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Comparing Happiness Determinants for Urban Residents

A Partial Least Squares Regression Model

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Abstract: Research on happiness determinants began in the 1970s in such fields as psychology and economics. While they tended to focus on individual variables, they have recently expanded to the built environment. Regarding the built environment, transportation systems—as opposed to land use—were mostly studied in relation to the transient happiness of satisfaction from one trip rather than overall happiness based on life satisfaction. By controlling for well-researched happiness determinants (i.e., the individual's psychological and economic variables), this study sought to explore how the built environment, especially transportation system variables, affect overall happiness. To this aim, we used a partial least squares regression model with a total of 61 research variables and tested it using data from a 2018 Seoul survey (n = 5,515 household heads). Through using the 2018 data, we could evaluate the environment for cyclists and pedestrians, and taxi, subway, and bus users. Based on the analytical results, this study concludes that to promote happiness, the government would do well to implement marketing/branding strategies to heighten the identity of, and attachment for, the city (i.e., to increase the pride its citizens feel in calling it their home), and to improve transportation infrastructure for better mobility and accessibility (of motorized—rather than nonmotorized—transportation, particularly taxis and buses). Between nonmotorized transport methods, the pedestrian environment is more important in urban centers than in residential neighborhoods, and the cycling environment is largely considered less significant. These overall happiness-related findings on transportation systems stand in contrast to those from studies on transient happiness from a single trip.

1. INTRODUCTION: HAPPINESS OF THE INDIVIDUAL AND SUSTAINABILITY OF THE CITY

The ultimate goal of human beings is happiness (Visentin, 2014). The cities in which they live tend to be artificially constructed to improve their happiness (Cunningham, 2011). Thus, cities that cannot improve happiness levels (or indeed, actively detract from them) lose their citizens, decline, and become unsustainable (Cloutier, Larson, & Jambeck, 2014). As an overarching and general concept, sustainability consists of three factors—economic, environmental, and social—and thus, human happiness

necessitates economic vitality, environmental quality, and social equity (procedural justice is occasionally added as political sustainability) (Neuman, 2005). Further to this conceptual definition, a city's sustainability may be more specifically evaluated from the perspectives of capacity, balance, fitness, resilience, and diversity (Neuman, 2005). (Carrying) capacity is an economic concept that refers to non-declining consumption over time, that is, a managed growth within a city's embedded limit. Balance, the most widely known concept, refers to the economy–environment–society harmony. Notably, these three axes are unable to grow separately grow but, as they are irreplaceable, they must be in accord. The concepts of fitness and resilience serve to establish the relationship between a city and its members (citizens, their activities, legislations, institutions, technologies, etc.). Fitness is a condition for the members and denotes that newly introduced members should fit the requirements of, or be acceptable to, the city. As a capacity of a city/system, resilience is its ability to cope with and quickly recover from the introduction and impact of external members. Lastly, diversity is defined by the types of members located in the city, and their coexistence is based on mutual understanding and reciprocal learning.

Therefore, a city's influence on happiness is both immediate and extensive. Thus, multiple institutions, such as the Center for Thriving Places (happycity.org.uk), What Works Center for Wellbeing (whatworkswellbeing.org), WalletHub (wallethub.com), Gallup-Sharecare (wellbeingindex.sharecare.com), and the Office of Civic Wellbeing (wellbeing.smgov.net), calculate the indices of city happiness, wellbeing, and quality of life for major cities—both on a national and global level—and publicize their scores. Nevertheless, happiness studies—most of which are conducted in the fields of economics and psychology—have tended to focus heavily on socioeconomic variables, such as income, gender, and age, and such psychological variables as personality (Lee & Jung, 2013). Particularly, compared to the effects of public goods and policies on citizens' happiness (Frey & Stutzer, 2012), how a city's built environment relates to happiness has not been sufficiently explored. While a handful of studies (e.g., Lee & Jung, 2013) have recently examined how happiness is affected by land use—itself a major component of the built environment (Frank & Engelke, 2000)—comparatively few studies have systematically studied transportation systems, the other significant component.

Therefore, while widely controlling for the above-stated variables in terms of life situation (socio-demographics), attitudes/personality, and land use, this study will test the transportation systems–happiness relationship. It is worth noting that the term "happiness" has also been referred to as quality of life, wellbeing, and life satisfaction. Terms are still mixed in studies on the effects of public policy and land use on happiness (Lee & Jung, 2013). However, after the launch of academic journals dedicated to happiness in the 1970s (e.g., the *Journal of Happiness Studies*), the definition of happiness has generally reached the following consensus. Quality of life consists of objective and subjective wellbeing, though these do not necessarily coincide. The latter depends on individuals' psychology. Thus, drinking alcohol might lower objective wellbeing, but heighten subjective wellbeing. As part of subjective wellbeing, happiness is defined as overall life satisfaction. Meanwhile, happiness may be further classified into evaluative and affective happiness. The former is based on the individual's evaluation of their entire life—this is closer to the intrinsic definition of happiness—while the latter hinges on personal feelings concerning the present and recent past.

Regarding affective happiness, transportation research has tended to measure even shorter-time transitory happiness, such as the utility of a single trip. For example, Morris and Guerra (2015) analyzed variations in travel satisfaction (travel-related happiness) according to which travel mode is chosen. They found that walking was the happiest mode, followed by automobiles and public transit. However, insofar as transit trips usually include walking as a link, and for their initiation/completion at the point of departure/arrival, they concluded that public transit, generally speaking, more effectively improves happiness than automobiles. This transportation research on happiness grew from the 2010s by analyzing the determinants of the travel happiness of one trip. In addition to travel modes, studies analyzed trip duration, the existence/number of companions, on-the-way activities/non-activities (e.g., taking a rest, thinking, napping, and getting reading for a transition to another type of activities) while controlling for life situation variables, such as gender, age, and income, and occasionally even for psychological variables, like travel attitudes (Fellesson & Friman, 2008).

