

Article

An Analysis of the Effect of Non-Parking Facilities in Parking-Only Buildings on the Traffic Inducement Rate

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Abstract: The designation parking-only building (POB) was first introduced in the Parking Lot Act on 14 December 1991. According to the law, POBs can be used for purposes other than parking facilities, that is, non-parking facilities (NPFs), up to 70% of the total floor area. In addition, the POB is an infrastructure in accordance with the National Land Planning and Utilization Act. Excessive introduction of NPFs in a POB weakens the public nature of the building and creates additional demand for parking due to NPFs, thus changing the original meaning of a parking lot. However, on the other hand, NPFs in POBs have a positive aspect in that they contribute to the realization of a compressed city through mixed-use development and increased user convenience. This study investigated and analyzed the usage status of NPFs for POBs in 31 cities in Gyeonggi-do, Korea. In addition, the amount of traffic generated by NPFs was defined as the traffic inducement rate (TIR) and policy implications were presented by analyzing the influencing factors. The ratio of NPFs in POBs was 20% on average, but 3% in public parking lots, and 24% in private parking lots. Most of the NPFs used were for-profit facilities such as neighborhood living facilities and sales facilities. As a result of analyzing the factors affecting the TIR, it was analyzed that the larger the total floor area of a POB, the higher the private ownership, the smaller the number of parking spaces; and the larger the entrance road width, the greater the TIR. In order to prevent excessive change in the use of POBs, the ratio limit of NPFs will be gradually lowered in proportion to the total floor area and public parking lots will be expanded. In the planning stage, meticulous district-wide planning is required for the use and ratio of NPFs in POBs according to the access road type. This article will be meaningful if you want to supply a POB that satisfies suppliers, consumers, and users. In particular, it will enable government officials who decide and implement policies related to POBs to recognize that full-scale research is necessary.



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Keywords: parking-only buildings; non-parking facilities; change of use; traffic inducement rate; multiple linear regression analysis

1. Introduction

This study relates to a parking-only building (POB) located in Gyeonggi-do. This chapter examines the background, purpose, research subject, and research content of the study. A POB is an off-street parking lot in which 95% or more of the total floor area of the building is used for parking facilities [1]. However, if the part used for purposes other than parking facilities in a POB is a specific facility, that is, a non-parking facility (NPF), it means an off-street parking lot in which the ratio of the part used as a parking facility is at least 70% of the total floor area of the building (Figure 1). NPFs refer to type 1 and type 2 neighborhood living facilities, cultural and congregational facilities, religious facilities, sales facilities, transportation facilities, sports facilities, office facilities, and automobile-related facilities according to Annex 1 of the Enforcement Decree of the Building Act [2]. According to the Act, an off-street parking lot is a concept that includes flat parking lots and POBs [3].

There are no national or regional statistical data for POBs. However, according to national statistics, there are 14,342 (559,131 number of parking spaces) nationwide as of 2020, and 3979 (133,072 number of parking spaces) off-street parking lots in Gyeonggi-do [4].

The increasing population in large cities and the unbalanced urban growth associated with massive use of private cars in metropolitan areas often lead to traffic jams and road congestion that warrant the construction of such capital-intensive buildings as off-street parking facilities [5]. The government is deregulating POBs and strengthening construction support, such as allowing housing installations in POBs to improve the sale-ability of POBs and revitalize the supply of parking facilities in downtown areas [6]. As a result, the off-street parking lot, which was mainly used two-dimensionally, was used three-dimensionally and complexly, which improved the efficiency of land use and increased the possibility of providing complex services. The use of POBs can have a positive effect, enabling transit-oriented development (TOD), a near-workplace city, low-carbon, an energy-saving city, and a compact city [7–12].

However, on the other hand, the focus is on the commercial use of NPFs rather than the supply of parking lots, which has the adverse effect of transforming parking facilities into warehouses of NPFs or into annexed parking lots [13]. Due to this problem of change of use, there are cases in which the supply of POBs promoted by the private investment method BTO (build-transfer-operate) is canceled due to opposition from local residents [14,15].

There are opposing views on POBs. As a result of LHI's expert perception survey in 2015, the opinion that private business operators should increase the ratio of NPFs to promote POB sales was 50.0%, which was higher than that of other occupational groups. On the other hand, researchers from research institutes answered that the ratio of NPFs should be reduced (34.6%) and public officials said that the current regulations are appropriate (31.8%). Additionally, in the case of university professors, other opinions (42.9%) were high. Specific opinions include "Differential application according to location and use", "Considering the sale situation, it is inevitable to maintain the current regulations", "Adjust the ratio of NPFs according to local demand", "Need criteria for determining the suitability of the ratio of NPFs", "The demand for parking at NPFs erodes the demand for parking facilities, so the demand for parking at NPFs is excluded from the demand for parking facilities and secured separately" [16].

To solve this problem, appropriate standards are needed, and the current National Land Planning and Utilization Act (hereinafter referred to as the "National Land Planning Act") and the Parking Lot Act stipulates the ratio and allowable use of NPFs. However, what is important here is whether the various types of NPFs equally weaken the public interest of the parking lot. It is necessary to prepare relevant standards through research on NPFs. Recently the Supreme Court also pointed out that in the case of the Audi maintenance center in Naegok-dong, it is necessary to prepare detailed installation standards for parking auxiliary facilities [17].

If a neighborhood living facility or sales facility is introduced as a NPF in a POB, it will face opposition from nearby merchants, and if a rental house is introduced, it will face opposition from rental business [18]. In addition, through the case of a transfer center in the station area developed by the private sector, an ironic situation can occur that rather induces traffic demand by attracting non-parking facilities centered on sales facilities [19].

