Analyzing the effect of social networks, built environment, and personality traits on out-of-home leisure activity generation: A case study of Fukuoka, Japan

社会的ネットワークと物的環境及び人格特性が余暇活動の発生に与える影響の分析：福岡市を事例として

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Departing from recent studies in the transportation field, this article discusses the effects of social networks and the built environment on out-of-home leisure activity generation. Using data from a survey conducted in Fukuoka City, Japan, an empirical model is estimated using structural equations model (SEM). Finding provide some additional empirical support to the role of social network characteristics and personality traits on out-of-home leisure propensity. In addition, the built environment was associated with higher leisure propensity by facilitating more out-of-home activity opportunities; however, the statistical significance of the built environment parameter was found to be sensitive to the neighborhood definition used to operationalize it.

Key Words : *Social networks, built environment, out-of-home leisure activities, structural equations model, personality traits*

1. INTRODUCTION

Against the backdrop of increasing number of non-work realted trips, in particular leisure-related activities, and considering the difficulties associated with prediction leisure behavior, recent studies in the transportation field are tackling the issue by considering individuals' social network characteristics. In the particular case of Japan, Otani (1999) points out that most social network studies in the sociology field hace focused on kinship rather than personal communities, even though urban industrial Japan, as many other nations saw a decline in kinship based relationships and a consequent increase in non-kin relations. Otani further points out that few studies in Japan have actually examined ego-centric networks beyond the neighborhood to include ties with kin and friends.

Departing from the work of Carrasco and Miller (2006), and Axhausen (2008), this article, aims at bridging the existing gap in the Japanese literature by

analyzing from an ego-centric network perspective social network characteristics in Japan and its relation with leisure activity generation. Furthermore, building up on the work of Troncoso Parady et al. (2014a), the effect of the built environment on travel behavior is also considered. Using data from a survey conducted in Fukuoka City, Japan, an empirical model is estimated using structural equations model (SEM).

The rest of the article is structured as follows, Section 2 details the survey design and data characteristics. Section 3 discussess the model specification and results while Section 4 summarizes the conclusions and further research.

2. SURVEY DESIGN AND DATA CHARACTERISTICS

Data used for this analysis was gathered through an online survey conducted in the City of Fukuoka, in December 2013, via Macromill Inc., a net-research company with over 2.3 million monitors all over Japan. According to the Communications usage trend survey, conducted by the Ministry of Internal Affairs and Communications, Internet penetration rate for Japan was estimated at 79.1% for 2011, with a 90% penetration rate for the 13-49 years old cohort. For the 60-64, 65-69, and 70-79 cohorts, rates stood at 73%, 60% and 42% respectively (MIC, 2012). Regarding digital literacy, the same survey estimated that users who use the internet for purchases or trade accounted for 60%, although a gap was observed between users under 49 years old and older users. This suggests that in spite of a high penetration rate, there might exist some limitations in terms of sample representativeness, especially concerning older cohorts, a limitations that has been pointed out regarding online surveys in general (Couper, 2000).
The survey aimed at gathering data on (i) individual and household information, (ii) mobility biography, (iii) transport related attitudes and habits, (iv) ego-centric social network characteristics, and (v) travel behavior . Adults (over 20 years old) residing in Fukuoka City were sampled via stratified random sampling based on household composition. The survey was pre-tested using a convenience sample of students and faculty in the Department of Urban Engineering of the University of Tokyo. A follow up survey was conducted on January 2014, to gather data on personality traits using the Big-Five Inventory (BFI), a 44 item self-reported inventory designed to measure the Big Five personality dimensions (John, et al., 2008).

(1) Built environment and travel behaviour

A continuous urbanization index was developed as a composite measure of the built environment following the work of Troncoso Parady et al. (2014), where urbanization level was conceptualized as a latent construct estimated via confirmatory factor analysis. The proposed index is a function of the observed distribution of (i) supply of goods and services , (ii) land use intensity, (iii) transport mobility and (iv) land prices in Fukuoka city . Regarding the spatial unit of analysis, a regular aggregation scheme was used given its propensity to produce more tractable results than census geographic units (Putman & Chung, 1989; Zhang & Kukadia, 2005). Accordingly, a 300m wide hexagon tessellation was used to subdivide the analysis area. Figures 1 and 2 illustrates the estimated model's path diagram and the urbanization index plot respectively.