In contrast to these transportation studies on travel-related happiness, a feature of the current study is that it attempts to examine how evaluative happiness (that is, overall life satisfaction) is affected by transportation systems variables. To do so, this study uses the 2018 version of the Seoul Survey (a quality of life survey for Seoul residents) so as to extract all research variables and their data: life situation, attitudes/personality, land use, happiness, and transportation systems. Launched in 1993, the annual Seoul Survey selects 20,000 households in which all members above the age of 14 are asked to respond. All data are publicly available, so one may consider using data for multiple years. Notably, the survey does not use a panel, meaning that any pooled data analysis could be used instead of a panel analysis. However, an undisclosed 70% of the sample continues to participate in the survey each year, while the remaining 30% changes, and the multiple data may fail to secure the independence assumption (i.e., possible issue of the temporal autocorrelation). A more critical aspect is that the 2018 version uniquely included questions about the bike use and commuting environment, allowing for a more comprehensive understanding of the transportation systems–happiness relationship.

The paper is structured as follows. The next section discusses what affects happiness, and identifies its elements and explanatory variables. Then, the data source for measuring the variables (the 2018 Seoul Survey) is described, followed by an explanation of how a subsample was extracted from the entire survey for the testing of the research model. The analytical technique section presents the grounds for employing a technique for analyzing the model, partial least squares (PLS) regression, and its conceptual and mathematical expression. Subsequently, analytical findings are discussed in relation to life situation, attitudes/personality, land use, and transportation systems, respectively. Based on the findings, this study concludes with policy implications, its own limitations, and future research directions.

2. RESEARCH VARIABLES: HAPPINESS DETERMINANTS

As the independent variable, this study selected a total of 56 items regarding life situation, attitudes, land use, and transportation. Happiness was defined as a factor with five indicator variables, as per the Seoul Survey.

Since its initiation in 2003, the Seoul Survey measures happiness in five areas: (1) health conditions, (2) financial conditions, (3) relations (with friends and relatives), (4) home life, and (5) social life (work, school, religion, hobbies, and fraternity/sorority). These are rated on an 11-point Likert-type scale (0 "the unhappiest status" and 10 "the happiest status"). The survey item is as follows. "Do you think you are happy these days? As 10 as the happiest case and 0 as the unhappiest case, please mark your happiness score for each area." Through the year-to-year evaluation, this measure has secured reliability–validity. This has also been confirmed with the data for this particular survey: Cronbach's $\alpha = 0.818$, Dillon-Goldstein's $\rho A = 0.820$, composite reliability = 0.873, and Fornell and Larcker's AVE = 0.579.

As the most frequently studied characteristic in social science studies on happiness, life situation was evaluated with the following 13 variables: female (discrete), birth year and its square, marriage (discrete), disability (discrete), stress (5-point rating scale from 1 "not felt at all" through 5 "felt very much"), religion (discrete), job (discrete), house ownership (discrete), actual and perceived household income, actual and perceived personal income (perceptions were scaled from 1 "the lowest class" to 10 "the highest class").

Both disability (Moller, 2011; Oswald & Powdthavee, 2008) and stress (Schiffrin & Nelson, 2010) have long been studied in public administration relative to evaluative and affective happiness, respectively. Insofar as marital status and religion are considered happiness elements (for home life and social life happiness) in the Seoul Survey, they were consistently found to amplify relationships, and improve happiness, in different temporal and spatial settings (Boarini et al., 2012; Diener et al., 1999; Helliwell, John F. & Wang, 2011; Helliwell, John F, 2003; Welsch, 2009). Indeed, according to Diener and Seligman's oft-cited paper, "Very Happy People," the top 10% of the happiest people sustain high-quality and affluent relationships.

The impact of gender and age on happiness is expected to differ between Western studies (which have dominated happiness discussions) and their East Asian counterparts. Western studies have tended to show that females report higher rates of happiness, and that age has a U-shaped relationship with happiness (Choi & Moon, 2011). Particularly regarding age, affluent after-school relational and extracurricular activities, and post-retirement leisure opportunities, tend to equate to a higher quality of life among younger and older populations, respectively. The working-age population, however, tend to have a lower happiness level, possibly due to work-related stress. By contrast, in somewhat patriarchal East Asian societies (e.g., Japan, South Korea, and Taiwan), males may be the happier group and the reverse U-shape relationship is expected between age and happiness; this is often attributed to the overwhelming stress of study and lack of leisure among younger people, and to post-retirement economic hardship due to insecure pension systems among the older population. Middle-aged happiness in East Asia is partially related to the hard-working culture. In order to test the hypothesized nonlinear relationship between age and happiness, this study examines birth year squared in addition to birth year. The hypothesis is accepted only if the original and squared variables have negative and positive coefficients, respectively, and rejected otherwise (then, the U-shape relationship between age and happiness is supported, as argued in Western studies). If both have positive/negative coefficients, this would mean that those of advanced ages have extremely higher/lower levels of happiness.

Job, house ownership, and household and personal income (both real and perceived) are related to economic happiness. Those who are employed, own their house, and have a higher income are expected to feel happier. Income is a key variable in economic research on happiness. Notably, the Easterlin Paradox states that, when income reaches a certain level, any additional income does not improve happiness. This was tested by analyzing squared variables in addition to their original forms, yet all of the variables were insignificant.

