Available online at www.sciencedirect.com

ScienceDirect

Transportation Research Procedia 00 (2018) 000–000

Transportation Research Procedia

www.elsevier.com/locate/procedia

World Conference on Transport Research - WCTR 2019 Mumbai 26-31 May 2019

A QOL evaluation method for SDGs and GNH in urban transport planning with an application to Japanese and German cities

Yongjian Khoo[a], Yoshitsugu Hayashi[b], Fumei Gu[c], Noriyasu Kachi[d], Shinichiro Nakamura[e]

[a]*Toyo Business Engineering Corporation,, Tokyo 100-0004, Japan*
[b]*Chubu University, Kasugai, Aichi 487-8501, Japan*
[c]*Nanjing University, Nanjing 210-093, China*
[d]*Toyo University, Tokyo 115-0053, Japan*
[e]*Nagoya University, Nagoya 464-8601, Japan*

Abstract

Cost-benefit analysis has always been used for evaluating infrastructure investment. It measures economic benefits in a way that how much GDP can be created by the saved travel time due to construction of rail or road. However, in aging society, the number of elderly people is increasing and they do not create an increment in GDP even if they save travel time. Whereas they could become happier if they could visit beautiful places or hospitals by using the new transport infrastructure. Each person receives different value by such projects.

In this study we have developed an evaluation method of Quality of Life (QOL) to consider the happiness or satisfaction for a citizen by considering his/her preference and attributes (male/female, young/old, income classes, etc.). Therefore, this QOL model can be used for evaluating a) whether an infrastructure investment is benefitting the different citizen groups in a balanced manner, namely, for checking the achievement of inclusiveness in SDGs, and also b) the increase in GRH (Gross Regional Happiness) created by the project, a measure of GNH in regional scale, by integrating each citizen's QOL over the whole population in the region.

A case study is conducted in Kozoji New Town in the Nagoya Metropolitan Area, Japan in comparison with City of Dresden, Germany, to demonstrate the practicality of the proposed QOL model.

Peer-review under responsibility of WORLD CONFERENCE ON TRANSPORT RESEARCH SOCIETY.

Keywords: Quality of Life, SDGs, GNH, Transport project evaluation

Peer-review under responsibility of WORLD CONFERENCE ON TRANSPORT RESEARCH SOCIETY

1. Introduction

In the 21st century, increasing attentions have been given to quality of life not only in developed countries where economic growth has slowed down but also in developing countries like Bhutan where they seek for Gross National Happiness (GNH).

A Happiness vs. GDP survey conducted by Ipsos in 2011 indicates that achieving a high GDP does not prove that happiness will also be achieved. Low GDP per capita countries such as Indonesia and India topped the survey in responding to happiness where more than 40% of the population choose very happy when given a choice between "very happy, rather happy, not very happy or not happy at all". In contrary, high GDP per capita countries such as Japan and Germany were ranked very much lower (around 15%). This means that personal income, which is a distribution from GDP, is only one of the factors of Quality of Life (QOL) but not equal to the whole QOL. Also, income (GDP) is an input to a person while QOL is an overall outcome representing the person's happiness.

Traditional transport planning starts with infrastructure provision. The cost-benefit analysis method COBA was first introduced to scientifically evaluate the economic values of infrastructure projects to be created by motorways in UK in 1972. It is the basic assumption that how much GDP would have been increased if the saved travel time by a new motorway would be used for production in factories or offices. However, this assumption has become not suitable especially in aging society because majority of citizens using motorways will consist not only the working generation, but also retirees where time saved are no longer an important factor.

After endorsement of SDGs by a UN Summit in 2015, the paradigm of evaluating development has drastically changed. Namely the goal of every development project is sustainability and happiness for everyone. However conventional cost benefit analysis, which is irrelevant for this purpose, is still used.

Therefore, what we need today is a comprehensive indicator system and a common method. It should be flexible and powerful to check if a transport or urban development project can meet citizens' needs which are becoming diverse due to rapidly changing configuration of citizens due to aging, widening income discrepancy, IT technology innovation and life-work styles. It is crucial to make improvement plans for infrastructures and amenity consider future changes in citizens' needs, but it is often ignored during the planning process as there is no method ready for quantifying such changes.

Therefore, in this study, a new method to measure individual person's QOL is proposed and case studies are shown to demonstrate the effectiveness of the method comparing Japan and Germany. The selected case study cities are plagued with net negative population outcome due to urbanization. Dresden of Germany declined sharply in 1990's and 2000's but in recent years have shown promising recovery in population and economy. It will be used as a proceeding model and approach to revitalize a problematic new town of Japan developed in 1970's, Kozoji New Town (hereafter Kozoji NT) in the Nagoya Metropolitan Area. There the subjective perception on QOL of current Dresden citizens are used as a reference to predict the changes in Kozoji NT.

2. Literature Review

It is widely established that there is no single admitted definition of QOL (Dissart, J.C., Deller, S.C., 2000, Zhang, J. Li, X., et al., 2009). People's attitudes and lifestyles are influenced not only by their social, economic and cultural backgrounds, but also by their environment (Hayashi et al., 2003).

Special attentions have been given to the concept of QOL to evaluate area development (Beukes, E., Colff, A.V., 1997), to investigate the determining factors of QOL, and making proposals to enhance it (Lever, J.P., 2000). It is widely accepted that a person's quality of life depends on both the exogenous facts (objective condition) and endogenous perception (subjective attitude) of these factors (Dissart, J.C., Deller, S.C., 2000).

Urban policies are known to affect the evaluation of QOL. The concept of QOL has been developed to evaluate well-being and happiness from multiple theoretical angles to be affected by urban policies (Diener and Suh, 1997; Kahneman, 1997, Frey and Stutzer 2002). QOL indices were initially developed as part of city-based sustainability indices to measure the progress of urban policies, selecting an indicator that composes QOL indices (Besleme and Mullin 1997; Briassoulis, 2001; MacMahon 2002).

