Chapter 21

Impacts of built environment and travel behavior on high school students' life satisfaction and future life plans: A preference-based case study in depopulated areas of Japan

Linghan Zhang[1], Junyi Zhang[2*], David Perez Barbosa[3]

[1] Post-doctoral researcher, Graduate School for International Development and Cooperation, Hiroshima University, 1-5-1 Kagamiyama, Higashi-Hiroshima, 739-8529, Japan. Email: maxzzlh@gmail.com

[2] Professor, Graduate School for International Development and Cooperation, Hiroshima University, 1-5-1 Kagamiyama, Higashi-Hiroshima, 739-8529, Japan. Email: zjy@hiroshima-u.ac.jp

[3] Former post-doctoral researcher, Graduate School for International Development and Cooperation, Hiroshima University, 1-5-1 Kagamiyama, Higashi-Hiroshima, 739-8529, Japan. Email: dapbarbosa@gmail.com

Abstract:
The impacts of built environment on travel behavior have been widely examined in the transportation literature. However, insights from the perspective of young people are very limited. This study focuses on high school students in depopulated areas of Japan. The aim of this study is to measure the interrelationships between the built environment, travel behavior, life satisfaction, and future life plans. The focus on future life plans makes this study unique. Data from 1,104 high school students in Hiroshima Prefecture of Japan were collected in 2016. Analyses based on a structural equation model found that the built environment associated with high school students' study life and non-study life can be barriers to making future life plans. The built environment and travel behavior have negative effects on life satisfaction. Thus, the development of depopulated areas should consider young people's needs from a variety of perspectives.

Key words: high school students; built environment; future life plans; travel behavior; life satisfaction; depopulated areas; Japan

INTRODUCTION

The impact of the built environment on people's behavior has long been of interest to transportation and urban planners. The most-discussed topics are its links with travel behavior and physical activities (Perdue, Stone & Gostin, 2003; Ewing & Cervero, 2001; Ding & Gebel, 2012; Wang & Zhou, 2017). Meanwhile, in the last decade, there is an increasing interest in adolescents' behavior (10–18 years old) under the influence of the built environment (Collins et al., 2010; Lake & Townshend, 2012). The related research includes two main questions: how to design effective built environment and promote active school travel modes for students (Mitra, 2010; Lin & Chang, 2010;

[*] Corresponding author: zjy@hiroshima-u.ac.jp

Broberg & Sarjala, 2015); and how the built environment affects young people's physical activities and their health outcomes (Holt, 2008; Santos et al., 2009; De Farias Junior et al., 2011; Assemi & Behrang, 2018). However, existing studies mainly focus on adults, and research on young people is very limited in both quantity and diversity (Holt et al., 2008). Many other important aspects of young people's lives are neglected in the literature, such as life satisfaction and future life plans under the influence of the current built environment, with very little relevant research focusing on high school students.

Adolescence is one of the most important periods for students, especially high school students under the age of 18, for cultivating behavior patterns and ways of thinking. It is suggested that habits of participating in activities and thinking at this stage in their lives make them more likely to remain active even after becoming adults (Telama & Yang, 2000; Yang et al., 1999). High school students face a series of interrelated choices (e.g., family, career, and self-achievement) across life domains (Zhang, 2017) in their emerging adulthood. Current built environment may have different effects on their various life choices. Identifying and improving understanding about the factors that influence adolescents' future life plans may be essential prerequisites for giving effective support to high school students' future life decisions. However, most existing studies on the impact of built environment on young people aim at informing the development of effective intervention strategies to promote safe school transportation or to halt the obesity epidemic (Ewing & Greene, 2004; Sallis & Glanz, 2006; Ferreira et al., 2007). Future life concerns on young people are seldom mentioned. On the other hand, young generations are expected to be an essential factor in keeping the vitality of rural areas (Bartsch, 2014).

In Japan, various regional revitalization policies have been implemented since the 1980s; however, there is still no sign that out-migration from local/rural areas to large-city areas will stop, especially to the three megacity areas (Tokyo, Nagoya, Osaka). In the case of rural areas of Japan, young people's massive out-migration to large city areas has already caused a few rural municipalities in Japan to disappear. In 2014, the Japanese government established a new agency called "Head Office of Towns, People and Creation of Jobs"[1] under the Cabinet Office, which is tasked with supervising all regional revitalization policies. Under this new policy scheme, many municipalities of local/rural areas are engaged in attracting young people to stay in or migrate to local/rural areas to help slow down the rate of depopulation and achieve socially and economically sustainable regional development[2]. Unfortunately, both quantity and quality of various infrastructures in local/rural areas are not comparable with those in large-city areas and as a consequence, they may become potential obstacles for young people to permanently stay. Considering this, it is important to know how young people from the rural settings utilize their surrounding environments to evaluate current life conditions and undertake future life decisions. A better understanding of young people's current behaviors and feelings, as well as future plans under the influence of the current built environment, is essential to rural revitalization policymaking. However, relevant research in literature seems missing.

To fill the above research gaps, this study aims to capture interrelationships between high school students' school travel behavior, current life satisfaction, and future life plans related to their individual career and other life design as well as family plans, by incorporating the influence of the built environment. This study focused on depopulated areas in Japan. The built environment is classified into study-related and other daily life related environment. Such a classification allows us to better evaluate the influences of the built environment by taking students' specific features

[1] https://www.kantei.go.jp/jp/singi/sousei/ [Accessed March 2, 2019]
[2] https://www.kantei.go.jp/jp/singi/sousei/data/case.html [Accessed March 2, 2019]

into account. Linking both the built environment and travel behavior to high school students' current life satisfaction and their propensity to undertake future choices is essential for proactive policymaking for regional revitalization. For the study, a questionnaire survey was implemented in 2016 in several high schools located in different depopulated areas of Hiroshima Prefecture, Japan, and valid data were collected from 1,073 high school students aged 14–18 years old. A structural equation model (SEM) with latent variables was adopted to quantify the aforementioned relationships.

CONCEPTS, MEASURES, FRAMEWORK, AND METHODS

The study aims to investigate the current living conditions and future life plans of young people, under the influence of the built environment, travel behavior, and life satisfaction. Future life plans contain individual plans, career plans and family plans. Here, relevant existing studies are reviewed with respect to these concepts, together with their interrelationships.

The built environment

The first concept is the built environment. It is a multidimensional concept and is often measured at various spatial scales (Handy et al., 2002; Wang et al., 2011). The prevalent dimensions of measuring the built environment are: density, diversity and design of activities in a given area (Cervero & Kockelman, 1997; Ewing et al., 2009); proximity of different land uses (Fan, 2007; Zhang et al., 2012); street connectivity, street scale, and neighborhood environment (Leyden, 2003; Saelens & Handy, 2008; Sun et al., 2017); and regional structure, the distribution of different activities and transportation facilities across regions (Handy et al., 2002).