A feature of this study is that income was separated into household and personal incomes, each of which was further classified into its perception and reality. Household-level variables were excluded from the household member questionnaire to which all adults were asked to respond, yet included in the household head questionnaire. Accordingly, this study used a household subsample; household head data were also extracted from the household member database. This study expects that individuals' behavior and psychology, including happiness, are determined by household (as opposed to personal) income, and that people who consider themselves affluent are happier than those who are objectively wealthy. Thus, one hypothesis is that, among the four income variables, perceived household income is significant (or, the most important). Meanwhile, reality influences perception (Gim, 2011), so when perception is controlled for, the actual income may still directly affect happiness (perception as a partial mediator in the reality–happiness relationship), or become insignificant in itself (perception as a full mediator) if the income has an effect only through perception.

The current study employed the following 12 attitudinal and personality variables: 4 categories (rest, hobby, family life, network building) of living time satisfaction (5-point scale from 1 "very dissatisfied" to 5 "very satisfied"); trust in 4 different groups (family, friends, neighbors, public agencies; rated from 1 "not trusted at all" to 5 "very trusted"), conservatism/liberalism (11-point scale of 0–10, with 5 as a mid-point); social activities; group activities; volunteering; and donation. Living time satisfaction was separately evaluated as: (1) time for mental and physical rest, (2) time for self-development and hobbies, (3) time spent with family, and (4) time for expanding networks with colleagues and acquaintances. Trust was evaluated according to four levels of closeness: (1) family, (2) friends, (3) neighbors, and (4) public institutions (e.g., Seoul Metropolitan Government and district governments). With high levels of living time satisfaction, and wider and stronger degrees of trust, people will have a stronger feeling of happiness.

Regarding ideological beliefs, Western studies have largely found that conservatives have a higher tendency to report feeling happy (Schlenker, Chambers, & Le, 2012). However, recent studies in Korea found the opposite to be true (Chung, 2011), and the statistical significance of this argument needs to be checked. Lastly, group activities, volunteer activities, and donations are associated with social life happiness, and are directly comparable to general group activities. Indeed, the Seoul Survey comprehensively defines group activities as fraternities/sororities, school/hometown alumni associations, clan meeting, online communities, hobby clubs, volunteer groups, civic groups, labor/profession unions, political parties, religious groups, and others. Volunteering is based on a higher level of commitment, and donation was reported to require stronger levels of motivation, both of which accordingly increase self-esteem and happiness (Nam, Yee, & Kim, 2012). It is worth noting that the Seoul

Survey defines donations as direct support for the recipient and indirect support through press media, fundraising institutions, religious groups, and workplaces, etc.

This study detailed the built environment using 23 land use variables and 8 transportation system variables. Regarding the former, the following items were included on the living environment from the inception of the Seoul Survey (using a 5-point scale from 1 "very dissatisfied" to 5 "very satisfied"): (1) housing environment (water supply and sewer systems, housing, electricity, communication, transportation, green spaces, etc.); (2) economic environment (living expenses, income, work time, etc.); (3) social environment (welfare, transmittable illnesses, medical facilities, etc.); and (4) educational environment (education expenses and conditions, etc.). Meanwhile, the 2018 version of the Seoul Survey again separately asked about satisfaction levels with green spaces among housing environment variables, using a 5-point level of satisfaction with "greens (parks, forests, etc.)" in the residential area. How green spaces influence wellbeing and quality of life is a major theme in landscape architecture (Kim, M., Gim, & Sung, 2017).

Along with those on the living environment, the Seoul survey has continuously included seven items on living safety—particularly in its household head questionnaire. They measure the severity of safety-related issues in the residential area on a 4-point scale (from 1 "not serious at all" to 4 "very serious," the items were rescaled to make higher values present better safety): (1) noise, (2) air pollution, (3) lack of rest areas and green spaces, (4) water pollution, (5) crime and violence, (6) street waste, (7) parking problems (illegal parking, parking space shortage, etc.). Notably, among the above four living environment variables, satisfaction with the housing environment partially evaluates transportation services, and parking problems are address as a living safety variable. This is to say that these two items, included in the household head survey, measured certain transportation characteristics.

In its community section, the 2018 Seoul Survey uniquely defined the neighborhood as being an area of approximately one-kilometer radius from the residence (or, a 15-minute walk distance), and measured the level of agreement with 4 neighborhood characteristics (exercise, facilities, safety, and help) on a 5-point scale from 1 "not agree at all," through 5 "strongly agree": (1) "my neighborhood is good for such exercises as jogging and walking;" (2) "my neighborhood has a sufficient number of public facilities (community centers, libraries, parks, etc.);" (3) "my neighborhood is safe;" and (4) "people in my neighborhood are willing to give me help when needed."

Considering the possibility that certain land use characteristics were not evaluated by other variables in the research model, this study employed seven variables to comprehensively evaluate the characteristics of Seoul and the particular neighborhood: (1) continuous residence in Seoul (months); (2) perception of Seoul as one's hometown (from 1 "very strong feeling" through 4 "rarely no feeling", the 4-point item was rescaled to make higher values present a stronger feeling); (3) intention to remain in Seoul 10 years from the survey time (4-point scale from 1 "not agree at all" to 5 "strongly agree"); (4) pride as a Seoul citizen (0 "no pride at all" to 10 "very high pride"); (5–6) residence in a (sub)center (Urban Center, comprising the districts of Jung and Jongno; Yeouido Subcenter; or Gangnam Subcenter, comprising the Seocho, Gangnam, and Songpa districts); and (7) continuous residence in the current address (months). Whether, and for how long, an

individual resides at their current address—be it in a (sub)center, Gangnam, or anywhere in Seoul—has a possible effect on happiness by forming hometown perception, future residence intention, and/or pride. However, it is certainly possible that these psychological identity and attachment variables are unconnected with the location and period of residence. According to the confirmation of this possibility, one may more highly prioritize projects improving the built environment or city marketing strategies.