Based on this awareness, research on parking-only buildings is necessary, but research so far has mainly focused on off-street parking lots in residential land development districts. Accordingly, this study aims to suggest implications for establishing parking-related policies by examining the current status of NPF use of POBs located in 31 cities and counties in Gyeonggi-do, establishing the concept of traffic inducement rate (TIR), and analyzing factors affecting it.

The spatial scope of this study was targeted at 302 POBs in Gyeonggi-do, Republic of Korea. Since Gyeonggi-do is a metropolitan government with a considerable number of POBs, it was determined that the analysis target could be secured, and the characteristics

of 31 cities in Gyeonggi-do could be compared. The temporal scope of the study was based on 2020 when a list of POBs was obtained from local governments.

The contents of this study can be divided into the data collection process through literature research and the statistical analysis process of the collected data. First, a list of POBs was obtained from the local government, and basic data such as the NPF usage status were investigated through building registers for each POB. Next, the TIR was calculated using the traffic inducement coefficient (TIC) according to the Urban Traffic Improvement Promotion Act. In addition, variables affecting the TIR were selected through review of existing studies and literature. Finally, significant influencing factors were extracted through multiple linear regression analysis (MLRA).

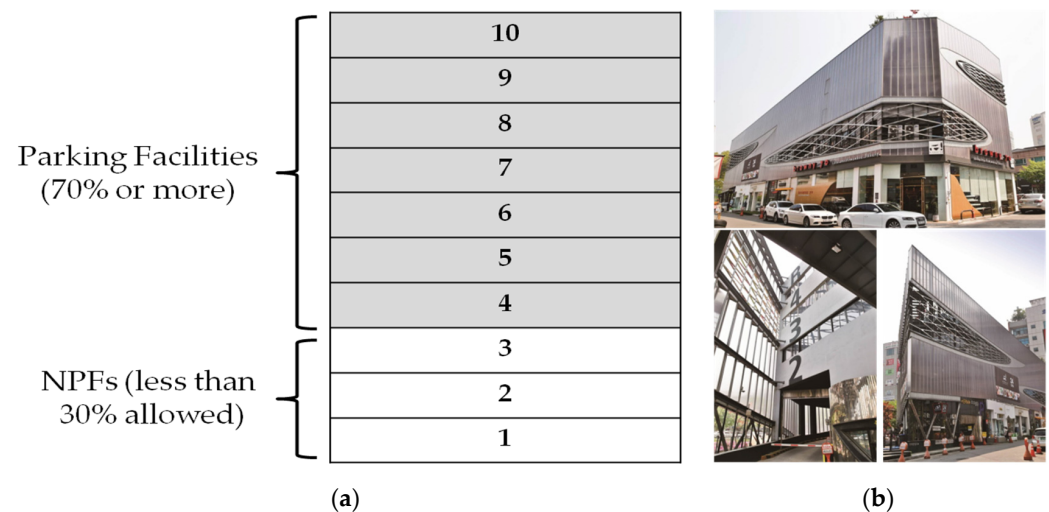


Figure 1. (a) Is a POB concept drawing on the premise of the 10th floor (drawings by the author based on [1,2]), (b) Is a picture of Herma POB in 8–19, Jukjeon-ro 15beon-gil, Giheung-gu, Yongin city, Gyeonggi-do, Korea [20].

2. Literature Review

The designation POBs is based on the Parking Lot Act. Therefore, the legal definition of a POB and the legal transition process was reviewed. To define the TIR, which is a dependent variable, we looked at related concepts in the relevant laws. Finally, the differentiation of this study was derived through previous studies related to the change of use of a POB.

2.1. Legal Status of Parking-Only Buildings

The legal transition process was investigated in relation to the legal definition of a POB, the subject of the study, and the permitted use of NPFs.

2.1.1. Concept of Parking-Only Building

A POB uses more than 95% of the total area of the building as parking facilities. However, when NPFs are installed in the POB, 70% of the total area of the POB can be used as parking facilities. NPFs are detached houses, apartment houses, type 1 neighborhood living facilities, type 2 neighborhood living facilities, cultural and congregational facilities, religious facilities, sales facilities, transportation facilities, sports facilities, office facilities, warehouse facilities, and automobile-related facilities [1,2]. A POB is a type of off-street parking lot, which is an infrastructure according to the National Land Planning Act, and is a public facility (limited to parking lots installed by administrative agencies) where ownership is transferred to local governments free of charge after completion. It is also a facility that can be designated as an urban planning facility that requires strong public interest [21,22]. In accordance with the Enforcement Decree of the Parking Lot Act, there is no need to install a separate parking lot except for sales facilities (department stores,

shopping centers, large stores) and cultural and congregational facilities (movies, exhibition halls, wedding halls) among NPFs [23]. In addition, in accordance with the Special Cases of the Parking Lot Act, the building-to-land ratio, floor area ratio, minimum site area, and height restrictions of buildings exclusively for parking may be differently determined as follows, notwithstanding the National Land Planning Act [3].

- Building-to-land ratio: 90% or less
- Floor area ratio: 1500% or less
- Minimum site area: 45 m² or more
- Height restriction:
 - When the site is in contact with a road less than 12 m in width: The height of each part of the building is three times the horizontal distance from that part to the boundary line on the opposite side of the road in contact with the site;
 - When the site is in contact with a road with a width of 12 m or more: The height of each part of the building is 36 times the horizontal distance from that part to the boundary line on the opposite side of the road facing the site/times the width of the road (1.8 times if the magnification is less than 1.8 times).