The built environment is a very important indicator to evaluate people's current life conditions across different life domains. Firstly, people's life satisfaction is assumed to increase with good neighborhood environment (Van Kamp et al., 2003). Environmental amenities are considered to be essential components in the built environment to increase people's life satisfaction. For instance, high accessibility to shops, services and amenities increase people's life satisfaction (Morrison, 2011). The public green space and vegetation rate have positive relationships with life satisfaction (Ambrey & Fleming, 2014; Hur et al., 2010). Meanwhile, high-density neighborhood and open space conducive to experience leisure activities can enhance life satisfaction (Sugiyama et al., 2009; Friedman et al., 2012). Overall, only a limited number of empirical studies have looked at the impact of built environment on life satisfaction (Cao, 2016), with almost none targeting young people in depopulated areas.

Secondly, the built environment may influence people's cognitive processes (Cao, 2016), social well-being and personal relationships (Mouratidis, 2018). People's quality of life and life plans are largely affected by personal relationships, frequency of socializing, social support and opportunities to meet new people and new challenges (Gifford, 2007; Mouratidis, 2018). The built environment, especially accessibility to local facilities, could increase opportunities for social activities and gatherings, and have positive impacts on people's lives (Leyden, Goldberg & Michelbach, 2011). However, there are still many unknowns about the built environment, people's life satisfaction and future life plans. The studies on the impact of built environment on people's lives are limited to the neighborhood domain, and most of the studies focus on urban sprawl. The direct and indirect effects of built environment on people's other life domains are scarcely

discussed. For instance, there is no research examining how the built environment influences young people's future life plans.

Travel behavior

There are plenty of studies on the correlation or causality between built environment and travel behavior (Handy, Cao & Mokhtarian, 2005). The characteristics of sprawling patterns of land development were claimed to have different effects on travel (Schwanen & Mokhtarian, 2005; Cao, Handy & Mokhtarian, 2006). Travel behavior was also captured to evaluate people's life satisfaction and future propensities. A growing number of studies have found significant relationships between travel behavior and travel satisfaction (Cao & Ettema, 2014; De Vos et al., 2016). Several essential components of travel behavior are often measured as factors influencing travel satisfaction, such as trip frequency, travel modes, travel distance (Handy, Cao & Mokhtarian, 2005; Cao, Handy & Mokhtarian, 2006). However, the link between people's satisfaction with travel and their general life satisfaction is still unclear. Ettema et al. (2011) developed a measure of travel-related subjective well-being (SWB). The SWB were shown to be affected by travel behavior. The connection between people's objective travel behavior and the cognitive and affective evaluations of life has attracted more and more attention in recent years. The impact of travel behavior on overall life satisfaction should be discussed. Unfortunately, little is known about how travel behavior affects people's future life plans, especially those of high school students.

Life satisfaction

In transportation studies, the most commonly discussed dimension is satisfaction with travel. For example, previous studies have explored the determinants to people's satisfaction with commuting (Páez & Whalen, 2010; Ye & Titheridge, 2017). The influences of travel satisfaction on satisfaction with life have not been well explored (Cao, 2013). Sigry et al. (2010) developed a model describing how tourism behavior affects tourists' life satisfaction with various domains. Zhang (2014 & 2017) proposed a life-oriented approach, which argues that various life choices are interrelated and attributable to people's quality of life. However, knowledge about the interrelationships between travel behavior and the built environment on people's overall life satisfaction is very limited.

Future life plans

Individuals' future life plans have often been studied in terms of psychological factors, such as motivation (Noble et al., 2010). The impact of built environment is a neglected but important factor to people's life choices. The built environment provides people with various opportunities to make personal and social relationships (Mitrany, 2005; Gifford, 2007). Personal and social relationships are among the most influential factors for achieving a happy life (Balducci & Checchi, 2009), forming personal ways of thinking and even affecting future lifestyles. In depopulated areas, accessibility to shops and meeting places is more inconvenient than in cities, and as a result, the chances to meet new people and learn new things are probably smaller. The accumulation of such inconvenient daily experience may gradually affect young people's various future life plans.

Research on interrelationships of the above concepts

The above concepts may have various interrelationships, but until now, these have not been adequately explored. The relationship between the built environment and travel behavior has been examined most frequently (Ewing & Cervero, 2010). Travel behavior directly influences travel satisfaction, which is a part of life satisfaction, and travel behavior is required for meeting people's various daily needs. Thus, it is very natural to assume that the relationship between the built environment and travel behavior should impose an influence on life satisfaction in various ways. Generally speaking, current travel behavior is affected by past travel behavior. Similarly, current life choices are affected by those life choices in the past. Then, it is not unrealistic to assume that the above relationship between the built environment and travel behavior should be further extended to cover future life choices (or plans). Unfortunately, the above extended relationship with future life plans has not been explored in the literature. Last but not least, existing studies on the above concepts are mainly conducted in the context of urban areas. Studies on depopulated areas are neglected.

CONCEPTUAL FRAMEWORK

The journey to school is a routine that high school students have to perform on weekdays. To better capture the influence of the built environment (hereafter, BE), it is classified into two parts: one related to study life (hereafter, SL_BE) and the other related to non-study life (hereafter, NSL_BE). It is assumed that SL_BE affects school travel behavior but NSL_BE does not. As for current life satisfaction and future life plans, it is assumed that they are influenced by both SL_BE and NSL_BE as well as school travel behavior. The last assumption is that life satisfaction is influential to future life plans. Two unique features of this study are the distinction between SL_BE and NSL_BE, and the focus on future life plans. Since future life plans involve medium- or long-term decisions, it is difficult to assume that good or bad life experiences observed on just a limited number of occasions affect such decisions. However, high school students repeat their experiences of school travel and BE almost every day for three years. Such an accumulation of daily life experiences may influence the preferences of high school students regarding future decisions in a positive or negative way from the perspective of health. For example, repeated walking under a good BE may allow high school students to form a healthy lifestyle and consequently generate a good feeling about walking. If such a good feeling is repeated on a daily basis, high school students may choose to walk more in their future lives. On the other hand, if high school students repeat walking under a poor BE every day, such a poor experience of walking may generate a bad feeling about walking, which may discourage a walking-oriented lifestyle. A convenient BE allows high school students to participate in compulsory daily life activities in an easy way. A better mixture of various land uses within their daily action space provides them with more opportunities to participate in recreational and social activities, which are essential to meet higher-order needs in life. Thus, a better BE may allow high school students to experience more positive aspects of daily life (i.e., life satisfaction), which may encourage them to generate more positive attitudes toward life, and vice versa.

