Analysis of Changes in Pedestrian Route Choice Priorities with Progress of Stage of Life

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Abstract: User focused pedestrian facility planning requires an understanding of pedestrian behavior and needs. Analysis presented here has considered user attributes primarily from the point of view of stage of life of the person. User needs have been measured through responses to ten opinion statements. The primary field survey was conducted in Japan, in five cities of different sizes. A secondary survey was performed in Sydney, Australia for comparison purposes. Analysis has shown the viability of using different indicators to designate the stage of life. It is also shown that a bipartition classification is suited to explain how pedestrian needs related to shortness of paths and pleasantness of walking space as individuals go through phases of their life.

Keywords: Pedestrian attributes, comfort, convenience, shortest path, pedestrian travel culture, EASTS IRG05

1. INTRODUCTION

Walking is an important mode of mobility even in the face of technological advances in other transport systems. Walking is an unavoidable element in all personal travel and there is a challenge from transport planning point of view to provide user oriented pedestrian facilities. The typical user population consists of subgroups with different characteristics and a fairness of treatment is deserved by all such subpopulations.

Previous publications such as Tsukaguchi et al. (2009) have set the foundation to explore the influence of regional properties of a population on attributes related to pedestrian behavior. While regional properties can define the pedestrian character, features of the local pedestrian behavior may become associated with the character of the region. Cyclic interactions between regional properties and pedestrian characteristics are the basis of the concept termed ‘pedestrian travel culture’ put forward by Tsukaguchi et al. (2009) and Tsuakguchi, et al. (2007). From transport and urban planning point of view, this concept questions the merit of national standards based on a one size fits all belief. The concept is further extended in this work by indicating non-homogeneity of characteristics of user properties. Analysis presented here shows that there are subpopulations with distinctly different priorities related to their pedestrian facility needs in a given community.

To a certain extent, the issue of stage of life has been previously investigated by the study team when the impact of age of residents on pedestrian attitudes was explored (Tsuakguchi, et al., 2009, 2011). Acceptance that age is one indicator but not the complete explanation of stage of life of an individual is the motivation for surveys and analysis done in

this current research project.

Stage of life is brought into the discussion through the use of variables such as the type of neighborhood where the respondent lives and activity patterns into modeling of transport decision making. Riley (2006) has studied the influence of stage of life on non-motorized transport use by families and has shown that families with children are relatively more car dependent and therefore less likely to engage in walking and cycling except as a leisure activity. Richardson (2006) has discussed the household structure as a stage of life indicator for transport modeling work. It is shown the average age of family members is a useful indicator to consider this particular view of stage of life for the purpose of transport modeling work particularly in relation to trip generation models. The importance of stage of life from the pedestrian safety perspective has been presented in analysis performed by number of statistics related authorities including National Centre for Statistics and Analysis (2012). As expected, such analysis shows the vulnerability of the elderly and young children in pedestrian accidents. Age groups representing elderly and children are over-represented according to pedestrian accident data.

The key objective of this work has been to explore whether there are significant differences among individuals about opinions and needs related to walking at different stages of their life. In addition, the project team sought to understand the degree of importance individuals placed on their needs for pedestrian facilities. The team also wanted to explore these properties in the context of region specific behavior and thus carried out field surveys in number of cities selected from different regions.

2. METHODOLOGY AND DATA COLLECTION

2.1 Methodology

As mentioned earlier, the theoretical framework for the current work began with Tsukaguchi et al. (2009). We have defined the pedestrian travel culture as a mixture of regional and pedestrian characteristics. The pedestrian travel culture is a result of relationships among specific attributes of the region and its residents. 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. The concept of pedestrian travel culture, is illustrated in Figure 1 in a schematic form.

Multiple relationhips among regional characteristics and pedestrian characteristics can be identified as shown in Figure 1. Some of these relationships have been analyzed and reported earlier (Tsukaguchi et al., 2009 and 2011). This paper focuses on the relationship between stage of life and awareness and attitude toward walking as shown by the thick line in Figure 1.

Tracking survey samples through different stages of life as a time series analysis was beyond the scope of available resources for this project. Therefore it was decided to take a random sample from the population in a given city and stratify them according to lifestyle attributes for the purpose of analysis.

227 cities in Japan having populations of more than one hundred thousand were classified according to principles of component analysis and successive cluster analysis. Details of the methodology were reported in Tsukaguchi et al. (2007). Based on the classification, fifteen cities were selected for surveys conducted for analysis of the overall concept of pedestrian culture in general. Findings were presented in previous publications such as Tsukaguchi et al. (2007), Tsukaguchi et al. (2009), and Tsukaguchi et al. (2011).