Lastly, transportation systems were evaluated in terms of satisfaction level with 8 types of travel settings (1 "very dissatisfied," through 5 "very satisfied"). First introduced in its 2018 version, the survey measured overall satisfaction with the commuting environment. Moreover, the survey has continuously asked respondents to report their satisfaction with 3 types of transportation modes in Seoul by comprehensively considering amenity, punctuality, and kindness, among other factors (only those with experience regarding the modes were asked to respond): (1) bus (city bus, community shuttle bus, express bus, etc.); (2) subway; and (3) taxi. Notably, the 2018 survey also collected data on the overall satisfaction with the bike use environment from those who cycle for mobility (commuting, shopping, work, etc.), exercise (leisure, etc.), or any other purposes. Lastly, from its inception, the survey asked about satisfaction with the pedestrian environment in relation to three different aspects: (1) residential area, (2) urban core (downtown), and (3) nighttime. As such, with the 2018 survey data, one can evaluate all major travel modes, including taxis (while items on the travel settings for automobiles do not exist, they could be at least indirectly identified by assuming taxis as proxies), public transit (as represented by buses and the subway), and nonmotorized modes (bicycles and walking).

3. DATA

This study used the 2018 Seoul Survey data, which became publicly available in May 2019. As the most recent survey data available at the time of writing, the data more accurately reflect the current urban settings. Additionally, as this study focuses on transportation systems, the 2018 data has the largest number of transportation-related variables among all of its previous incarnations. The Seoul Survey includes regular items on, for example, citizens' quality of life and the urban living environment, and adds questions concerning major current issues. For instance, the 2018 survey evaluated smart city projects in line with those conducted by the central government, and the local currency system as introduced by the city government, in 2018. More specifically, and as discussed in "Research variables: happiness determinants", the 2018 survey additionally measured levels of satisfaction with the commuting and bike use environments.

The survey asked household heads to answer an additional set of questions in comparison with other household members (which predominantly concerned such household characteristics as household income). Due to several items in the household head questionnaire accurately reflecting the built environment, this study extracted a subsample consisting only of the heads. As such, this study was able to further analyze otherwise unavailable data in the household member database. This data includes: (1–2) residential district (whether the respondents live in a [sub]center or Gangnam); (3) house ownership; (4–7) housing, economic, social, and educational satisfaction with the living environment; (8–14) the

impact of noise, air pollution, lack of rest areas and green spaces, water pollution, crime and violence, street waste, and parking on the perception of living safety/risk; and (15–16) the reality and perception of household income.

To evaluate the happiness of those who experienced all major travel modes, this study selected data for those who responded to items regarding satisfaction with the bike environment (only bike users answered these items). We similarly selected commuters. As such, from a total of 42,991 household heads, this study selected 30,120 who commute to school/work. This number was further reduced to 7,038, according to bike experience. We also extracted 5,677 cases of the employed (only these were asked to answer questions on objective and perceived personal income). Finally, by excluding those who have not used buses, the subway, and taxis—i.e., those who did not report their satisfaction with these modes—this study selected 5,515 cases for statistical analysis.

4. ANALYTICAL TECHNIQUE: PARTIAL LEAST SQUARES REGRESSION

This study used PLS instead of the traditional ordinary least squares (OLS) as the regression model's estimator. This was chosen—as highlighted in related studies—happiness predictors are usually highly correlated (Im & Hong, 2014) and easily cope with the multicollinearity issue. In this particular study, the collinearity could be expected between the age and its square, between the reality and perception variables (e.g., actual and perceived income), and between the residence variables (e.g., urban center and Gangnam). Moreover, theoretical and empirical correlations were expected between the sub-concepts/different types of the same concept: (1) four types of the time use satisfaction; (2) four trust variables according to the degrees of closeness (from family to public agencies); (3) four types of the living environment and green space satisfaction; (4) seven perceived living safety variables; (5) four neighborhood perception variables; (6) continuous residence in Seoul and in the current residence, and perceptions of pride in being a citizen; and (7) eight commuting and transportation mode satisfaction variables.

When multicollinearity occurs in OLS regression, one variable among collinear variables is chosen through a variable selection technique (e.g., stepwise selection, or one with the highest loading on a factor/principal component that consists of collinear variables. Alternatively, factor scores (rather than variable values) can be used by combining the variables into a factor/component. However, the variable selection makes it impossible to analyze the removed original variables, and the variable combination makes the factor/component meaning unclear, thereby leading to limited policy implications (Gim, 2013).

When multicollinearity is present, PLS regression can be used with all of the original variables. Developed by Herman Ole Andreas Wold and refined by Svante Wold (Wold, Sjöström, & Eriksson, 2001), the use of this technique has rapidly grown in popularity since the early 2000s. The basic equation is as follows:

$$X = BR^{B} + E$$
$$Y = CS^{B} + F$$

In the equation, X is an independent variables matrix (f * g) and Y is a dependent variables matrix (f * q). The coefficients (B and C) are f * k matrices for the projections of X and Y—also called X and Y factor matrices—respectively. Each of R and S is a g * k and q * k orthogonal loading matrices—with E and F as disturbances. X and Y are identified in order to maximize the B–C correlation. Within this study, X and Y are listed in *Table 1*. To run PLS regression, this study used SmartPLS 3.0.

5. RESULTS

Table 1 displays the descriptive statistics of 60 variables. It shows the means, standard deviations, and ranges for 50 continuous variables, including 5 happiness indicators, and the frequencies and proportions for 10 discrete (binary) variables. In addition to the above 60, the analytical model included the age "squared" and consequently used 61 variables (= 56 independent variables + happiness factor with 5 indicator variables).