The above assumed interrelationships may co-exist in high school students' evaluations and decisions. To jointly capture the above interrelationships, a structural equation model (SEM) is used. Use of SEM is not new in the field of transportation. SEM-based studies can be found with respect to the connections between BE and travel behavior (Guo & Chen, 2007; Ding et al., 2018), between BE, physical activities and obesity (Rutt & Coleman, 2005), and between BE and residential behavior (Chatman, 2009; Cao, 2014). SEM has also been applied to evaluate the

influence of psychological aspects, such as the relationships between individual lifestyles, travel behavior and BE (Etminani-Ghasrodashti & Ardeshiri, 2015) and the role of BE in commuting satisfaction (Ye & Titheridge, 2017).

Because of the development of utility-based choice modeling approaches, SEM-based research has become more and more difficult to get published in the field of transportation. Major criticisms are (1) only linear relationships between variables (both observed and latent variables) can be incorporated, (2) it is a statistically-oriented approach and consequently ignores behavioral decision-making mechanisms. On the other hand, the advantages of SEM lie in its flexibility in dealing with multi-layer direct and indirect effects between various latent variables (Wasilah & Fahmyddin, 2018; Yoon & Goulias, 2010) and to reflect multidimensional features of various types of factors (Cools et al., 2011). SEM is especially effective in jointly testing various hypotheses. This feature has made it one of the most common tools in the fields of psychology, marketing, tourism study, education, etc. The most important point of applying SEM is not the use of SEM itself, but how to use it to derive unrevealed important relationships between variables.

Another important feature of SEM is that it allows the use of latent variables, which captures common unobserved factors behind observed variables. In particular, when the number of observed variables is large, the number of direct interrelationships between them will become unmanageable. For example, there exists 2^{10} (=1,024) pairs (i.e., 1024) of 10 observed variables and each pair may appear as a cause-effect relationship. Such a huge number of combinations is not manageable. However, if the 10 observed variables are classified into three groups, the number of combinations becomes 2^{10} (=8). Use of latent variables reduces the number of assumed interrelationships between observed variables into a manageable size, which makes analyses of complicated relationships between observed variables much easier.

In this study, BE, school travel behavior, life satisfaction, and future life plans are represented by using four relevant latent variables. In other words, instead of directly investigating the interrelationships between BE, school travel behavior, life satisfaction, and future life plans, this study focuses on the interrelationships of unobserved common factors behind them. Then, what are unobserved common factors behind them? Interpreting unobserved common factors depends on what kinds of observed variables are used. In this study, distances from home to daily facilities (e.g., school, town hall, nearest bus stop and supermarket) are used to describe the BE, travel time by mode (walk, bicycle, bus, etc.) is adopted to represent school travel behavior, current life satisfaction is evaluated in terms of various life aspects (education, health, family life, leisure activities, social networking, etc.), and future life plans are about how high school students agree/disagree to various statements about family formation, career development and other life design. Thus, unobserved common factors behind the above four groups of observed variables can be interpreted as high school students' preferences, i.e., *preference for SL_BE*, *preference for NSL_BE*, *preference for school travel*, *preference for life satisfaction evaluation*, and *preference for decision on future life plans*. Therefore, the assumed *structural* interrelationships between BE, school travel behavior, life satisfaction, and future life plans can be illustrated in Figure 1, from the perspective of high school students' preferences where each interrelationship is formed as a hypothesis. "*Structural*" interrelationship is used because SEM specifies the relationship between a pair of latent variables as a structural equation. Meanwhile, the relationship between a latent variable and corresponding observed variables is called a measurement equation.

The most important feature of using SEM in this study is to jointly test the above hypotheses, i.e., H1a, H1b, H1c, H2a, H2b, and H3. Considering that the ultimate purpose of urban and transportation planning is to improve people's quality of life, it is essential to clarify how urban and transportation policies affect people's lives over a longer period. To the authors' best

knowledge, no study in the field of transportation can be found in the literature which is framed from the perspective of *future life*, in general, let alone on high school students' *future life plans*.

SURVEY AND DATA

The questionnaire survey in this study was conducted with high school students in Hiroshima Prefecture, Japan from May to September 2016. Hiroshima Prefecture is located in western Japan. The northern part of Hiroshima Prefecture has been designated as depopulated by the central government (Ministry of Internal Affairs and Communication, 2017). Such depopulated areas have suffered from a decline of the total population, a rapid increase in the share of elderly people, and a continuing out-migration of young people. The Japanese government has proposed various regional revitalization policies since the 1980s; however, massive out-migration of young people from local areas to larger cities, especially megacities, is still a clear trend of internal migration in Japan. Here, it is argued that poor built environment and unsatisfactory current life conditions are major factors affecting high school students' future life plans, including migration, where daily school travel behavior works as a mediator.

The questionnaire survey contains all items related to the five latent variables. The built environment was measured in this study in terms of self-reported distances to the nearest daily facilities. As shown in Figure 1, the built environment is further divided into two parts: the built environment related to study life (SL_BE) and that related to non-study life (NSL_BE). SL_BE is measured by the distances (unit: km) to the nearest educational facilities (high school and cram school), to the nearest transportation facilities (bus station and train station), and to the nearest sports facilities (sports center and swimming pool). These facilities are used by most high school students almost every day. NSL_BE is measured by the distances to the nearest life service facilities for compulsory activities (city hall, community center, post office, bank, health center or hospital, police station), to the nearest shopping facilities (supermarket, drug store and clothing shop), and to the nearest recreational facilities (park, game center), which facilitate students' participation in non-study activities. School travel refers to school travel time by mode: walking, bicycle, train, bus, and car. Travel time was reported with respect to the whole school trip, i.e., it refers to the total travel time by all used travel modes. Each respondent was further asked to report their life satisfaction (8-point Likert scale, with a larger value meaning more satisfactory) with living standards, family life, leisure activities, current safety, family's health, education, family finance, personal health, personal achievement, spirituality/religion, social networking, neighborhood relationships, and future security (Zhang & Xiong, 2015). Future life plans were investigated in terms of willingness (measured with a 5-point Likert scale) related to family plan, individual career plan, and other personal life design. Family plan is about having a partner / being married, having two children or more, having one child, and having a pet. Personal career plan refers to earning a lot of money, having a worthwhile job in a corporation, owning your own business, and working in a family business. Other personal life design is about having a good car, traveling to a faraway destination, being famous, having personal achievement in sports or arts, and studying at a university.

In this study, four different types of high schools were selected: one in Kita-Hiroshima Town, two in Akitakata City, and one in Higashi Hiroshima City. The first three high schools are in the northern part of Hiroshima Prefecture. The fourth school in Higashi Hiroshima is not located at a depopulated area, but has also been facing out-migration of young people. In total, 1,104 high school students aged from 14 to 18 years old were invited to participate in the survey, and 1,073

returned questionnaire sheets (i.e., valid sample size is 1,073). The average age was 16.0 years old. 48.8% of them are male and 51.2% are female. Among the respondents, 62.7% were born and raised in local areas, while 37.3% experienced migration at least one time. The average number of family members are five, implying that most of the respondents have brothers and sisters.

