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Forecasting Changes in Trade Areas Due to the Introduction of GTX, a New Regional Express Rail System in Seoul Metropolitan Area*

수도권 광역급행철도(GTX) 도입에 따른 상권 변화 예측

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Abstract

The purpose of this study is to forecast changes in trade areas of the Seoul Metropolitan Area as a result of the introduction of the Great Train Express (GTX) which connects Seoul and its neighboring cities. Existing studies have not shown consistent analysis findings as to whether the introduction of high-speed transportation system such as the GTX would aggravate the population concentration on megacities such as Seoul. Some argue that the population concentration on big cities will be unavoidable, while others maintain that such concentration will not take place and travel time between cities will only reduce.

This study extracted the travel time and the size of existing trade areas as main factors affecting the formation of trade areas and identified a probability model that determines trade areas from such factors. While this study adopted general study methodology in this regard, it is differentiated from existing studies in that (1) it used the discrete probability model to reflect actual effects of travel time, which represents accessibility, on the selection of a trade area; and (2) it conducted feedback analysis on the complex network through which results of an analysis serve as input values for another analysis.

The feedback analysis using the probability model proposed by this study allowed us to predict that the introduction of the GTX would aggravate the population concentration on Seoul.

Keywords: Trade Area, Discrete Probability Analysis, Complex Network, Feedback Analysis, Travel Distance

I. Introduction

1. Purpose of Study

The Seoul Metropolitan Area ("Metropolitan Area") is comprised of two different administrative districts: Seoul and other cities in Gyeonggi-do. Most of the transportation system of the Metropolitan Area connects Seoul and its neighboring cities. On the other hand, the transportation system connecting those neighboring cities to each other is relatively insufficient. The Metropolitan Area in Korea has steadily advanced since the establishment of the Korean

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government, allowing for continuous advancement of the transportation system to support its expansion (Kwon 2002). The continual urban sprawl in the Metropolitan Area has overloaded its transportation system connecting Seoul and its satellite cities (Lee 1998).

As part of measures to resolve such a transportation problem in the Metropolitan Area, the metropolitan railway system called the Great Train Express ("GTX") is under construction. The GTX is a high-speed rail system linking Seoul to its adjacent cities in Gyeonggi-do such as Suwon, Uijeongbu, and Bucheon. To avoid existing traffic congestion on the roads while construction, most railroads are to be built below ground and the number of intermediate stations between Seoul and its satellite cities will be minimized.

The GTX is expected to bring changes in the metropolitan transportation system as a whole by reducing travel time between regions around the GTX stations. This will also transform the trade areas that are the geographic areas from which a community generates the majority of its customers. Although previous studies have discovered a variety of factors that affect the changes in trade areas, distance (from a consumer's origin location to a store) is deemed to be a common factor (Satania, Uchidaa, Deguchia and Ohaib et al. 1998; Schomann 1999). The changes in transportation systems due to the construction of the GTX will change the distance (travel time) between a consumer's origin location and a store, thereby rendering changes to trade areas unavoidable.

The purpose of this study is to develop a common model to forecast changes in trade areas resulting from the construction of the GTX and use the model in predicting changes in a certain trade area.

2. Study Methods

This study was conducted by carrying out the following sub-studies and applying respective study methods:

1) Selection of the Choice Probability Model

A number of existing studies have suggested models to estimate the probability of a consumer at an origin location selecting a specific store (or a commercial center which denotes a set of stores) from the consumer's location. this study has selected a model from out of existing ones that are being used for similar purpose. It was selected by considering how effectively a probability model reflects the change in distance. For instance, the Logistic Model or the Discrete Logistic Model is more effective in reflecting the change in distance than the Gravity Model or the Huff Model. It will be explained in more detail in Section "III. Establishment of Theory" in below.

2) Development of the Urban Model that the Probability Model can be Applied to

Once a Choice Probability Model is selected to define how likely a consumer selects a certain commercial store from a certain location, an urban model that the Choice Probability Model can be applied to should be developed. The urban model represents an abstract form of a city. Abstraction means a process of extracting specific information from an actual being, i.e., a city, in a specific format. As such, the urban model to be developed in this study should contain all information required for the calculations in the Choice Probability Model that was developed in the previous step and concurrently be able to extract such information from the actual city. In this study, the "Saejuso" map which contains a number of text-based data as well as geographical data is used for the abstraction since the map represents cities in an abstract manner. The information necessary to calculate probability of selection includes distance (travel time) between a specific commercial center and a certain consumer's location, capacity of a commercial center, and so on.