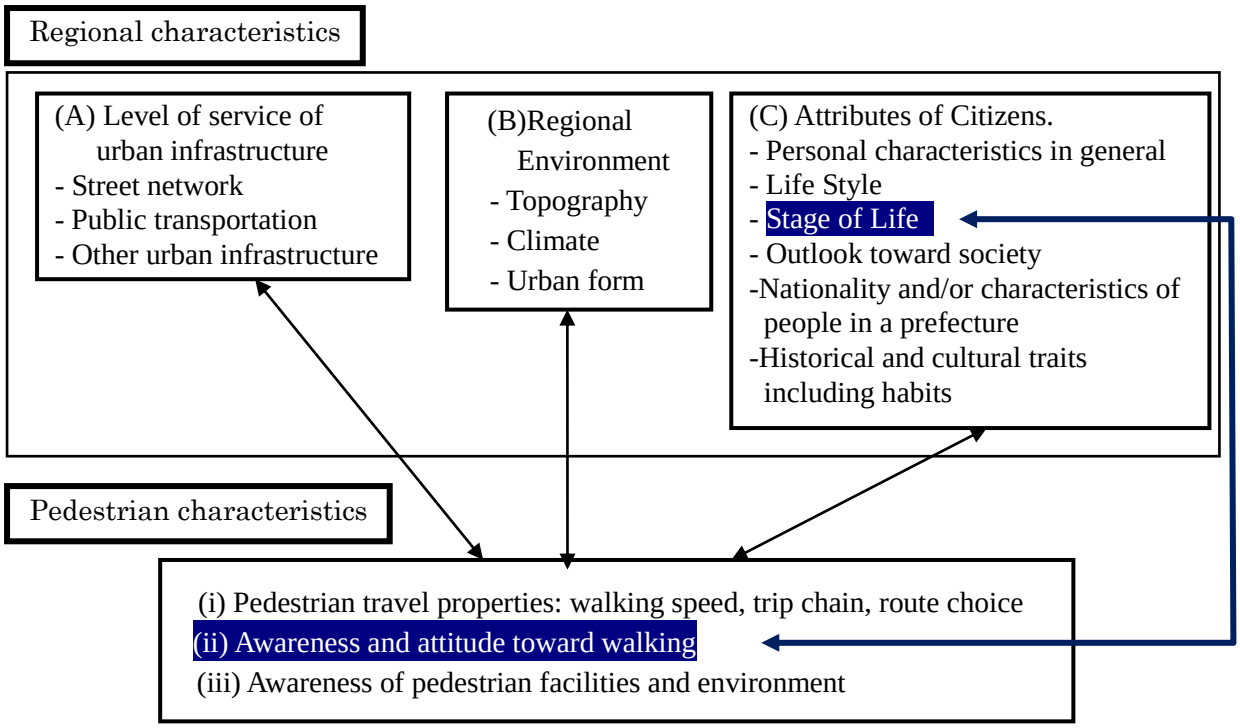


Figure 1 Topics of relevance for current study from the overall framework of pedestrian travel culture

For the current investigation a new questionnaire was prepared with the focus on 'stage of life' attributes. The survey was conducted on 5 cities, a subset of the previous 15 cities. The largest of the selected cities was Tokyo and the smallest was Urazoe as shown in Table 1. Population values of cities are also shown in the tabulation to indicate that sizes of cities range from about 100 thousand to 9 million residents. Data collection was performed in early 2011 for the five cities mentioned in Japan. The tabulation also lists Sydney (in Australia) as a sixth city where the survey was repeated in late 2011. The original survey administrator traveled to Sydney, translated the questionnaire, piloted and refined it to be able to perform the survey in a country with contrasting history and culture.

Table 1 Number of respondents in different cities

Country	City	Population	Response Sample Size
Japan*	Sapporo	1,913,545	239
	Tokyo	8,945,965	210
	Osaka	2,665,314	205
	Matsuyama	517,231	249
	Urazoe	110,351	208
Australia**	Sydney (the Sydney Statistical Division)	4,119,190	177
Total			1,288

Note) *: 2010 Japan Census, **: 2006 ABS Census

The stages of life have been defined in many ways to suit different cultures and religions. Most recognize the human life cycle as having several distinct stages followed by all living creatures, for example, birth, infancy, childhood, adulthood and elderly. Such classifications rely on progressing along with the age of the individual concerned. Additional sub-classifications such as adolescence, teenager and young adult are adopted in some work. For example, Armstrong (2007) has identified a twelve stage life cycle, namely; pre-birth,

birth, infancy, early childhood, middle childhood, late childhood, adolescence, early adulthood, midlife, mature adulthood, late adulthood, and passing away. A similar classification is often applied in medical research to associate susceptibility to different ailments at various stages of life. In applications that relate to demand modeling work it may be suitable to adopt classifications borrowed from the field of marketing research where there is an additional emphasis on spending capacity and the range of activities carried out by the individual (Moschis, 1996).

For the current research work, an age based classification has been adopted as the primary indicator of stage of life. This classification uses a numerical scale of age to broadly classify individuals to (a) children and youth, less than 20 years old (b) young, 20-40 years old (c) mature, 40-60 years old and (d) elderly, above 60 years of age.

Another potential indicator variable adopted here is based on the marital status. This variable may include additional characteristics to reflect the activity level and productivity of the individual to the society. To reduce the complexity of the survey, marital status has been divided to only two categories as (a) single and (b) not single. It is acknowledged that 'single' could mean sub-categories such as never married, divorced, separated, and widowed. Therefore this variable as selected here may be infective in its ability to correspond to the variable of age.

A third variable available in the survey is type of family. This selection is based on the argument that position of the family structure can reflect the stage of life. Seven categories have been adopted in the surveys performed. Researchers may use terms such as; nuclear family, single parent family, and extended family. However, it has been decided to provide a rather descriptive wording to the respondents of the survey. Thus the categories were labeled as; (1)live alone, (2)couple, no children yet, (3)family group containing parents and children and youth, (4)couple, children already left home, (5)three generations from grand-parents to children and youth, (6)in shared accommodation or hostel.

Another potential indicator of stage of life considered is how long the person has lived in the present city. It may be speculated that the individual is in a more advanced level in terms of stage of life if the person had been a resident in the present urban area for a comparatively long time.

2.2 Questionnaire design

Questionnaire prepared for this research project consists of two parts. First part is related to seeking opinions toward walking according to a Likert scale format. The other part is focused on recording respondent attributes including stage of life indicators.

Questions in the first part asked subjects to indicate their agreement or disagreement to 10 statements related to opinions and reflections about walking. The statements put forward to subjects were:

(a) I like walking.
(b) Walking is smart (clever).
(c) I am willing to walk at least a short distance every day.
(d) I like walking during my leisure times.
(e) I like to walk on roads that have pleasant scenery.
(f) I like to walk on roads through good neighborhoods even when the distance could be somewhat longer.
(g) I like to walk on streets where they're other people around even when the distance could be somewhat longer.
(h) I prefer the shortest route when the neighborhood is not pleasant for walking.

(i) I think I walk faster than others.
(j) If there is no traffic, I often cross the road while the pedestrian signal is still red.

Complete agreement with the statement was recorded as 4.0, while the other extreme, complete disagreement with the statement was indicated by a value of 0.0. Statements that received a response greater than the midpoint 2.0 were considered to be positive according this scheme.

In the second part of the questionnaire, subjects were asked to provide demographic data such as gender, age and occupation using tick box options. Further information pertaining to stage of life, such as marital status, family type and duration of tenure in the present city were also gathered in this section.

2.3 Survey administration

In Japan, it was decided to use the mail back technique to enable researchers to cover the five cities selected within a short period. It was also decided to target 1000 residents per city with the expectation of achieving about 20% response rate. To reduce the mailing cost, it was decided to select only 500 residences and send two questionnaire forms to each household with prepaid return envelopes. Addresses of target households were randomly selected from the respective telephone directories. As shown previously in Table 1, a response rate of about 22% was achieved in the survey of five cities in Japan.