MODELING ESTIMATION AND DISCUSSION

The SEM estimation results are summarized in Figure 2 and Table 1. As for the model accuracy, the RMSEA (Root Mean Square Error of Approximation) value is 0.070, which is under 0.08. This indicates a reasonable error of approximation (Browne & Cudeck, 1993; Arbuckle, 2013). In other words, the assumed interrelationships are estimated to be statistically acceptable. It is found that with the exception of H1b, the other five hypotheses are fully supported. H1b is partially supported, because an insignificant relationship is revealed between SL_BE and life satisfaction. Furthermore, a majority of estimated parameters are statistically significant.

Interpretive meanings of latent variables

In the conceptual framework given in Figure 1, the five latent variables are given a tentative name to represent the meanings of unobserved common factors behind corresponding observed variables. However, whether such meanings hold or not depends on actual modeling estimation results. In other words, after modeling estimation, each latent variable should be appropriately renamed by properly estimating results, especially by looking at those observed variables with statistically significant and larger standardized parameter values. This is because a large standardized parameter of an observed variable means that it can be well represented by the corresponding latent variable and, therefore, the corresponding latent variable should be better named by interpreting the meanings of the observed variables. In line with such considerations, the names of the five latent variables were modified according to the modeling results. Detailed descriptions of each latent variable are given below.

Preference for decision on future life plans: Family-oriented
For this latent variable, there are four observed variables related to family plan, four related to individual career plan, and five related to other life design. All the parameters of the 13 observed variables are positive and statistically significant, where only three family plan related parameters have a higher standardized value, i.e., “having a partner / being married” (0.878), “having two children or more” (0.871), and “having one child” (0.707). Other parameters all have very low values, ranging between 0.105 and 0.415. Thus, the latent variable “preference for decisions on future life plans” can be interpreted as “*family-oriented preference for decisions on future life plans*”.

Preference for life satisfaction evaluation: Diversity-driven
This latent variable is used to represent 13 observed variables about life satisfaction evaluations. All these 13 variables are estimated to have statistically significant and positive parameters. The standardized parameters have values ranging between 0.660 and 0.856, with differences which are not remarkable. In other words, high school students evaluate their current life satisfaction by emphasizing various aspects. Thus, the latent variable “preference for life satisfaction evaluation” can be interpreted as “*diversity-driven preference for life satisfaction evaluation*”.

Preference for school travel behavior: Walking-focused
This latent variable is used to represent five observed variables of travel time by mode. All the corresponding parameters are statistically significant, where three are positive (travel times on foot and by train and by bus) and two are negative (travel times by cycling and by car). The variable with the largest standardized parameter is travel time on foot (0.778), whose value is about two times higher than the second largest parameter for travel time by train (0.406). In other words, high school students express their preference for travel time mainly in terms of walking. Thus, the latent variable "preference for school travel behavior" can be interpreted as "*walking-focused preference for school travel behavior*".

Preference for SL_BE: Cram school centered
There are five observed distance variables that are represented by this latent variable. All these variables are estimated to have a positive and significant parameter. However, only the parameter of distance to cram school has a large standardized value (0.737). Other parameters range between 0.239 and 0.571. In Japan, going to cram school is the most popular way for students (high school students or below) to go on to a better school. The above finding about the importance of cram school is consistent with this fact. Comparing the average distance to cram school (3.10 km from home), it is 44% of the distance to school (6.99 km), 62% of the distance to train station (5.00 km), and 72% of the distance to the nearest sport facility (4.30 km). The distance to the nearest bus stop from home is 1.04 km, on average, which is the shortest among the five distances related to study life; unfortunately, it is not the most important distance to characterize high school students' preferences for SL_BE. Thus, the latent variable "preference for SL_BE" can be interpreted as "*cram school centered preference for SL_BE"*.

Preference for NSL_BE: Diversity-driven
Here, 10 observed variables are represented by this latent variable. In a similar way to the above distance variables, all these 10 variables are also estimated to have positive and significant parameters. In comparison with the above SL_BE variables, the differences of parameter values are much smaller, ranging between 0.541 and 0.786. In other words, high school students evaluate the role of BE by focusing on distances to diverse facilities. Thus, the latent variable "preference for NSL_BE" can be interpreted as "*diversity-driven preference for NSL_BE"*.

Revealed Structural Relationships

Looking at direct effects (Figure 2), it is found that cram school centered preference for SL_BE does not matter for diversity-driven preference for life satisfaction evaluation, and walking-focused preference for school travel is not influential for family-oriented preference for decision on future life plans. However, preference for school travel becomes influential in terms of the total effects connected via life satisfaction (see Table 1). Unfortunately, the total effect estimation still suggests that preference for SL_BE does not matter to life satisfaction. Considering that high school students have to travel to school every day, SL_BE should affect their current life satisfaction. Such an observation of insignificance implies that high school students in rural areas may not expect anything from a better SL_BE for improving their life satisfaction. It may also be interpreted that the current built environment does not have sufficient power to affect people's life satisfaction. On the other hand, SL_BE affects preference for decisions on future life plans via the influences of

preferences for school travel and life satisfaction evaluation. As for the other hypotheses, they are supported by both direct and total effects.

Total effects further indicate that the largest influence on preference for decisions on future life plans is observed with respect to preference for life satisfaction evaluation (standardized parameter: 0.193), followed by preferences for school travel (0.136) and for SL_BE (-0.133). The influencing sizes of the latter two latent variables are almost indifferent. Preference for life satisfaction evaluation is mostly affected by preference for NSL_BE (-0.134), which is also influential for preferences for decisions on future life plans, but the influence is minor. Preference for school travel affects preference for life satisfaction evaluation; however, its influence (-0.095) is about 71% of that of preference for NSL_BE.

Discussion

Influences of SL_BE and school travel behavior on life satisfaction and future life plans: Tests of H1a, H1b, and H1c

The most featured preference for decision on future life plans is related to family plan and the most important distance for school travel preference is that from home to cram school, which is shorter than that to school and to the nearest train station and sport facility. The estimated influence of school travel preference on future life plans suggests that such a shorter distance to cram school is positively associated with high school students' future family plan, especially related to family formation and child rearing. In other words, good experience of high-quality education-related built environment may contribute to a potential increase of population.

Preference for school travel behavior is mostly characterized by travel time on foot, and life satisfaction is evaluated in terms of various aspects. Modeling estimation results show that high school students having a shorter walking time to school are more likely to be satisfied with their lives in terms of all aspects. On the other hand, experiencing shorter walking time to school on a daily basis is less likely to encourage high school students to form a family and have children. Such mixed effects of walking time on life can also be observed with respect to travel time by train and bus. Differently, travel times by cycling and car show opposite influences. High school students experiencing long travel time by bicycle and car are less satisfied with their current life, but are more likely to form a family and to have children.

