three Group A cities (Tokyo, Osaka, and Kyoto) were selected. One city each was selected from Group B (Fukuoka) and Group C (Matsuyama) cities. Pedestrian observation field surveys were carried out in Kyoto, Osaka, Fukuoka and Tokyo during winter months from December 2004 to January 2005. The observation survey at Matsuyama was conducted in December 2007.

The survey addressed two aspects: (a) walking speeds during different times of the day and (b) compliance of pedestrian traffic signals. The walking speed was classified according to gender of pedestrian as well as whether the pedestrian is walking alone or in a group. The observers recorded travel time taken between predetermined marker points from video recordings of the pedestrian activity. Table 2 shows that the number of subjects in this survey varied from 196 in Osaka to 540 in Fukuoka. Observation survey results will be discussed in Section 5.

Pedestrian traffic signal compliance survey was carried out for 50 signal cycles (see Table 2) at a selected signalized intersection in each city, except Tokyo, where this survey was carried out at two such locations. The locations selected had clearly marked zebra crossings for pedestrian use. Cycle length of signals at these sites ranged from 110 to 180 seconds. The pedestrian signal has three phases, Green, Flashing Green and Red. For the purpose of this survey any pedestrian who commenced the crossing activity during a Pedestrian Red signal was considered non-compliant and all others were considered compliant. Results of this survey will be presented in section 5.2.

Table 2 Sample size of observation surveys

	Number of subjects in walking speed survey	Number of signal cycles in compliance survey
Tokyo	493	50
Osaka	196	50
Kyoto	387	50
Fukuoka	540	50
Matsuyama	200	50

4. DIFFERENCES OF AWARENESS AND ATTITUDE TOWARD WALKING

In this section we focus on the particular pedestrian characteristic "awareness and attitude toward walking" earlier discussed using Figure 1 in Section 2.1. Section 2.1 also introduced ten statements incorporated to the survey tool. These statements can be classified into three categories. Statements (a) through (d) represent the general attitude toward walking, statements (e) through (h) relate to characteristics of preferred routes for walking, and the statements (i) and (j) relate to the personal reflection of walking behavior. The aim here is to analyze the relationship between these pedestrian characteristics and demographic attributes of citizens such as gender and age.

4.1 Statistical method

In addition to estimation of mean scores for responses and visual comparison of graphical presentations, the nonparametric variance analysis using Kruskal-Wallis test has been applied to inspect the statistical significance of differences between attributes of citizens and cities from the view point of the above statements. If equation (1) given below holds, a significant

difference exists between the responses (Siegel and Castellan, 1988).

$$H(\chi^2) = \frac{h}{1 - \sum_{j=1}^{m} \frac{Tj}{\left(N^3 - N\right)}} \geq \chi^2_{a-1}(\alpha) \qquad (1)$$

where

$$h = \frac{12}{N(N+1)} \sum_{i=1}^{k} \frac{R_i^2}{n_i} - 3(N+1) \ ,$$

$T_j = t_j^3 - t_j$,

n_i : number of respondents with a particular attribute i ,

m : number of attributes in the analysis,

N : total number of respondents,

R_i : sum of the ordered data for each attribute i,

t_j : number of samples in the same rank order j, and

α : level of significance.

When a difference was identified, the level of significance for the particular pair of citizen attributes or the pair of cities was identified using the Bonferroni method (Siegel and Castellan, 1988). in which the following estimator was computed.

$$Z = \frac{\left(U - \frac{n_1 n_2}{2}\right)}{\sqrt{\frac{n_1 n_2}{N(N-1)}\left(\frac{N^3 - N}{12} - \sum_i T_i\right)}} \qquad T_i = \frac{t^3 - t}{12}$$

where

U: Mann-Whitney's U parameter,

n1, n2: sample size of the pair of groups

4.2 General attitudes toward walking

General attitudes toward walking observed through statements (a) through (d), are examined using the above method to find out whether there are differences that can be associated with citizen attributes or attributes of city or type of city where the respondents live. Table 3 shows results of the non-parametric variance analysis for statements (a) to (d). When there is a statistical difference between scores, the higher score sample group is reported first and the lower score sample is stated second (with a greater than sign separating them) in this tabulation. For example, for statement (a), only the last attribute (public transport usage) showed a statistically significant difference. The last row states 'User > non-user' indicating that those who use public transport (at least once a month) reported a statistically significant higher score than others.

