

Developing a Location Affordability Index in Korea that Incorporates Transportation Costs

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- Role and Responsibility of Central and Local Government for Enhancement of Housing Right, 2019, KRIHS [in Korean]
- Housing Welfare Programs for Young-Single in Korea, 2017, KRIHS [in Korean]
- New Housing Policy Directions in the Era of Single-Person Households, 2017, KRIHS [in Korean]
- Lessons from Korea: Policy Recommendations for Rental Housing in Latin America and the Caribbean, 2017, Inter-American Development Bank
- Trends and Characteristics of Housing Precariat in Korea : Focused on Young Single Generation, 2017, Space and Society [in Korean]
- Housing Policies in the Republic of Korea, 2016, in The Housing Challenge in Emerging Asia: Options and Solutions, Asian Development Bank Institute.
- Achievements and Limitations of Korea's Housing Policy in Respect to the New Urban Agenda in United Nations Conference on Housing and Sustainable Development (Habitat III), 2016, Space and Society.
- Geography of Private Rental Market in Korea. KRIHS Special Report. KRIHS.
- Housing Vouchers as a Means of Poverty Deconcentration and Race Desegregation: Patterns and Factors of Voucher Recipients' Spatial Concentration in Cleveland, 2013, Journal of Housing and the Built Environment

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Summary

The housing cost burden has been a growing concern due to the shortage of affordable housing, specifically for renters. The housing cost burden is generally defined as the proportion of rent payment over the monthly gross income of the household. Location is critical when households choose their residence because location decides not only residential costs but also commuting costs, which are the two most important elements of household expenditure. Measuring housing cost burden has a significant effect on policymakers and academia because the appropriate level of spending on housing affects public housing subsidies and the quality of life for every single household.

The purpose of this study is to develop a location affordability index that incorporates transportation costs, which is defined as location affordability. Factoring location into the housing cost burden equation is beneficial for several reasons. First, it reflects the spatial differentiation of household expenditure on housing and transportation. Second, it reveals the trade-off relationship between housing costs and transportation costs in the Seoul Metropolitan Area. Third, the location affordability index (LAI) has great potential for policymakers in terms of helping them decide where housing should be constructed and why the public transportation-oriented development is crucial not only for low- to middle- income households but also for compact urban development as a whole.

Interestingly but not surprisingly, the analysis reveals that lower-income households tend to spend more money on housing and transportation. When it comes to housing plus transportation expenditure, the cost burden reaches as high as 31.2% of the monthly income for low-income households. The importance of location should gain its primary position in housing research and housing policymakers should be aware of the spatial differentiation of policy implementation. Because this is the first attempt to introduce the LAI in Korea, this will be the stepping stone for the next stage of research.

Introduction

I. Background and Purpose of Research

Through national tasks, the Korean government prioritizes housing stability for the working class, mitigates housing costs for young people and newlyweds, lowers the cost of living by reducing transportation and communications costs, and attempts to ease household expenses using a variety of methods. Global recognition of the housing issue grew when UN Habitat III was held in Quito in 2016 and the Korean government subsequently adopted the “New Urban Agenda” that emphasizes the importance of residential development in locations that have easy access to public transportation and that are close to job opportunities.

A theoretical basis has been established regarding the importance of transportation costs when deciding where to locate housing. Affordability indices that consider transportation costs have been developed and utilized for policy decisions in advanced countries. While the affordability index used in Korea reflects income-level differences across the entire nation, a lack of locational difference implies the limited consideration of spatial heterogeneity.

This research aims to supplement the existing affordability index and to develop an affordability index that factors location into the equation. The primary focus is to calculate housing costs and transportation costs at a disaggregated spatial level, to provide an alternative affordability index (location affordability index (LAI)), and to draw some policy implications for the housing and transportation fields. This is the first attempt to calculate location affordability in Korea using all data on rental contract transactions for renter-occupiers.

2. Methodology

The spatial scope of the research was the Seoul Metropolitan Area (SMA). In order to improve spatial precision, analysis was done at the eup/myeon/dong levels, which are the most disaggregated administrative units in Korea. The research focused on renter-occupiers who are more likely to their residence as the rent cost increases, which leads them to prioritize housing policies. Two major sources of data were utilized to calculate both housing costs and transportation costs. The former involved renters' lease contract data during a 2-year period (January 1, 2016–December 31, 2017), as most of the lease contracts in Korea are for 2 years. Calculating transportation costs required the most recent Household Travel Survey (2016) by the Ministry of Land, Infrastructure, and Transport (MoLIT). This research employed spatial analysis including geocoding, network analysis, and thematic mapping using GIS.

3. Definition of Terms

Housing costs are defined as the cost of living, specifically the rent cost for renter-occupiers. Housing costs are the sum of the expenditures incurred as a result of renting, and as this research primarily focused on renter-occupiers' households, housing costs were limited to monthly rent. In Korea, the most prevalent type of lease contract is *jeonse*, which requires an upfront lump-sum deposit instead of monthly rent. It is required to convert the large deposit into monthly rent utilizing the *jeonse* to Rent Conversion Rate (JRCR). The Korea Appraisal Board releases the JRCR every month by housing type and region. Therefore, this research adopts the JRCR by housing type and region during the period data utilized.

Transportation costs are defined as the direct costs paid by households considering their mode of transport and the distance to work and/or school. Transportation costs are aggregated by household because every household has its own members who may travel to places of work and go to school using different types of vehicles. The depreciation cost of owning a car is not included in this research. Rather, direct transportation expenses are the primary concern of this research.

Affordability is either the absolute or the relative level of housing costs by household. Various methods of measurement have been developed, such as the ratio approach,

which measures the ratio of these expenditures to household income, and the residual income approach, which compares absolute levels of income to housing costs (rent plus utility costs) after excluding necessary expenditures.

① **The affordability index is calculated as a household's housing costs (rent) divided by the household's monthly income.**

- It is generally expressed as the RIR (Rent–Income Ratio), and it is expressed in this research as $RIR(H)$ in order to differentiate it from RIR including transportation costs.

② **The LAI is calculated as a household's housing costs and transportation costs divided by the household's monthly income.**

- For the purposes of making comparisons with $RIR(H)$, the LAI is expressed as $RIR(H+T)$.

Additional housing cost limit and additional commuting time limit: The additional housing cost limit is the maximum additional amount of housing costs that can be paid when making a housing decision in situations where an increase in housing costs is unavoidable in order to reduce commuting time. As this research only deals with renter-occupiers, this term was focused on the limits of additional *jeonse* deposits. The additional commuting time limit is the upper limit of commuting time increases, given that transportation costs and time increase when a household moves to a location where housing costs are lower.