Therefore QOL index is advantageous for evaluating the residential quality of land-use transport systems, as they are able to consider various QOL factors and their diverse values among socioeconomic groups. First, a range of life

domains can be included in the indices in a comprehensive and simple way as QOL factors, such as job, house, health, leisure, and environment (Van Praag et al., 2003; Poortinga et al., 2004; Doi et al., 2008; Senlier, 2009). QOL evaluation of land use - transport systems pay more attention to easy access from residential locations to various opportunities of activities (Lotfi and Koohsari, 2009). Conventional transport studies have been focused on access to employment as commuting, but the QOL index includes access to non-commuting activities (Hayashi et al., 2003; Doi et al., 2008). The contribution of access to QOL can also be compared to those of the other factors of residential quality, such as amenity and safety (Kachi et al., 2005; Nakanishi et al., 2013).

As for the second advantage, the QOL index can capture the socio-economic difference in values of each QOL factor. The value difference may be consistent with Maslow's hierarchy of needs, in terms of QOL, safety is the most basic demand, followed by economic opportunity, service cultural opportunity, spatial amenity and environmental benignity. The value of access to various opportunities may be attributed to the hierarchy of needs depending on income/time budget and physical ability of a socioeconomic group, which is called social accessibility (Kenyon et al., 2002). As the differences in value between socioeconomic groups may generate different needs for sustainable transport (Steg and Gifford, 2005), social accessibility is particularly important for evaluating social exclusion (Preston and Raje, 2007). For instance, people with lower mobility, such as poor and elderly people, have more difficulty to access to opportunities, which is called mobility-related social exclusion (Kenyon et al., 2002). The QOL indices distinguishing socioeconomic groups developed in this study can identify the level of social exclusion.

3. Methodology

3.1. Basic concept of QOL evaluation model

Each location of a city has both desirable and undesirable characteristics. Its location provides its own value (hereafter we call "Existing Value"). Desirable characteristics including shops, hospitals, cultural assets and green space will be enjoyed positively by the citizens. These characteristics can be called as services having a certain value. On the other hand, undesirable characteristics including air and noise pollutions, traffic accidents and low neighborhood security will bring down the living standard of the citizens. If the location of living is far from the location of service provision, the accessible value will become smaller (hereafter we call "Accessible Value").

Identifying and quantifying the existing values of service provision and its positively or negatively transmitted values at the living location is the first step. The second step is to quantify its importance for the citizens. For instance, if a young woman perceives hospitals as unimportant, the value of hospital may be low despite within walking distance. An individual perceives the accessible values referring to subjective preference. The subjective preference of an individual and existing values of service at each location forms the foundation of our QOL research.

To create a comprehensive QOL indicator system that can provide quantitative evaluations, 3-dimensional visualization, future simulation and planning policy implication, this study is based on the following premises.

1. People's subjective preference will change as time proceeds.
2. The sum of subjective preference is adjusted uniformly from 0 to 1 to serve for comparisons between different age groups, genders, income classes and even across nationalities.
3. The subjective preference from a more matured city in economic development can used as a benchmark to guide the less matured city.

Time use survey is a continuous surveying method used to measure the amount of time spent by a person on various activities. OECD historical time survey have shown how people have changed their daily behaviors, which ideally provide a foresight for possible future change. However, if there is no prior study to quantify subjective preference, prediction of future change in subjective preference will be impossible. Preference has two dimensions: one is traditional and cultural tendency which is unique and specific to country or local region and does not change much over time while the other dimension is economic development which brings changes in subjective preferences as the development stage progresses. This study demonstrates these changes in preference by conducting a survey in both Germany and Japan. The result of Germany will be used as a reference for the change in Japanese subjective preference.

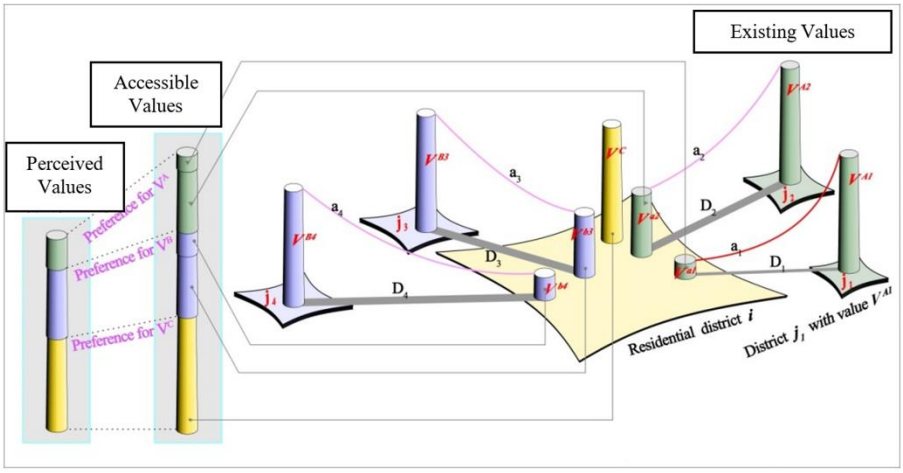

Fig. 1. QOL conceptual model

To visualize the spatial distribution of QOL values in any given city,

1. Case study city is divided into 100 m × 100 m mesh; each mesh has a centroid to represent the location of all citizens residing in the mesh block.

2. Each mesh contains a certain value of a type of service (Existing Value).

3. The services will be accessible by neighboring vicinity but at a decreasing rate from existing value due to travel time and travel cost (Accessible Value); assuming that citizens have equal opportunities to use the transport facilities (Joseph, A.E., Phillips, D.R., 1984, Pirie, G.H., 1979).

4. The QOL for a citizen is define as a conversion of Accessible Value weighted by his/her subjective preference between types of services (QOL's factors).

5. Summation of QOL over all citizens will give the city's GRH (Gross Regional Happiness).

3.2. Existing Value

In each mesh there are some service values such as medical service, shopping service or eco-service. We define these value as Existing Value of QOL factor *m* (type of service such as hospitals, shops or green space) in district *j as* V_j^m.

3.3. Accessible value

A person living in district *i* can utilize not fully the existing value V_j^m provided in district *j*, but only diminished value due to travel time and cost between *i* and *j*. We define this diminished value as Accessible Value A_{ij}^m :

$$A_{ij}^m = V_j^m \times e^{\left(-\alpha \cdot c_{ij}\right)} \qquad (1)$$

Where,

i : Living district *i*,

j : Service provision district j,
α : diminishing parameter,
c_{ij} : Travel generalized cost from district i to j,
V_j^m : Existing Value of service m provided in district j,
A_{ij}^m : Accessible Value in district i of service m provided from district j.