2.1.2. Parking Lot Law Change Process

Over time, we investigated how the government changed the parking lot law as a policy, and what NPFs were allowed for POBs. In order to actively cope with the urban parking problem, which is getting worse day by day due to the rapid increase of automobiles, dedicated parking buildings are emerging. At the time of the enactment of the Parking Lot Act (17 April 1979), there was no mention of a POB [24]. However, due to the revision of the Parking Lot Act (31 March 1983), the part of the parking lot with buildings exceeding the statutory area was allowed to be converted into an off-street parking lot [25]. This can be seen as the beginning of the POB. The first POB was specified in the Act on 14 December 1991 when the Parking Lot Act was amended. In the revised law, standards such as building-to-land ratio and floor area ratio, minimum site area and height restrictions were entrusted to the Enforcement Decree [26]. In 1992, the ratio of parking facilities was divided into 70%, 80%, and 90% based on whether the POB was decided as an urban planning facility and had a total floor area of 1000m². The types of NPFs were the same as before [27]. In 1995, when POB was an urban planning facility, the ratio of permitted uses other than parking lots was expanded to 20%, and office facilities, sports facilities, and exhibition facilities were added to permitted uses [28]. In 1996, to promote the creation of parking lots, the ratio of NPFs was increased to 30% regardless of the presence or absence of urban planning facilities or the total floor area, and sales facilities and viewing hall facilities were added as permissible uses. The obligation to install an attached parking lot to NPFs was also exempted. In consideration of the conditions between local governments, the permitted use of NPFs was restricted in some areas through the ordinance [29]. In 1999, cultural facilities and office facilities were added as permitted uses for NPFs [30]. In 2007, religious facilities and transportation facilities were added as permitted uses for NPFs [31], and detached houses and apartment houses were added in 2014 [32]. In 2016, a warehouse facility was added [33] (Table 1).

Table 1. Change of ratio of NPFs and permitted use according to the revision of the Parking Lot Act.

Year	Percentage of NPFs and Permitted Uses
1992	<p><Urban planning facility> 90%: Neighborhood living facility, automobile-related facility, and neighborhood public facility</p> <p><Non-urban planning facility></p> <ul style="list-style-type: none"> - (Total floor area of 1000 m² or more) 80%: Neighborhood living facility, automobile-related facility, and neighborhood public facility - (Total floor area less than 1000 m²) 70%: Neighborhood living facility, automobile-related facility, and neighborhood public facility
1995	<p><Urban planning facility> 80%: Neighborhood living facility, automobile-related facility, neighborhood public facility, office facility, sports facility, and exhibition facility</p> <p><Non-urban planning facility></p> <ul style="list-style-type: none"> - (Total floor area of 1000 m² or more) 80%: Neighborhood living facility, automobile-related facility, neighborhood public facility, office facility, sports facility, and exhibition facility - (Total floor area less than 1000 m²) 70%: Neighborhood living facility, automobile-related facility, neighborhood public facility, office facility, sports facility, and exhibition facility
1996	70%: Neighborhood living facility, automobile-related facility, neighborhood public facility, office facility, sports facility, exhibition facility, sales facility, and viewing and congregational facility
1999	70%: Type 1 and type 2 neighborhood living facility, cultural and congregational facility, sales and business facility, sports facility, office facility, and automobile-related facility
2007	70%: Type 1 and type 2 neighborhood living facility, cultural and congregational facility, religious facility, sales facility, transportation facility, sports facility, office facility, and automobile-related facility
2014	70%: Detached house, apartment house, type 1 and type 2 neighborhood living facility, cultural and congregational facility, religious facility, sales facility, transportation facility, sports facility, office facility, and automobile-related facility
2016	70%: Detached house, apartment house, type 1 and type 2 neighborhood living facility, cultural and congregational facility, religious facility, sales facility, transportation facility, sports facility, office facility, warehouse facility, and automobile-related facility

In relation to the obligation to install an attached parking lot for NPFs, the process of changing the parking lot laws was investigated [34]. In 1995, when an attached parking lot was installed in the POB, it was amended to acquire the ownership of the building [35]. In 1999, it was amended to arbitrarily install an attached parking lot for all NPFs [36]. In 2004, when NPFs were department stores, shopping centers, large stores among sales and business facilities, and movie theaters, exhibition halls, and wedding halls among cultural and congregational facilities, it was amended to install an attached parking lot [37]. The current legislation is the same.

2.2. Traffic Inducement Coefficient

In order to calculate the amount of traffic caused by NPFs permitted in a POB, the characteristics of the TIC according to the Urban Traffic Improvement Promotion Act were investigated. Through this, we intended to define the TIR to be used as a dependent variable. The TIC is a coefficient for calculating the traffic inducement charge under the Urban Traffic Improvement Promotion Act. It is a relative indicator that shows the degree of congestion load that generated traffic exerts throughout the entire urban area by facility use and region [38]. The traffic inducement charge is an economic burden imposed on facilities that cause congestion in accordance with the principle of the causative factor to alleviate traffic congestion [39].

Its formula is as follows [40]:

$$\text{Traffic inducement charge} = \text{Total floor area of each floor of the facility} \times \text{Unit charge} \times \text{TIC} \quad (1)$$

The TIC was first introduced in 1990 to calculate the traffic inducement charge, and at that time, the coefficient was classified into 19 facilities and four regions for a total of 76 items. The regional classification was broadly classified into Seoul Metropolitan City and other regions, which were then subdivided into downtown and outlying regions, respectively. In 1994, general restaurants were added to the facility use, adding a total of 80 classification systems. In 1996, the use of facilities was divided into 34 facilities and 4 regions, expanding to a total of 136 classification systems. In the regional division, there is no division between the city center and the suburbs, and cities are classified into four types according to the size of the population. The TIC is a relative number. Based on a city with a population of 500,000 or more and less than 1 million, the TIC of office facilities is 1. For other facilities, the TIC (0.47~5.56) is determined by reflecting the relative difference based on this value [38,41]. Bergman, D. investigated 127 ordinances to prepare a comprehensive parking standard report for 180 land uses, including airports, universities, post offices, and telecommunication facilities. Within each land use, the criteria vary from requiring the least amount of parking to the most [42].