Theory and Application of Measuring Affordability

I. Measuring Affordability

The method of calculating the proportion of household income taken up by housing costs as an affordability index was developed quite some time ago, and it has been widely adopted in housing policy. Academics have attempted to complement this index by debating a variety of methods to develop an alternative affordability index. The division of housing costs by household income was first done in the 1910s, when it was known that workers in the state of Massachusetts spent 20%–25% of their income on rent. Thus, monthly rent was equivalent to the amount of a weekly paycheck. In the 1940s, the U.S. Department of Housing and Urban Development (HUD) began to adopt a 20% affordability rule in public housing policy, limiting monthly rent payments to less than 20% of income, with this policy being revised to 25% in the 1960s and 30% in 1981. The standard of affordability began to be applied to determine tenants' ability to pay their rent, and it was later applied to determine owners' ability to pay their mortgage.

The housing cost affordability index has a significant influence over the standards for housing policy criteria in HUD. HUD regulations state that a household is considered under a “housing cost burden” when housing costs are 30%–50% of a household's income, and if this percentage exceeds 50%, a household is seen as suffering a “severe cost burden” and thus in the greatest need of housing policy support. The standard of 30% of income is widely adopted in housing policies, such as the public rental housing policy and the Housing Choice Voucher Program.

Academics have been debating a variety of affordability measurement methods, such as the residual income approach, the shelter poverty measure, the amenity-based housing affordability index, the self-sufficiency standard, the housing wage, and the quality-adjusted measure.

2. Development of an Affordability Index that Considers Transportation Costs

As housing and transportation costs take up a large portion of household expenditures and have a trade-off relationship, the consensus that transportation costs must be included when developing an affordability index has emerged. In addition to housing costs, transportation costs are a necessary household expenditure. Given the fact that transportation costs are inversely related to income level, the importance of an affordability index that reflects transportation costs is becoming increasingly evident.

The Housing + Transportation Affordability Index (H+T Index) was developed as part of a 2005 Brookings Institute project, and after being employed in a pilot project involving several metropolitan areas, the utilization of the index was expanded to include 52 major urban areas. Meanwhile, the traditional affordability standard of RIR 30% was replaced with a new standard of 45% of income when including transportation costs. The LAI was developed as issues began to emerge with this index, such as limited applicability and data reliability. The LAI offered better prediction by improving the data so that detailed disaggregated spatial units were possible and by increasing data transparency so that the model was corrected and reflected various types of households and income levels.

3. Examples of LAI in Public Policy

① Adopting in a comprehensive housing plan

An affordability index that takes transportation costs into account can be utilized when establishing a comprehensive housing policy framework and when developing a region-specific index, providing information on households in a region, conducting education in a region, distributing public funds, selecting applications for public funds, and providing support functions and monitoring when establishing housing-related plans. Specific examples are as follows.

- Support for residential construction in and increasing the number of mortgage loans for areas adjacent to public transportation
- Funds for affordable housing in transit-oriented development
- Analyses of residential area typology and categorization of areas by degree of affordability
- Analyses of regional differences between comprehensive affordability levels that take housing costs and transportation costs into consideration

② Application in transportation policy

A LAI reflecting transportation costs can be utilized by the transportation sector when selecting locations for infrastructure. It is currently used in a variety of ways by metropolitan planning organizations as an index to help establish transportation plans and land use plans, and it is even used when establishing long-term metropolitan transportation plans.

③ Utilization in urban planning and policy

An affordability index incorporating transportation costs was used by the Chicago Planning Authority when it established a comprehensive long-term plan for the Chicago Metropolitan area. Moreover, Such an index was used in Cleveland to identify the determinants of regional declines and an uneven real estate market and a strategic plan for urban revitalization.

4. Need for LAI

An examination of cases overseas where an affordability index that considers transportation costs was utilized reveals the following implications. First, the need for government monitoring of and policy-based support for households under excessive housing burdens was confirmed. Second, transportation costs and location must be taken into consideration when measuring what is affordable for a household and providing affordable housing. This leads to the conclusion that when Korea develops new towns, there is a need to advance a transportation plan simultaneously with a housing supply plan.

Analysis of Affordability Taking Transportation Costs into Account and Development of an Index

I. Flow of Analysis

Method of calculating housing costs

To calculate housing costs, the units of analysis were the smallest administrative districts, eup/myeon/dong, as they could best reflect residential locations. In addition, real lease contract data was utilized to increase spatial precision and timeliness instead of survey data based on sampling, which could not offer the level of precision provided by eup/myeon/dong. After geocoding actual *jeonse*/rental transactions over the past two years based on location using the GIS spatial tool, monthly rent (housing costs) was calculated by applying the JRCR based on region, time, and housing type.

Method of calculating transportation costs

Commuter origin and destination (OD) and network analysis were applied using the Household Travel Survey. Transportation costs were defined as commuting costs calculated based on the travel distances and travel modes from home to work or school.

Data

The analysis utilized actual *jeonse*/monthly rent with deposit (MRD) transaction (rental contract transaction hereafter) data (January 1, 2016–December 31, 2017) for housing costs and aggregated Household Travel Survey data (2016) for transportation costs.

Figure 1. Flowchart of Housing Costs and Transportation Costs Analysis

Source Created by author

Category	Spatial Unit of Analysis	Data	Conversion Rate, Reference Value	Method of Calculation
Traditional	Nationwide, Cities, and Provinces	Housing Survey Individual Research Data	JRCR	Median Housing Costs / Median Income
 Refinement of Analysis Data and Spatial Unit of Analysis from Traditional Method				
①	H	Eup/Myeon/Dong Actual <i>Jeonse</i> /Rental Transaction Data	JRCR by Timeframe and Housing Type	Average of Individual Transactions by Eup/Myeon/Dong
 + Addition of Transportation Costs				
②	T	Eup/Myeon/Dong Household Travel Survey	Network Distance, Reference Prices	Calculation of Transportation Costs by Household and Method of Passage, Taking Distance into Consideration
 Affordability Analysis when Housing Costs and Transportation Costs are Both Taken into Consideration				
③	Comparison	H vs H + T		→ Comparison of Differences According to T Values
 Region Classification, Identifying Areas Areas with Excessive Housing Costs				
④	Analysis	H↑T↑	H↑T↓	H↓T↑
				H↓T↓

2. Housing Cost Burden

The data on rental contract transactions reveal that 47% of transactions in the SMA occur in Seoul and that the apartment transaction is the most prevalent type of rental contract transaction. Renter-occupiers in the SMA spend on average KRW 687,000 (USD 625) per month on housing costs, while those who live in Seoul spend on average KRW 769,000 (USD 699) per month. Renters residing in apartments in Seoul tend to have the highest housing cost burden, which is on average KRW 1,189,000 (USD 1,081) (conversion rate USD 1=KRW 1,100).