All of the above revealed influences of SL_BE and school travel behavior on future life plans are also similarly confirmed with respect to individual career plan of job, income earning, and business ownership and operation, and other personal life design related to conspicuous consumption (i.e., ownership of a good car and travel to faraway destinations), higher education and personal achievements. Related to transportation, long distances to daily facilities and long travel time by cycling and car discourage high school students to own a good car in the future, while travel times by walk, bus and train show opposite influences.

Influences of NSL_BE on life satisfaction and future life plans: Tests of H2a, H2b, and H3

It is found that diversity-driven preference for NSL_BE has a negative influence on diversity-driven preference for life satisfaction and a positive influence on family-oriented preference for decision on future life plans. Concretely speaking, poor built environment related to non-study daily life (i.e., long distances to daily facilities) results in a decline in high school students' current life satisfaction. This is as expected: poor built environment discourages high school students from expressing positive attitudes toward future life. The longer the distance to non-study daily facilities, the lower the probability of high school students to get married, to have a child, and to have a pet;

to find a nice job with good salary and to do business; to have a good car, to travel to faraway destinations, to become famous, to have personal achievements in sports or arts, and to become a university student. The above results mean that negative experience of the built environment, which is repeated on a daily basis, does not only worsen high school students' current life satisfaction but also discourages them from forming a family and having children.

CONCLUSION

Travel behavior research needs to examine not only travel behavior itself but also the impacts of travel behavior on people's lives. In this regard, research on the built environment has attracted increasing attention in the field of not only transportation but also related disciplines of urban planning and health research. Accumulated daily experience of the built environment and the resulting travel behavior may impose significant influences on people's future lives; however, no research to explore this can be found in existing studies. To fill this research gap, this study made an initial attempt to explore how the built environment and travel behavior affect future life plans via the influence on current life satisfaction of high school students in rural areas of Japan. Using data collected from 1,073 high school students in Hiroshima Prefecture in 2016 and applying a structural equation model, the following findings are obtained.

[1] Preference for decision on future life plans is mostly characterized by the family-oriented plan about marriage and child rearing. Such family-oriented preference is mostly influenced by the diversity-driven preference for life satisfaction evaluation, followed by the cram school centered preference for study life related built environment and walking-focused preference for school travel behavior. The diversity-driven preference for non-study life related built environment also imposes an influence on preference for decision on future life plans; however, the influence is just half of that of the preference for study life related built environment.

[2] The diversity-driven preference for non-study life related built environment is most influential for preference for life satisfaction evaluation. This influence is 1.4 times higher than that of preference for school travel, which is mostly featured with walking time to school. Unexpectedly, the cram school centered preference for study life related built environment does not matter to high school students' satisfaction in terms of any life aspect, even though it is influential for walking-focused preference for school travel behavior.

[3] Comparing the two types of the built environment (related to study life and non-study life), the study life related built environment does not affect current life satisfaction, while the non-study life related built environment is influential. Focusing on future life plans, the influence of study life related built environment becomes statistically significant and is about twice higher than the influence of non-study life related built environment.

[4] As for the preference for having a good car (i.e., conspicuous consumption), bad experience of the built environment (i.e., long distances to various daily facilities) discourages high school students from owning a good car in the future. High school students experiencing long travel time by cycling and car are also less likely to own a good car in the future. On the other hand, longer travel time by walk, bus and train results in higher possibility of owning a good car.

Although the relationship of the built environment and travel behavior has been widely researched in the field of transportation, important but neglected aspects still remain for future research. First, the built environment is a multi-dimensional concept, related to transportation systems, land uses and natural resources at different spatial scales (Ewing & Cervero, 2010). Different dimensions may have different influences on not only travel behavior but also other life

decisions, which may not be independent of each other, as suggested by the life-oriented approach (Zhang, 2017). Once the built environment is established, it affects people's lives in an accumulative way, i.e., its realized effects (both positive and negative) may take some time. Effects of a certain built environment may be cancelled out or amplified by the effects of other types of built environment. Thus, effects of the built environment should be examined within a unified evaluation framework, such as the life-oriented approach, allowing for the joint analyses of people's decisions at various interrelated life domains. To better capture the accumulative effects of the built environment, the aforementioned life-oriented analysis should be conducted over a longer period (i.e., life course). Such an extension of research scope further requires both survey and modeling improvements. Last but not least, most of the existing studies of built environment and travel behavior focus on adult behavior and neglects youth, elderly people, and other minorities (Feng, 2017). More efforts should be made to look at their behaviors in the future.

Acknowledgement

This study was fully supported by the Grants-in-Aid for Scientific Research (A), Japan Society for the Promotion of Science (JSPS) for the project titled "Interdisciplinary Research on Policies Promoting Young People's Migration to and Permanent Residence in Local Cities" (Principal researcher: Junyi Zhang, Hiroshima University; 15H02271).

References

Ambrey, C., & Fleming, C. (2014). Public greenspace and life satisfaction in urban Australia. *Urban Studies*, *51*(6), 1290–1321.

Arbuckle, J.L., 2013. IBM SPSS Amos 22 User's Guide.

Assemi, Behrang, Zapata-Diomedi, Belen, & Boulange, Claire (2018). A novel approach to investigate the impact of the built environment on physical activity among young adults. In *Active Living Research Conference 2018*, 11–14 February 2018, Banff, Alberta.

Balducci, A., & Checchi, D. (2009). Happiness and quality of city life: The case of Milan, the richest Italian city. *International Planning Studies*, *14*(1), 25–64.

Bartsch, J. (2014). Youth as resources in revitalizing communities. In Gruenewald, D.A and Smith, G.A. (Eds.), *Place-based Education in the Global Age*, (pp. 89–108), Routledge.

Broberg, A., & Sarjala, S. (2015). School travel mode choice and the characteristics of the urban built environment: The case of Helsinki, Finland. *Transport Policy, 37*, 1–10.

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In Bollen, K.A. & Long, J.S. (Eds.), Testing structural equation models (pp.136–162), Newbury Park, CA: Sage.

Cao, J. (2013). The association between light rail transit and satisfactions with travel and life: evidence from Twin Cities. *Transportation*, *40*(5), 921–933.

Cao, J. (2014). Residential self-selection in the relationships between the built environment and travel behavior: Introduction to the special issue. *Journal of Transport and Land Use, 7*(3), 1–3.

Cao, J., & Ettema, D. (2014). Satisfaction with travel and residential self-selection: How do preferences moderate the impact of the Hiawatha Light Rail Transit line?. *Journal of Transport and Land Use*, *7*(3), 93–108.

Cao, X. J. (2016). How does neighborhood design affect life satisfaction? Evidence from Twin Cities. *Travel Behaviour and Society*, *5*, 68–76.