3) Selection of a Specific Commercial Center

There can be various types of commercial centers in the Metropolitan Area: an area for shopping or an area for amusement. They vary in light of their locations and capacities. As such, a specific type of commercial center needs to be selected.

In this study, 'commercial center' refers to department stores which are located in the Central Business District of an individual city within the area being analyzed. Although there are other commercial facilities than department stores, such as superstores and shopping malls, this study restricts commercial center to department stores because (1) most of superstores and shopping malls are not located in the Central Business District; and (2) the superstores and shopping malls within the Central Business District are mostly called 'department stores'.

4) Trade Area Analysis before Changes in the Transportation System for the Metropolitan Area

The probability of selecting a commercial center from a certain location before the introduction of the GTX needs to be identified.

5) Trade Area Analysis after Changes in the Transportation System for the Metropolitan Area

The probability of selecting a commercial center from a certain location after the introduction of the GTX needs to be identified.

6) Prediction of Changes in Trade Areas by Comparing Pre– and Post–GTX

The current distribution of trade areas and the simulated distribution after the introduction of the GTX are compared to predict the changes in trade areas resulting from the introduction of the GTX.

II. Formulation of Problems

1. Review of Existing Studies

This study deals with the changes in consumers' commercial activities in a certain area. In that regard, to put it in an existing term, it would be a study on 'retail trade areas'. According to existing studies, trade areas are ultimately determined by product suppliers and consumers. More specifically, trade areas are determined by (1) the characteristics of product suppliers, (2) the characteristics of consumers, and (3) their relationship in light of the spatial distribution.

Characteristics of suppliers are defined by the type of products, size of a store, synergy from integration of similar stores, quality of a store, traits of store clerks, and so on. Regarding the type of products that a store deals in, consumers' buying behavior differs depending on whether the product is specialty products, consumables or monopoly goods. As regards the size of a store, consumers' buying behavior may change depending on whether a store is a large shopping mall or a neighborhood shopping center (Choi, Lee and Jun 2009; Lee and Choi 2005).

On the other hand, characteristics of consumers include their income level, age, and preference. They can also be categorized into their buying power and buying preference. It is certain that the most significant factor to affect buying power is the income level of consumers. If the income level of consumers is relatively high, there is a more need for shops that deal in expensive merchandise. Preferred buying behavior is another factor to consider (Shin and Jung 2005; Lee, Kim and Min 2007; Jung and Choi 2006).

Spatial distribution between suppliers and consumers is mostly related to travel time. It is widely acknowledged that where there are a slew of stores available in a location, a consumer prefers a store within a shorter distance from his or her location (Kim and Jung 2003; Kwon 2016). Most existing studies dealt with each of the determining factors for trade areas or with interactions between those individual factors (Son 1996; Lee and Kim 2000; Oh and An 2005).

2. Need for Study on the Prediction of Changes in Trade Areas due to Changes in Spatial Distribution of Suppliers and Consumers

Specifically speaking, this study explores the characteristics of the spatial distribution between suppliers and consumers, which is the third topic in the existing study topics mentioned above. Among the characteristics, this study focuses especially on how to predict the changes in trade areas when travel time changes. Reviews of existing studies found that the number of studies on this topic is relatively small. Furthermore, there is almost no study that applies such perspectives to the GTX and the Metropolitan Area in Korea. In this regard, this study has originality and significance.

III. Establishment of Theory

1. Choice Probability Model

A number of existing studies have proposed models to estimate probabilities of consumers selecting a store from a certain origin location. Most widely-used models include the Gravity Model, Huff Model, and Discrete Probability Model. As stated in Section 1.2 Study Methods, this study will not propose any separate Choice Probability Model. Instead, it selects a model considered most suitable for the purpose of this study from among existing models.

This study aims at predicting the changes in trade areas when the spatial distribution between suppliers and consumers changes. Among the characteristics, this study focuses especially on the changes to trade areas that are made when the distance (or travel time) between suppliers and consumers changes. Thus, an existing probability model that this study intends to adopt should be able to capture the changes in distance most effectively.