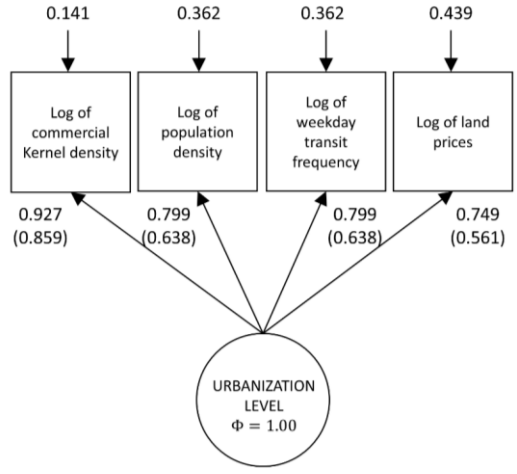

Figure 1. Path diagram of urbanization level latent variable

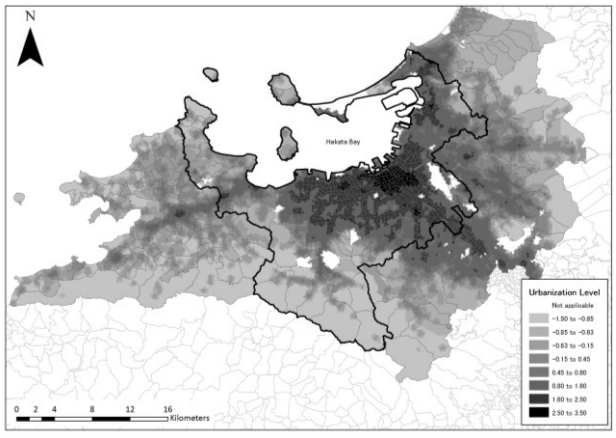

Figure 2. Urbanization level map of Fukuoka City (z-scores)

Regarding leisure travel behavior, respondents were asked to state the number of leisure activities engaged in in the past two week before the survey. Leisure activities were classified as leisure shopping (mean: 2.2, sd.: 2.8), eating out (mean: 1.1, sd.: 2.4) and other

leisure (i.e. Theater, movies, karaoke, sports, etc.) (mean: 1.2, sd.: 1.5). In addition, respondents were asked in detail regarding two randomly-selected activities performed in the last week prior to the survey, which as later explained is used in part as a name generator.

(2) Social network data and characteristics

An ego-centric approach was used to gather data on social network characteristics of respondents. Although current best practices suggest the use of a name generator to elicit names of all members which ego can recall (Carrasco & Miller, 2006; Axhausen, 2008; Kowald & Axhausen, 2012), due to the extensiveness of the survey, a simpler instrument was used. Instead, our methodology follows partly a survey conducted by Otani (1999) on several Japanese cities, which allows us to compare results. To measure network size, respondents were asked "How many intimate kin, coworkers, neighbors and friends do you have? (People you get together with frequently)" and were prompted to respond the number of alters that fall into each category. As illustrated in Figure 3, the sample mean network size is 10.56 alters, with a standard deviation of 11.26.

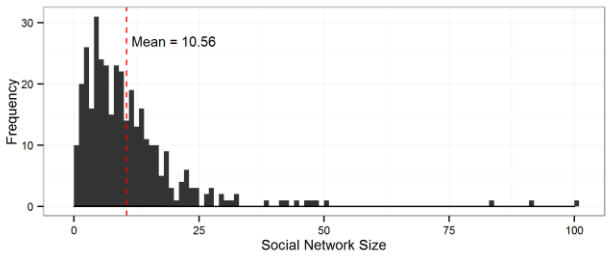

Figure 3. Social network size histogram

Compared to findings by Otani (1999) in Hiroshima and Matsuyama cities, both in terms of size and network composition, reported values are similar among cities (see Table 1). In the Fukuoka sample, family members composed on average 28% of the total network, work or school mates added up 29%, while other friends made up 35% of the network. The biggest difference comes in terms of average network size and the share of neighbors, which made up only 8% of the total network, compared to 17% in both Hiroshima and Matsuyama cases.

To gather more specific information on alters whom which ego usually engages in leisure with, two name generators were used. The first name generator aimed at eliciting the top 5 closest alters outside the household (Question: Who are the five persons outside your household (irrespective of order) whom you feel closest to?). The second name generator focused on eliciting alters whom which ego engaged in leisure activities in the week before the survey.