Mail back technique was disregarded in Sydney because of excessive set up costs and administration difficulties. Therefore, face to face interview technique was adopted for data collection in Sydney. Road side surveys were conducted at five different sites. An attempt was made to ignore the first four available individuals and approach the next person as a way of introducing randomness to the selection of respondent sample. Impact on sample characteristics due to differences in survey administration between Sydney and Japan surveys was investigated later when sample demographics were estimated.

2.4 Preliminary analysis

Figure 2 shows the gender distribution of samples for the cities surveyed. In all cities, the male count is larger than the count of females. This is different from the expected property of general population where there are more females than males. Anyhow, this discrepancy maybe considered within acceptable bounds. In mail back surveys performed in Japan there may have been some tendency for male head of household to be the stated respondent although a female member may have completed the survey on his behalf. Nevertheless, even in the Sydney survey where the interviewer can physically see the respondent, the gender breakdown has followed the same pattern as in Japan surveys.

The age distribution of respondents shown in Figure 3 is much different from that of the general population. Japan surveys conducted using mail back surveys have a large over representation of the above 60 age group. This is mainly due to landline telephone ownership being biased towards that age group. The respondents were randomly selected from the city telephone directory and this bias is understandable. It is also possible that members of that age group were more willing to afford the time for questionnaire surveys. On the other hand, Sydney survey has almost 70% in the 20-40 age group. Some survey sites being near universities may have contributed this sample bias.

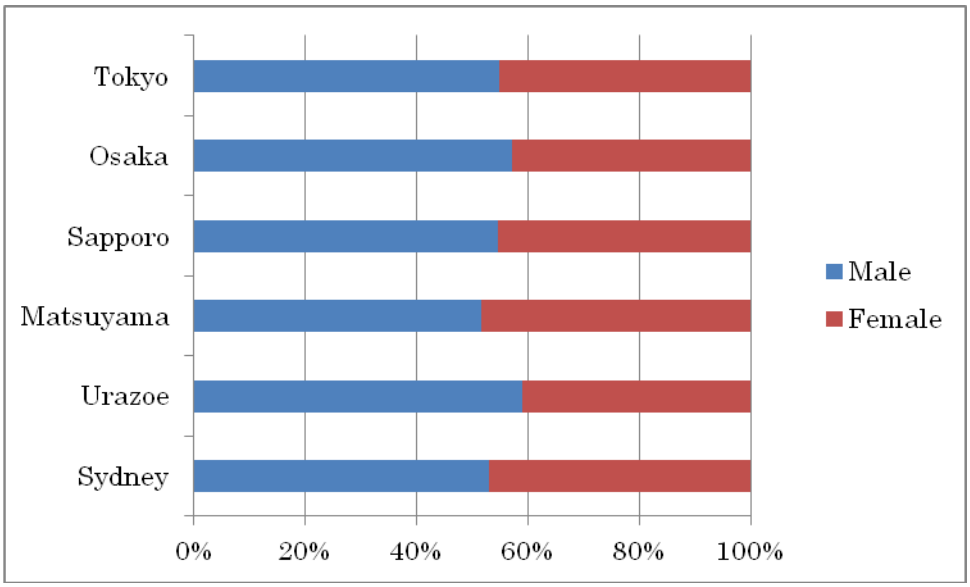


Figure 2 Gender distribution of respondents

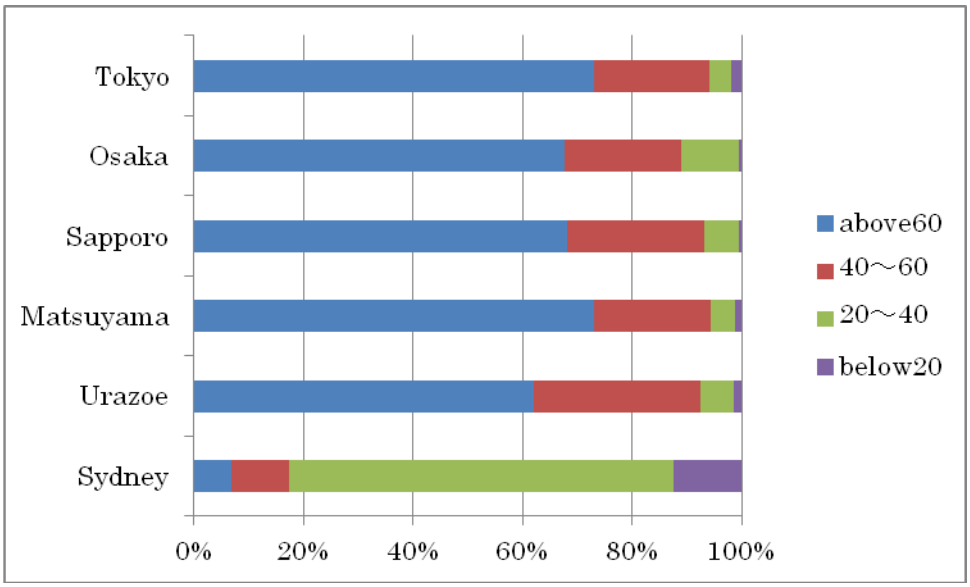
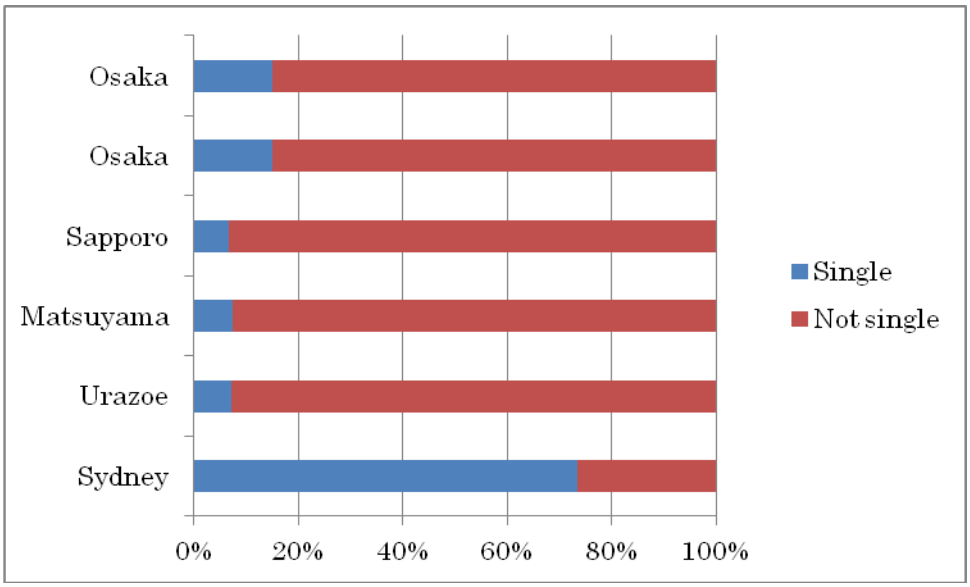