Absolute term: Level of housing cost burden → (H)

Relative term: Rent-income ratio → RIR(H)

Table 1. Average Housing Cost Burden by Housing Type and Region

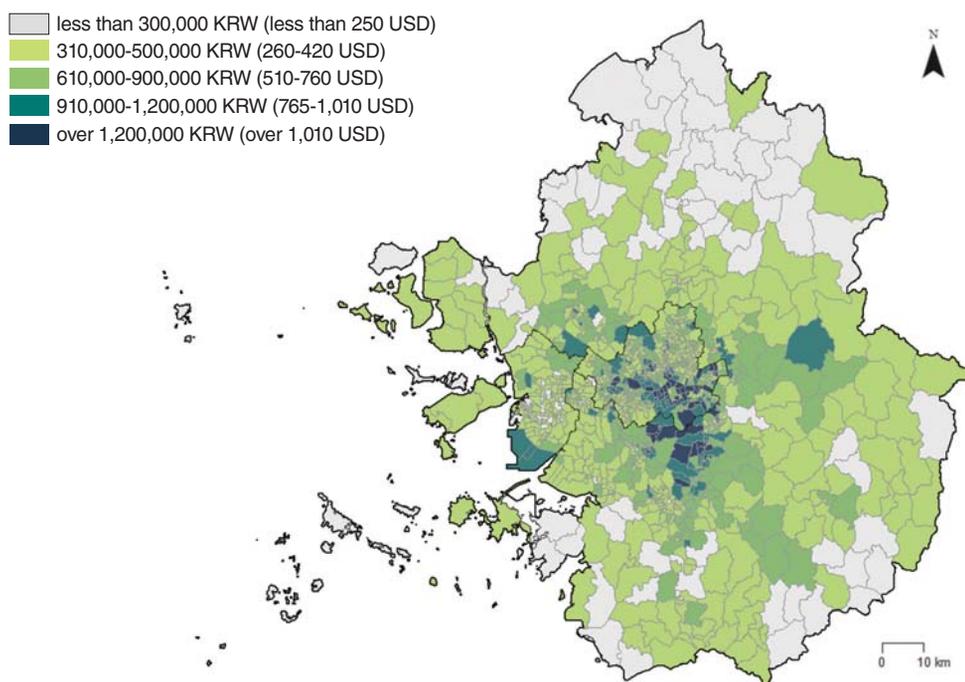
(Unit: USD/month)

	Apartment	Single	Multi-unit	Officetel	Average
Seoul	1,081	366	554	412	699
Incheon	563	346	312	386	468
Gyeonggi	684	433	480	454	573
SMA average	834	396	508	424	625

Note: Conversion rate of USD 1=KRW 1,100

Source Composed based on data analysis from *jeonse* /MRD transaction data released from MoLIT's actual transaction price disclosure system (2016–2017) with *jeonse*/rental conversion rates from the Korea Appraisal Board.

Figure 2. Housing Cost Burden in Capital Region by Eup/Myeon/Dong (Average)



Source Composed based on raw data from MoLIT's actual transaction price disclosure system (2016–2017).

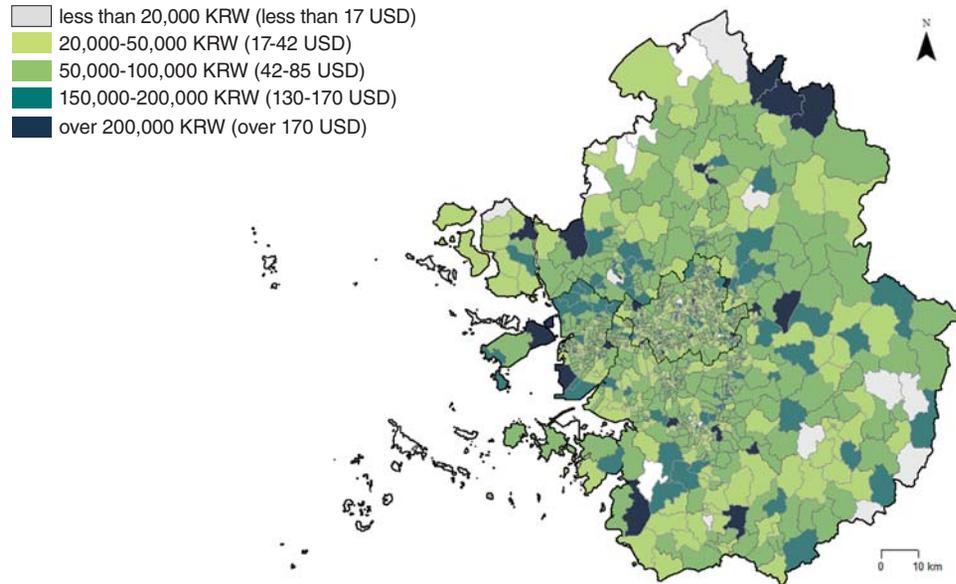
3. Analysis of Transportation Costs

Calculating transportation costs using data from the Household Travel Survey showed that the average transportation cost for 1 day in the SMA was KRW 5,875 (equivalent to USD 5). The analysis revealed that income level and transportation expenditure have

a proportional relationship, as transportation expenditures were lower for low-income levels. The average monthly transportation costs per household were determined as KRW 117,000 (USD 106) on average for the capital area. Within the capital area, transportation expenditures were lowest in Seoul at KRW 114,000 (USD 104) and highest in Incheon at KRW 123,000 (USD 112).

Figure 3. Transportation Cost Burden in Capital Region by Eup/Myeon/Dong (Averages)

Source Composed based on source data from MoLIT's Household Travel Survey (2016).



4. Analyzing of Housing Cost Burden Plus Transportation Costs

After analyzing the comprehensive housing cost burden taking both housing costs and transportation costs into account, regions were categorized into four types based on both costs. Type 1 regions were regions where both housing costs and transportation costs were high, with the average housing costs being KRW 825,000 (USD 695) per month and the average transportation costs being KRW 140,000 (USD 120). Type 4 regions were regions where both housing costs and transportation costs were low, with the average housing costs being KRW 382,000 per month (USD 347) and transportation costs being KRW 81,000 (USD 70).