Among the abovementioned models, the Gravity Model and the Huff Model do not effectively reflect the changes in distance (travel time).

$$P = A / D \quad \text{<1>}$$

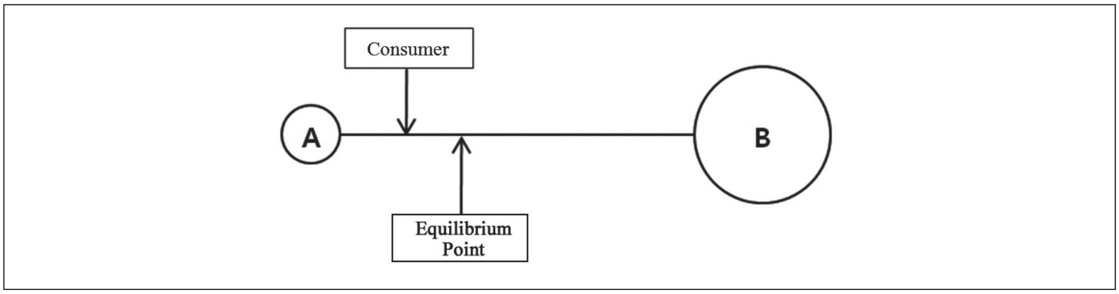
P: Probability of a consumer choosing a store

A: Area of a store

D: Distance from a consumer's location to a store

The Gravity Model and the Huff Model, represented in <1>, cannot explain the mechanism involving the changes in distance (or travel time) because the probabilities that a consumer selects stores A or B increase in the same proportion due to the improvement of the transportation system. In other words, if the Gravity Model or the Huff Model is used, no matter what changes are made in distance (or travel time) due to the improvement of the transportation system between stores A and B, the equilibrium point would remain unchanged as shown in Figure 1.

Figure 1_ Limitations of the Gravity Model and the Huff Model



On the other hand, the Discrete Probability Model would directly reflect the movement of the equilibrium point that occurs when the transportation system between the two points is improved.

$$P=A*X1+B*X2+C \quad <2>$$

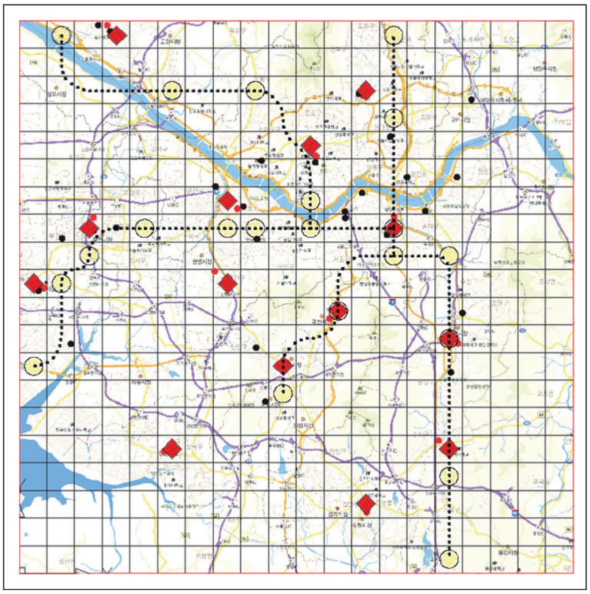
The Discrete Probability Model represented in <2> can reflect more effectively the movement of the equilibrium point due to the improvement of the transportation system by applying the coefficient A, which adjusts X1 representing the size of a store, and the coefficient B, which adjusts X2 representing the distance (travel time).

The reason why only 'size of store' and 'travel distance' are chosen is that among all factors discussed in '1. Review of Existing Studies' under '2. Formulation of Problems', only these two factors cannot be intentionally improved and/or changed.

For these reasons, this study has chosen to adopt the Discrete Probability Model represented in <2> as its Choice Probability Model.

This study employed a regression equation including two factors such as the total floor area of stores, and the distance. The regression equation was established based on the findings of surveys conducted for residents living in the area where the GTX is accessible. The total floor area of stores is used to analyze the distribution of department stores within the area where the GTX is accessible to define the characteristics of the areas where department stores are clustered.

Figure 2_ Distribution of Department Stores within the GTX Coverage and the Distribution of Centers of Each Group of Department Stores



Note: Black colored dots indicate department stores and red colored dots indicate the center of each group of department stores.

As demonstrated in Figure 2, the department stores within the GTX coverage can be geographically classified according to the spatial proximity to others. The center of a group is the point which is the shortest distance from all department stores in the group.

And the total floor area of an individual trade area is the sum of the areas of department stores within a group. To calculate the choice probability equation established at this stage, the area of an individual trade area and the distance from a consumer to a center of a group of department stores are needed. The latter can be extracted by using a 'Saejuso' map. To this end, an Urban Data Model needs to be developed to convert the 'Saejuso' map into an appropriate format, which is explained below.