Cao, X., Handy, S. L., & Mokhtarian, P. L. (2006). The influences of the built environment and residential self-selection on pedestrian behavior: evidence from Austin, TX. *Transportation*, *33*(1), 1–20.

Cervero, R., & Kockelman, K. (1997). Travel demand and the 3Ds: Density, diversity, and design. *Transportation Research Part D: Transport and Environment*, *2*(3), 199–219.

Chatman, D. G. (2009). Residential choice, the built environment, and nonwork travel: evidence using new data and methods. *Environment and Planning A*, *41*(5), 1072–1089.

Collins, P., Al-Nakeeb, Y., Nevill, A., & Lyons, M. (2012). The impact of the built environment on young people's physical activity patterns: A suburban-rural comparison using GPS. *International Journal of Environmental Research and Public Health*, *9*(9), 3030–3050.

Cools, M., Brijs, K., Tormans, H., Moons, E., Janssens, D., & Wets, G. (2011). The socio-cognitive links between road pricing acceptability and changes in travel-behavior. *Transportation Research Part A: Policy and Practice*, *45*(8), 779–788.

De Farias Júnior, J. C., Da Silva Lopes, A., Mota, J., Santos, M. P., Ribeiro, J. C., & Hallal, P. C. (2011). Perception of the social and built environment and physical activity among Northeastern Brazil adolescents. *Preventive Medicine*, *52*(2), 114–119.

De Vos, J., Mokhtarian, P. L., Schwanen, T., Van Acker, V., & Witlox, F. (2016). Travel mode choice and travel satisfaction: bridging the gap between decision utility and experienced utility. *Transportation*, *43*(5), 771–796.

Ding, C., Wang, Y., Tang, T., Mishra, S., & Liu, C. (2018). Joint analysis of the spatial impacts of built environment on car ownership and travel mode choice. *Transportation Research Part D: Transport and Environment*, *60*, 28–40.

Ding, D., & Gebel, K. (2012). Built environment, physical activity, and obesity: what have we learned from reviewing the literature?. *Health & place*, *18*(1), 100–105.

Etminani-Ghasrodashti, R., & Ardeshiri, M. (2015). Modeling travel behavior by the structural relationships between lifestyle, built environment and non-working trips. *Transportation Research Part A: Policy and Practice*, *78*, 506–518.

Ettema, D., Gärling, T., Eriksson, L., Friman, M., Olsson, L. E., & Fujii, S. (2011). Satisfaction with travel and subjective well-being: Development and test of a measurement tool. *Transportation Research Part F: Traffic Psychology and Behaviour*, *14*(3), 167–175.

Ewing, R., & Cervero, R. (2001). Travel and the Built Environment: A Synthesis. *Transportation Research Record: Journal of the Transportation Research Board*, *1780*(1), 87–114.

Ewing, R., & Cervero, R. (2010). Travel and the built environment: A meta-analysis. *Journal of the American Planning Association*, *76*(3), 265–294.

Ewing, R., Greenwald, M. J., Zhang, M., Walters, J., Feldman, M., Cervero, R., & Thomas, J. (2009). Measuring the impact of urban form and transit access on mixed use site trip generation rates—Portland pilot study. *US Environmental Protection Agency, Washington, DC*.

Ewing, R., Schroeer, W., & Greene, W. (2004). School location and student travel analysis of factors affecting mode choice. *Transportation Research Record*, *1895*(1), 55–63.

Fan, Y. (2007). *The Built Environment, Activity Space, and Time Allocation: An Activity-based Framework for Modeling the Land Use and Travel Connection*. Doctoral thesis, Department of City and Regional Planning, The University of North Carolina at Chapel Hill.

Feng, J. (2017). The influence of built environment on travel behavior of the elderly in urban China. *Transportation Research Part D: Transport and Environment*, *52*, 619–633.

Ferreira, I., van der Horst, K., Wendel-Vos, W., Kremers, S., van Lenthe, F.J., Brug, J. (2007). Environmental correlates of physical activity in youth-a review and update. *Obesity Reviews 8*, 129–154.

Friedman, D., Parikh, N. S., Giunta, N., Fahs, M. C., & Gallo, W. T. (2012). The influence of neighborhood factors on the quality of life of older adults attending New York City senior centers: results from the Health Indicators Project. *Quality of Life Research*, *21*(1), 123-131.

Gifford, R. (2007). The consequences of living in high-rise buildings. *Architectural Science Review*, *50*(1), 2–17.

Guo, J. Y., & Chen, C. (2007). The built environment and travel behavior: making the connection. *Transportation*, *34*(5), 529–533.

Handy, L, S., Boarne, G, M., Ewing, R., & Killingsworth, E, R. (2002). How the built environment affects physical activity: Views from urban planning. *American Journal of Preventive Medicine*, *23*(2S), 64–73.

Handy, S., Cao, X., & Mokhtarian, P. (2005). Correlation or causality between the built environment and travel behavior? Evidence from Northern California. *Transportation Research Part D: Transport and Environment*, *10*(6), 427–444.

Holt, N.L., Spence, J.C., Sehn, Z.L., Cutumisu, N. (2008). Neighborhood and developmental differences in children's perceptions of opportunities for play and physical activity. *Health & Place 14*, 2–14.

Hur, M., Nasar, J. L., & Chun, B. (2010). Neighborhood satisfaction, physical and perceived naturalness and openness. *Journal of Environmental Psychology*, *30*(1), 52–59.

Lake, A. A., & Townshend, T. G. (2013). Exploring the built environment, physical activity and related behaviours of young people attending school, college and those not in employment. *Journal of Public Health (United Kingdom)*, *35*(1), 57–66.

Leyden, K. M. (2003). Social capital and the built environment: the importance of walkable neighborhoods. *American Journal of Public Health*, *93*(9), 1546–1551.

Leyden, K. M., Goldberg, A., & Michelbach, P. (2011). Understanding the pursuit of happiness in ten major cities. *Urban Affairs Review*, *47*(6), 861–888.

Lin, J. J., & Chang, H. T. (2010). Built environment effects on children's school travel in Taipai: independence and travel mode. *Urban Studies*, *47*(4), 867–889.

Matanle, P., & Rausch, A. S. (with the Shrinking Regions Research Group). (2011). Japan's Shrinking Regions in the 21st Century: Contemporary responses to depopulation and socioeconomic decline. New York: Cambria Press.

Ministry of Internal Affairs and Communication. (2017). *The Division of Depopulated Areas in Japan* (In Japanese). Japan: Tokyo.

Mitra, R., Buliung, R. N., & Roorda, M. J. (2010). Built environment and school travel mode choice in Toronto, Canada. *Transportation Research Record*, *2156*(1), 150–159.

Mitrany, M. (2005). High density neighborhoods: Who enjoys them?. *GeoJournal*, *64*(2), 131–140.

Mouratidis, K. (2018). Built environment and social well-being: How does urban form affect social life and personal relationships?. *Cities*, *74*, 7–20.