Table 2. Descriptive Analysis of H+T by Municipality

(Unit: USD/month)

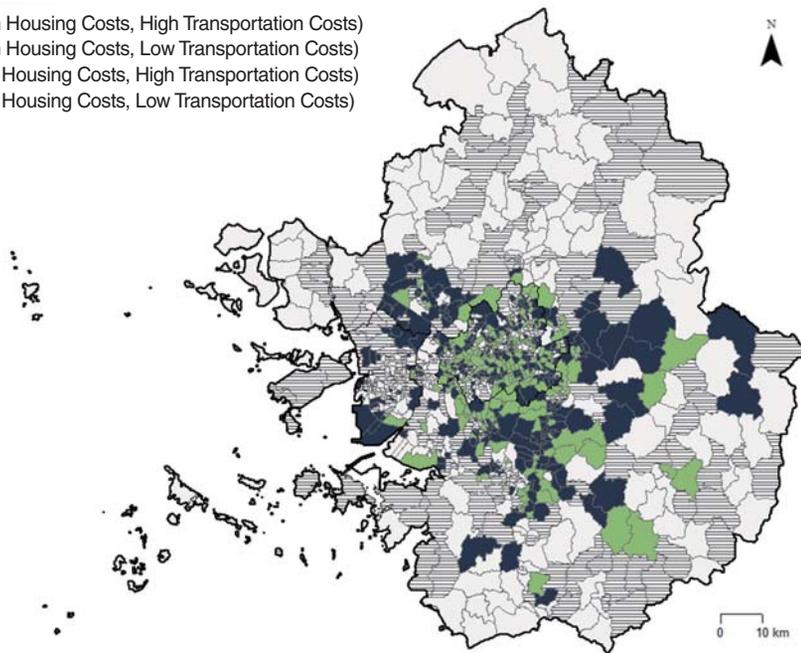
Category	Type 1 (Housing Costs ↑, Transportation ↑)	Type 2 (Housing Costs ↑, Transportation ↓)	Type 3 (Housing Costs ↓, Transportation ↑)	Type 4 (Housing Costs ↓, Transportation ↓)	Mean
Average Housing Costs (H)	82.5	85.7	41.0	38.2	61.6
Average Transportation Costs (T)	14.0	9.1	14.4	8.1	11.4

Source Composed based on housing cost and transportation cost analysis

Note: Conversion rate of USD 1=KRW 1,100.

Figure 4. Categorization of Regions by Housing Burden Taking Transportation Costs into Consideration

- Type 1 (High Housing Costs, High Transportation Costs)
- Type 2 (High Housing Costs, Low Transportation Costs)
- ▨ Type 3 (Low Housing Costs, High Transportation Costs)
- Type 4 (Low Housing Costs, Low Transportation Costs)



Source Composed based on actual Jeonse/rental transaction source data and Household Travel Survey data from MoLIT.

A comparison between the ratios of monthly income to only housing costs versus housing costs and transportation costs together by region shows that the addition of transportation costs results in the percentage of monthly income taken up by these burdens increasing to 23.3%. When only Jeonse/rental prices are taken into consideration, the ratio of monthly income to the housing burden (RIR(H)) is an average of 19.6% for the entire capital area, with Seoul being the highest at 21.7%. The ratio of monthly income to housing and transportation burdens (RIR(H+T)) that also takes transportation costs into account is an average of 23.3% for the entire capital area, with that in Seoul going up to 25.3%.

Table 3. Ratios of Housing (RIR(H)) and Housing + Transportation Cost Burdens (RIR(H+T)) to Monthly Income by Municipality

(Unit: %)

Category	Seoul	Incheon	Gyeonggi	Entire Capital Area
RIR(H)	21.7	17.5	17.9	19.6
RIR(H + T)	25.3	22.3	21.4	23.3

Note: RIR(H) is the ratio of housing costs to income; RIR(H+T) is the ratio of housing costs plus transportation costs to income.

Source Composed based on actual Jeonse/rental transaction data and Household Travel Survey data from MoLIT.

Income level and transportation costs show an inverse relationship. Housing cost burdens increase as income level drops, and when the household income is less than KRW 3,000,000, housing plus transportation burdens (RIR(H + T)) reach up to 30% of income.

Table 4. Comparison of RIR(H) and RIR(H+T) by Income Level

(Unit: %)

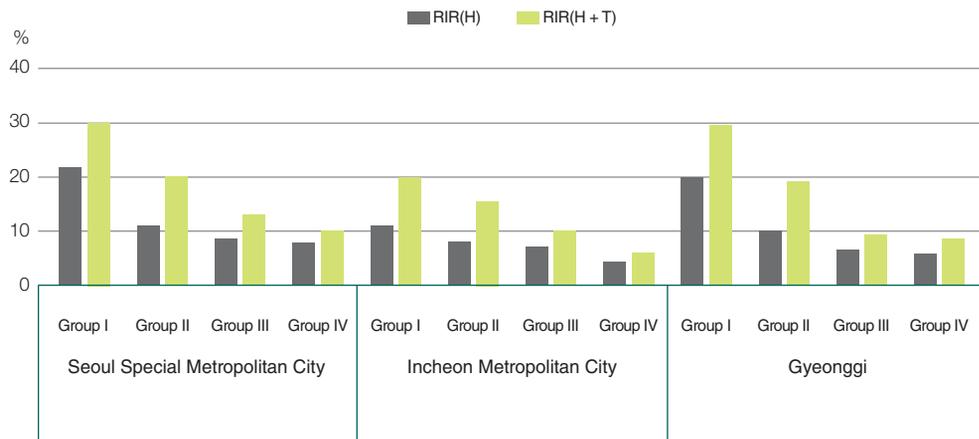
Monthly Household Income	Group I	Group II	Group III	Group IV	Average
RIR(H)	24.9	16.2	10.6	8.5	19.6
RIR(H + T)	29.6	19.3	12.4	9.9	23.3

Note Note: Income range of Groups
Group I : KRW 2,000,000-3,000,000
Group II : KRW 3,000,000-5,000,000
Group III : KRW 5,000,000-10,000,000
Group IV : >KRW 10,000,000

Source Composed by author based on Household Travel Survey data and household burden calculations.

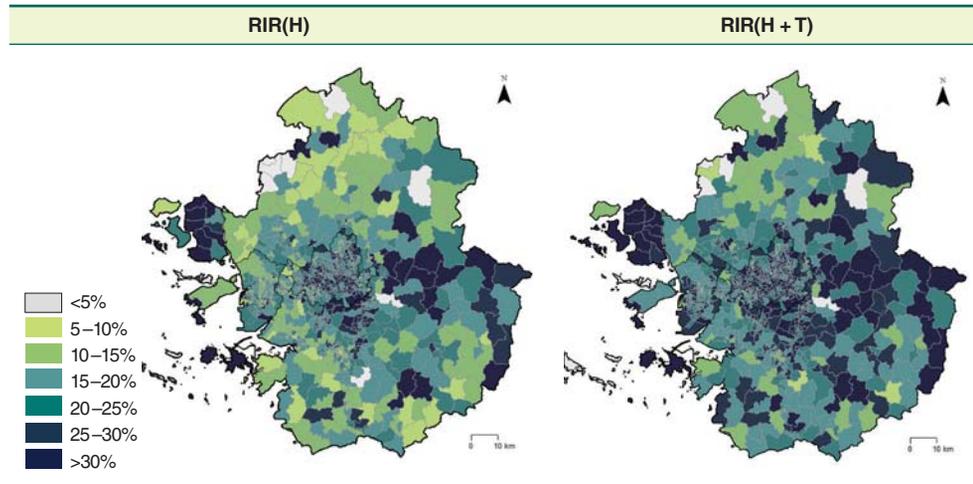
The analysis by income level shows that RIR(H+T) for the mid- to low-income households in Seoul reaches the highest at 31.2%, followed by the same income group in Gyeonggi at 30.0%.