3.4. Perceived value

Even if A_{ij}^m is accessible, a population group k does not always wish to obtain all of A_{ij}^m. This is because each person has his/her own preference on each service w^{mk} due to social-economic attributes such as age, gender, etc. We define Perceived Value as weighted sum by w^{mk} of Accessible Value A_{ij}^m . We call it Perceived Value for population group k living in district i.

As Perceived Value can be one of the expressions of Quality of Life, we denote it as QOL_i^k:

$$QOL_i^k = \sum_m \sum_j w^{mk} A_{ij}^m \quad (2)$$

Where,
i : Living district,
j : Neighborhood district,
k : Population group,
w^{mk} : Preference weight of QOL factor m for population group k,
QOL_i^k: Quality of Life for population group k living in district i.

3.5. Gross Regional Happiness (GRH)

Aggregating over the city over i, we can get Gross Regional Happiness by GRH^k .

$$GRH^k = \sum_i P_i^k \bullet QOL_i^k \quad (3)$$

Where,

P_i^k : Size of population group k living in district i,
GRH^k : Gross Regional Happiness for population k.

Summing up the entire population groups over k will derive the total quality of life in the region, namely Gross Regional Happiness.

$$GRH = \sum_k QOL^k \quad (4)$$

The method proposed in this study can provide individual citizen's QOL which can be used as an indicator for evaluating SDGs' "Inclusiveness" as well as an aggregated indicator "Gross Regional Happiness" (region can refer to any size of territory such as nation, city, etc.).

4. Analyzing personal preferences

4.1. Design of questionnaire surveys

There are three phases in designing this survey. The first phase is to gather respondents' personal attributes such as age and gender and their needs such as house types and transport mode. The second phase is scoring to find out the respondents' sentimental value of their living environment. The last phase is conjoint cards whereby respondent's living preferences are compared and compiled. Living Preferences are quantified by several criteria which are selected if and only if supporting data are readily made.

Identical online survey is conducted in both Nagoya MA (Metropolitan Area) and Dresden MA (Metropolitan Area) in May 2017 and 500 valid responses were collected from each city. The response from each set of survey is split evenly between male and female and between 3-age categories (18~30 years old, 31~50 years old, 50 years old and above).

4.2. Satisfaction of life

The result of the first simple question on overall happiness shows that Dresden MA citizens feel more satisfied than Nagoya MA. In each city, respondents are asked to score their current Quality from 1 to 7 where 1 represents 'very dissatisfied', 4 represents 'neutral', and 7 represents 'very satisfied'. According to the weighted average, although satisfaction scores in both cities are over 4, which stands for the neutral, Dresden MA has achieved an average of 4.97, while Nagoya MA has received an average of 4.41. It is easy to conclude that, Dresden MA citizens feel much more satisfied with their living environment than Nagoya MA's. The score of each group of citizens show how they are differently satisfied according to their attributes such as age, gender, education level, income level and household type will lead to their different satisfaction in the two metropolitan areas. The results were shown in Fig. 2. With limited exception, no matter which group the citizens were belonging to, Dresden MA has scored higher than Nagoya MA.

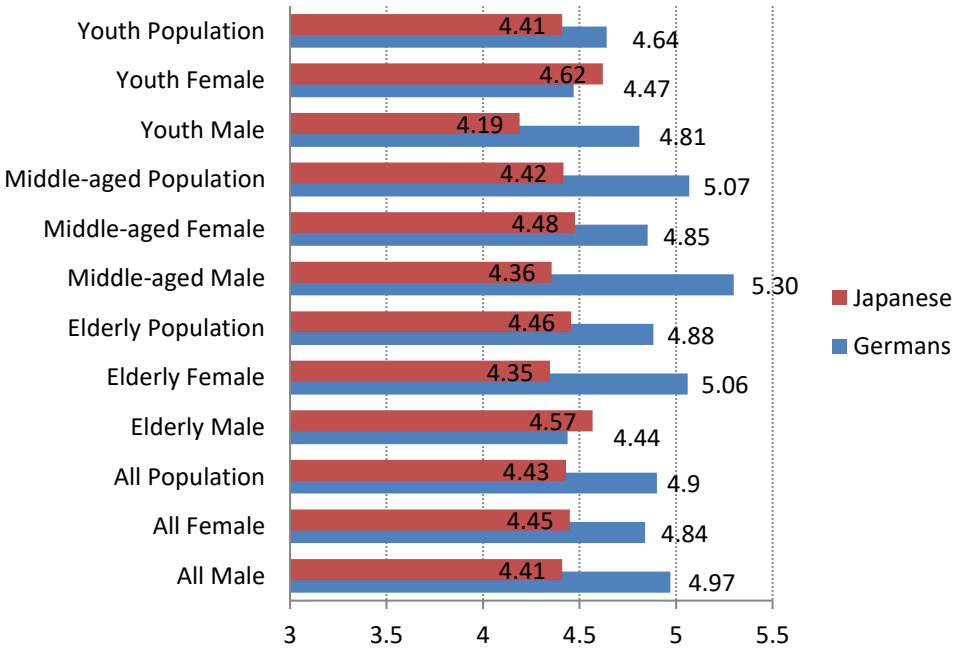

Fig. 2. Satisfaction Level (Gender-Age)

4.3. QOL determinant factors, their indicators and weight estimation method

The above result in overall happiness must come from how the local services satisfy citizens' variety of preferences of factors determining QOL. In this study we classify into five factors as shown in Table 1; Economic Opportunities, Living Opportunities, Amenity, Safety and Security, Environmental Burden. Each dimension was further composed of two measuring indicators selected as below.