Results presented in Table 3 indicate that there is no impact from gender on the scores given by the respondents. On the other hand, the age group the respondent belongs to makes a significant difference in attitudes toward walking according to three of the statements evaluated. The older age groups express relatively more positive attitude toward walking. Also, variables reflecting transport usage show some interesting results. For example, car ownership has no effect on attitude toward walking. But the public transport usage has an impact. Respondents who use public transport at least once a month have a positive attitude toward walking compared to others.

The results are unclear about whether the size of the metropolitan region affects the attitude about walking, but responses to one statement shows there seems be a tendency that citizens in larger cities have a higher degree of positive thinking about walking.

A two dimensional variance analysis was done to verify interactions between citizen attributes and cities. There is no interaction, statistically meaningful, between them other than one exception. Regarding the statement (d), there is a significant interaction between cities and usage of public transport. Citizens in larger cities who use public transport more than once a month prefer a more leisurely type of walk.

Table 3 General attitude toward walking

	(a) I like walking	(b) Walking is smart	(c) Willing to walk a short distance daily	(d) I like a leisurely walk
Between cities	None	Tokyo > Matsuyama Tokyo > Sapporo Tokyo > Osaka	None	None
Between city size	None	None	Pop 1-1.5 mil > pop below 1 mil	None
Sex	None	None	None	None
Age	None	20~40 > below 20 40~60 > below 20 Above 60 > below 20*	40~60 > below 20 Above 60 > below 20 Above 60 > 20~40	Above 60 > 20~40*
Car ownership	None	None	None	None
Public transport usage	User > non user	None	User – non user	User – non user

Note * = difference significant at 5%. All others 1% significance.

4.3 Preferred character of routes for walking

Statements (e) through (h) mentioned in section 2.1 represent preferences taken into account in route choice. The size of the metropolitan area has more occurrences of significant differences (see Table 4) with these preference statements than with the attitude statements discussed in the previous section. Relative ranking of the three groups of cities shows more positive responses for this statement from citizens in larger metropolitan areas. Similarly, gender plays a more prominent role with preference statements than with the attitude statements discussed in the previous section. For example, more males prefer the shortest route than females. On the other hand, females find good scenery and good surroundings important for their walking routes, even when some detour may be necessary.

Age group has an impact according to certain statements considered in this survey. For example, elder age groups have a stronger preference for streets with good surroundings, even when that route is not the shortest. The statement concerning the route distance shows younger groups have a stronger preference for the shortest route than other age groups. In some sense this finding is not intuitive when one considers younger age groups are physically strong in general and able to better cope with distance than older groups. However, the potential larger time budget available to older groups may explain the observed preference.

Even once a month usage of public transport affects preferences taken into account in route

choice, whereas this attribute did not play a major role earlier with attitudes toward walking. Car ownership provided significantly different results with only one preference statement, car owners showing a greater dislike to walk on crowded pedestrian facilities.

Table 4 Preferences related to route choice

	(e) Prefer good scenery en-route	(f) Prefer good neighborhood en-route	(g)Prefer busy routes	(h) Prefer shortest route
Between cities	Osaka > Matsuyama	Tokyo > Kyoto	Tokyo > Matsuyama Osaka > Matsuyama Fukuoka> Matsuyama	Kyoto > Osaka
Between city size	Pop above 1.5 mil > pop 1-1.5 mil Pop 1-1.5 mil > pop below 1 mil	None	Pop above 1 mil > pop below 1 mil	None
Sex	None	Female>male	Female>male	Male>female
Age	None	Above 60 > below 20 Above 60 > 20-40 Above 60 > 40-60 40~60 > 20-40 40~60 > below 20*	None	Below 20 > above 60 20-40 > above 60 Below 20 > 40~60 20-40 > 40-60 Below 20 > 20~40*
Car ownership	None	None	Non owner > owner	None
Public transport usage	User > non user	User > non user	User > non user	None

Note * = difference significant at 5%. All others 1% significance.