Table 1. Comparison of Network size and composition among Japanese Cities

	Fukuoka (2014)		Hiroshima (1999)		Matsuyama (1999)	
Population (million)	1.46		1.04		0.42	
Mean size	10.4		14.5		13.9	
Out of which		Ratio		Ratio		Ratio
Family	2.90	0.28	3.80	0.26	3.80	0.27
Work/School	2.05	0.20	2.40	0.17	3.40	0.24
Neighbor	0.81	0.08	2.40	0.17	2.40	0.17
Club member	0.64	0.06	-	-	-	-
Other friends	3.62	0.35	4.70	0.32	4.10	0.29

Hiroshima and Matsuyama City Data source: Otani(1999)

A maximum of 5 alters were selected from both name generators and information was gathered on their gender, age cohort, driving license status, tie strength, type of relation, time knowing each other, residential location and contact frequency (face to face, phone, instant messaging/SMS, and e-mail). Since the object of interest of this study is leisure activities, priority was given to alters elicited in the second name generator (activity alters). It is important to note however, that there was an overlapping of 76.5% between the top 5 closest alters and activity alters.

With an effective sample of 359 egos (out of a total sample of 657), information on 1423 alters was gathered, an average of 4 alters per ego. Table 2 summarizes the general characteristics of sampled alters.

Table 2. personal attributes of sampled alters

Variable	Mean	Median	Std. Dev.
Network density (Top 5 closest alters only)	0.42	0.3	0.35
Gender homophily	0.75	-	-
Age cohort match (10 year cohorts)	0.55	0.60	0.32
Tie strength (if strong tie 1, else 0)	0.94	-	-
Years knowing each other			
Less than a year	0.06	-	-
2 to 5 years	0.23	-	-
6 to 9 years	0.14	-	-
More than 10 years	0.57	-	-
Greater circle ego-alter distance (km)	122.37	5.59	833.07
Yearly contact frequency			
Face to face	75.84	12.00	116.90
Phone	33.30	3.00	101.70
E-mail	50.10	2.00	173.40
SMS/Instant messaging	40.20	0.00	426.46

In terms of contact of the relationship between contact frequency and ego-alter greater circle distance, as illustrated in Figure 4, similar to findings by Kowald and Axhausen (2012), face-to-face

contact frequency diminishes as ego-alter distance increases, however, even at near distances, it was not always the dominant contact mode (in terms of frequency), which might be partly explained by lower costs of non-face-to face contact modes. Figure 4 also illustrates less sensitivity of non-face-to-face modes to distance, with all three modes exhibiting an increasing trend towards the highest distance deciles.

Regarding the spatial relation between egos' current and previous residential locations and alter present location, as expected the bulk of alters are located within Fukuoka prefecture and Kyushu island (See Figure 5). At the same time, two large clusters of egos' previous residential locations and alters current locations can be observed in the Kansai Region (Kyoto, Osaka, Kobe) and the Kanto Region (Tokyo, Chiba, Kanagawa, Saitama). It is certainly plausible that the spread of ego's network is associated with previous residential locations, as well as population and labor supply and demand dynamics.

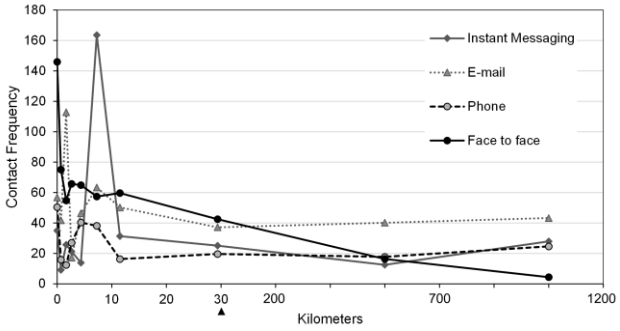

Figure 4. Contact frequency by mode given ego-alter great circle distances

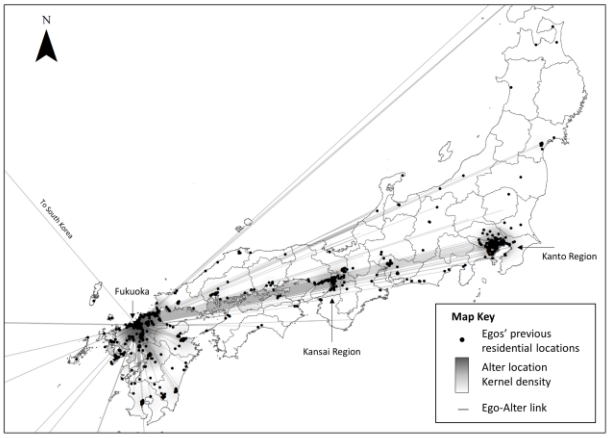

Figure 5. Spatial distribution of egos' previous residential locations and alters' current locations.

3. MODEL SPECIFICATION AND RESULTS

To analyze the effect of social networks, the built environment and personality traits on out-of-home leisure activity generation, a structural equations model (SEM) was specified. The model was estimated using MPLUS6 by Muthen & Muthen (2010). Goodness of fit threshold are guided by the values recommended by Hu and Bentler (1999) as follows: root means square error of approximation RMSEA (≤0.05), standardized root mean square residual SRMR (≤0.08), comparative fit index CFI (≥0.95), Tucker-Lewis index TLI (≥0.95).