Figure 5. Housing Cost Burden Levels Taking Transportation Costs into Consideration by Region and Income Level



An affordable region in terms of housing costs turns out to be unaffordable when transportation costs are taken into account. Attention should be paid in areas where RIR(H) is less than 30% but RIR(H+T) increases over 30%, implying poor access to public transportation and the need for public investment to increase accessibility to job centers.

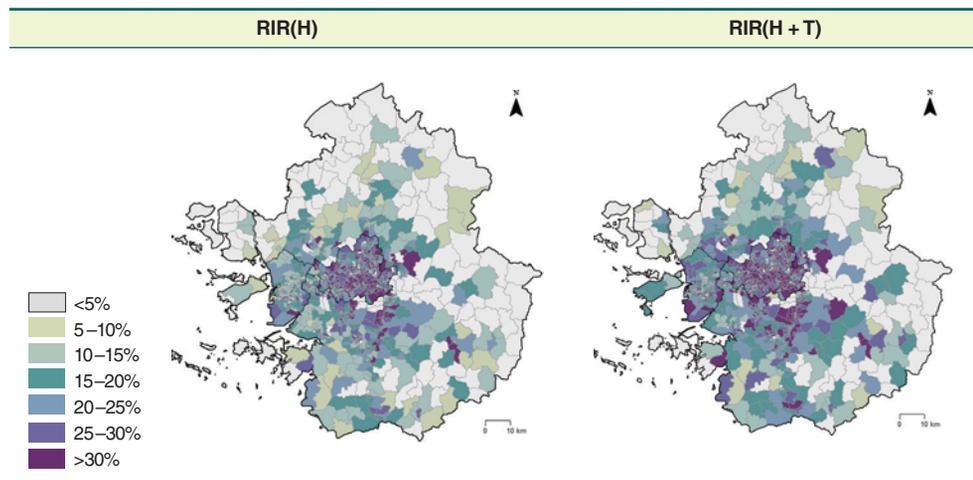
Figure 6. Mapping Affordability (RIR(H)) vs. Location Affordability (RIR(H+T)): All Households



Source Composed based on actual *Jeonse*/rental transaction source data and Household Travel Survey data from MoLIT.

When RIR(H) and RIR(H + T) classifications are made based on whether the housing type is an apartment or not (non-apartment), regional differences become very apparent. In terms of apartments, regions that are significantly affected by transportation costs are inner Seoul and the neighboring areas, while non-apartments that are affected in this way located in the outer part of the capital area, showing a spatial difference by housing type.

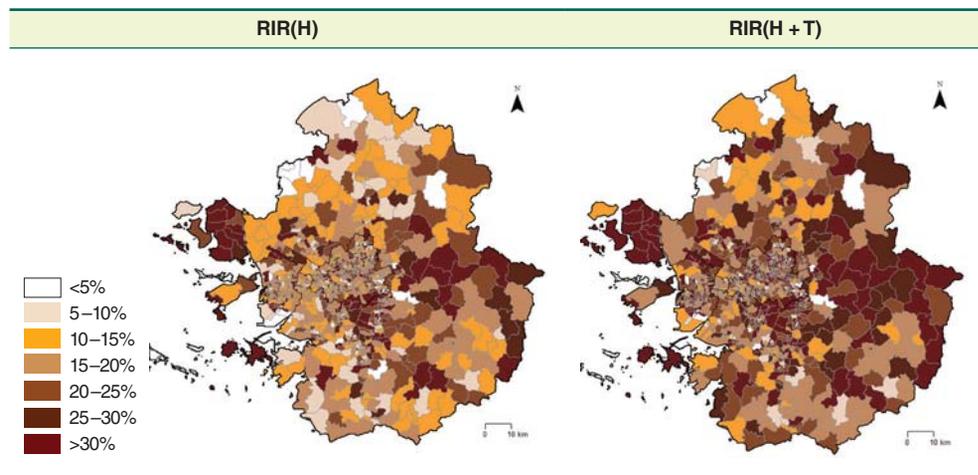
Figure 7. Mapping Affordability (RIR(H)) vs. Location Affordability (RIR(H+T)): Apartments



Source Composed based on actual *Jeonse*/rental transaction source data and Household Travel Survey data from MoLIT.

Figure 8. Mapping Affordability (RIR(H)) vs. Location Affordability (RIR(H+T)): Other than Apartments

Source Composed based on actual Jeonse/rental transaction source data and Household Travel Survey data from MoLIT.



5. Development Principles For LAI

Developing an LAI requires several principles, such as comprehensiveness, objectiveness, practicality, complementariness and timeliness. A comprehensive index is one developed within the context of not only the residential sector but also the transportation and city planning sectors and one that can be utilized for not only housing policies but for transportation policies and urban revitalization policies as well. An objective index is one in which the accuracy of the data is ensured. Practicality means that the index must be developed in a straightforward and way so that it can be easily created, used, and understood. Complementariness means that the index is not intended as a substitute for the existing affordability index but instead will be used as a complementary index to better capture affordability. A timely index must be updated on a regular basis and periodically disclosed so that policymakers and researchers can easily notice affordability changes.

Developing an LAI is aligned with the core concept of the housing policy pillars emphasized by The United Nations Human Settlements Programme (UN-Habitat) The provision of affordable housing that reflects residential location is necessary to mitigate housing costs for low-income households. There must be a re-examination of the method used to provide mass housing in the outskirts of cities. The demand for affordable housing needs to be responded to by considering links with urban systems

and sustainable urban development. Improving the quality of life for low-income households and preventing isolated residential areas through transit-oriented development contribute to sustainable urban development.

6. Defining LAI and Methods of Utilization

The LAI is defined as the proportion of a household's monthly income that is taken up by the sum of housing costs and transportation costs. In this research, as the first attempt to calculate location affordability in Korea using total lease contract data, location affordability focuses on renter-occupiers and calculates their direct payments on rent and commuting as a transportation cost. Therefore, the opportunity cost of owning a house or owning a car is not included in this research.