4.4 Personal reflections about walking behavior

The walking behavior attributes considered in the survey are walking speed and pedestrian signal compliance. Table 5 shows comparison of results obtained from analysis of personal reflections of walking behavior of respondents. Analysis of the statement (i) related to walking speed shows there is significant difference with gender and age. However, there is no significant difference observed between city pairs. Males and younger age groups have evaluated them as faster walkers more often than females and older persons. All six attributes

Table 5 Personal reflections on walking behavior

	(i) Fast walker	(j) Regular signal violator
Between cities	None	Osaka > Kanazawa, Osaka > Matsuyama Osaka > Nagano, Osaka > Sendai Osaka > Fukuoka, Osaka > Hiroshima Osaka > Sapporo, Tokyo > Matsuyama Tokyo > Sendai, Tokyo > Nagano Kyoto > Matsuyama, Kyoto > Sendai
Between city size	None	Pop above 1.5 mil > pop 1-1.5 mil Pop above 1.5 mil > pop below 1 mil
Sex	Male > female	Male > female
Age	20-40 > above 60 40~60 > above 60	20~40 > below 20 40~60 > below 20 Above 60 > below 20*
Car ownership	Owner > non owner	Owner > non owner
Public transport usage	None	User > non user

considered in this analysis showed differences of statistical significance for the statement that

related to signal observance. Respondents in larger cities such as Osaka and Tokyo have stated their tendency to cross a road during a red signal for pedestrians when there is no traffic.

5 OBSERVED PEDESTRIAN TRAVEL BEHAVIOUR

5.1 Walking speed

As mentioned in section 3, walking speed for pedestrians were obtained from observation surveys as well, for 5 selected cities. The observers selected pedestrians randomly and recorded the walking speed according to a time of day classification and pedestrian type classification. Data were collected for four time of day periods, namely, morning (8:00 am to 10:00am), lunch time (12:00 am to 14:00 pm), afternoon (14:00 am to 16:00 pm) and evening (17:00 pm to 19:00 pm, typically when people return home). Observers categorized pedestrians to three types, namely “walking alone, male” “walking alone, female” and “walking in group”. Cross-tabulation of sample sizes in each category is shown in Table 6.

Average speeds and variances were computed for the 60 cross-classifications (i.e. number of cells in Table 6). Table 7 shows results of a conventional variance analysis performed to compare average speeds for the 20 city pairs for the 12 time of day and type of pedestrian cross-classifications. There is a statistically significant difference between certain pairs of cities in all twelve cross-classifications. In this tabulation, the first city mentioned in a pairing has a mean walking speed larger than that of the second city. The percentage values shown in Table 7 are the level of significance (null hypothesis being the mean values compared are the same). Generally speaking, significant differences exist between large cities (referred to as group A cities in section 3, cities with more than 1.5 million population) and medium sized

Table 6 Sample size of walking speed survey

		Walking alone, male	Walking alone, female	Walking together
Tokyo	morning	53	32	15
	lunch time	26	12	59
	afternoon	94	47	59
	evening	40	34	22
	total	213	125	155
Osaka	morning	22	19	9
	lunch time	18	7	5
	afternoon	29	18	19
	evening	31	17	2
	total	100	61	35
Kyoto	morning	29	17	4
	lunch time	36	40	22
	afternoon	67	65	57
	evening	36	12	2
	total	168	134	85
Fukuoka	morning	85	53	12
	lunch time	38	37	15
	afternoon	30	33	87
	evening	59	51	40
	total	212	174	154
Matsuyama	morning	24	23	3
	lunch time	26	20	4
	afternoon	18	21	11
	evening	24	21	5
	total	92	85	23