Figure 3 Distribution of age group of respondents

The distribution of marital status also indicates the influence of differences in data collection methods applied. Figure 4 shows that a large proportion of respondents in Japan is 'not single' which is consistent with the large proportion of elderly in those samples as shown earlier with Figure 3. On the other hand, Sydney sample consists of a large number of singles. This is consistent with the speculation stated earlier that this survey may be over-represented by university students.

Figure 5 shows the duration individuals claim to have lived in the current city. In the five cities in Japan the group that has lived more than 20 years in the present city is almost 80%. In contrast, there is distinctly different, even spread of time durations reported in the Sydney survey.



Note) 'Not single' means 'Not married' in Japanese survey.

Figure 4 Distribution of marital status

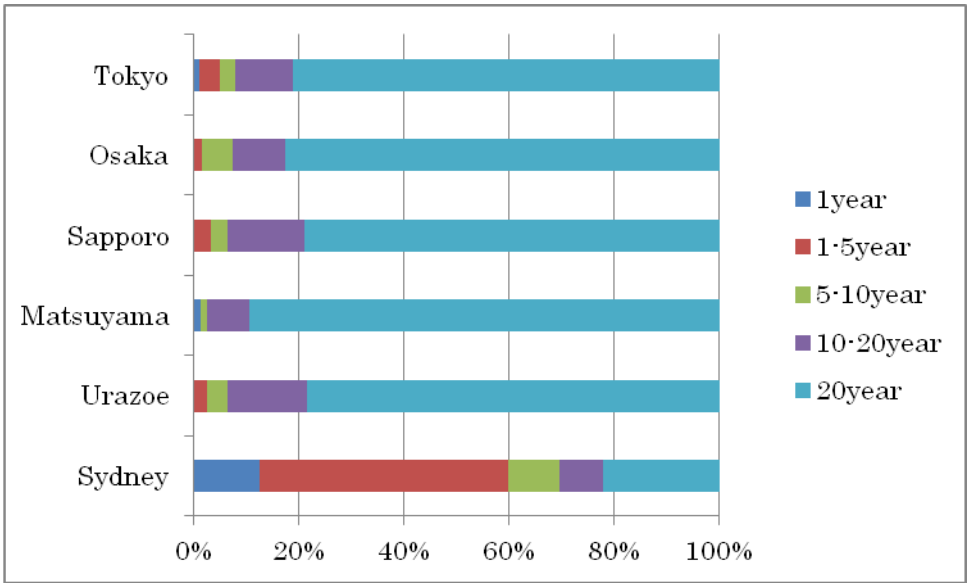
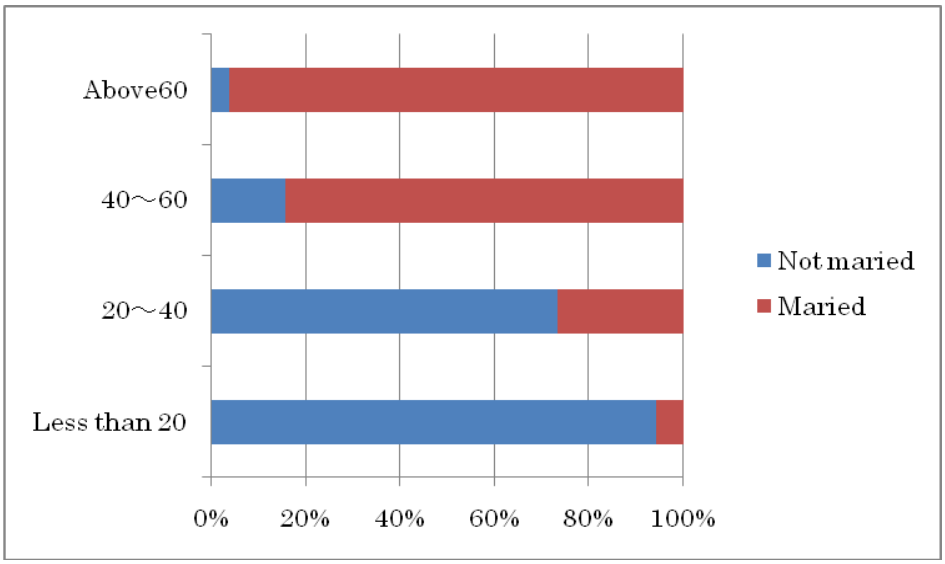


Figure 5 Distribution of duration respondents have lived in the city

This section has shown that differences in survey administration methods have contributed to respondent demographics in the available samples. Surveys conducted in Japan has an unusually high number of respondents aged more than 60 years, who are married and have lived a long time in the current city. Sydney survey has a high number of young adults, not yet married and a somewhat even distribution of time they have spent in the current city. It is important to note that these biases are not a particular problem for the next sections where the analysis is continued to investigate the relationship among different demographics and focus on perceptions from the point of view of each subcategories. A mathematical method is later introduced to address this issue in a statistically valid manner.

2.5 Relationships among stage of life variables

Few relationships among different demographic attributes are investigated in this section. To simplify the process, age group will be applied as one variable and the other variables mentioned in the previous section will be cross tabulated for the purpose of analysis. Figure 6 shows the relationship between marital status and age group using aggregate of all data for Japan and Sydney. As expected, the bar chart shows that 'not single' proportion increases as individuals proceed through stages of life from a zero percent married at childhood stage to more than 95% of respondents in the age group above 60 years.



Note) 'Not single' means 'Not married' in Japanese survey.

Figure 6 Proportion married increases with age

The relationship between the family type and age also shows a recognizable pattern. The proportion living with parents is understandably high for the lowest age group, and that proportion steadily decreases at subsequent age groups (Figure 7). On the other hand, husband and wife family type first emerges with the age group 20-40 and increases with following age groups until it attains the highest proportion at the most senior age group considered.