An LAI can be utilized as ① a policy index to supplement the existing RIR index, ② a method to detect and select policy priority areas, and ③ a tool to determine areas where housing cost burdens are high.

CHAPTER IV.

Analysis of Effects of Housing Costs and Transportation Costs When Deciding Housing Locations

I. Research Outline

A questionnaire survey was conducted in order to examine the trade-off relationship between housing costs and transportation costs based on housing location. The spatial scope of the research was divided into two categories so that the effects of selecting a location could be examined to determine whether between housing costs and transportation costs exist. The categories were ① areas where housing costs are high and transportation costs are low (“High Housing Cost Areas,” such as Gwacheon, Seongnam, Yongin, and Anyang) and ② areas where housing costs are low and transportation costs are high (“High Transportation Cost Areas,” such as Ansan, Goyang, Osan/Hwaseong, Hanam, Namyangju, and Guri). The survey was limited to renter households that commuted from these areas to the job-centered part of Seoul, which is the Central Business District (CBD) comprising the Gangnam, Seoul Station/Jongno, Yeouido, and Jamsil areas.

2. Housing Cost Burden and Housing and Transportation Cost Burden

The questionnaire results showed that the survey respondents mostly resided in apartments and wished to move to apartments when moving in the future. While the average rental housing deposit was KRW 280 million (USD 254,500), this figure was KRW 360 million (USD 327,300) in “High Housing Cost” areas and KRW 210 million (USD 190,100) in “High Transportation Cost” areas, showing a difference of roughly KRW 150 million (USD 136,400) by location. The ratio of rent to monthly income in “High Housing Cost” areas was 33.2 % and 22.3% in “High Transportation Cost” areas. When transportation costs were also taken into consideration, these figures increased to 40.6% and 29.0%, respectively.

Table 5. Ratio of Housing Cost Burden to Monthly Income (RIR(H)) by Region

			(Units: USD, %)
Region	Jeonse Deposit	Rent	RIR(H)
Average	257,754.5	1,154.5	27.8
High Housing Cost	325,418.2	1,431.8	33.2
High Transportation Cost	189,181.8	873.6	22.3

Source Composed by author based on survey results.

Note 1: High housing cost areas are areas among the surveyed areas where housing costs are relatively high, and high transportation cost areas are areas among the surveyed areas where transportation costs are relatively high.

Note 2: Rent indicates the amount equivalent to monthly rent converted from the *jeonse* deposit, as the *jeonse* lease contract does not require the payment of monthly rent.

Table 6. Ratio of Integrated Housing Cost Burden to Monthly Income (RIR(H+T)) by Region

			(Units: USD, %)
Region	Transportation Cost	Rent + Transportation	RIR(H+T)
Average	280.9	1435.5	34.9
High Housing Cost	309.1	1740.9	40.6
High Transportation Cost	253.6	1127.3	29.0

Source Composed by author based on survey results.

Note 1: High housing cost areas are areas among the surveyed areas where housing costs are relatively high, and high transportation cost areas are areas among the surveyed areas where transportation costs are relatively high.

Note 2: Rent indicates the amount equivalent to monthly rent converted from the *jeonse* deposit, as the *jeonse* lease contract does not require the payment of monthly rent.

Those living in “High Housing Cost” areas tend to find housing costs more burdensome than those in “High Transportation Cost” areas. In addition, the burden is heavier for householders who are married, have children, and own a car.

3. Transportation Costs and Sensitivity Characteristics

The survey showed that the average commuting time is almost an hour one way; more specifically, it is 58 minutes for “High Housing Cost” areas and 65 minutes for “High Transportation Cost” areas. Compared to their previous residences, respondents’ commuting time increased in “High Transportation Cost” areas, and they wished that this figure would drop by approximately half when they moved in the future. “High Transportation Cost” areas are not areas where the absolute level of transportation costs is high but rather areas where it takes a long time to get to the city center, implying that enhanced accessibility to the CBD is a prerequisite for reducing the cost burden. Transportation burdens are heavier for residents of “High Transportation Cost” areas than for residents of “High Housing Cost” areas, and transportation burdens are heavier for householders who are unmarried, childless, and have no vehicle, showing the opposite trend of the perception of the housing cost burden.

4. Impact of Housing Costs and Transportation Costs on Location Decisions

In terms of whether housing costs or transportation costs were more important when moving to their current residence, respondents in “High Housing Cost” areas indicated that transportation costs were relatively more important, while those in “High Transportation Cost” areas stated that housing costs were relatively more important. Transportation costs and reductions in transportation time served as important motivators for those moving to areas with high housing costs. In contrast, households that selected areas with high transportation costs or long commuting times were motivated by low housing costs.

Table 7. Reasons for Selecting Current Residence (Past ⇒ Present)

(Unit: %)

Source Composed by author based on survey results.

Region	Housing Costs Important	Similar	Transportation Costs Important
Average	71.4	13.5	15.1
High Housing Cost	68.6	13.1	18.3
High Transportation Cost	74.2	13.9	11.9

Note: High housing cost areas are areas among the surveyed areas where housing costs are high, and high transportation cost areas are areas among the surveyed areas where transportation costs are high.

When asked whether they would prefer a housing cost subsidy or transportation cost subsidy if the same amount of support were provided, respondents generally replied that they would prefer a housing cost subsidy. However, younger respondents who commuted to the city center (respondents who were in their 30s, unmarried, did not own a vehicle, and commuted to the Seoul Station and Jongno areas) responded that they would prefer to have a transportation cost subsidy. This finding implies that subsidizing transportation costs for younger age groups that mainly use mass transit can be effective and improve satisfaction.