Figure 3 _ Cells + Actual Transportation Systems (Simplified)

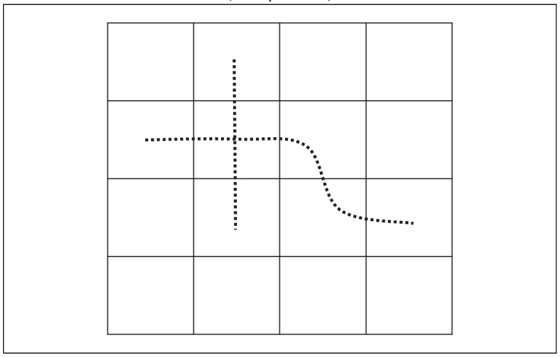
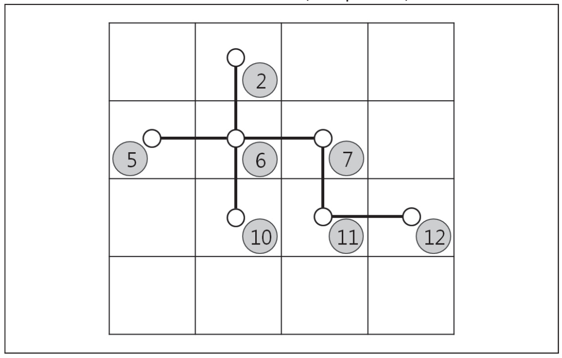


Figure 4 _ Cells + Actual Transportation System that Connects Cells(Simplified)



2. Urban Data Model to Apply the Choice Probability Model

In order to calculate the probability that a consumer selects a store by using the Choice Probability Model established at the previous stage, we need the Urban Data Model that contains information on a certain consumer's location, each trade area's location, distance from a consumer's location to each trade area, and the area of each trade area. To meet such a need, this study represents a city as a set of cells that are connected to each other through the transportation system. Each cell contains the information on locations of each consumer and each trade area. Any cell containing a commercial center has the information on its total floor area. The traffic networks within the area for analysis are represented with the relationship of connection between cells.

To create a Choice Probability Model, firstly the area being analyzed is abstracted with numerous cells and the lines representing actual transportation system as shown in Figure 3. Secondly, the cells and the lines are transformed into nodes and links which constitute a network as shown in Figure 4. Lastly, a connectivity matrix in Table 1 is extracted and used to find the shortest distance between a certain cell (node) and another cell (node) can be found.

If there is a transportation system between neighboring cells, the two cells concerned are considered connected. The travel speed between connected cells is 45 km/hr, which is the average vehicle speed in the Metropolitan Area.

Figure 5 _ Representing Figure 3 in a Network(Simplified)

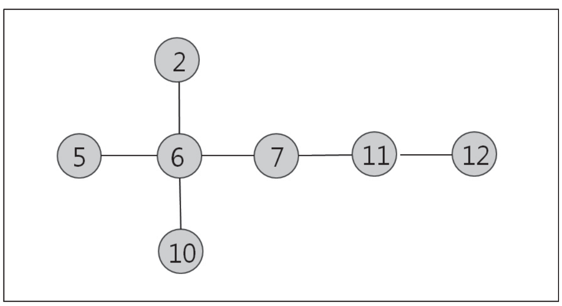
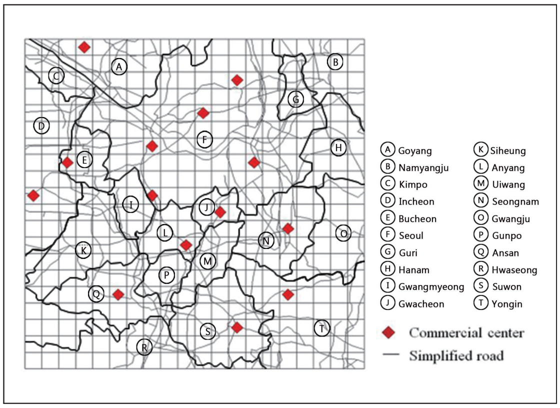