2.3. Review of Previous Studies

This study focuses on identifying the usage status of NPFs in Gyeonggi-do POBs and analyzing the factors affecting the TIR calculated using the TIC. The author investigated the previous studies to establish the influence factors and dependent variables on the change of use of the POB, but could not find any previous studies consistent with this study. This is due to the special characteristics of POBs and NPFs based on the Korean Parking Lot Act. Nevertheless, the author broadened the scope of the investigation to an off-street parking lot and investigated previous studies that can be referenced as follows.

Kim Min-Ji investigated the change in use of the first off-street parking lot in the metropolitan area (15 in Ilsan, 21 in Bundang) and analyzed the factors affecting the change in use through logistic regression analysis. Based on this, he suggested a parking lot management plan that reduces the deterioration of parking lot use in the new city [43]. Jang Myeong-Su derived variables through expert surveys on 23 public parking lots in Incheon, Suwon, Seongnam, and Goyang, and derived factors affecting turnover through regression analysis (RA). Based on this, he proposed a plan to improve the use of on-street parking [44]. Kim Tae-Gyun, Byun Wan-Hee, and Lee Yun-Sang reviewed various characteristics that affect the operation of off-street parking lots in order to prepare a plan to revitalize the use of 185 off-street parking lots in the metropolitan area. To this end, factors to be considered when arranging an on-street parking lot when establishing a development plan were derived using a logistic regression model. Through this, a plan to activate the operation of the off-street parking lot was suggested [45]. Choi Jong-Ho conducted an expert survey on the use of POBs in Yongin city's housing site development district to derive problems and improvement plans for POBs. Based on this, a plan to improve the supply of parking lots was suggested to solve the parking problem [46]. Kim Eun-Ji investigated the parking lot usage status of Dongtan 1 New Town. The usage status was divided into use change type, construction progress type, parking recognition type, small-scale building type, and large-scale single use type. Based on this, considerations were presented when the project operator supplies parking lot land for private investment [13]. Kim Myung-Bae derived planning elements through a case study of POBs in five buildings in Gyeonggi-do housing site development districts supplied since 1990. Based on this, he proposed a legal change process and improvement directions for POBs [34]. Park Jong-Cheon, Kim Myeong-Soo, and GeumEun-Ji investigated a POB in an administrative complex city. Based on this, as a way to increase the utilization rate of POBs, it was proposed to change the perception of paying parking fees, to agree on nearby shopping malls and to support fees from local governments, and to utilize new means of transportation in idle parking spaces [47]. Park

Jong-Woo investigated the usage status of 13 POBs in the Administrative City 1 and 2 living zones. He investigated the cause of the usage conditions through a survey on the awareness of parking lot users. Based on this, the utilization rate of POBs was increased, and a plan for the utilization of idle parking surfaces was suggested [48].

Previous studies mostly focused on off-street parking lots in specific housing site development districts, suggesting usage conditions, surveys, and efficient use methods. Through this, considerations for the arrangement of off-street parking lots and measures to improve the use rate of off-street parking lots to solve the problem of illegal parking nearby are dealt with.

There are studies that directly deal with factors that affect parking lot use, but the research subjects are limited to road parking lots and housing site development districts in some new towns. There was a limitation in that whether the use of the POB was changed depends on the subjectivity of the researcher. In addition, there was no specific use status survey for NPFs. For this reason, in the research method, logistic analysis was performed by setting use change as a nominal variable [43]. It is considered that this is because it is difficult to set a variable that indicates the degree of change in use.

Previous overseas studies on off-street parking include country-specific policy comparison, location and supply, demand such as parking behavior factors, and intelligent systems. Weant et al. discussed parking policy, finance, administration, planning, and functional design and operation [49]. Paul compared non-residential and off-street parking policies in 14 metropolitan areas in East Asia, Southeast Asia, and South Asia [50]. Hsien-Ming explored the application of location theory to the allocation of off-street parking facilities [51]. Li et al. presented a model for optimizing parking fees and parking supply according to time of day [52]. William et al. explained that parking behavior is greatly affected by movement demand, walking distance, parking capacity, and parking fee [53]. Rajabioun et al. discussed the development of reliable parking guidance and information (PGI) systems that indicate parking availability [54]. Nadav et al. discussed the intelligent parking guidance system [55]. Christie, T. described elements of various types of multi-use parking garages, as more new facilities are designed to incorporate uses other than storing cars in their structures [56].

There was no investigation into the specific usage status of NPFs in POBs, which account for the majority of changes in the use of off-street parking lots. In addition, there are few studies that quantify the degree of change in use and empirically analyze the influencing factors.

Therefore, in this study, all POBs in Gyeonggi-do were investigated first and the scope of the study was expanded. Second, the status of NPFs use of POBs was investigated and analyzed. Third, it can be said that it is different from previous studies in that the influencing factors were empirically analyzed using the TIR quantified as a dependent variable.

3. Usage Status and Analysis of Non-Parking Facilities

Previously, we looked at the types of NPFs permitted for POBs according to the Parking Lot Act. In this chapter, the author investigated the type and area of NPFs in POBs.

3.1. Current Status of Parking-Only Buildings

A total of 302 POBs out of 31 cities and counties in Gyeonggi-do were investigated. Looking at the status of owners, there were 243 private buildings (80.5%) and 59 public (including public and private) buildings (19.5%), which were about four times more than public POBs.

As for the ownership of the POBs, there are 147 (48.7%) collective buildings, which is similar to that of general buildings. By owner, 96.6% of public POBs are general buildings, and 59.3% of personal POBs are collective buildings. Based on this, it can be seen that private POBs have more NPFs owned by multiple owners.