Table 1. Descriptive statistics

Continuous variables [codes]	**Mean**	**SD**	**Min**	**Max**
Birth year [BYear]	1,967.60	12.404	1,925	1,996
Stress [Stress]	3.45	0.879	1	5
Job satisfaction [Sat_Job]	3.508	0.756	1	5
Household income: reality [HIncome]	512.849	193.054	75	3,000
Household income: perception [Per_HIncome]	5.732	1.229	1	10
Personal income: reality [PIncome]	314.257	135.994	25	3,000
Personal income: perception [Per_PIncome]	6.522	1.395	1	10
Living time satisfaction: mental and physical rest [Sat_LivTim_Rest]	3.501	0.86	1	5
Living time satisfaction: personal development and hobbies [Sat_LivTim_Hobb]	3.257	0.914	1	5
Living time satisfaction: family activities [Sat_LivTim_Fami]	3.361	0.844	1	5
Living time satisfaction: network building [Sat_LivTim_Netw]	3.15	0.862	1	5
Trust: family [Trust_Fam]	4.343	0.675	1	5
Trust: friends [Trust_Fri]	3.821	0.738	1	5
Trust: neighbors [Trust_Nei]	3.149	0.812	1	5
Trust: public institutions [Trust_Pub]	3.205	0.87	1	5
Conservativism [Conserv]	4.771	1.863	0	10
Living environment satisfaction: housing [Sat_LivEnv_Hous]	3.488	0.852	1	5
Living environment satisfaction: economic [Sat_LivEnv_Econ]	3.285	0.863	1	5
Living environment satisfaction: social [Sat_LivEnv_Soci]	3.327	0.899	1	5
Living environment satisfaction: educational [Sat_LivEnv_Educ]	3.281	0.856	1	5
Park and green satisfaction [Sat_Gre]	3.459	0.825	1	5
Living safety perception: noise [Per_LivSaf_Noi]	2.681	0.785	1	4
Living safety perception: air pollution [Per_LivSaf_Air]	2.517	0.815	1	4
Living safety perception: rest and green space shortage [Per_LivSaf_Gre]	2.712	0.78	1	4
Living safety perception: water pollution [Per_LivSaf_Wat]	2.814	0.768	1	4
Living safety perception: crime and violence [Per_LivSaf_Cri]	2.656	0.786	1	4
Living safety perception: street waste	2.534	0.814	1	4

[Per_LivSaf_Was]				
Living safety perception: parking [Per_LivSaf_Par]	2.343	0.885	1	4
Neighborhood perception: fit for walking and jogging exercise [Per_NH_Exer]	3.769	0.753	1	5
Neighborhood perception: enough public facilities [Per_NH_Faci]	3.651	0.801	1	5
Neighborhood perception: safety [Per_NH_Safe]	3.541	0.792	1	5
Neighborhood perception: voluntary help [Per_NH_Help]	3.275	0.832	1	5
Continuous residence (months): Seoul [RMonth_Seo]	380.906	158.762	12	924
Hometown perception: Seoul [Per_Hometown]	3.155	0.822	1	4
Future residence intention: Seoul [SeoulInten]	3.758	0.902	1	5
Pride: Seoul [SeoulPride]	7	1.476	0	10
Continuous residence (months): current address [RMonth_Hom]	95.24	84.246	0	756
Commuting environment satisfaction [Sat_ComEnv]	3.403	0.828	1	5
Transportation environment satisfaction: taxi [Sat_TraEnv_Tax]	3.316	0.921	1	5
Transportation environment satisfaction: subway [Sat_TraEnv_Sub]	3.805	0.829	1	5
Transportation environment satisfaction: bus [Sat_TraEnv_Bus]	3.758	0.813	1	5
Bike environment satisfaction [Sat_BikEnv]	3.519	0.85	1	5
Pedestrian environment satisfaction: neighborhood [Sat_PedEnv_Nei]	3.512	0.787	1	5
Pedestrian environment satisfaction: urban centers [Sat_PedEnv_Cen]	3.512	0.781	1	5
Pedestrian environment satisfaction: night [Sat_PedEnv_Nig]	3.245	0.862	1	5
Happiness: health [Happy_Hea]	7.447	1.29	1	10
Happiness: finance [Happy_Fin]	6.547	1.445	0	10
Happiness: relationship [Happy_Rel]	7.216	1.409	0	10
Happiness: home life [Happy_Hom]	7.257	1.379	0	10
Happiness: social life [Happy_Soc]	7.085	1.426	1	10

Discrete variables	**Values**	**f**	**%**
Female [Female]	Male (= 0)	4,866	88.2
	Female (= 1)	649	11.8
Marriage [Marriage]	Single (= 0)	1,049	19
	Married (= 1)	4,466	81
No handicap [Nhandicap]	Handicapped (= 0)	75	1.4
	Normal (= 1)	5,440	98.6
Religion [Religion]	No (= 0)	2,999	54.4
	Yes (= 1)	2,516	45.6
House ownership [HousOwn]	No (= 0)	2,270	41.2
	Yes (= 1)	3,245	58.8
Group activities [GroupActiv]	No (= 0)	629	11.4
	Yes (= 1)	4,886	88.6
Volunteer activities [Volunteer]	No (= 0)	4,693	85.1
	Yes (= 1)	822	14.9
Donation [Donation]	No (= 0)	3,076	55.8
	Yes (= 1)	2,439	44.2
Urban center residence [Dist_Centers]	No (= 0)	4,099	74.3
	Yes (= 1)	1,416	25.7
Gangnam residence [Dist_Gangnam]	No (= 0)	4,652	84.4
	Yes (= 1)	863	15.6

As shown, continuous variables have enough variations for inferential statistics. For binary variables, the distributions of their values were relatively even in the two categories, except for the no-handicap variable: respondents with disabilities constituted only 1.4% (75 persons) of the total participants. However, as another strength of PLS regression, it works

effectively regardless of the variable distribution. In an extreme case, a PLS model may require only six cases (Tenenhaus et al., 2005); PLS regression is particularly useful when independent variables outnumber the sample size. Nonetheless, regarding continuous variables, their wider range may refer to enhanced representativeness and external validity. For most survey items on Likert-type scales, their maximums and minimums were the lowest and highest response options, except for health and social life happiness—for which no respondents checked the option of "the unhappiest status" (= 0).