"Economic Opportunity" refers to the economic activities that revolve around daily life. It comprises of ease of commutating measured by access to closest public transport or expressway as well as the purchase opportunity measured by the accessibility to departmental stores or shopping centers within reachable distance. "Living opportunity" refers to facilities that are important for living. It is comprised of medical care opportunity measured by available number of beds in the hospitals and education opportunity measured by the size of kindergarten. "Amenity" refers to the luxury of pursuing a better lifestyle. It is comprised of surroundings intimacy measured by accessible parks' size and biological service measured by density of greenery in the neighbourhood residential area. "Safety & security" focus on neighbourhood safety. A safer neighbourhood is quantified by sufficient lamp-posts and occurrence of a traffic accident. "Environmental burden" refers to exposure to human-induced pollution. It is comprised of Air and noise pollutions.

Table 1. QOL determinant factors and their indicators

Dimensions	Factors	Indicator
Economic Opportunity	Ease of Commutation	Access to closest public transport or expressway
	Purchase Opportunity	Availability of departmental stores
Living Opportunity	Medical Care Opportunity	Access to hospital
	Education Opportunity	Access to kindergarten
Amenity	Surroundings Intimacy	Availability of neighbourhood parks
	Biological service	Percentage of overall surrounding Greenery
Safety & Security	Neighbourhood security	Well-lit night-time
	Accident risk	Number of traffic accidents occurred
Environmental Burden	Air Pollution	Felt Air Quality (good or bad)
	Noise Pollution	Traffic Noise level (disturbing, not disturbing)

The weight between indicators is different depending on person's attribute, young or old, male or female, rich or poor, etc. Most simply we could ask in a way that 10- minute reduction in travel time to shopping is equivalent to how many minutes to hospital, 5 min, 10 min or 20 min, etc. This method has demerits such that we have to ask so many combinations of questions, and also the respondents cannot not imagine so precisely value of each indicator.

According to our experiences, in this study we adopt the conjoint analysis method. As shown in Fig.3. as an example of "Amenity" factor of QOL, we first prepare imaginary sites A and B having different values of locational attributes such as travel time to park, percentage of greenery and house price, then ask the respondents to choose his/her preferred site A or B. Such questionnaires are set and asked for ten factors. Cards are graphically designed to allow respondents to have an easier understanding when comparing the two different levels. Questionnaire sheets are translated into their mother languages so that the respondents will have no difficulties in answering, in this study in German and in Japanese.

Qns. Please choose the Site (A or B) you prefer to live in with regard to different Amenity opportunities.

Site A	Amenity	Site B
☐ 15 min	Travel time to nearest park	☐ 45 min
☐ 10%	Percentage of greenary in your neigbhourhood	☐ 40%
☐ 5 %	House price/rent increment relative to current house	☐ 10%

Site A	Amenity	Site B
☐ 15 min	Travel time to nearest park	☐ 45 min
☐ 40%	Percentage of greenary in your neigbhourhood	☐ 10%
☐ 10%	House price/rent increment relative to current house	☐ 5 %

SITE A	Amenity	SITE B
☐ 15 min	Travel time to nearest park	☐ 45 min
☐ 10%	Percentage of greenary in your neigbhourhood	☐ 40%
☐ 10%	House price/rent increment relative to current house	☐ 5 %

Fig. 3. Questionnaire sheet for conjoint analysis

4.4. Estimated personal weights between factors of QOL (Nagoya MA vs Dresden MA)

The weights between the factors of QOL are unique for an individual citizen. Fig.4 highlights the estimated results of weight by citizens group which is different to one another depending on the attributes of citizens. The values vary from minus to plus because the scores are determined in relation to house rent in the questionnaire. This result contains variety of hints for evaluation of investment in urban transport and land use planning for whom. This sill become an important information for urban transport planning to achieve SDGs, which assures “No one left behind”.