5. Willingness to Pay Additional Amounts for Housing and Transportation Costs

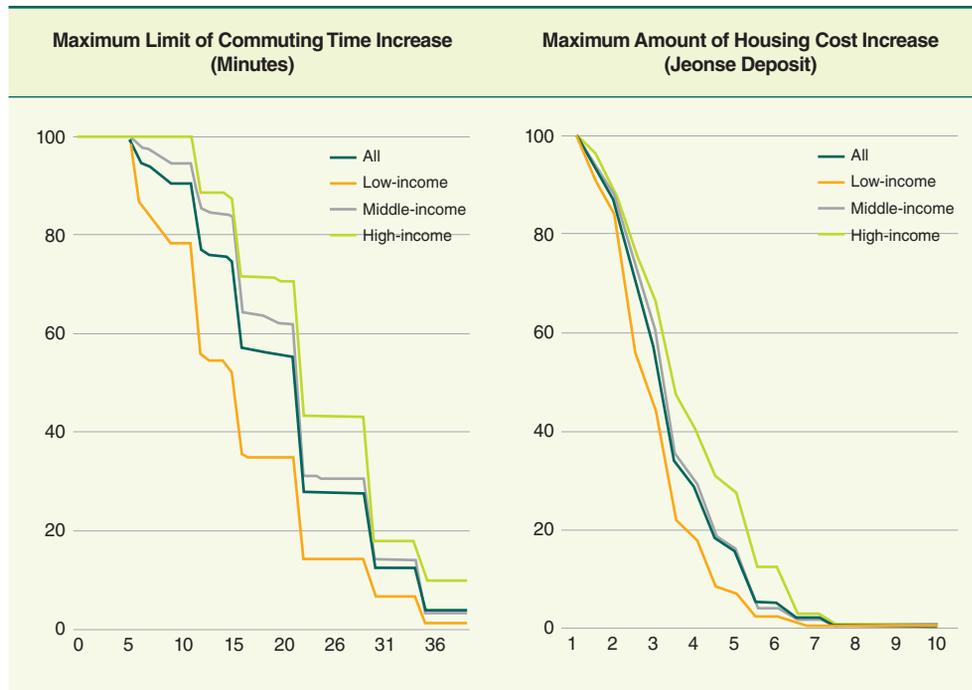
The differences in the maximum limits to which each households could increase their commuting time and jeonse deposit under trade-off situations were analyzed based on their current location. “Additional commuting time limit” refers to the maximum acceptable increase in commuting time when moving to affordable housing. “Additional housing cost limit” refers to the maximum additional housing cost (jeonse deposit) increase when reducing transportation costs, given that an increase in housing costs is unavoidable when transportation costs are decreased.

Low-income households tend to increase additional commuting time less. The additional commuting time for monthly income levels of less than KRW 3 million (USD 2,700) is 10–15 minutes, while that for monthly income levels of more than KRW 6 million (USD 5,500) is more than 30 minutes.

A similar trend is seen for additional housing cost burden by income level. The willingness to pay more in deposits decreases as income level decreases. The deposit increase cap for 50% of households is KRW 25 million (USD 22,700) for low-income households, KRW 30 million (USD 27,200) for middle-income households, and KRW 35 million (USD 31,800) for high-income households.

Figure 9. Analysis of Additional Burden Limits by Income Level

Source Survey results.



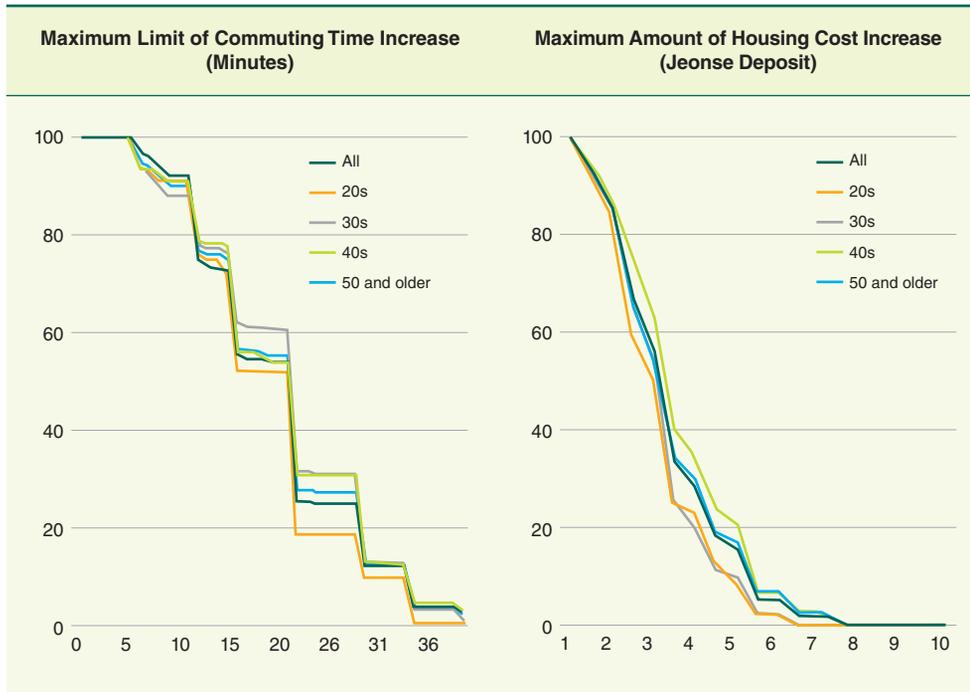
Note: (Left graph) The X-axis is the maximum additional commuting time(minutes), The Y-axis is the probability of survival (%), (Right graph) The X-axis is the maximum additional Jeonse deposit (KRW 10 million), The Y-axis is the probability of survival (%)

Young commuters tend to increase commuting time less. The maximum increase to commuting times is 15–20 minutes for 50% of those in their 20s and up to 30 minutes for those in their 40s.

Jeonse households express longer commuting times and the potential to pay higher deposits as compared to households living in MRD. In terms of the maximum *Jeonse* deposit payable if housing costs increased while transportation costs decreased, 50% of MRD households responded they would pay KRW 19.4 million (USD 17,600), while 50% of *jeonse* households responded KRW 30.5 million (USD 27,700).

Figure 10. Analysis of Additional Burden Limits by Age

Source: Survey results.



Note: (Left graph) The X-axis is the maximum additional commuting time(minutes), The Y-axis is the probability of survival (%), (Right graph) The X-axis is the maximum additional Jeonse deposit (KRW 10 million), The Y-axis is the probability of survival (%)

Policy Implications of LAI

I. Implications for Housing Policies

Utilization for new town and housing construction

An LAI can be utilized in several policy arenas, such as housing policy, transportation policy, and urban planning and regeneration. First, housing policy is the core area for adopting an LAI instead of the housing affordability index that is now widely used. The benefit of adopting spatial affordability is to provide a wider perspective on the affordability issue, to provide theoretical and practical grounds for developing affordable housing, and to implement integrated and inclusive housing policies for low-income households.

An LAI can be utilized when selecting locations for new towns and large-scale housing developments. The index can be used as a basis for increasing accessibility to transportation nodes and expanding transportation accessibility to new towns. It can also be utilized to select locations with low transportation times and costs when choosing areas for the construction of public rental housing meant to provide residential stability to low-income tenants.