Table 1 _ Representing Figure 5 in a Connectivity Matrix

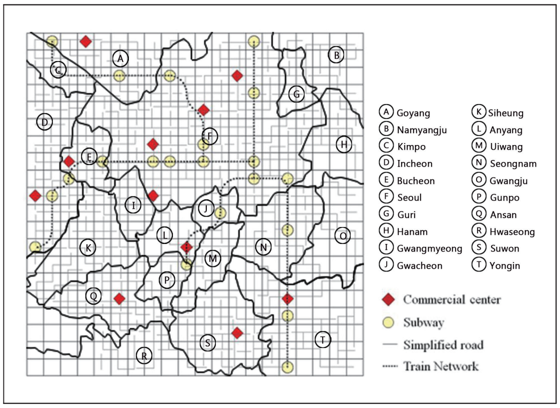
Variable	②	⑤	⑥	⑦	⑩	⑪	⑫
②	0	-	1	-	-	-	-
⑤	-	0	1	-	-	-	-
⑥	1	1	0	1	1	-	-
⑦	-	-	1	0	-	1	-
⑩	-	-	1	-	0	-	-
⑪	-	-	-	1	-	0	1
⑫	-	-	-	-	-	1	0

Figure 6_Current Status of the Metropolitan Area



Note: Grids+Roads+Commercial Centers.

Figure 7_Cells + Network of the Metropolitan Area



Note: Grids+Simplified Roads+Commercial Centers+Railway Systems (Railway Stations).

Figure 6 indicates the urban structure of the Metropolitan Area represented in an ordinary map. This urban structure is converted to a format as in Figure 7, where each cell (2.5km×2.5km) denotes a node; and a line connecting nodes is regarded as a link of network. The travel speed between nodes connected through the GTX is 100km/hr, which is an average speed of the GTX. These conversions render it possible to use the Choice Probability Model.

3. Probability that a Commercial Center is Chosen from a Certain Residence

1) Estimation of the Area and Location of a Commercial Center

The total area of a commercial center is the sum of total floor areas of the department stores in each group. The location of a commercial center is the center of gravity of department stores that constitute the commercial center.

2) Estimation of the Distance from a Consumer's Residence to a Commercial Center

The distance from a consumer's residence to a commercial center is the shortest distance from a certain node to a commercial center that is calculated by using the 'Urban Data Model' that has been converted into the format of a network.

3) Estimation of Choice Probabilities

The choice probability can be obtained by using <2> and the data as shown in the Table 2. A consumer is highly likely to choose a commercial center that has the largest probability value.

Table 2 _ Calculation of Probability

Respondent	Commercial Center(ID)	Area	Distance	Probability	Remark
a	1	90347	10		
	2	259540	46		
	3	155135	46		
	4	191906	30		
	5	155425	43		
	6	335620	66		
	7	172463	43		
	8	16606	53		
	9	103563	69		
	10	70521	86		
	11	52503	69		
	12	36919	66		
	13	47286	99		
	14	66600	96		
b	1	90347	7		
	2	259540	43		
	3	155135	43		
	4	191906	26		
	5	155425	40		
	6	335620	63		
	7	172463	40		
	8	16606	50		
	9	103563	66		
	10	70521	83		
	11	52503	66		
	12	36919	63		
	13	47286	96		
	14	66600	92		
c	1	90347	3		
	2	259540	40		
	3	155135	40		
	4	191906	23		
	5	155425	36		
	6	335620	59		
	7	172463	36		
	8	16606	46		
	9	103563	63		
	10	70521	79		
	11	52503	63		
	12	36919	59		
	13	47286	92		
	14	66600	89		

IV. Trade Area Analysis upon Introduction of the GTX

1. Trade Area Analysis through Choice Probability

1) Choice Probability Equation and Urban Data Model

<2> was used to identify the choice probability equation. The Urban Data Model as in Table 1 was used to find one of the inputs of the choice probability equation, the distance between the cell representing the location of the consumer and the other cell representing the location of commercial center shown in the "Distance" column of Table 3. The "Distance" was captured by using the Urban Data Model derived from the networks in Figure 7.

2) Regression Equation

The survey of collecting data for the formulation of the regression equation was conducted as to which commercial center a consumer in a certain location (cell) visits and how often. The survey was conducted to 100 persons who lives in the area as shown in Figure 7.

Respondents were asked how many times they visited a nearby commercial center out of a total of ten times and which cell they live in. The distance between the respondent and the commercial center is calculated according to the network as shown in Figure 7. The findings of the survey were put together as shown in Table 3 below.