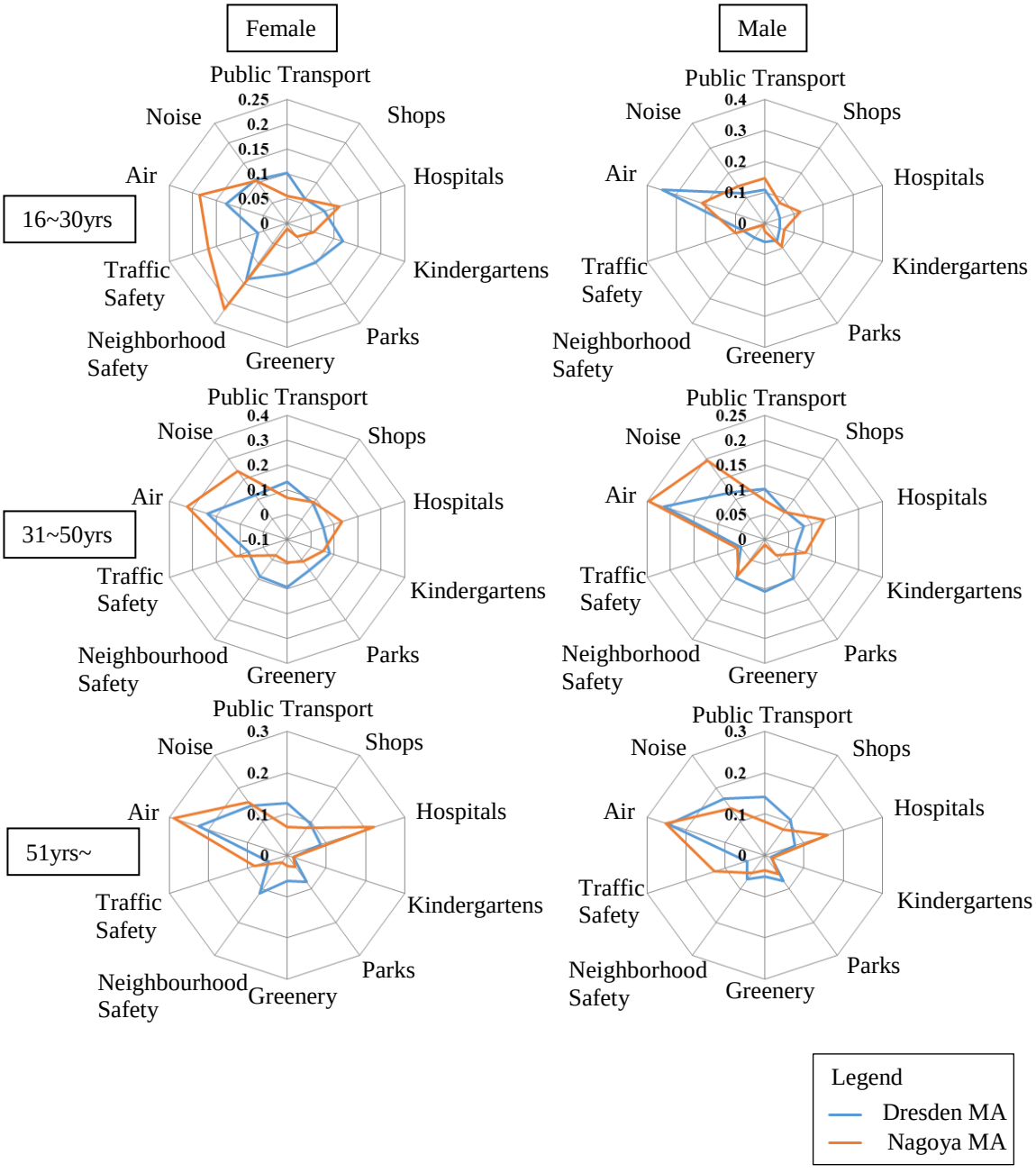

Fig. 4. Comparison of weight between QOL factors by Citizens' attribute group of female/male and age groups

The results in Fig 4. are interpreted as follows:

1) Dresden MA citizens prefer Greenery and Parks as well as Public Transport than Nagoya MA. This seems to come from the mentality of the Germans who traditionally love forest. Also, it may reflect that Dresden MA has only trams for urban transit while Nagoya MA has suburban railways, urban underground, guided way bus and BRT on surface.

2) Nagoya MA citizens think hospitals more important than Dresden MA citizen do. This is presumably because Japanese society is more aged. The elderly citizens may depend heavily on medical service. This is recognized by whole generations.
3) Both citizens of Nagoya MA and Dresden MA think air is very important. The reason for Nagoya MA may be because the region is much more urbanized and therefore citizens require fresh air. Air pollution such as PM2.5 transmitted from continent is becoming serious. The desire for fresh air in Dresden MA may overlap with their direction towards forest.
4) One of the biggest gaps between the citizens of Nagoya MA and Dresden MA is desire for Greenery. The desire by the Germans come not only from their traditional wants but also from the progress in maturity of economic society. This can be a useful hint for Nagoya MA in making urban development policies for the future generations who might prefer Greenery more than today.

5. Policy scenario analysis of case study in Kozoji NT

5.1. Case study area

Kozoji NT with a population of 45,000 is taken as the case study area. It is a satellite town 20km away from Nagoya (2.3 million population), the central city of Nagoya MA (about 10 million). The only station in Kozoji is connected by a suburban railway 25 minutes from Nagoya station. Many citizens are using this line to Nagoya to go for working and shopping.

5.2. Spatial distribution of accessible values

According to the evaluation model, if a citizen lives in a mesh that is accessible to the service facilities such as hospitals and shops located in neighborhoods, the total accessible value is regarded as cumulative values provided by the relevant service facilities located in all accessible neighborhoods. Travel coefficients are assumed at an impedance of -0.0072/yen, estimated by our study, and walking speed at 5km/h. With geocoded data including transport network and POI data, the absolute value (accessible value) in each mesh is calculated and displayed as shown in the below figures.

Fig. 5(a) shows an example of spatial distribution of accessible value of Parks. The existing value of the parks is represented by size of the circle. Majority of the bigger Parks are located in the center of the town, therefore, the accessible values of citizens living near the center are high, while those in the place located far from the central area are low.

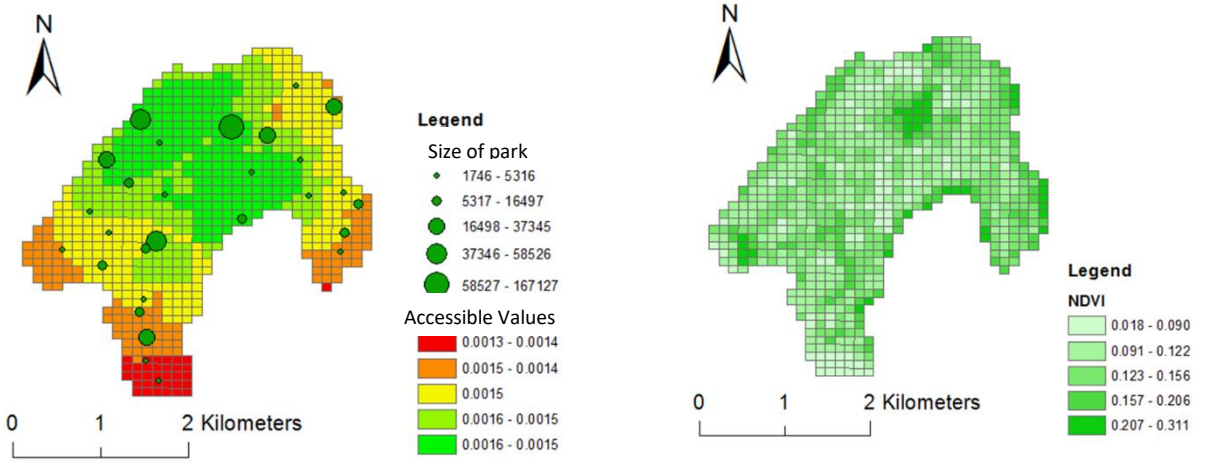

Fig. 5. (a) Accessible values of Park; (b) NDVI (normalized difference vegetation index) value of Local Greenery

Fig. 5(b) shows the density of local greenery that used to measure the existing value of biological service. In this case it is treated that the value remains in their respective mesh only. Noises, neighborhood security and traffic accident risk are examples of such values.

5.3. Spatial distribution of QOL

Fig.6 represents a 3-D visualization of QOL where the height of each mesh refers to population and the color coding refers to level of QOL. Citizens living in Area C enjoy the highest QOL due to the best accessibility to the railway station for commuting and medical care opportunity. The accessible values for commuting and medical service are high near the railway station. The population is the highest in Area A mainly due to multistory apartments. The only shopping as well as other service facilities area are also in Area A. Area B is dominated by single family houses suffering badly from low level of QOL as it is farthest away from the railway station and hospitals and connected only by poor bus transport services.