The time duration respondents have spent in the city also shows an identifiable pattern when compared with the age group as shown in Figure 8. Short periods of residency in the current city are more evident with low age groups. Percentage with a residency period of 20 years or more is steadily growing from low age groups until it reaches about 90% for the age group 60 years and above.

Figures 6 to 8 have shown that there are interrelationships among variables considered here for stage of life. Encouragingly, variables considered have visible relationships with age group, which is a relatively easy variable to manage in data collection. Therefore, using age group as a proxy variable for stage of life can be considered justifiable. Nevertheless, work presented in the next section takes into account all variables mentioned above to investigate the impact of stage of life on attitudes toward walking. The objective from the point of view of urban planning is to understand variations of these attitudes to identify pedestrian needs for those at different stages of life.

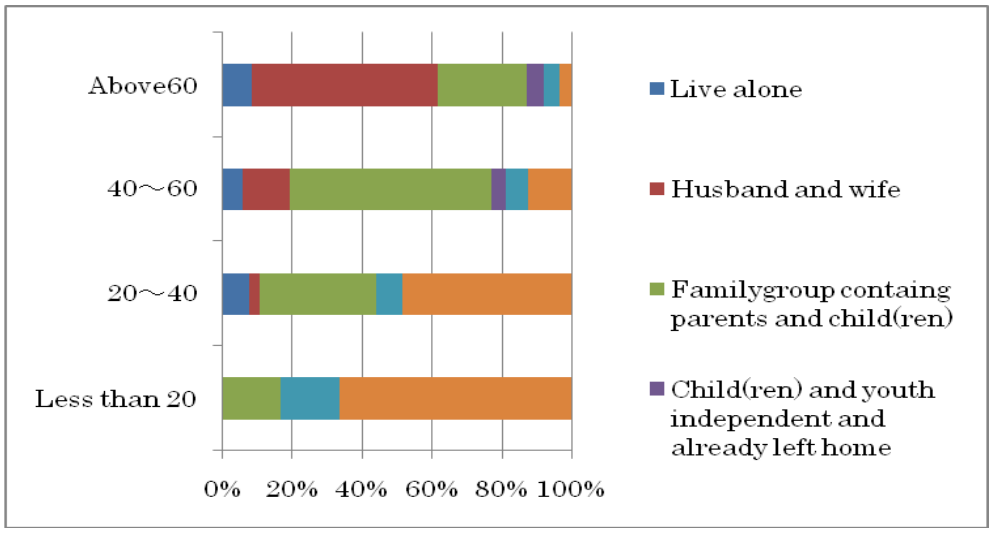


Figure 7 Bar chart for the relationship between family types with age groups

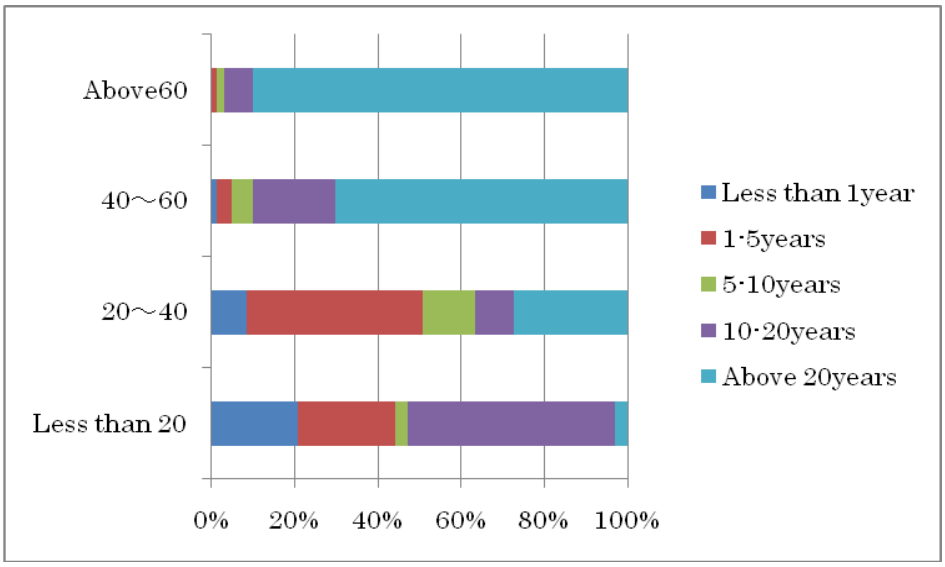


Figure 8 Cross classification pattern between age and residency period

3. DIFFERENCES OF PEDESTRIAN OPINIONS ACCORDING TO STAGE OF LIFE

3.1 Statistical analysis method

There are two important issues considered in selection of statistical analysis methods suitable for data acquired during this project. On one hand, it is important to learn whether there is a difference between averages of scores for agreement with statements put forward to respondents. In particular, it is of interest to know whether a sample from one stage of life provides a higher or lower average score of agreement compared to a sample from another stage. The other issue is related to differences of sample sizes for different stages of life according to variables considered before. Therefore, this study has selected a nonparametric analysis using Kruskal-Wallis method to inspect the statistical significance of differences between level of agreement for pedestrian opinion statements mentioned previously (in sections 2.2) for different stages of life. A particular advantage of the Kruskal-Wallis method is that the data does not have to follow the normal-distribution. However, the method

assumes that data in all subgroups within the population follow the same statistical distribution. This method is suitable to perform statistical comparisons where multiple significance tests are necessary to account for different sizes of groupings within the overall sample. The level of significance has been then corrected using Bonferroni method recommended as a conservative method suitable to handle multiple pairings from a database. Details related to these statistical methods are available in many statistical method text books including Siegel and Castellan (1988) , briefly explained as follows:

If the H statistic is greater than the critical Chi-squared value as shown in the equation (1) given below, a significant difference exists between the responses.

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

where

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

and

$T_j = t_j^3 - t_j$,

Also:

m : number of attributes in the analysis,

N : total number of respondents,

n_i : number of respondents with a particular attribute i ,

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 is identified using the above method, the following estimator from the Bonferroni method provides the level of significance for comparison of the particular pair of subgroups.