As illustrated in Table 3, goodness of fit statistics suggest an adequate model fit for most indicators. It is important to note that given the relatively novelty of the topic there is no well-established theory regarding the relation between leisure travel, social networks and the built environment. As such, several hypothetical models were tested based on findings from existing studies and the best fitting model was selected (see Figure 6). To do so, the data were split into two random parts, with one half used as an estimation sample, and the other half as the validation sample. Once validated, the model was re-estimated with the full sample, which are the results reported in this article.

Similar to findings in the literature, the presence of children in the household is associated with less propensity to engage in out-of-home leisure, mostly as a result of time constraints (Carrasco & Miller, 2006). Similar to Lu and Pas (1999), higher income is associated with higher leisure propensity. Car availability is negatively associated with leisure propensity, a rather surprising finding given higher mobility levels associated with car ownership. A possible explanation for the direction of this effect is that drivers might choose one place to conduct several activities a time (i.e. large-scale shopping centers, etc), while transit and non-motorized modes users might engage in several trips during one outing.

Regarding the effect of social networks, both network size and club membership are positively associated with leisure propensity. The size effect is rather intuitive, since given a larger network size, ego has to invest more time to maintain individual ties, translating in higher leisure propensity. In a similar manner, belonging to any type of club/association might impose some pressure to participate in such association's activities, which is particularly the case of student clubs or circles in Japan. As expected, time constraints were negatively associated with leisure propensity, a phenomena well-documented in the transportation literature. As hypothesized, High scores in the extraversion personality trait are also associated with higher out-of-home leisure propensity. Finally, the positive coefficient of the urbanization level index suggest that an increase in potential activity opportunities is associated with higher leisure propensity. This is an important finding, as the literature regarding the effect of the built environment and travel behavior has paid little

Table 3: Standardized direct effects of SEM model

From/To	Leisure propensity	ICT contact propensity	Time constraints	Urbanization level	Eating out frequency	Other leisure frequency	Phone frequency	E-mail frequency	SMS/ISM frequency	Commute frequency	Working hours	Work-based maintenance trip frequency
Leisure propensity	-	0.13	-	-	0.73	0.36	-	-	-	-	-	-
	-	2.65	-	-	11.01	9.15	-	-	-	-	-	-
ICT contact propensity	-	-	-	-	-	-	0.73	0.51	0.12	-	-	-
	-	-	-	-	-	-	12.47	11.59	3.28	-	-	-
Time constraints	-0.15	0.13	-	-	-	-	-	-	-	0.92	0.79	0.50
	-4.09	3.44	-	-	-	-	-	-	-	123.42	69.01	23.91
Urbanization level	0.10	-	-	-	-	-	-	-	-	-	-	-
	2.67	-	-	-	-	-	-	-	-	-	-	-
Network size	0.11	-	-	-								
	2.99	-	-	-								
Club membership	0.25	-	-	-								
	6.28	-	-	-								
Ego-alter distance (Log)	-	-0.10	-	-								
	-	-2.88	-	-								
Strong tie	-	0.09	-	-								
	-	2.57	-	-								
Gender match	-	-0.22	-	-								
	-	-6.62	-	-								
Extraversion	0.08	0.11	-	-								
	2.14	3.16	-	-								
Worker	-	-	0.93	-								
	-	-	65.96	-								
Student	-	-	0.48	-								
	-	-	26.43	-								
Household size	-	-	-	-0.25								
	-	-	-	-5.57								
Children in household	-0.14	-	-	-								
	-3.52	-	-	-								
Income over JPY 8 million	0.21	-	-	0.14								
	5.11	-	-	5.11								
Has Car (Dummy)	-0.16	-	-	-								
	-4.05	-	-	-								
Number of cars in HH	-	-	-	-0.24								
	-	-	-	-6.88								
Car use habit	-	-	-	-0.22								
	-	-	-	-7.00								
R square	0.16	0.11	0.82	0.21	0.53	0.13	0.53	0.26	0.01	0.85	0.62	0.25

Goodness of fit statistics: Chi square: 295.33, d.f.=133 (0.00), RMSEA 0.029, 90%C.I. [0.025,0.034], p-value=1.000, CFI 0.96, TLI 0.95, SRMR 0.03

attention to leisure activities so far.