For statistical inference, PLS regression uses the computationally intensive bootstrapping. For its settings, this study followed the academic consensus: the actual sample size (= 5,515) was set as the resample size and for the stability of analytical results, and the number of resampling was set to 5,000 times (a large number is generally recommended). We will now present and interpret the major results of the analysis.

The complete report, automatically produced by SmartPLS, can be found at: https://drive.google.com/open?id=1LK1EnDJXRgG4Z2JDgDfPIdJMlKxLf-uX

For the reproducibility of the analytical results, the refined data for the analysis is stored at:
https://drive.google.com/open?id=1RejaN6KtDxwyh1eY47c0Vxw9YbZ0-S88

Lastly, the raw data—publicly available through the Seoul Metropolitan Government—can be found at: https://data.seoul.go.kr/dataList/OA-15565/F/1/datasetView.do (The ID variable is key for data comparison.)

As shown in *Table 2*, the model fit was generally high. The model accounted for a large variance (R2 = 0.334 and adjusted R2 = 0.327) and, as a goodness-of-fit index, NFI far surpassed the criterion of 0.9. Moreover, SRMR, a badness-of-fit index, was almost negligible and RMSθ was at the acceptable level. However, it is worth noting that the cutting point for RMSθ has been insufficiently studied. PLS regression evaluates the model fit by comparing coefficients estimated from the original sample, and the means of the samples, through bootstrapping. Due to their negligible differences, one can reason that the data and model structure are without particular issues.

The PLS regression model specified in this study is structural equation modeling (PLS-SEM), which improves the traditional regression structure. Reflecting on the fact that the happiness concept comprised of five indicators within the Seoul Survey, this study combined the indicators into one factor. By individually running factor analysis, we were able to use factor scores in the analytical model. However, if the regression and factor analyses are conducted together within a model—as was the case here—we can check (1) whether the indicators are well suited in the model via the factor, and (2) how independent variables affect individual indicators. The effects on the indicators can be calculated by multiplying the two coefficients. For example (and as seen in *Table 2*), the effect of pride as a Seoul citizen on relational happiness is 0.142 (= 0.183 * 0.776).

Table 2. Path coefficients

	Standardized coef.					
	Original sample	**Sample mean**	**SD**	**t**	**p**	**VIF**
Life situation						
Female*	0.011	0.011	0.015	0.736	0.462	
BYear	7.153	7.144	3.332	2.147	0.032	
BYear2	-7.065	-7.056	3.332	2.121	0.034	
Marriage*	0.031	0.031	0.016	1.963	0.050	
Nhandicap*	0.007	0.007	0.012	0.566	0.572	
Stress	-0.103	-0.102	0.012	8.576	0.000	
Religion*	0.000	0.000	0.012	0.025	0.980	
Sat_Job	0.059	0.059	0.012	4.719	0.000	

HousOwn*	0.003	0.003	0.012	0.220	0.825	
HIncome	-0.014	-0.014	0.013	1.103	0.270	
Per_HIncome	0.133	0.133	0.014	9.144	0.000	
PIncome	0.077	0.077	0.012	6.290	0.000	
Per_PIncome	0.073	0.073	0.013	5.471	0.000	
Attitudes/personality						
Sat_LivTim_Rest	0.037	0.036	0.015	2.451	0.014	
Sat_LivTim_Hobb	0.051	0.051	0.015	3.343	0.001	
Sat_LivTim_Fami	0.054	0.053	0.014	3.957	0.000	
Sat_LivTim_Netw	0.012	0.012	0.014	0.832	0.406	
Trust_Fam	0.136	0.135	0.014	9.428	0.000	
Trust_Fri	0.058	0.058	0.014	4.197	0.000	
Trust_Nei	0.036	0.035	0.015	2.420	0.016	
Trust_Pub	0.021	0.021	0.014	1.476	0.140	
Conserv	-0.007	-0.007	0.012	0.616	0.538	
GroupActiv*	0.014	0.014	0.012	1.160	0.246	
Volunteer*	0.011	0.011	0.011	0.950	0.342	
Donation*	-0.025	-0.024	0.012	1.991	0.047	
Land use						
Sat_LivEnv_Hous	-0.007	-0.007	0.013	0.524	0.600	
Sat_LivEnv_Econ	0.000	0.000	0.013	0.005	0.996	
Sat_LivEnv_Soci	0.015	0.015	0.013	1.199	0.231	
Sat_LivEnv_Educ	0.007	0.006	0.013	0.509	0.611	
Sat_Gre	0.057	0.057	0.013	4.511	0.000	
Per_LivSaf_Noi	-0.008	-0.008	0.013	0.614	0.539	
Per_LivSaf_Air	0.011	0.011	0.014	0.756	0.450	
Per_LivSaf_Gre	-0.004	-0.004	0.014	0.290	0.772	
Per_LivSaf_Wat	-0.006	-0.006	0.015	0.383	0.702	
Per_LivSaf_Cri	-0.004	-0.004	0.014	0.306	0.760	
Per_LivSaf_Was	-0.011	-0.011	0.014	0.830	0.407	
Per_LivSaf_Par	0.003	0.004	0.012	0.273	0.785	
Per_NH_Exer	-0.020	-0.020	0.014	1.373	0.170	
Per_NH_Faci	0.001	0.001	0.014	0.100	0.920	
Per_NH_Safe	0.000	0.000	0.014	0.002	0.998	
Per_NH_Help	0.000	0.000	0.014	0.014	0.988	
RMonth_Seo	-0.081	-0.081	0.014	5.842	0.000	
Per_Hometown	0.027	0.027	0.014	1.945	0.052	
SeoulInten	0.015	0.014	0.014	1.065	0.287	
SeoulPride	0.183	0.183	0.015	12.489	0.000	
Dist_Centers*	-0.015	-0.015	0.017	0.879	0.379	
Dist_Gangnam*	-0.042	-0.042	0.017	2.424	0.015	
RMonth_Hom	-0.012	-0.012	0.014	0.870	0.385	
Transportation						
Sat_ComEnv	-0.022	-0.022	0.012	1.889	0.059	
Sat_TraEnv_Tax	0.068	0.068	0.014	5.007	0.000	
Sat_TraEnv_Sub	0.010	0.011	0.013	0.817	0.414	
Sat_TraEnv_Bus	0.064	0.064	0.013	4.937	0.000	
Sat_BikEnv	-0.009	-0.009	0.012	0.692	0.489	
Sat_PedEnv_Nei	-0.015	-0.015	0.013	1.179	0.238	
Sat_PedEnv_Cen	0.039	0.039	0.013	2.940	0.003	
Sat_PedEnv_Nig	0.006	0.006	0.014	0.422	0.673	
Happiness: outer loadings†						
Happy_Hea	0.732	0.732	0.009	78.324	0.000	1.528
Happy_Fin	0.738	0.737	0.008	89.813	0.000	1.468
Happy_Rel	0.776	0.776	0.008	103.080	0.000	1.691
Happy_Hom	0.784	0.784	0.007	105.555	0.000	1.706
Happy_Soc	0.775	0.775	0.007	105.402	0.000	1.661