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

where

$$T_i = \frac{t^3 - t}{12}$$

U: Mann-Whitney's U parameter,

n_1, n_2: sample size of the pair of subgroups

3.2 Patterns related to change of pedestrian opinions with stage of life

Results from application of Kruskal-Wallis test along with Bonferroni method are shown in Table 2. The tabulation shows the 10 opinion statements in rows and comparison tests according to different indicators for stage of life in columns. Empty cells indicate that

although there may be a difference between the average scores for opinion calculated for different stages of life, that difference is not statistically significant for that cell. A notation such as A4 > A1 shown in the row for opinion 'f' for column 'Age-Japan' means that there is a significant difference between 'Age more than 60 years' (sample A4) and 'Age less than 20' (sample A1) scores for that particular opinion statement (i.e. preference for pedestrian paths through good neighborhoods). The sign ">" indicates that the average score for sample A4 is larger (i.e. more positive) than that for sample A1.

Table 2 Statistical analysis according to stage of life indicators; age, marital status and type of family

	Age		Marital status		Family type	
Statement	Japan	Sydney	Japan	Sydney	Japan	Sydney
(a)I like walking		A3>A1*****				
(b)Walking is smart						
(c)Willing to walk a short distance daily						
(d)I like a leisurely walk		A3>A1*		M2>M1*****		
(e)Prefer good scenery en-route		A3>A2*				
(f)Prefer good neighborhood en-route	A4>A1 A4>A2 A4>A3*	A3>A1 A3>A2*	M2>M1		F2>F3 F2>F5	
(g)Prefer busy route	A3>A4*		M1>M2			
(h)Prefer shortest route	A1>A4* A2>A4 A3>A4*		M1>M2			
(i)Fast walker	A3>A4					
(j)Regular signal violator	A1>A4 A2>A3 A2>A4 A3>A4	A1>A4*	M1>M2	M1>M2*	F3>F2 F6>F2	

Note) [Age] A1: below 20, A2:20~40, A 3: 40~60, A4: above 60 years
[Marital status] M1: unmarried (single in Sydney), M2: married (not single in Sydney)
[Family type] F1: live alone, F2: couple, no children yet, F3: family group containing parents, and child(ren) and youth, F4: three generations from grand-parents to children, F5: couple, children and youth already left home, and F6: in shared accommodation or hostel.
Blank cell: no significant differences, *: difference significant at 5%, all others 1% significance.

Figure 9 is included to assist understanding of Table 2. Average values computed according to age groups for samples for the five cities from Japan are shown in Figure 9. There are fluctuations in average scores for statements (a) to (e), but Table 2 has shown that these differences are not statistically significant for any of those statements. Average scores for statements (f), (h) and (j) are relatively spread out, giving opportunity to yield scores significantly different among the age groups. Figure 9 shows that for statement (f), the lowest average score is given by the sample for the lowest age group and the highest average score is provided by the oldest age group. For that statement, the average scores were increasing in value with the age group. Methodology followed in Table 2 has taken into account the dispersion of data in each sample in a statistical meaningful manner to locate instances where we can be confident of the existence of a difference between computed average values.

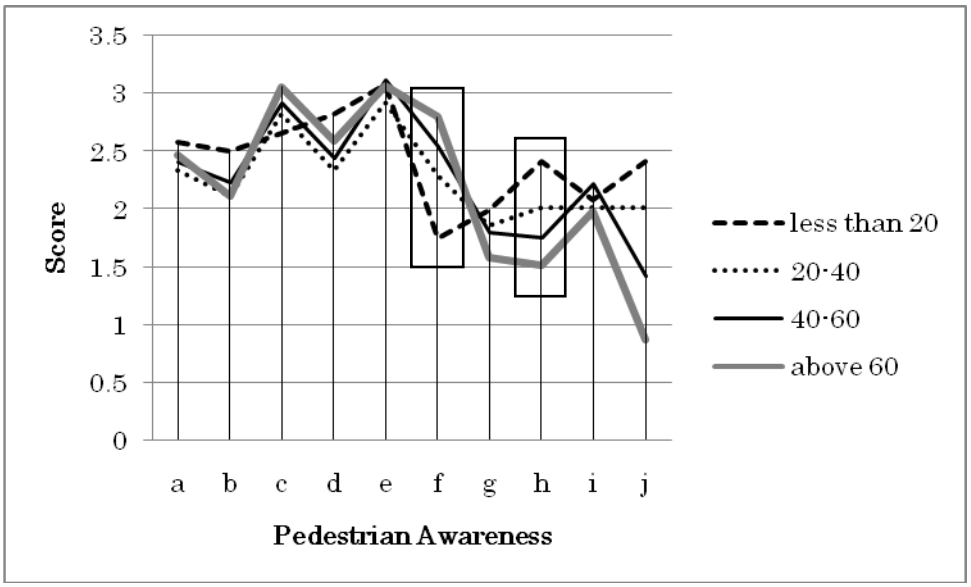


Figure 9 Pedestrian opinion scores for the five cities in Japan

Figure 10 provides the corresponding graphs for data from Sydney. In general, scores in Sydney are larger (more positive) than those in Japan. Also, it can be seen that scores of the 40-60 age group in Sydney maintains the highest score for most statements. Furthermore, groups less than 20 years old and above 60 years old tend to score lower than other groups. Although these graphs appear to be somewhat spread out, differences of scores for a given opinion statement is significant only for a limited number of statements, and only between selected number of age groups as shown with the statistical analysis reported in Table 2. It is important to refer to Figure 9 and 10 in making interpretations related to statistically significant comparison identified in Table 2.