Noble, J., Hechter, F. J., Karaiskos, N., & Wiltshire, W. A. (2010). Motivational factors and future life plans of orthodontic residents in the United States. *American Journal of Orthodontics and Dentofacial Orthopedics*, *137*(5), 623–630.

Perdue, W. C., Stone, L. A., & Gostin, L. O. (2003). The built environment and its relationship to the public's health: the legal framework. *American Journal of Public Health*, *93*(9), 1390–1394.

Páez, A., & Whalen, K. (2010). Enjoyment of commute: A comparison of different transportation modes. *Transportation Research Part A: Policy and Practice*, *44*(7), 537–549.

Rutt, C. D., & Coleman, K. J. (2005). Examining the relationships among built environment, physical activity, and body mass index in El Paso, TX. *Preventive Medicine*, *40*(6), 831–841.

Saelens, B. E., & Handy, S. L. (2008). Built environment correlates of walking: a review. *Medicine and Science in Sports and Exercise*, *40*(7 Suppl), S550–S556.

Sallis, J. F., & Glanz, K. (2006). The role of built environments in physical activity, eating, and obesity in childhood. *The future of children*, *16*(1), 89–108.

Santos, M. P., Page, A. S., Cooper, A. R., Ribeiro, J. C., & Mota, J. (2009). Perceptions of the built environment in relation to physical activity in Portuguese adolescents. *Health and Place*, *15*(2), 548–552.

Schwanen, T., & Mokhtarian, P. L. (2005). What affects commute mode choice: neighborhood physical structure or preferences toward neighborhoods?. *Journal of Transport Geography*, *13*(1), 83–99.

Sirgy, M. J., Kruger, P. S., Lee, D. J., & Yu, G. B. (2011). How does a travel trip affect tourists' life satisfaction?. *Journal of Travel research*, *50*(3), 261–275.

Sugiyama, T., Thompson, C. W., & Alves, S. (2009). Associations between neighborhood open space attributes and quality of life for older people in Britain. *Environment and Behavior*, *41*(1), 3–21.

Sun, B., Ermagun, A., & Dan, B. (2017). Built environmental impacts on commuting mode choice and distance: Evidence from Shanghai. *Transportation Research Part D: Transport and Environment*, *52*, 441–453.

Telama, R. I. S. T. O., & Yang, X. (2000). Decline of physical activity from youth to young adulthood in Finland. *Medicine & Science in Sports & Exercise*, *32*(9), 1617–1622.

Van Kamp, I., Leidelmeijer, K., Marsman, G., & De Hollander, A. (2003). Urban environmental quality and human well-being: Towards a conceptual framework and demarcation of concepts; a literature study. *Landscape and Urban Planning*, *65*(1-2), 5–18.

Wang, D., & Zhou, M. (2017). The built environment and travel behavior in urban China: A literature review. *Transportation Research Part D: Transport and Environment*, *52*, 574–585.

Wang, D., Chai, Y., & Li, F. (2011). Built environment diversities and activity-travel behaviour variations in Beijing, China. *Journal of Transport Geography*, *19*(6), 1173–1186.

Wasilah, S., & Fahmyddin, T. (2018). The advancement of the built environment research through employment of structural equation modeling (SEM). In *IOP Conference Series: Earth and Environmental Science* (Vol. 126, No. 1, p. 012001). IOP Publishing.

Yang, X., Telama, R., Leino, M., & Viikari, J. (1999). Factors explaining the physical activity of young adults: the importance of early socialization. *Scandinavian Journal of Medicine & science in sports*, *9*(2), 120–127.

Ye, R., & Titheridge, H. (2017). Satisfaction with the commute: The role of travel mode choice, built environment and attitudes. *Transportation Research Part D: Transport and Environment*, *52*, 535–547.

Yoon, S., & Goulias, K. (2010). Impact of time-space prism accessibility on time use behavior and its propagation through intra-household interaction. *Transportation Letters*, *2*(4), 245–260.

Zhang, J. (2014). Revisiting residential self-selection issues: A life-oriented approach. *Journal of Transport and Land Use*, *7*(3), 29–45.

Zhang, J. (2017). Life-oriented Behavioral Research for Urban Policy, Springer.

Zhang, J., & Xiong, Y. (2015). Effects of multifaceted consumption on happiness in life: a case

study in Japan based on an integrated approach. *International Review of Economics*, *62*(2), 143–162.

Zhang, L., Hong, J., Nasri, A., & Shen, Q. (2012). How built environment affects travel behavior: A comparative analysis of the connections between land use and vehicle miles traveled in US cities. *Journal of Transport and Land Use, 5*(3), 40–52.

Table 1. Standardized total effects

	Preference for SL_BE: Cram school centered	Preference for school travel: Walking-focused	Preference for NSL_BE: Diversity-driven	Preference for life satisfaction evaluation: Diversity-driven
Preference for school travel: Walking-focused	-0.122** (H1a: supported)			
Preference for life satisfaction evaluation: Diversity-driven	0.002 (H1b: partially supported)	-0.095**	-0.134** (H2a: supported)	
Preference for decision on future life plans: Family-oriented	-0.133** (H1c: supported)	0.136**	-0.067* (H2b: supported)	0.193*** (H3: supported)

*: significant at 10% level; **: 5% level; ***: 1% level.

Table 2 Standardized estimation results of measurement equations

Variables	Parameter	Mean
1. Preference for decision on future life plans (unit: 5-point scale)		
◆ *Family-oriented future life plans*		
Items related to family plan		
Having a partner / being married	0.878***	3.82
Having two children or more	0.871***	3.56
Having one child	0.707***	3.45
Having a pet	0.282***	3.60
Items related to individual career plan		
Earning a lot of money	0.366***	4.18
Having a worthwhile job in a corporation	0.331***	4.21
Owning your own business project	0.188***	2.25
Working in a family business	0.137***	2.21
Items related to other personal life design		
Having a good car	0.415***	3.43
Traveling to a faraway destination	0.409***	3.78
Being famous	0.336***	2.66
Having personal achievement in sports or arts	0.246***	2.69
Studying at a university	0.105***	3.86
2. Preference for school travel behavior (unit: minutes)		
◆ *Walking-focused*		
Travel time on foot	0.778***	7.24
Travel time by train	0.406***	4.63
Travel time by cycling	-0.270***	10.39
Travel time by car	-0.114***	3.53
Travel time by bus	0.080**	4.55
3. Preference for SL_BE (unit: km)		
◆ *Cram school centered*		
Distance to cram school	0.737***	3.10
Distance to nearest train station	0.571***	5.00
Distance to school	0.412***	6.99
Distance to nearest sport facility	0.357***	4.30
Distance to nearest bus stop	0.239***	1.04
5. Preference for life satisfaction evaluation (unit: 8-point scale)		
◆ *Diversity-driven*		
with living standards	0.856***	7.48
with family life	0.843***	7.63
with leisure activities	0.832***	7.43
with current safety	0.787***	7.49
with family's health	0.759***	7.41
with education	0.755***	7.04
with family finance	0.745***	7.12
with personal health	0.728***	7.22
with personal achievement	0.716***	6.77
with spirituality/religion	0.714***	6.74
with social networking	0.704***	7.15
with neighborhood relationships	0.676***	7.22
with future security	0.660***	6.14
6. Preference for NSL_BE (unit: km)		
◆ *Diversity-driven*		
Distance to the nearest supermarket	0.786***	1.51
Distance to the nearest drug store	0.734***	3.41
Distance to the nearest hospital	0.728***	2.88
Distance to the nearest clothing shop	0.700***	4.21
Distance to the nearest convenience store	0.689***	1.77
Distance to the nearest police station	0.630***	2.97
Distance to the nearest bank/post office	0.590***	1.81
Distance to town hall	0.580***	4.38
Distance to the nearest park	0.574***	1.90
Distance to the nearest community center	0.541***	1.98