Figure 2 and Table 2 show the proportion of parking facilities and NPFs in the total floor area of buildings exclusively for parking by city. POBs in Gwacheon, Yongin, Icheon,

and Pocheon consist of 100% parking facilities. In other cities, Dongducheon had the lowest ratio of parking facilities at 73.2%. The average of Gyeonggi-do is 80.0%. This means that the ratio of NPFs is 20.0% on average.

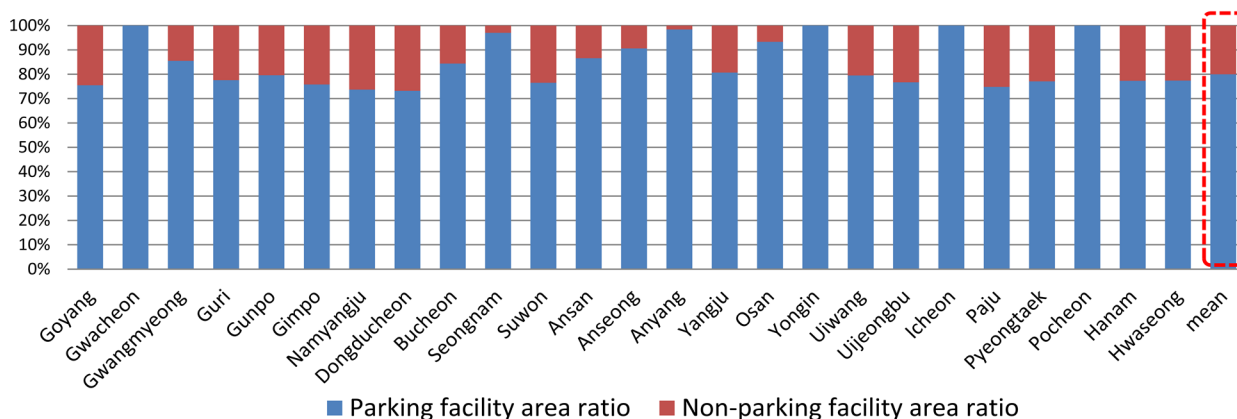


Figure 2. Ratio of the total floor area of parking facilities and NPFs for POBs.

Table 2. Average ratio of parking facility area to total floor area by type of ownership/owner of a POB.

Cities	Sum	Public		Public and Private		Private	
		GB	CB	GB	CB	GB	CB
% (amount)	80.0 (302)	97.5 (54)	87.3 (3)	75.0 (2)	-	74.9 (99)	76.9 (144)
1 Goyang	75.5 (36)	-	-	-	-	75.5 (19)	75.5 (17)
2 Gwacheon	100.0 (1)	100.0 (1)	-	-	-	-	-
3 Gwangmyeong	85.5 (6)	93.0 (3)	-	-	-	77.9 (3)	-
4 Guri	77.6 (3)	82.1 (1)	80.7 (1)	-	-	70.1 (1)	-
5 Gunpo	79.6 (8)	91.6 (2)	-	-	-	73.1 (1)	76.1 (5)
6 Gimpo	75.8 (19)	-	-	-	-	77.4 (7)	74.9 (12)
7 Namyangju	73.7 (24)	-	-	-	-	70.3 (7)	75.1 (17)
8 Dongducheon	73.2 (5)	-	-	-	-	72.2 (4)	77.2 (1)
9 Bucheon	84.4 (14)	91.8 (7)	-	-	-	-	76.9 (7)
10 Seongnam	97.0 (17)	99.6 (14)	90.6 (2)	73.3 (1)	-	-	-
11 Suwon	76.5 (24)	100.0 (2)	-	-	-	71.7 (7)	75.6 (15)
12 Ansan	86.6 (14)	-	-	-	-	71.4 (2)	89.1 (12)

Table 2. Cont.

	Cities	Sum	Public		Public and Private		Private	
			GB	CB	GB	CB	GB	CB
13	Anseong	90.6 (5)	100.0 (3)	-	-	-	-	76.4 (2)
14	Anyang	98.4 (2)	96.8 (1)	-	-	-	100.0 (1)	-
15	Yangju	80.7 (7)	100.0 (2)	-	-	-	-	72.9 (5)
16	Osan	93.3 (3)	100.0 (1)	-	-	-	79.9 (1)	100.0 (1)
17	Yongin	100.0 (5)	100.0 (5)	-	-	-	-	-
18	Uiwang	79.5 (7)	100.0 (1)	-	-	-	70.0 (1)	77.3 (5)
19	Uijeongbu	76.7 (1)	-	-	76.7 (1)	-	-	-
20	Icheon	100.0 (2)	100.0 (2)	-	-	-	-	-
21	Paju	74.8 (10)	-	-	-	-	74.6 (4)	74.9 (6)
22	Pyeongtaek	77.1 (30)	92.4 (2)	-	-	-	76.5 (18)	75.1 (10)
23	Pocheon	100.0 (2)	100.0 (2)	-	-	-	-	-
24	Hanam	77.3 (20)	100.0 (1)	-	-	-	76.4 (12)	75.6 (7)
25	Hwaseong	77.4 (37)	100.0 (4)	-	-	-	71.7 (11)	76.1 (22)

Note: A general building (GB) means a building with only one owner and a collective building (CB) means a building in which several owners own a building equal to their own shares.

3.2. Usage Status of Non-Parking Facilities

The use status of 292 buildings in 21 cities and counties, excluding four cities without NPFs (Gwacheon, Yongin, Icheon, and Pocheon), was investigated among POBs in Gyeonggi-do.