Using the data in Table 3, regression analysis was conducted to obtain the findings in Table 4. R-squared

Table 3 _ Survey Response Examples

Respondent	Commercial Center(ID)	Area	Distance	Visit Frequency
1	1	90347	33	0
	2	259540	17	1
	3	155135	3	5
	4	191906	33	0
	5	155425	13	2
	6	335620	23	2
	7	172463	46	0
	8	16606	23	0
	9	103563	26	0
	10	70521	43	0
	11	52503	33	0
	12	36919	50	0
	13	47286	56	0
	14	66600	59	0
2	1	90347	86	0
	2	259540	50	0
	3	155135	50	0
	4	191906	66	0
	5	155425	53	0
	6	335620	30	0
	7	172463	66	0
	8	16606	43	0
	9	103563	26	0
	10	70521	10	1
	11	52503	26	0
	12	36919	43	0
	13	47286	3	9
	14	66600	20	0
3	1	90347	25	0
	2	259540	13	0
	3	155135	15	0
	4	191906	20	0
	5	155425	15	0
	6	335620	10	1
	7	172463	17	0
	8	16606	13	0
	9	103563	8	0
	10	70521	3	0
	11	52503	8	0
	12	36919	11	0
	13	47286	1	9
	14	66600	6	0

value was 0.659, and the significance levels of factors (area and distance of commercial centers) were 0.000 and 0.000, respectively, showing that they were significant. Consequently, the regression equation in <3> allowed us to obtain the frequency of a consumer in each location (each cell) visiting a certain commercial center with statistical significance.

$$\text{Visit Frequency} = 0.85 * \text{X1(Area of a commercial center)} - 2.447 * \text{X2(Distance)} - 3.829 \quad \langle 3\rangle$$

2. Trade Areas before the Introduction of the GTX

The visit frequency forecast equation in <3> was applied to all cells within the GTX coverage. Each cell belonged to a trade area which a commercial center that had the highest visit frequency creates.

Figure 8 shows the distribution of trade areas that was forecast through the process. Each “diamond” denotes the commercial center.

3. Trade Areas after the Introduction of the GTX

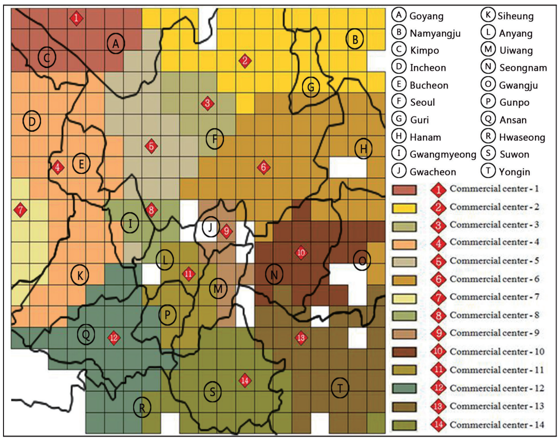
Trade areas after the introduction of the GTX were analyzed by employing the same methods of analyzing those before the introduction of the GTX. Figure 9 shows the distribution of trade areas that was forecast through the process. Each trade area of the individual commercial center is presented with the same color.

The trade area distribution maps before and after the opening of the GTX demonstrates that it brings substantial

Table 4 _ Regression Analysis Results Coefficients[a]

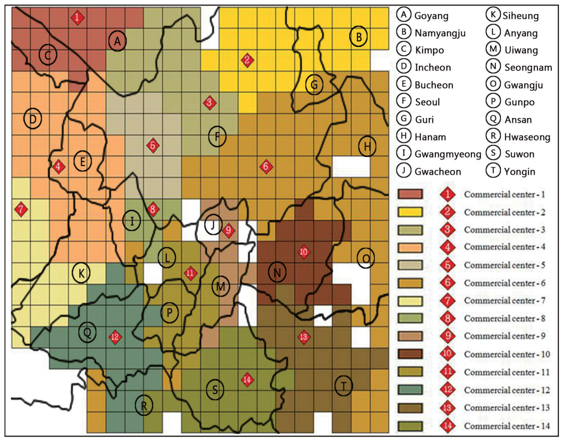
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	-3.829	0.167	-	-22.991	0.000	-	-
Distance	-2.447	0.109	-0.794	-22.383	0.000	0.979	1.022
Total Floor Area	0.850	0.093	0.323	9.101	0.000	0.978	1.022
R 0.812		R Square 0.659		Adjusted R Square	0.657	Std. Error of the Estimate 0.50885	

Figure 8 _ Current Trade Area Analysis Diagram



Note: Before the opening of the GTX.