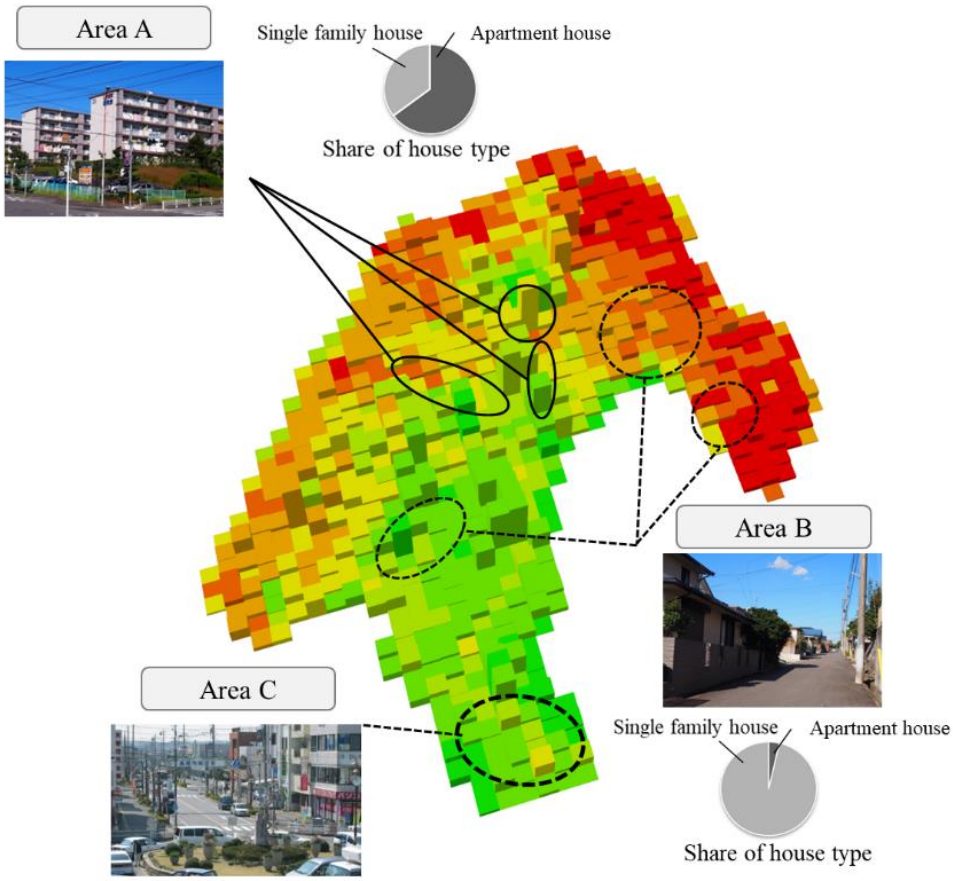

Fig. 6. 3D average QOL map

5.4. Policy Scenarios to increase QOL

We assume that the preference of citizens changes according to the maturity of the city. Therefore two different types of policy scenarios, construction of new LRT vs. planting of trees, are proposed in this study. Here we examine how the evaluation of two policies would change if the preference of citizens of Kozoji NT would become like the current Dresden citizens',

- Policy 1: Constructing a 12km LRT system with 20 stations to increase the accessibility within Kozoji NT and to allow a shorter travel time from everywhere to reach the railway station and hospitals located in Area C.
- Policy 2: Planting trees to increase green space we anticipate the changes in subjective preference of citizens in Kozoji NT in a way to follow the Dresden's citizens. A 20% increase by 2025 and a 50% increase by 2040 are assumed to transform Kozoji NT to contain the similar green density per km^2 as Dresden.

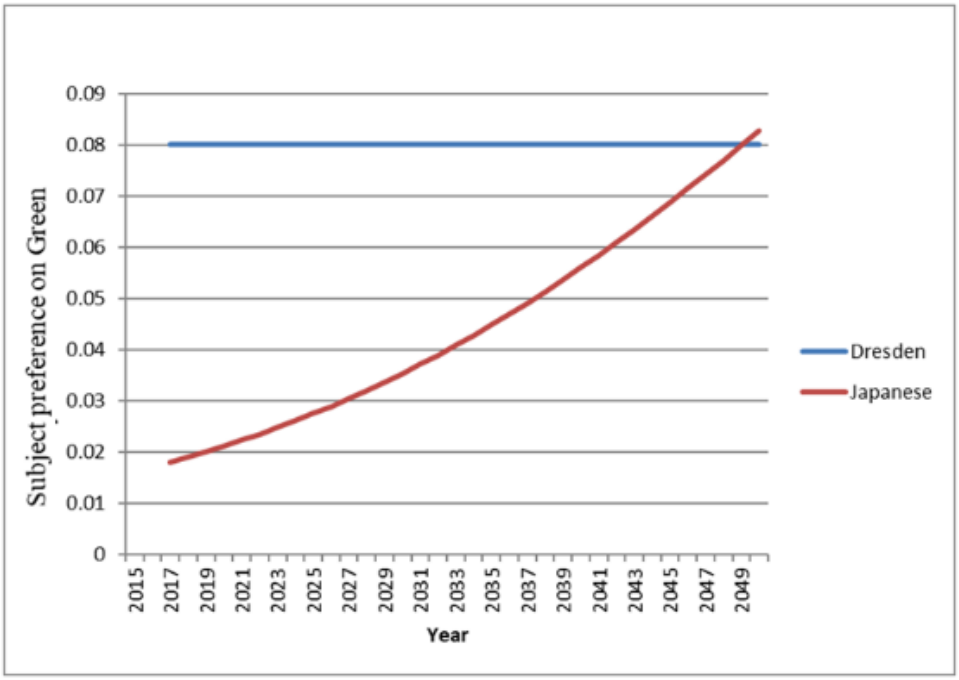

Fig. 7. Assumed change in preference of greens by the Japanese

5.5. Effects of green policy implementation

The amount of green in an urban area is an important factor of citizens' quality of life. The percentage of green space inside one kilometer and a three-kilometer radius had a significant relation to perceived general health (Maas J et al. 2006). Both elderly, youth benefit the most from the presence of green space. Urban green space, such as parks, forests, green roofs and community gardens, provides critical ecosystem services. Green space also promotes physical activity, psychological well-being, and the public health of citizens.