Figure 3 and Table 3 show the average total floor area and composition ratio of NPFs by use. The average total floor area of NPFs in POBs is 1366 m². Among NPFs, type 2 neighborhood living facilities have the largest average total floor area of 625 m² (45.8%). The remaining facilities are type 1 neighborhood living facilities, sales facilities, office facilities, sports facilities, automobile-related facilities such as car washes, apartment houses, cultural and congregational facilities, warehouse facilities, and religious facilities in that order. In particular, profit facilities such as type 1 and type 2 neighborhood living facilities and sales facilities accounted for 85.7%.

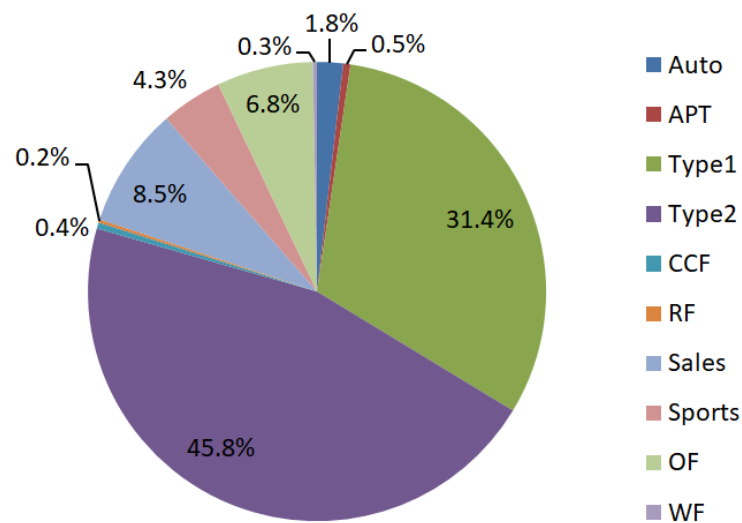


Figure 3. Average total floor area composition ratio by use of NPFs.

Table 3. Average total floor area by use of NPFs.

Cities	Sum	Auto	APT	Type1	Type2	CCF	RF	Sales	Sports	OF	WF
Average (m ²) (%)	1366 (100)	25 (1.8)	7 (0.5)	428 (31.4)	625 (45.8)	6 (0.4)	3 (0.2)	116 (8.5)	59 (4.3)	93 (6.8)	4 (0.3)
Goyang	2007	7	9	376	782	13	-	566	80	174	-
Gwangmyeong	1007	-	-	554	94	-	-	-	359	-	-
Guri	1287	-	-	356	217	-	-	-	155	559	-
Gunpo	1069	-	195	151	542	-	-	-	182	-	-
Gimpo	1077	3	-	683	391	-	-	-	-	-	-
Namyangju	1035	-	-	520	613	-	6	-	112	54	-
Dongducheon	972	-	-	259	653	-	-	-	-	60	-
Bucheon	2008	8	-	641	1234	-	-	-	-	125	-
Seongnam	592	-	-	139	270	20	-	-	163	-	-
Suwon	2344	2	-	707	1382	-	-	107	52	94	-
Ansan	1169	-	-	419	636	-	-	-	-	114	-
Anseong	406	-	-	246	160	-	-	-	-	-	-
Anyang	88	-	-	88	-	-	-	-	-	-	-
Yangju	2595	-	-	1116	966	-	-	-	-	513	-
Osan	347	-	-	252	95	-	-	-	-	-	-
Uiwang	805	-	52	103	613	-	-	-	-	37	-
Uijeongbu	2052	-	-	2052	-	-	-	-	-	-	-
Paju	2449	-	-	621	1299	-	-	183	-	346	-
Pyeongtaek	923	7	-	266	485	31	24	69	-	-	41
Hanam	1178	283	-	376	235	-	-	-	101	183	-
Hwaseong	1350	36	-	397	580	-	-	219	61	57	-

Note: Auto, APT, Type1, Type2, CCF, RF, Sales, Sports, OF, and WF are abbreviations for automobile-related facility (car wash, etc.), apartment house, type1 neighborhood living facility (retail stores, etc.), type 2 neighborhood living facility (restaurant, etc.), cultural and congregational facility, religious facility, sales facility (large stores, etc.), sports facility, office facility, and warehouse facility, respectively.

Warehouse facilities permitted by the 2016 Parking Lot Act Enforcement Decree amended are only for POBs in Pyeongtaek. In 2014, apartment houses approved by the revision of the Parking Lot Act enforcement ordinance were introduced only in Gunpo, Uiwang, and Goyang, which are adjacent to Seoul. Most of the residential facilities were supplied in the form of office facilities (officetel: facilities that allow residence mainly for offices, exclusive area of about 20 m² to 30 m²). Automobile-related facilities, such as car washes, accounted for only 1.8%.

Looking at the characteristics of each city, the total floor area occupied by NPFs is low in the POBs in Anseong, Seongnam, and Osan. On the other hand, cities with large total floor areas of NPFs such as Goyang, Bucheon, Suwon, Yangju, and Paju supplied a lot of parking lots that allowed POBs through the housing site development project.

3.3. Analysis of Usage Status of Non-Parking Facilities

As a result of examining the usage status of NPFs, the ratio of NPFs in POBs, owners, usage status by building, and usage status by region are as follows. When looking at the ratio of NPFs, the average was 20.0%, which fell short of the legal limit of 30.0%. Looking at the owners, the ratio of NPFs in public POBs was only 3.1%, while the ratio of NPFs in private POBs was as high as 24.5%. This shows that it is difficult for the private sector to secure business feasibility with only parking facilities in POBs, and that it is conserving business feasibility through NPFs. This is because, in Korea, parking fees are set by local government ordinances and are kept at a low level to reduce the burden of parking fees on citizens.