Regarding ego-alter ICT contact propensity, an interesting finding is the positive association with both leisure propensity and time constraints. On the one hand, higher leisure propensity might prompt ego to contact alters via ICT on higher frequencies, possibly to coordinate joint activities, etc. On the other, as a result of bigger time constraints, the necessary contacts to maintain the network are done via ICT , which exhibits lower costs than face-to-face contact. Similar to findings in the literature regarding the spatial distribution and emotional closeness of alters (Carrasco & Miller, 2009; van den Berg, et al., 2012), the negative coefficient of ego-alter distance, suggest an impedance effect on ICT contact propensity, while strong ties are positively associated with higher ICT contact propensity.

Among personality traits, extraversion is again positively associated with contact propensity, a fact that is consistent with the definition of this trait. Although network homophily in the sample was estimated at 0.75, the effect of the alter-ego gender match coefficient negative, suggesting higher contact propensity with alters of the opposite sex. To control for possible residential self-selection bias in the built environment effect, socio-demographics, attitude and habit variables were included as predictors of urbanizationlevel (see Troncoso Parady (2014) for details of estimation of attitude and habit variables). It is important to note that although the attitude coefficients were statistically significant, the inclusion of these variables resulted in poor goodness of fit, hence were excluded. Only the car use habit variable, as measured by the Response Frequency Index (Verplanken, et al., 1994) remained in the final model.

(1) Built environment sensitivity analysis

A sensitivity analysis of the effect of the built environment was conducted in order to evaluate possible MAUP (Modifiable Areal Unit Problem) effects. Although given the way the urbanization level variable was estimated, zoning and scale problems are to some extent controlled for, the optimal scale of analysis is in practice not known. Similar to Guo & Bhat (2007) Radial network neighborhoods were operationalized. In addition, a fourth scale of analysis is used where a weight is assigned to surroundings areas as a function of distance from each unit centroid via a kernel density function, so that closer locations are given more importance than more distant ones.

As shown in Table 4, at all scales, the direction of the effect is consistent, although the precision of the estimates differ by analysis scale, with the fourth scale having rather low t-statistic, suggesting that the effect estimates might be sensitive to the analysis unit used. In terms of overall goodness of fit, Scale 1 exhibits a marginally better fit.

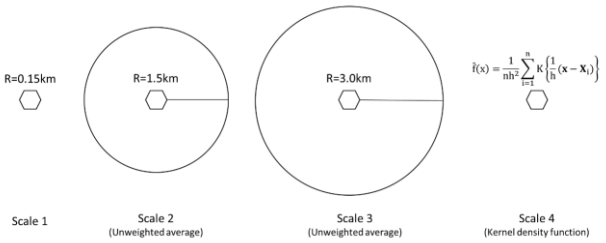

Figure 7. Scale definitions for sensitivity analysis

Table 4. Sensitivity analysis of the built environment effect on leisure propensity

	Scale 1	Scale 2	Scale 3	Scale 4
Built environment effect				
Standardized direct effect	0.10	0.06	0.10	0.04
t-statistic	3.44	1.61	2.32	1.15
Overall model goodness of fit				
Chi square (d.f.)	295.22 (133)	327.56 (133)	332.43 (133)	311.58 (133)
RMSEA point estimate	0.029	0.032	0.032	0.031
RMSEA (90% C.I.)	(0.025 - 0.034)	(0.028 - 0.036)	(0.028 - 0.037)	(0.026 - 0.035)
CFI	0.962	0.955	0.953	0.958
TLI	0.950	0.945	0.943	0.949
SRMR	0.027	0.028	0.027	0.028

4. CONCLUSION AND FURTHER RESEARCH

This study aimed at exploring the relation between social networks, the built environment, personality traits and out-of-home leisure activity generation. Findings suggest that propensity to engage in out-of-home leisure activities is influenced by socio-demographic factors such as presence of children in household and income, social network characteristics such as network size and club membership, extraversion traits, time constraints and built environment characteristics at residential location. Although findings do support the explicit incorporation of social network characteristics in leisure travel behavior modeling, some important limitations are worth mentioning. Firstly, the extensiveness of the survey did not allow for a more in-depth information gathering on social network, so some of the networks characteristics presented in this study might be rather rough, as compare to the fine-grained details possible through more comprehensive instruments such as the ones used in the Connected Lives study used by Carrasco and Miller (2006) or

the snowball sampling study conducted by Kowald and Axhausen (2012). On the other hand, the explicit incorporation of personality traits and built environment characteristics in this analysis shed some light on the nature of these interactions.

Although the present study focused only on activity generation, more in-depth analysis on the nature of these activities is desirable, such as activity location choice etc, incorporating the negotiations between ego and alters, thus deepening our understanding of the mechanism underlying leisure behavior.

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