Figure 9 _ Simulated Trade Area Analysis Diagram



Note: After the opening of the GTX.

changes. The commercial centers that would be expanded as a result of the introduction of the GTX are '3'(+146%), '6'(+45%), '7'(+100%), '9'(+11%), '11'(+29%), top 3 of which are located in Seoul. On the other hand, the commercial centers that would be reduced are '1'(-5%), '2'(-25%), '4'(-17%), '5'(-36%), '8'(-25%), '10'(-19%), '12'(-20%), '13'(-18%), '14'(-19%), most of which are located outside Seoul. However, the commercial centers within Seoul such as '2' and '5', which are far from the GTX service areas, are also shrunk. The most remarkably expanded trade area is '3', while the most remarkably reduced trade area is '5'. Not only the size of trade areas but also their distribution is changed. What is most notable is that a commercial center can be composed of several isolated islands. Upon introduction of the GTX, the commercial center '6' is distributed along with the GTX lines like islands.

The trade area analysis shows that the introduction of the GTX brings changes in trade areas. This result is quite different from that of existing studies claiming that the GTX would not considerably change the distribution of trade areas (Hur 2010).

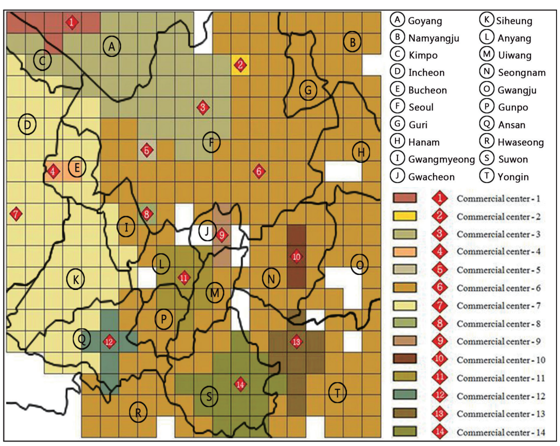
4. Ripple Effect of Changes in Trade Areas due to the Introduction of the GTX

Changes in trade areas due to the introduction of the GTX are not an one event but have a ripple effect. Once trade areas are expanded or reduced, it leads to the changes in the area of the commercial centers, which ultimately affects the visit frequency for them. If the area of a trade area is reduced, it brings a reduction in the revenue and size of stores in the trade area; and vice versa. For example, if sales of a store fall or rise by more than a given percentage, the size of the store is inevitably reduced or expanded accordingly. The only problem is what the given percentage is.

As shown in <3>, the reduction or expansion of a store affects the expected visit frequency. In this study, trade areas were analyzed based on the premise that if the existing area of a trade area is changed by up to 80%, which is a threshold value, the area of a store within the trade area is also changed. In other words, the visit frequency was calculated based on the premise that if the area of a trade area is reduced by up to 80%, the size of a store in the trade area is also reduced by the same percentage. This calculation was carried out on an iterative basis until the size of all trade areas was reduced by up to 60%. This means that if the area of a store is reduced at least 60%, the store stops reducing its size.

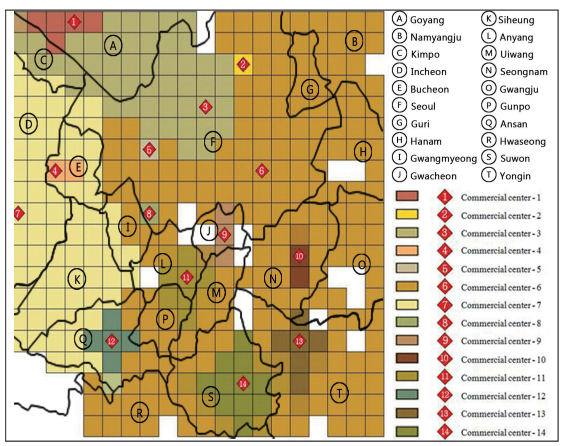
The thresholds such as 80% and 60% are not absolute numbers. It cannot be concluded that the reduction in the store area takes place at the threshold of 80% or that the stop of reduction in store size takes place at the threshold of 60%. However, it is empirically confirmed and theoretically supported by a number of studies that the reduction in the trade area leads to the reduction in the area of stores and the pace of reduction in the area of stores slows down by intentional actions such as urban regeneration and/or redevelopment and finally arrives at a new equilibrium point(Kim and Chung 2013; Ryu and Choi 2012; Son and Park 2017). In such context, the threshold

Figure 10_Trade Area Analysis Diagram



Note: Threshold Value: 80%.

Figure 11_Trade Area Analysis Diagram



Note: Threshold Value: 90%.

of 80% and 60% were provisionally chosen. Although there could be a difference between the real threshold and the temporarily premised threshold, it is arguable that the premise is acceptable and useful because the tendency proposed in this study is significant. Figure 10 shows the findings.