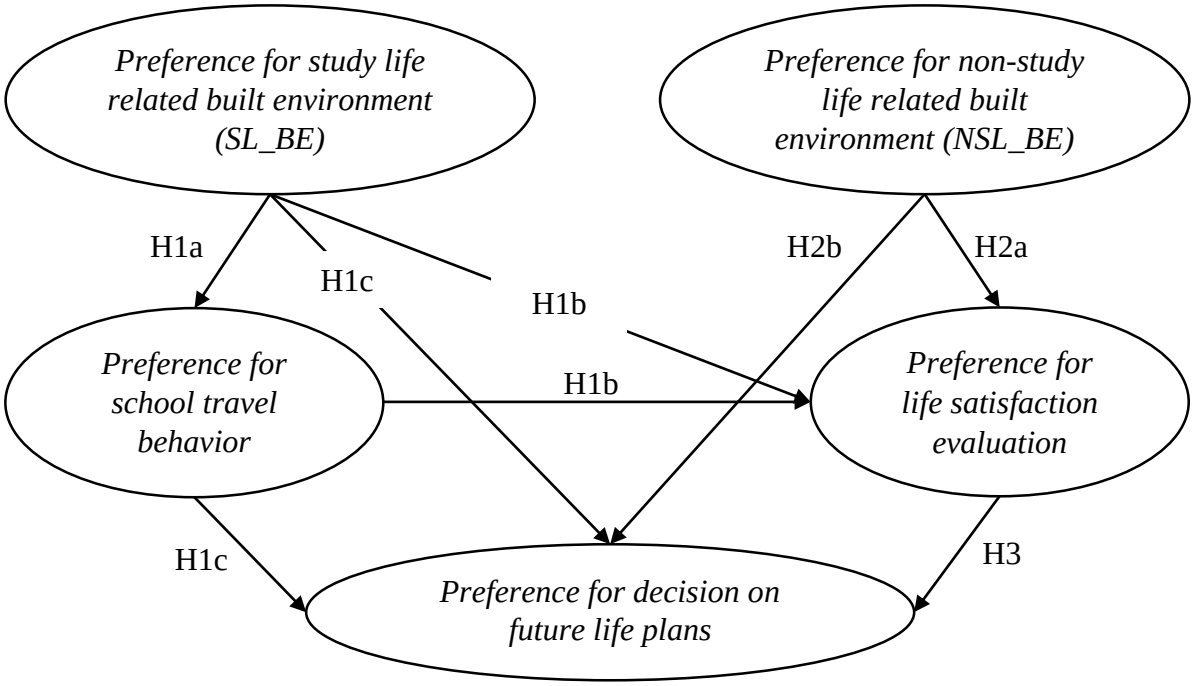
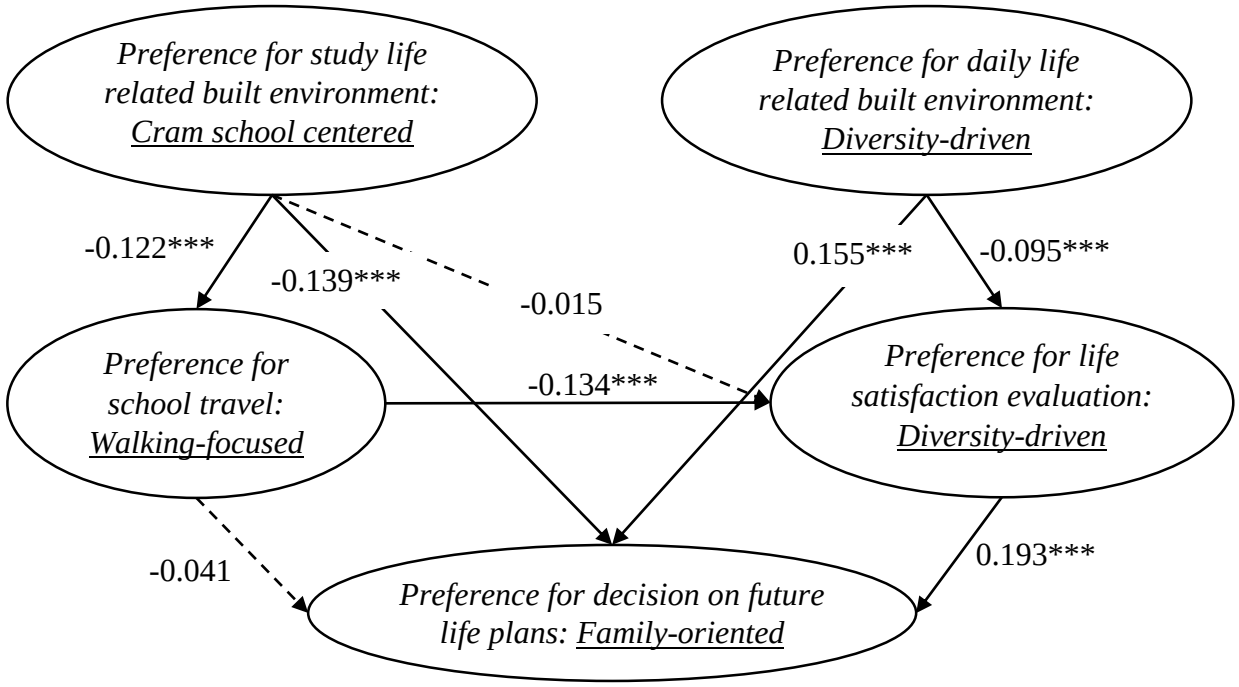


Figure 1 Conceptual analysis framework of structural interrelationships



RMSEA=0.070; Sample size=1,073
*: significant at 10% level; **: 5% level; ***: 1% level.

Figure 2. High school students' structural relationships