Most NPFs consist of profit facilities. In the case of neighborhood living facilities, most are sold to individual owners in the form of small-scale separate ownership. Sales facilities are mainly operated by corporations as direct owners or by leasing them to individuals. The reason why there are no detached houses is that it was not possible to secure the residential environment desired by detached house occupants as a POB. The lack of transportation facilities is due to structural limitations that cannot accommodate buses, such as the height of the floor and the turning radius of the ramp.

As a result of analyzing the usage status by region, the warehouse facility of the POB in Pyeongtaek is located in the Poseung General Industrial Complex near Pyeongtaek Port, and it seems to satisfy the logistics demand of the industrial complex. All officetels were introduced in privately operated POBs. An officetel is classified as an office facility according to the Building Act, but in fact, they are in charge of residential functions for one or two-person households. Most of these officetels are located in areas with excellent transportation conditions and abundant demand for housing, such as semi-residential or commercial areas in large cities with a population of 500,000 or more, such as Suwon, Bucheon, Goyang, and Hanam.

As a result of analyzing the status of each city, there are only two in Anyang City and three in Osan. Seongnam is a large city with a population of 930,000. Most POBs are located in the old city center. Due to the serious parking problem in the old town, most POBs are operated publicly, and most of the parking facilities consist of parking facilities, so the ratio of NPFs is low. Although Anseong is a small city with a population of 180,000, the ratio of NPFs was low as a POB was located in the downtown area where parking was relatively difficult.

4. Analysis Results

This chapter describes the research model, research method, data collection, and selection of variables for analyzing the factors affecting the TIR of NPFs.

4.1. Research Model

This study begins with the following questions. Will there be additional traffic inducement due to NPFs permitted for POB? Is there any way to quantify the degree of change in use of POBs due to NPFs? What factors are affecting traffic inducement of POBs?

First, detailed variables used in previous studies were classified into parking lot facility characteristics, land use characteristics, location characteristics, and population characteristics. Through a literature review, the TIR was defined using the TIC under the Urban Traffic Improvement Promotion Act. Therefore, the research model shown in Figure 4 and research hypotheses were established to investigate the relationship between building characteristics, land use characteristics, location characteristics, population characteristics, and TIR for POBs in Gyeonggi-do.

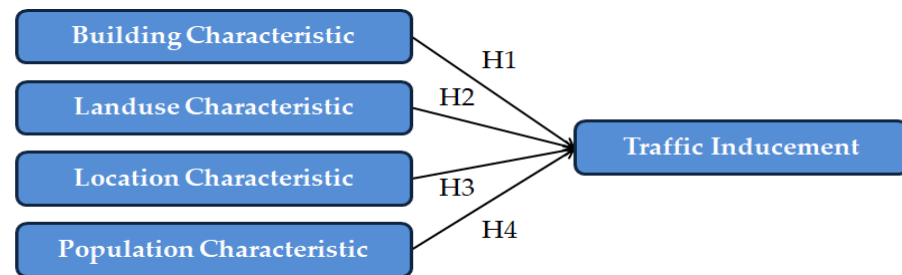


Figure 4. Research Model.

Hypothesis 1(H1): *The building characteristics of POB will have a significant effect on TIR.*

Hypothesis 2(H2): *The landuse characteristics of POB will have a significant effect on TIR.*

Hypothesis 3(H3): *The location characteristics of POB will have a significant effect on TIR.*

Hypothesis 4(H4): *The population characteristics of POB will have a significant effect on TIR.*

As an analysis method, Multiple Linear Regression Analysis (MLRA), which is relevant to practical validity, was performed to analyze the pure effect of a specific independent variable on the dependent variable while considering the effects of other independent variables included in the RA. Through this analysis method, the degree and direction of the pure influence of each independent variable on the TIR, which is the dependent variable, can be compared with each other. In this analysis, the following regression model was established to examine the relationship between the dependent variable Y and the independent variables X1, X2, . . . Xn.

$$Y = \beta + \beta_1X_1 + \beta_2X_2 + \dots + \beta_nX_n + \varepsilon \quad (2)$$

4.2. Research Method

4.2.1. Data Collection

In this study, in order to empirically analyze the factors affecting the TIR due to NPFs of POBs in Gyeonggi-do, all POBs in the relevant city in Gyeonggi-do were selected. In relation to the analysis target, from the list of POBs secured by the basic local government, POBs that did not fit the purpose of analysis, such as underground parking lots in parks and plazas, were excluded from the analysis target. Due to the lack of standardized statistical data, lists of POBs were obtained through an information disclosure request (www.open.go.kr, accessed on 20 March 2022) targeting 31 cities and counties in Gyeonggi-do. For the POB, detailed information was constructed using public documents such as the Building Register, the National Land Information Service (<https://www.eum.go.kr>, accessed on 20 March 2022), Kakao Map (<https://map.kakao.com>, accessed on 20 March 2022), and the National Statistics Portal (<https://kosis.kr>, accessed on 20 March 2022). The list of POBs provided by local governments was a total of 401. However, in accordance with the Parking Lot Act, the quality of the analysis was improved by excluding a total of 99 parking lots, underground parking lots, and annex parking lots that did not meet the requirements for POBs. As a

result, a total of 302 POBs were finally selected for the investigation. Detailed data on the analysis target was constructed for use analysis and MLRA.

4.2.2. Selection of Variables

In this chapter, the independent variable is selected and the dependent variable is defined. First, for the selection of independent variables, the final variables were selected as shown in Table 4 based on previous studies. As for the factors affecting the change of use of a parking lot, some variables were replaced with similar variables based on the variables selected in the study of Min-Ji Kim [43], and variables determined to be necessary were newly added.

Table 4. Selection of variables.