In the survey result, the Japanese show lack of concern for green but a high concern for medical care. This contradiction is identified in this study as a lag in consciousness on the importance of green. We assume that the

subjective preference will change eventually and thus use the response from Dresden as a reference for the future citizens of Kozoji NT. This study quantified a yearly growth of 6% in reflecting the importance of green and finally, in 2050, the preference of Kozoji NT's citizens will reach the current level of Dresden. According to the green increment simulation, the model predicts an increase of 2% in overall QOL by 2025 and finally, an 8.2% in overall QOL by 2040.

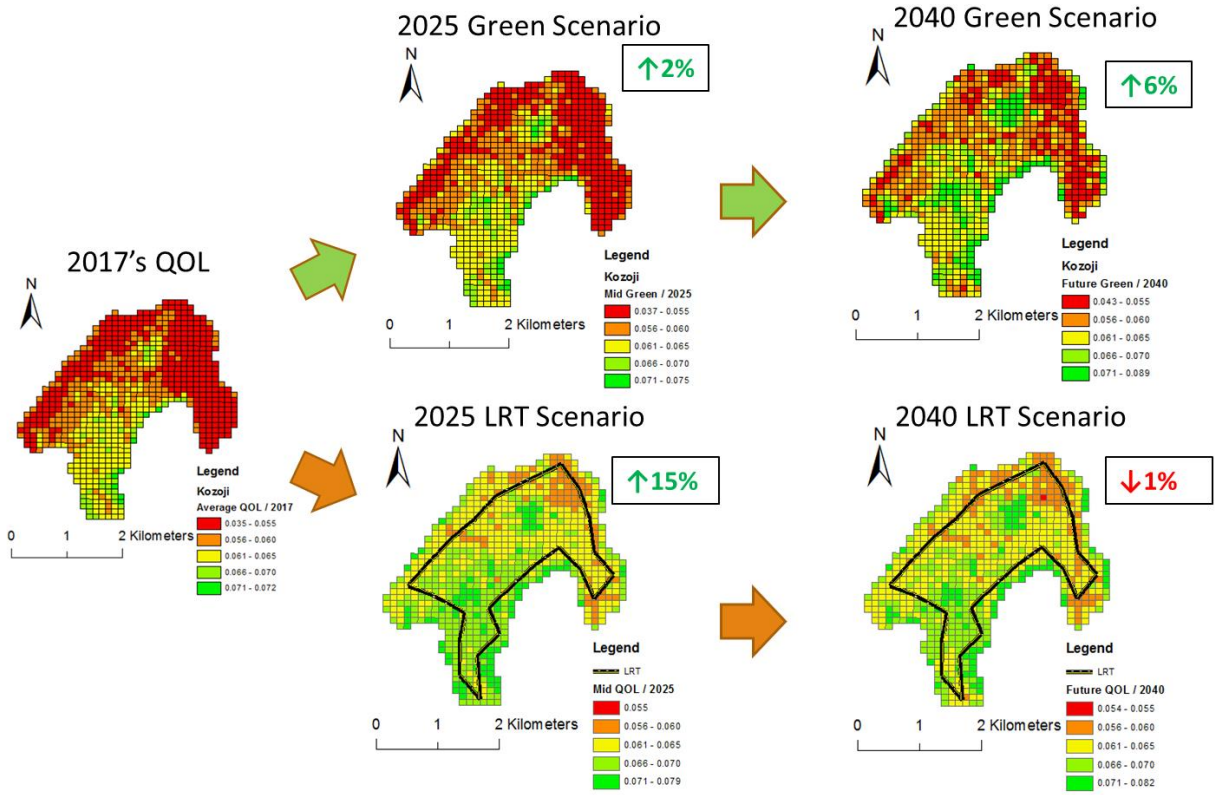

Fig. 8. Comparison of QOL increases in policy scenarios of Green and LRT

5.6. Effects of LRT policy implementation

A municipal survey conducted at Kozoji NT in 2014 shows that citizens under 50 years old prefer better access to schools and job while those above 50 years old prefer better access to medical care and shopping facilities. Over 14,000 households will benefit if the government helps to shift the citizens to the locations according to their preferences but the budget will be estimated to cost over 26 billion yen. In this study, a 12km Light Rail Transit system is planned for Kozoji NT with the aim to improve the accessibility within the town, thus, increases the QOL.

Implementing the 12km LRT system, the QOL model predicts an increase of 15.3% in overall QOL by 2025 and finally, a slight decrease to 14% by 2040. The slight drop from 2025 to 2040 is because the subjective preference is assumed to change to prefer more local green to accessibility. Since local green itself is a static value, the increase in accessibility by LRT will not affect QOL obtained from local green.

5.7. Comparison of green scenario and LRT scenario

The usefulness of QOL model for evaluating urban development will be discussed. In the conventional cost benefit analysis, GDP always favor the development of LRT compared to green planting. Improvement of LRT will bring two types of monetary effects which are multiplier effect of investment as well as the long-term facility effect due to shortening of travel time created by operation of LRT. On the other hand, improving amenity by planting trees and thus in turns, creating more green space is difficult to be quantified by monetary terms.

By quantifying the increase in QOL due to the different policy scenarios, this study can estimate and compare the effectiveness of different types of urban development investments spending budget per unit of QOL. Table 2. shows how much investment is required to increase the QOL by 1%. The budget estimated in this study does not include any maintenance and labor cost.

The result shows that to increase QOL by 1%, the short-term measure to increase the accessibility by LRT will be the better policy. For a long-term target, investing in green space shows a possibility of getting a better return. This type of evaluation can never be achieved by conventional cost benefit analysis. QOL model can be used to prepare totally new guidelines where not only monetary benefit but also satisfaction of citizens is the priority.