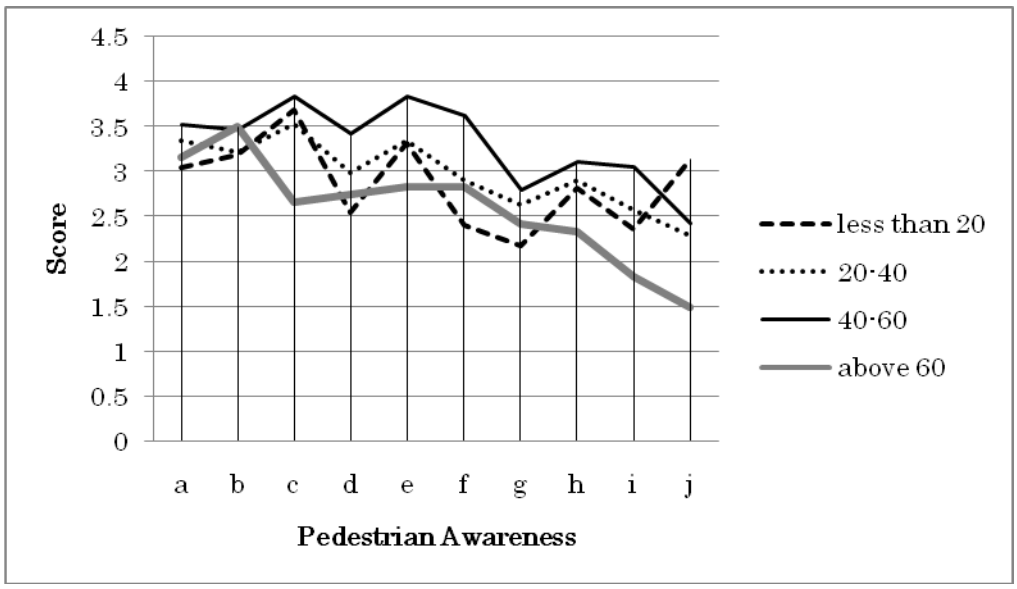


Figure 10 Pedestrian opinion scores for the sample from Sydney

If the graph for the age group of less that 20 is removed from Figure 10, there is only few crossovers among the remaining age groups. This indicates a general tendency to provide

a higher level of agreement for all opinion statements as individuals in Sydney advance from 20-40 group to 40-60 age group. Scores from the next age group (above 60) shows the least agreement for almost all opinion statements. This characteristic is less visible in Figure 9 for Japan data because of many crossovers by the two graphs representing the lowest and largest age groups. Scores from the next age group (above 60) shows the least agreement for almost all opinion statement.

Note that scores for statements (f) and (h) are highlighted by a border in Figure 9 to assist focus on two statements where the differences are significant when the stage of life is indicated by the age group for samples from the Japanese cities. Statement (f) related to the preference for good environment of the walking paths whereas statement (h) related to the preference for the shortness of pedestrian paths in terms of distance. The sequence of age groups for the average values reported to the statement (f) is completely opposite to the sequence of averages reported for statement (h). In other words, the youngest sample prefers the short route, but as they progress through different stages of life, pedestrians change to prefer pleasant surrounding for walking paths. At the same time, pedestrians in advanced stages of life reduce their preference toward shortness of the pedestrian paths. However, this pattern has not been reproduced in the Sydney sample in a statistically significant manner. For the purpose of this survey, in statement (f), the meaning of what is meant by a good environment of road is left for the respondent to decide. It has not been attempted to define this term from the point of view researchers to let the respondents work on the basis of what they consider as characteristics of a good surrounding.

Statement (j) is about whether respondents are signal violators as pedestrians. The presence of a statistically significant difference is evident according to all three indicators (age, marital status and type of family) of stage of life as shown in Table 2. In general, lower age groups are more likely to ignore traffic signals when there is no traffic. Interestingly, three age groups have provided an average value less than 2, indicating majority disagreement with the statement in samples from Japan, whereas only one age group has reported an average value below the neutral level in Sydney (see Figures 9 and 10).

3.3 Comparisons with indicators such as occupation and length of residency

As mentioned earlier in discussion of Figure 8, the length of residency may have validity as a stage of life indicator. A person who has lived a long time in a city is likely to be in an advanced stage of life. It can be also speculated that the type of occupation may have potential to be used as a stage of life indicator under certain conditions. The argument could be that a student is likely to be in an early stage of life and a person of full time employment in a private company is likely to be in an advanced stage of life. The validity of using these respondent characteristics as stage of life indicators is not well established because of the difficulty of identifying subcategories that could well correspond to stage of life of the individual. Therefore, analysis for these two indicators is presented separate from other indicators discussed in the previous section. Table 3 provides a list of comparisons made using the statistical methods mentioned earlier from the point of these additional indicators related to stage of life.

Table 3 shows that respondents in different occupations have differences of opinions about walking and pedestrian facilities. There are more occasions of significant differences identified with samples from Japan compared to Sydney. In comparison of occupation subcategories, the general pattern is $O_i > O_j$ when $i < j$ in both Japan and Australia. The variable residency period has provided only limited number of instances where there is a significant difference.

The pattern observed in Table 3 is consistent with sequences observed previously with the 'Age' columns in Table 2. For example, consider the statement (j) (signal violator) in Table 2. The sequence of entries indicates that lower age groups have consistently given a score greater than senior age groups. Table 3 repeats those findings by indicating that students and unemployed (generally representing low age groups) have similar differences of opinion about walking with those on good employment (generally representing advanced age groups).

Table 3 Comparisons made using employment and residency period as stage of life indicators.

Statement	Occupation		Staying term	
	Japan	Sydney	Japan	Sydney
(a)I like walking	O1>O4			
(b)Walking is smart	O1>O6* O5>O6*	O1>O2		
(c)Willing to walk a short distance daily				
(d)I like a leisurely walk		O1>O2*		
(e)Prefer good scenery en-route		O1>O2*		
(f)Prefer good neighborhood en-route			S4>S3	S5>S3*
(g)Prefer busy route				
(h)Prefer shortest route	O3>O2* O3>O5 O3>O6			
(i)Fast walker	O1>O4 O1>O6 O2>O4 O2>O5 O2>O6			
(j)Regular signal violator	O1>O5 O1>O6 O2>O5 O2>O6 O3>O4 O3>O5 O3>O6 O4>O6*		S4>S5 S3>S4 S2>S5*	

Note:
[Occupation] O1: employed at private company, O2: official in national or local government, O3: student, O4: part time employee, O5: housewife, O6: unemployed (in the case of Japanese cities), and
O1: employed, O2: student (in the case of Sydney)
[Staying term] S1: less than 1 year, S2: 1~5 years, S3: 5~10 years, S4:10~20 years, 5: above 20 years.
Blank: no significant differences, *: difference significant at 5%, all others 1% significance.