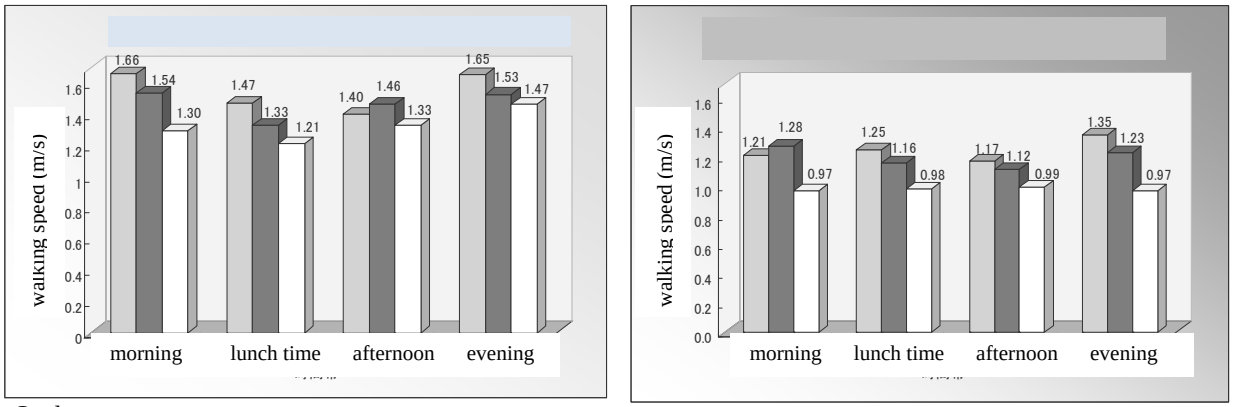
ones (previously referred to as group B, cities with 1 to 1.5 million population) as well as

large cities and small cities (i.e. cities with less than 1 million population, previously referred to as group C cities). The average walking speed at a given time of a day in Osaka, regardless of gender, was the highest average speed for cross classifications among all five cities considered in this survey.

Table 7 Significance test for walking speed

	Walking alone, male	Walking alone, female	Walking together
morning	1% Osaka > Matsuyama, Tokyo > Matsuyama Kyoto > Matsuyama, Osaka > Tokyo Osaka > Fukuoka, Tokyo > Fukuoka Kyoto > Fukuoka	1% Osaka > Matsuyama Osaka > Tokyo Osaka > Fukuoka Tokyo > Fukuoka Kyoto > Fukuoka	1%
lunch time	1% Osaka > Matsuyama Osaka > Tokyo Osaka > Fukuoka Osaka-Kyoto	1% Kyoto > Fukuoka	5% Osaka > Matsuyama Osaka > Fukuoka
afternoon	1% Osaka > Matsuyama Fukuoka > Matsuyama Osaka > Kyoto	1% Osaka > Matsuyama Tokyo > Matsuyama Osaka > Kyoto Tokyo > Kyoto	1% Osaka > Matsuyama Tokyo > Matsuyama Osaka > Kyoto, Tokyo > Fukuoka Tokyo > Kyoto, Kyoto-Fukuoka
evening	1% Osaka > Matsuyama, Osaka > Tokyo Osaka > Fukuoka, Osaka > Kyoto Tokyo > Fukuoka, Kyoto > Fukuoka	1% Osaka > Matsuyama Osaka > Tokyo Osaka > Fukuoka	1% Osaka > Matsuyama Osaka > Fukuoka

In Table 7, the city pair Osaka and Matsuyama showed significant speed differences in a large percentage of cross-classifications. In order to save space, speed profiles for only these two cities are shown in Figure 4. The walking speeds are given in m/sec. The lowest average speed value in the graph is 0.97 m/sec recorded during morning and evening time periods, by pedestrians walking together in Matsuyama. On the other extreme, the highest average speed is 1.68 m/sec in Osaka recorded by males walking alone in the morning. It is acknowledged that this analysis has not included disable pedestrians and children who may have average walking speeds much less than observed here.



Osaka Matsuyama

Figure 4 Walking speeds at different times of the day for different types of pedestrians in Osaka and Matsuyama

It is important to recall that Table 5 showed there is no significant difference between city pairs about the walking speed from the point of view of the respondent awareness. Yet, the observational data in Table 7 shows there are numerous occasions where the difference of speed is significant between cities. It is likely that respondents were comparing their speed

with fellow citizens they meet in daily life. It may be also difficult for respondents to confidently compare their walking speeds with those of other cities. The supplementary data obtained from the observational survey allowed us to clarify the true nature of the speed differences.