It is notable to find that there is substantial difference between Figures '9' and '10'. The '3', '6' in Seoul and '7' in Gyeonggi-do continue to expand while the '1', '9', '10', '12' and '13' were remarkably reduced, and the '2', '4', '5' and '8' were even nearly eliminated. The changes in trade areas become more drastic if the threshold value is set at a higher level. Figure 11 shows the final changes in trade areas when the threshold value for changes is 90%. It is especially remarkable that the '6' in Seoul expands exceptionally in comparison with the expansion of the '3' in Seoul and the '7' in Gyeonggi-do.

The reduction or elimination of a trade area is more clearly illustrated in Figure 11 than Figure 10.

V. Conclusion

This study proposed a way to predict changes in trade areas resulting from the future introduction of the GTX in the Metropolitan Area in Korea and predicted the changes in such ways as proposed. To predict the change, we first developed a Choice Probability Model that chooses a certain commercial center from a certain location, and then developed the urban data model to provide the information required to apply the Choice Probability Model. The probability model adopted by this study needed two factors: the area of each commercial center, and the distance from a consumer's location to an individual commercial center. To capture the distance, each city was represented by a set of cells connected through traffic networks. This allowed the locations of a consumer and an individual commercial center to be represented simultaneously. The area of a commercial center was obtained through a separate survey to be put into the Choice Probability Model. In this way, the changes in trade areas before and after the introduction of the GTX were predicted. It was found that the trade areas of commercial centers in Seoul were expected to be expanded while those in other regions to be reduced. According to the trade area analysis conducted in this study, changes were likely to occur in the distribution of trade areas as well as in the size of trade areas. The trade area of '6' is distributed in the form of several isolated islands after the opening of the GTX. This study also showed that the changes in trade areas due to the introduction of the GTX were not an one event but had a ripple effect. Once trade areas are expanded or reduced, it leads to the changes in the area of the commercial centers, which ultimately affects the visit frequency for them. If the area of a trade area is reduced, it brings a reduction in the revenue and size of stores in the trade area; and vice versa. It was found from this chain reaction that the changes in trade areas stemming from the changes in transportation systems might be more severe than expected.

The findings of this study are different from those of existing studies claiming that the introduction of the GTX would not considerably change trade areas in the Metropolitan Area and that it would not aggravate the problem of concentration of the population in Seoul. Such different findings render it possible to argue that more diversified approaches are required to analyze the changes in trade areas arising from the introduction of the GTX. It is certainly necessary to ensure more accurate prediction of the changes in trade areas due to the introduction of the GTX through more various studies in the future and to take appropriate measures based on such predictions. On the other hand, we can argue that it is necessary to provide a strategic urban planning to enhance the competence of other Metropolitan Areas than Seoul.

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요약

주제어: 상권, 이산확률분석, 복잡계 네트워크, 피드백 분석, 수도권

본 논문의 목적은 서울과 인근의 다수 도시를 연결하는 고속전철망인 GTX 개통 이후 서울을 중심으로 하는 수도권의 상권변화를 예측하는 것이다. 기존의 연구들은 GTX와 같은 고속 교통체계의 도입이 서울과 같은 중심 도시로의 집중을 심화시킬 것인가에 대해서 일관성이 있는 분석을 내놓지 못하고 있다. 일부에서는 중심 도시로의 집중이 불가피하다고 주장하는 반면 또 다른 일부에서는 집중이 없을 것이며 단순히 각 도시 간의 이동 시간을 감소시키는 효과만이 있을 것이라고 주장한다.

본 논문에서는 상권 형성에 영향을 미치는 주요인으로, 이동거리와 기존 상권의 크기를 추출하고 그로부터 상권을 결정하는 확률모형을 도출하였다. 이렇게 도출한 회귀식을 이용하여 상권의 변화를 예측하였다. 여기까지는 일반적인 연구방법을 따르고 있지만, 본 논문의 차별성은 다음과 같은 두 가지 측면에서 주장된다. 첫 번째, 접근성을 대표하는 이동거리가 상권 선택에 미치는 영향을 현실적으로 반영하기 위하여 이산확률모형을 사용하였다는 점이다. 두 번째, 분석 결과가 또 다시 분석을 위한 입력값으로 작동하는 되먹임 분석을 실시하고 있다는 점이다.

본 논문에서 제안하는 확률모형을 사용하여 되먹임 분석을 실시한 결과, GTX의 개통은 서울로의 집중을 심화할 것이라는 예측을 가능하게 한다.