R^2 = 0.334, adjusted R^2 = 0.327, SRMR = 0.015 (cutoff ≤ 0.10), NFI = 0.980 (cutoff ≥ 0.90), RMSθ = 0.120 (cutoff ≤ 0.12)

* Binary variables; reference categories with the value of 0 are "no."

† Construct reliability and validity: Cronbach's α = 0.818, Dillon–Goldstein's ρA = 0.820, composite reliability = 0.873, AVE = 0.579

According to multiple criteria, the happiness factor had exceedingly high levels of reliability and validity (see "Research variables: happiness determinants"). This, combined with the VIFs, show that the indicators were unaffected by the multicollinearity issue (cutoff ≤ 4 or 5). In the loadings order of the indicators, the factor was well reflected by mental happiness—specifically, home life, social life, and relationship all had a score of 0.78—financial happiness (0.74), and health happiness (0.73), which partially supports the findings of previous studies on the importance of social relations (Diener & Seligman, 2002). Notwithstanding, the loading differences were generally modest and, all factors well-reflected all indicators (high loadings are another major criterion in assessing validity).

As for the four areas of the independent variables, 62% of the life situation variables (= 8 / 13), 58% of the attitudinal variables (= 7 / 12), and half of the transportation variables (= 4 / 8) were found to be significant, whereas only 22% of the land use variables (= 5 / 23) were significant.

The significant land use variables were pride as a Seoul citizen (standardized coef. = 0.183), perception of Seoul as one's hometown (0.027), continuous residence in Seoul (-0.081), residence in Gangnam (-0.042), and satisfaction with green spaces (0.057). The influence of pride was the largest of these, and hometown perception also had a positive coefficient. By contrast, as expected associations with each of the variables, Gangnam residence and continuous Seoul residence presented negative coefficients. That is, while the Gangnam residence and the continuous Seoul, if these subjective variables are controlled for, the objective variables by themselves may have negative effects if these subjective variables are controlled for. The implication here is that city marketing strategies are desirable for improving the subjective variables. Furthermore, satisfaction with green spaces was found to be significant, thus supporting the argument within landscape architecture that green spaces promote wellbeing. Their therapeutic effects (Kim, M., Gim, & Sung, 2017) and influences on building social capital (Hong et al., 2018) have been well highlighted.

Among life situation variables, age (7.153) and its square (-7.065), marriage (0.031), stress (-0.103), and job satisfaction (0.059) were significant. In relation to income, while household income reality was only insignificant, household income perception (0.133), personal income reality (0.077), and personal income perception (0.073) were important in descending order.

First, all other variables (standardized coefficients < 1) were overpowered by age and its square (> 7). Furthermore, the opposite directions of their coefficients support previous Korean research which states that, as age increases, happiness first rises but then decreases after a certain level, forming a reverse U-shape relationship. Low happiness among each of the younger and older populations is attributed to overwhelming study loading (and lack of leisure/extracurricular activities) and, when compared to the middle-aged, considerably low disposable incomes (possibly due to untrustworthy public pension systems). As another possibility, Bardo (2017) argued that different levels of happiness according to age cohorts result from their distinct group experiences.

Western studies have found that happier people tend to be those who are under low stress, satisfied with their jobs, and married—all of which echo our findings (Layard, 2006). Notably, however, this study separated income into household and personal income, and further classified them into real and perceived amounts. Accordingly, we found that happiness is more associated with household income and subjective perception. Traditional economics

argues that consumption, which is ultimately determined by income, is a source of happiness (Mason, 2000). These results are aligned with the expectation that individuals' consumption and happiness rely largely on how they perceive the income of the household to which they are affiliated.

With regard to attitudes, (leisure) living time satisfaction variables, trust-related variables, and donation were significant. Among the leisure types (except for time use for network expansion), rest, self-development/hobby, and family time were meaningful. Their coefficients ranged between 0.04–0.05, which is slightly lower than that of job satisfaction (0.06). This implies that, while the East Asian hard-working culture makes job satisfaction more important—or perhaps because people spend more time at work than at home—the marginal difference reflects the recent social change for more optimal work–life balance (Kim, S.-h., 2018).