Utilization when establishing comprehensive housing plans

When the central government establishes comprehensive housing plans, this index can be employed to measure rent burdens. It can allow for detailed spatial analyses and can track changes over time in addition to changes resulting from access to transportation. When regional governments establish comprehensive housing plans, the index can be used to measure housing burdens for regional residents and to determine housing needs. It can induce the utilization and methodology, which would be developed by the central government and disclosed to regional governments when establishing regional plans. It can be used to select and monitor areas of special interest, such as areas having low burdens when only housing costs are considered but having high burdens when transportation costs are factored into the equation. The index can also be adopted by

be adopted not only by individual regional governments but also by regional government alliances when they jointly establish comprehensive metropolitan housing plans and plans connected with the transportation sector. Metropolitan cooperative systems that take the regional movement of leasing households into account must be established.

Utilization when procuring and allocating funds meant to provide affordable housing

The index can be a useful tool when the central government provides affordable housing with housing funds/subsidies. Escalating housing prices prevent low-income renters from living in pleasant neighborhoods with quality amenities. In terms of providing affordable housing for low-income households, free market force does not meet their needs; therefore, so the government utilizes subsidies or incentives to develop affordable housing. Housing funds are one of the widely used tools to boost affordable housing production by house builders. When allocating public funds to meet policy goals, such as procuring affordable housing, an LAI is useful because it can help determine whether to alleviate low-income renters' housing cost burden by comparing the situation before and after building a housing project. It can also be used to provide funding for public transit-oriented housing development.

Utilization as supplementary index for housing financing

When considering a household's ability to repay a housing loan based on the price of the housing, instead of considering housing costs alone, transportation costs can also be reflected. In other words, the size of a loan can be increased for a household residing in an area with high mass transit accessibility. This is because the household would lower their transportation costs by using public transportation instead of a personal automobile, thereby increasing their discretionary income by that amount. As such, the index can be used to help evaluate actual mortgage repayment ability by taking into account transportation cost reductions for households that do not have a car and that reside in neighborhoods with good access to public transportation.

2. Implications for Transportation Policies

Utilization for central government's large-scale transportation project decisions

Pre-feasibility analyses are required to determine whether to proceed with large-scale transportation projects. There are several indicators to measure economic, social, and financial feasibility. An LAI would play an important role in reflecting regional conditions and comparing project results.

Utilization to determine the relationship between regional housing and transportation burdens and to categorize regions

Areas with low housing costs and high transportation costs indicate low accessibility to public transportation. Therefore, the index can be used as a basis to select areas for mass transit infrastructure expansions and to increase mass transit accessibility.

Utilization to select areas and households to receive support for mass transit costs

The index can be used to select areas and households to receive support by a commuting cost subsidy as a complement to providing affordable housing. In particular, an LAI can be used as the basis for preferentially providing transportation cost support to young households and industrial complex workers.

3. Methods of Utilization for Urban Renewal Policies

Utilization as an index to evaluate urban renewal projects and monitor results

Utilization as a supplementary index to determine declining and shrinking cities

Conclusions and Follow-Up Tasks

I. Conclusions and Policy Proposals

When a household makes a decision about where to live, both housing and transportation costs must be considered; however, the current affordability index is limited in reflecting this. As the current affordability index only provides wide-area information on a national or regional level, it is unable to offer a detailed analysis of the differences between housing locations. As such, there is a need for a comprehensive LAI that analyzes affordability by using actual transaction data to improve spatial accuracy down to the eup/myeon/dong level and that includes transportation costs.

The results show that the average RIR in the capital area is 19.6% but that this increases to 23.3% when transportation costs are also taken into consideration. For Seoul, these figures increase to 21.7% and 25.3%, respectively, and in terms of income level, a correlation between income and rent burden was confirmed where the housing burden increased as income decreased.

In terms of the impact of housing costs and transportation costs when making a decision about housing location, the influence of housing costs was much higher given the absolute difference between the two costs. For the areas on the periphery of the capital area where the commuting time to the Seoul city center was long and mass transit conditions were poor, the influence of transportation costs was relatively high. Because the limits to additional commuting time were shorter and housing price increases limits were low for low-income levels, there is a need to supply affordable housing in areas adjacent to mass transit.

An LAI that takes transportation costs into consideration can be utilized in several policy areas, such as housing policies, transportation policies, and urban renewal policies.

- ① (Housing Policies) It can be used as an index for new town developments, housing construction, and public rental housing construction, and it can be used when establishing comprehensive housing plans and allocating public funds to incentivize affordable housing supply.
- ② (Transportation Policies) It can be used as an additional index by the central government for large-scale transportation project decisions, and it can be used when selecting areas and households to receive support for mass transit costs.
- ③ (Urban Renewal Policies) It can be used as an index to evaluate urban renewal projects and monitor results and as a supplementary urban decline index.

2. Academic and Policy Contributions of the Research

This research contributes in the following two ways. First, in terms of academia, it helps to broaden the diverse debates over measuring affordability. The research utilized various methodologies including spatial analysis, network analysis, survival analysis, and importance–performance analysis. In addition, it was not an analysis based on sampling, which was the prevalent method of analyzing affordability in the past. Instead, the research offers a new analytical methodology that utilized disaggregated real-time transactions as big data. It detected and confirmed the theoretical basis for the influence of transportation costs on regional housing location decisions, which will help trigger follow-up research.

In terms of policy contributions, it provides a comprehensive viewpoint for housing policies and transportation policies. It provides an empirical basis for policies meant to reduce housing burdens that consider transportation conditions when new town policies are being established. It helps diversify the policy options for reducing housing costs and improves quality by proposing the establishment of housing policies that reflect location. Finally, it provides an alternative supplementary index for urban renewal projects.

3. Limitations of the Research and Follow-Up Tasks

This research focused on renter-occupiers and analyzed direct costs from among other related costs. As such, a proposed follow-up task is to conduct comprehensive research that is expanded to include owner-occupiers and methods that take opportunity costs and time costs into account.

Additional follow-up tasks include diversifying the categories included in housing costs, supplementing income data, and preparing Korean standards for affordability that reflect the characteristics of Korea's rent contract traditions, such as the jeonse lump-sum deposit lease.

4. Implications for Developing Nations

Many countries are trying to solve quantitative and qualitative housing shortages. This, however, may result in massive housing construction without adequate access to public transportation, which does not align with sustainable development or improve the quality of residents' lives. In some cases, large-scale housing is supplied in areas with poor accessibility to public transportation; however, this is just a temporary solution. To echo UN-Habitat III, affordable housing should be supplied with consideration of accessibility to public transportation, urban amenities, and job centers.

Housing developments meant to lower housing costs that do not reflect location can ultimately lead to increases in transportation costs, which can in turn lead to lower discretionary income or increased commuting times for households. Therefore, there is a need to develop an LAI that overcomes the limitations of traditional affordability index by considering location, and even developing nations will need to establish and execute housing policies that take this into account.

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