Table 2. Cost breakdown of each policy scenario

Type of cost	Unit cost	Total cost in LRT policy		Total cost in Green policy	
		2025 (+12km)	2040 (+0 km)	2025(+20%)	2040(+30%)
LTR's track construction	3 bil.yen /km	36 bil.yen	36 bil.yen	0	0
Land acquisition	0.7 mil.yen /m^2	25.2 bil.yen	25.2 bil.yen	17.7 bil.yen	44.3 bil.yen
Rolling stock	0.46 bil.yen/vehicle	1.84 bil.yen	1.84 bil.yen	0	0
Station construction	0.9 bil.yen/station	18 bil.yen	18 bil.yen	0	0
Tree planting	1.11 mil.yen /ha	0	0	0.3 bil.yen	0.7 bil.yen
Total cost		81 bil.yen	81 bil.yen	18 bil.yen	45 bil.yen
Yearly GRH increase compare to 2017's GRH		+ 15.3%	+ 14.0%	+ 2.0%	+ 8.2%
Cost for 1% increase in GRH		5.30 bil.yen	5.79 bil.yen	8.91 bil.yen	5.43 bil.yen

6. Conclusions

Chapter 5 demonstrated how the QOL model can depicts the effects of land use - transport development. The model can contrast the evaluations between different population groups as well as between two cities in Japan and Germany.

6.1. Problems of a post-developed city

Kozoji NT was developed forty years ago to incorporate increasing population in the Nagoya MA. It has been operated and maintained by the Japan Housing Corporation, a development corporation under the government. The pioneer generation (young couples at that time) who resided in Kozoji NT have now become elderly generation. There has been no substantial reform in Kozoji NT to fit the lifestyles of the younger generation (children of the pioneer generation) and this has caused their children to leave the town once they reached adulthood. This situation is further worsened as Kozoji NT had already loses its attractiveness to bring in new citizens to reside in and therefore the population has continuously declined and aged.

The new towns of Dresden first developed in East Germany days has been also once deteriorated but renovated in recent years. The successful recovery of Dresden is shown in an annual increase in birth rate and economy. The quality of life in Kozoji NT would be deteriorated badly in 2040 due to an aged society and further population decline. The

fragility of a suburban new town such as Kozoji NT should be well studied and use as a guideline for proceeding cities' experiences in the post-developed syndrome.

6.2. Implication for policies

There are two typical main policies proposed in chapter 5 to achieve a strategic urban planning. The first one is to increase the accessibility and the second one is to improve the amenities. Both approaches share the same goal to ease the unbalance in spatial growth and both of them bring forward their advantages and disadvantages.

The fundamental of urban planning is to house its population. Therefore, the citizens should be treated as the most valuable asset that will determine the city's values. Prior to adopting either policy, it is important to forecast the change in citizens' subjective preferences such that the development will always go beyond their needs and expectations.

With all the analyses of QOL above, we confirmed the problem that urban inequality exists not only in location but also between social groups (age, gender, etc.). Thus, the first task for urban planning is to ease such inequalities. This QOL model is powerful to evaluate projects in terms of inequality, namely it can provide individual citizen's QOL which is the fundamental information necessary to access SDG's Inclusiveness.

To plan well the infrastructures and urban amenity, we need the subjective preferences of future generation of Kozoji NT. Since we cannot know the preferences of the future generation, we use those of a matured city as references instead. In this study, Germans subjective preference is used to predict Japanese future.

This improvement shows that traditional evaluation criteria of urban development are not enough to judge the success or failure of the development of a city. The developments today are always behind the preferences of variety of citizens living in current society. The proposed QOL model can identify both the performance of urban structure and life satisfaction of citizens and thus adaptability towards future changes.

As shown in this paper, this QOL model can evaluate differences in values, which are created by various types of projects, for the citizens with different attributes, thus can contribute to evaluation of projects from inclusive point of view in SDGs. It can provide also Bhutan's Gross Regional Happiness by summing up over the citizens.

Acknowledgements

The authors are indebted to Professor Mueller, Director and other members of Leibniz Institute of Ecological Urban and Regional Development who have contributed to designing the web questionnaire for Dresden, also to Mr. Sascha Hahn and Nihon No Ie (architectural office) in Leipzig for their advices.

References

Besleme, K., Mullin, M. (1997) Community indicators and healthy communities. National Civic Review, 86(1), 43-52.

Beukes, E., Colff, A.V. (1997) Aspects of the quality of life in black township in a South African city: Implication for human development. Social Indicators Research, Vol. 41, pp. 229-250

Briassoulis, H. (2001) Sustainable development and its indicators: through a (planner's) glass darkly. Journal of Environmental Planning and Management, 44, 409-427.

Cobb, C., T. Halstead, and J. Rowe. (1995 Oct). If GDP is Up, Why is America Down? Atlantic Monthly 276. Available online: http://www.theatlantic.com/past/politics/ecbig/gdp.htm

Diener, E., Suh, E. (1997) Measuring Quality of Life: economic, social, and subjective indicators. Social Indicators Research, 40, 189-216.

Dissart, J.C., Deller, S.C. (2000) Quality of life in the planning literature. Journal of Planning Literature, Vol. 15, pp. 135-161

Doi, K., Kii, M., Nakanishi, H. (2008) An integrated evaluation method of accessibility, Quality of Life, and social interaction. Environment and Planning B: Planning and Design, 35, 1098-1116.

Frey, B.S., Stutzer, A. (2002) The economics of happiness. World Economics, 3(1), 1-17.

Fumei, G., Y. Hayashi, F. Shi, H. Zhang, H. Kato (2015) Measuring and Mapping Spatial Distribution of Quality of Life in a city – A case study of Nanjing, International Journal of Urban Science

Hayashi Y., Mai, X., Kato, H. (2011) The role of rail transport for sustainable urban transport. In Rothengatter, W., Hayashi, Y., Schade W. (eds.), Transport moving to climate intelligence. Springer, New York.

Hayashi, Y., Sugiyama I. (2003) Dual strategies for the environmental and financial goals of sustainable cities: de-suburbanization and social capitalization. Built Environment, 29(1), 8-15.

Maas J, Verheij RA, Groenewegen PP, et al. (2006) Green space, urbanity, and health: how strong is the relation? Journal of Epidemiology & Community Health 2006;60:587-592.

Maull, H. (1990) Germany and Japan: The New Civilian Powers. Foreign Affairs, 69(5), 91-106.