As theoretically conceptualized, a higher magnitude was found for trust to closer groups: family > friends > neighborhood > public agencies (insignificant). Among all variables, family trust was the most important following the above-stated age and Seoul pride variables. Actually, among the five happiness indicators, home life happiness was the most important (with the highest factor loading).

Among the eight transportation satisfaction variables, the key variable groups of this study—namely taxi (0.07) and bus (0.06) services, the pedestrian environment in urban centers (0.04), and the commuting environment (-0.02)—were meaningful in descending order. Generally, motorized transportation was more important than nonmotorized transportation (even the bike environment proved to be insignificant), a finding in stark contrast to the findings of previous studies concerned with the transitory happiness of a single trip (i.e., nonmotorized travel is more beneficial in improving happiness or travel satisfaction). Consequently, to improve overall life satisfaction, one must understand (in terms of transportation welfare) how mobility—the ability to travel where and when demand exists—contributes to the quality of life. In this sense, public transportation infrastructure with a wider service range appears to be more important than short-length travel modes (e.g., walking and cycling) whose performance depends on the traveler's ability. Notably, between the two public transportation modes, subway satisfaction was not significant. This could possibly be due to the (aforementioned) fact that subway services have less fine-tuned networks compared to bus services, and their lower accessibility may not sufficiently contribute to quality of life. Similarly, because of the highest levels of mobility and accessibility, taxi satisfaction had the largest coefficient.

Among the pedestrian environment variables, only the urban center was significant. In relation to the mobility and accessibility discussion above, this means that, to make a happier transportation environment, planners should more heavily focus on whether people can reach urban center destinations/facilities with superior aesthetics, quality, and uniqueness, than on easily-accessible local destinations. Alternatively, it could be argued that people are more sensitive to the pedestrian environment in urban centers (which generally have a higher pedestrian density), which negatively affects the quality of the environment.)

Lastly, different from our initial expectation, the commuting environment was found to significantly reduce, not increase, happiness. Among different purposes of travel, commuting has a considerably compulsory purpose (Goulias & Kitamura, 1991) and a utilitarian ground (Gim, 2015). This is to say that the generation of the commuting trip is dominated by the derived

utility rather than by the intrinsic utility of the trip itself or ancillary utilities by en-route activities. This study also considered work-based utility with the job satisfaction variable. Thus, while the derived utility is controlled for, the commuting itself leads only to disutility (Gim, 2018). Thus, this result is consistent with our assumption that increases in commuting result in more disutility per se. Indeed, the importance of the commuting variable was the lowest among those which were revealed to be significant.

6. SUMMARY

Research on happiness conducted in the fields of psychology and economics have focused on individual variables. However, while the active role of the government on citizens' quality of life has been emphasized, studies on public variables—especially those on the built environment—are at the initial stage. In particular, regarding land use and transportation systems that comprise the built environment, little is known about how transportation affects individuals' overall life satisfaction.

Using the 2018 Seoul Survey, this study evaluated the significance and magnitudes of transportation systems, as well as major happiness determinants (i.e., life situation, attitudes/psychology, and land use) for statistical control. The 2018 version uniquely measured systems for bike use in addition to other modes that have been continuously asked about (i.e., taxis, buses, and the subway). As we expected multicollinearity among a total of 56 independent variables (insofar as they were grouped into sub-concepts for the same concept), this study employed PLS, as opposed to OLS, regression in order to provide stable results under the multicollinearity condition. The regression model found that age and age squared are predominantly important variables, and that the original and squared variables had positive and negative coefficients, respectively, implying the reverse U-shape age–happiness relationship as posited by previous East Asian studies.

Aside from age, the most important variable was pride as a Seoul citizen. Among land use variables, the second-most important variable was the perception of Seoul as a hometown. While these may increase happiness, their assumed correlates (i.e., Gangnam residence and continuous residence in Seoul) were found to reduce it. This suggests that to increase happiness by deepening place identity and attachment to Seoul, city marketing approaches are more desirable than projects for improving the physical environment.

Except for the age variables, the results concerning other life situation variables, such as marriage, stress, and job satisfaction, were consistent with the findings of Western studies. Meanwhile, as a major subject in happiness economics, we separately evaluated personal and household, and by their reality and perception. As expected, individuals' (consumption and) happiness was found to rely on the subjective perception of the economic status of their households.

Lastly, among transportation system variables, taxi and bus services, and the urban center walking environment, were beneficial for higher happiness in their descending order. The finding that motorized travel outweighs nonmotorized travel implies that, in contrast to transitory happiness from a single trip, higher overall happiness about one's life can be achieved by promoting mobility and accessibility through improved motorized travel infrastructure. Moreover, when a project is considered for improving the walking environment, less accessible urban centers should be prioritized

over closer residential neighborhoods. In short, the planner's role for citizens' happiness should be to use "soft" policies to increase their place attachment (concerning land use characteristics), and to improve the "physical" settings for higher mobility and accessibility (concerning transportation systems characteristics).

This study has several limitations. By choosing a subsample of people with a combined experience of various travel modes, we eliminated 76.6% of the sample (30,120 commuters were reduced to 7,038 individuals with cycling experience). Had this elimination been systematic, rather than random, it would have harmed the external validity of the study. Thus, future studies should specify multiple models by travel mode. Secondly, the Fourth Industrial Revolution has introduced various transportation modes and services, such as owned and shared motorized/nonmotorized personal mobility, electric/hydrogen vehicles and autonomous vehicles, and shared transportation services, including car- and bike-sharing (e.g., Velib in Paris and Ddareungi in Seoul). Further research on how happiness varies by the running environment for these modes would offer novel implications for planning practice. Regarding the second limitation, transportation systems were evaluated only with subjective satisfaction with each travel mode. Other variables could possibly provide a different picture of the transportation systems–happiness relationship, such as cost efficiency, headway/interval, punctuality, and service range in time and space.

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