5.2 Pedestrian Signal Compliance

As mentioned in section 3, pedestrian behavior at signalized zebra crossings was observed for 50 cycles in five cities. Analysis of this signal compliance data showed that average compliance rates are between 92.4% for Osaka and 99.5% for Fukuoka. Pedestrians of larger cities have displayed relatively poor traffic signal compliance. This is consistent with reflections of respondents from these cities, documented earlier in section 4.4.

Table 8 Signal compliance rates

	Tokyo	Kyoto	Osaka	Matsuyama	Fukuoka
Signal compliance rate	0.964	0.982	0.924	0.994	0.995

As average signal compliance rates shown in Table 8 are all within a small band there is no large difference of this value among cities. Nevertheless, the statistical method has been applied to compare these mean values. First, we examined the regularity of signal compliance raw data. As observed data did not follow a normal distribution, the nonparametric variance analysis mentioned earlier in section 4 was applied for comparison of these data as well.

The Kruskal-Wallis test reveals that the average signal compliance rates among the five cities have statistically significant differences. The Bonferroni's method mentioned earlier is then applied to find the city pairs in which the differences exist. There is a difference in the mean compliance rates in three city pairs, namely, between Osaka and Kyoto, between Osaka and Fukuoka as well as Osaka and Matsuyama, at 1% significance. Two other pairs of cities showed a difference at 5% significance. They are the city pairs of Osaka-Tokyo and Tokyo-Fukuoka.

6. CONCLUSIONS

The work presented in this paper is part of an ongoing research work carried out by members of the International Research Group (IRG05) of the Eastern Asia Society for Transportation Studies (EASTS) to develop a planning philosophy for culturally sensitive pedestrian-centric urban form in East Asia. The study group plans to present cross-country comparisons among cities in Japan, Taiwan, Korea and Australia in foreseeable future to demonstrate the relevance of the concept of pedestrian travel culture. The work presented in this paper is based on data collected from a questionnaire survey carried out in 10 cities in Japan and an observational survey carried out in 5 of those cities.

Pedestrian travel culture is defined in this paper as a composite of characteristics of the urban system, environment, demographics and pedestrian behavior. Two-way relationships among such characteristics form the core of the pedestrian travel culture, and there is a particular focus on the role of pedestrian habits, life style, way of thinking, and outlook toward society in the evolution of pedestrian behavior. This research project included only four pedestrian attributes and two system attributes in the analysis.

Analysis of data from the field surveys has provided the response profiles related to attitudes toward walking, preferences related to route choice and walking behavior characteristics, cross classified by the 10 cities and the 6 selected attributes. The analysis then focused on identifying comparisons that show statistically significant differences. Results presented indicate that there is no impact from gender of the respondent on the attitude toward walking in the cities considered. On the other hand the age of the respondent of the sample makes a significant difference in attitudes toward walking. The older age groups express relatively more positive attitude toward walking. Variables reflecting transport usage have shown that while a certain variable is not of significant importance another related variable is significantly relevant. For example, car ownership has no significant effect on attitude toward walking, while public transport usage has an impact. Respondents who use public transport at least once a month have a more positive attitude toward walking compared to others in the 10 cities analyzed.

Although comparison of age groups has not shown an impact on attitudes, it has an impact on preferred character of routes. For example, older age groups living in these cities have shown a stronger preference for streets with good surroundings. Younger groups have indicated a stronger preference for the shortest route than other age groups. Even once a month usage of public transport affects the preferences taken into account in route choice, whereas this attribute of public transport usage has not played a significant role in attitudes toward walking.

The average walking speeds obtained ranged from 58.2 m/min to 99.6 m/min according to an observation survey conducted in 5 of above cities. The walking speeds were analyzed using a cross classification of gender, group size and time of day. Pedestrians in relatively large cities in this sample were found to be walking relatively faster than pedestrians in other cities. At the same time, pedestrians in larger cities were more likely to cross streets in violation of pedestrian signals. The signal compliance rates averaged between 92.4% and 99.5% in the cities surveyed.

The research project has been successful in providing initial results that indicate a relationship between pedestrian behavior and socio-cultural attributes of different areas. The results have indicated the need for planners to account for pedestrian culture in planning for walking facilities to meet attitudes and expectations of the local community.

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