4. IMPLICATIONS FOR PLANNING OF PEDESTRIAN FACILITIES

The pattern we have observed in the previous analysis has shown that there is a significant difference in certain pedestrian opinions among different stages of life. This was evident earlier when it was observed that low age groups prefer paths with short walking distance whereas senior age groups prefer a pleasant urban environment for walking paths. This type

of phenomenon is not rare in planning literature and concepts related to dealing with these situations have been the subject of some literature. An analogues situation has been reported as the Buchanan law in relation to the setting of environmental standards and accessibility standards for motor vehicle traffic (Buchanan, 1963; Starkie, 1982). According to this conceptual framework it was argued that setting minimum environmental quality determines what we can achieve as the accessibility level under a given amount of overall funding for road projects. According to the present study, pedestrian facility planners have to face a similar situation when attempting to satisfy two different needs, one of providing paths with good surroundings and one with providing routes that are direct. For lack of a better terminology we select the term 'pleasantness' to refer to good environment and 'directness' to imply shortness in relation to pedestrian paths to explain this concept in Figure 11.

It is acknowledged that further research is required to better identify what is meant by respondents for terms such as 'short path' and 'path with good surrounding'. This project has not explored this in sufficient detail and more research work is required to better understand actual user intentions in relation to those terms.

Figure 11 is a schematic representation of the correlation between two forms of user needs. The analysis has identified two zones. Facilities that provide the shortest path to the destination, termed 'convenient paths' are preferred by one segment of the city population. Another segment of the population expects planners to spend on 'comfortable paths' to create a walking space having a good urban environment.

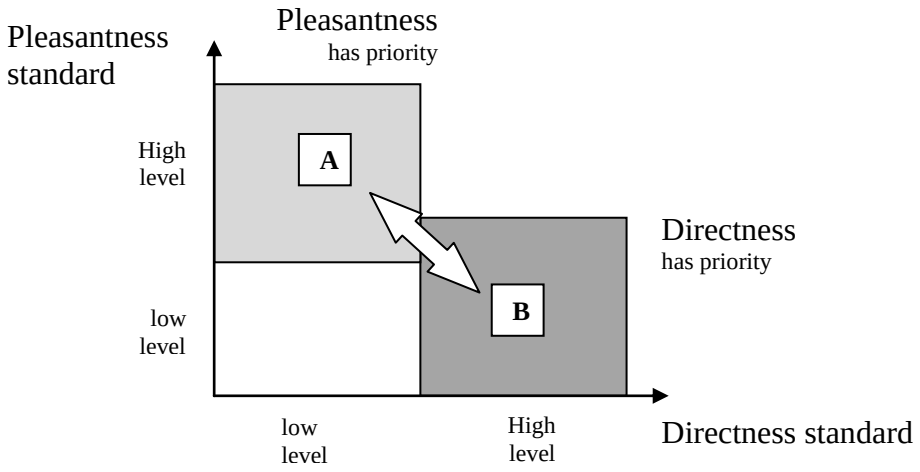


Figure 11 Conceptual diagram of two-zones according classification of pedestrian needs

From engineering analysis point of view these situations are handled by providing a weighting according to segment population with these different needs. It is now possible to move away from the 'one size fits all' approach for specification of pedestrian facilities. For example, pedestrian facilities near educational institutions could be designed to cater for the perceived needs of users from early stages of life. Infrastructure associated with a commuter train station could cater a majority of users from middle stages of life. This research project has provided a statistically acceptable methodology to identify user needs of those in different stages of life.

In Japan which has a rapidly growing mature age population zone B in Figure 11 could be the prevailing default state for planning work in the absence of demographic information about the user population. Zone A could be recommended as the default state for societies that still have the conventional population pyramid with large proportions in relatively young age groups. Nevertheless, the key message of this research work is that user population

demographics should finally determine the facility specifications for a particular location.

It may be possible to address findings related to a particular opinion in isolation as well. For example, the previous section discussed the 'signal violator' pedestrian behavior. This behavior is more pronounced with low age groups. Therefore pedestrian crossings where majority of users are young need to account for this behavior trait. Again, it is clear, individual locations have to be planned with care according to the distribution of stage of life of users.

5. CONCLUSIONS

Research work presented here followed on from a broader investigation to show the presence and importance of regional differences of pedestrian needs. This paper is focused on describing a methodology suitable for analysis of opinions and requirements related to facility planning for pedestrians from different stages of life. Field surveys were carried out in five urban areas of different sizes in Japan. Robustness of the methodology has been verified by performing a useful follow up survey in Sydney, Australia.

The questionnaire survey provided the opportunity for respondents to reveal their opinions toward ten aspects of pedestrian facilities and walking. Also, five different variables such as age, marital status, family type and duration of residency in the present city have been included in the questionnaire as indicators of stage of life. Statistical methods have been applied to analyze multiple pairings of subgroups of survey samples.

Section 2 has followed on from an initial investigation about the relevance of the 'stage of life' earlier presented in Tsukaguchi et al. (2011) and discussed the correlations between different indicators for stage of life. It has been possible to establish the robustness of "age" to represent the stage of life in the context of opinions related to walking activities although age was introduced initially to the analysis as a proxy variable.

A particular finding of research interest from opinions expressed by the respondents in Japan is that one age group prefers shortness of pedestrian paths and another group prefers the path to be located in a pleasant urban environment. Preference for the shortness of pedestrian paths in terms of distance becomes less important as individuals pass through different stages of life. On the other hand, "preference for good environment of walking path" becomes more important for individuals as they progress through stages of life. However, this pattern has not been reproduced in the Sydney sample in a statistically significant manner, but indicates the importance of understanding the role of regional characteristics in dealing with these relationships. In any case, further research is required to explain adequately what respondents meant by terms such as shortest path and paths with good environment.

Based on above findings, a two-zone classification of users according their preference toward shortness and pleasantness has been explained. Some implications to pedestrian facility planning and engineering have been also discussed. This is a noteworthy observation to pedestrian facility providers in the light of growing aging population in some countries.

Another finding that is of interest to regulators and road authorities is related to signal violations by pedestrians. Firstly, data reveals such violations to be a common occurrence. Also, data analysis has shown that the propensity to ignore signals varies with the age group of the pedestrian. This indicates the importance of knowing site specific demographics of pedestrians crossing the road in addition to demand counts collected for traditional method of engineering design for pedestrian crossing sites.

This study covered five Japanese cities and Sydney which has different historical and cultural backgrounds. The relationships between stage of life and the presented pedestrian

opinion statements in Japan are more distinct than those in Sydney. It is also noted that the scores for each opinion statements in Sydney have been relatively high irrespective of stage of life, compared to Japan. Further investigations may be required to explain these properties.

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