Category	Variables	Kim M.B. [34]	Kim M.J. [43]	Jang M.S. [44]	Kim T.K. [45]	Variable Selection
Building	Total floor area					● *
	Land category					● **
	Number of parking spaces			●		● *
	Type of ownership					● **
	Date of approval for use					● **
	Owner		●			●
	Structure					● **
	Building-to-cover ratio	●				
	Floor area ratio	●				
	Height	●				
	Parking area ratio	●				
	Installation standards for annexed parking lots	●				
	Exterior	●	●			
	Parking entrance	●				
	Lamp type	●				
	Parking frequency by floor	●				
	Parking lot usage	●				
	Parking fee	●				
	Parking lot type			●	●	
	Parking lot sign			●		●
Land Use	Number of operating days			●		
	Operating time			●		
	Acceptable use	●				
	Zoning				●	●
	District unit planning area					● **
	Official land price					● *

Table 4. Cont.

Category	Variables	Kim M.B. [34]	Kim M.J. [43]	Jang M.S. [44]	Kim T.K. [45]	Variable Selection
Location	Distance from public office			•		•
	Distance from school					• **
	Distance from subways			•		•
	Distance from bus stop					• **
	Distance from park		•			•
	Distance from CBD			•		
	Access road type					• *
	Number of lanes on adjacent roads		•			
	Number of lanes on nearby roads					•
Population	Dong population					• *
	City population					• *
	Population per parking area			•		

Note: CBD stands for central business district and Dong is an administrative subunit of the city. * Similar to variables measured in previous studies, but with some changes. ** New variables not measured in previous studies.

First, the author explains the variables that have been substituted for the variables used in the previous study. Due to the multicollinearity problem, the total floor area was selected as a substitute variable instead of the floor area ratio and height. Because the distance from central business district (CBD), a variable in previous studies, may be subject to the author's subjectivity, a more objective official land price was used as a substitute variable. The closer to the CBD, the higher the official land price. The access road type was selected as a variable that substitutes the number of lanes on the adjacent road (the number of lanes on the road in contact with the entrance of the POB). The access road type is similar to the number of lanes on adjacent roads, but is a more objective variable. This is because distortion can occur when examining the number of lanes. For example, some places have a left-turn lane for POB access and some don't. There is a question as to whether the left-turn lane can be recognized as the number of adjacent roads. On the other hand, the access road type can be officially confirmed according to the road width determined by the law [57]. The road width according to the access road type is shown in Table 5. The number of parking spaces and dong population/city population were selected as variables to replace the number of population per parking space.

The newly selected variables are land type, type of ownership, use approval date, structure, district unit planning area, official land price, distance to school, and distance to bus stop. The land type was selected as a variable because the type of land where the POB was located was investigated as a building site, a mixed site, and a railway site in addition to the parking lot site. Most of the POBs with a high ratio of parking facilities were general buildings (owned by one person), and most of the POBs with a high ratio of NPFs were collective buildings (each facility has different owners). Accordingly, the type of ownership of the building was selected as a variable. The date of approval for use was intended to verify the effect of the revision of the parking lot law on the use and ratio of NPFs. Most of the parking facilities have a steel frame structure, and the NPF has a reinforced concrete structure. This is because the beam of the parking facility must withstand light loads, and the NPF must withstand heavy loads. Therefore, it was attempted to understand the effect between structure and change of use. The beams of the multi-purpose POB must be designed for higher loads [58]. As for district unit planning zones, district unit planning zones are mainly designed for new towns and not for old town centers, so this difference was investigated. The distance from the school was selected as a variable under the assumption that since the school is located in the center of the living area according to

the neighborhood district theory, the closer the building is to the school, the more likely it is to affect the use of NPFs. The distance to the bus stop was selected as a variable under the assumption that, along with the distance from the subway station, the area with high pedestrian accessibility could affect the use of NPFs.

Table 5. Definition of variables.

	Variables	Units	Definition
	Dependent variable	-	TIR
Building	SQRT Total floor area (TFA)	m ²	square root of total area
	Land category (LC)	dummy	1 = parking lot, 0 = other
	Number of parking spaces (NPS)	number	number of parking spaces in the parking lot
	Type of ownership (TO)	dummy	1 = collective building, 0 = general building
	Date of approval for use (DAU)	year	Year of approval for use of POBs
	Owner	dummy	1 = Private, 0 = Public or Public and Private
	Structure	dummy	1 = reinforced concrete structure, 0 = steel frame structure, etc.
Land use	Zoning	dummy	1 = residential area, 0 = other
	District unit planning area (DUPA)	dummy	1 = District unit planning area, 0 = N/A
	SQRT Official land price (OLP)	won/m ²	Square root of the official land price in 2021
Location	SQRT Distance from public office (DPO)	m	The square root of the distance to the nearby public office (city hall, community center)
	SQRT Distance from school (DS)	m	The square root of the distance to nearby elementary, middle, and high schools
	SQRT Distance from subways (DSW)	m	The square root of the distance to the nearest subway station
	SQRT Distance from bus stop (DB)	m	The square root of the distance to the nearest bus stop
	SQRT Distance from park (DP)	m	The square root of the distance to the nearby park (neighborhood/theme park)
	Access road type (ART)	dummy	1 = narrow road (width less than 12 m) 0 = middle road (width 12 m or more and less than 25 m), main road (width 25 m or more and less than 40 m), vast road (width over 40 m)
Population	SQRT Dong	person	The square root of the dong's population
	SQRT City	person	The square root of the city's population

Note: Total floor area; official land price; distance from public buildings, schools, subways, bus stops, and parks; dong population, and city population meet the normal distribution criteria suggested by Finch and Curran (1995) through SQRT ($|Walkdo| < 3$, $|Kurtosis| < 8$).

The reason for excluding variables used in previous studies is explained. There was no significant difference in the building-to-land ratio due to the special application of the Parking Lot Act. The floor area ratio and the number of floors were replaced by the total floor area. The area ratio of parking facilities was excluded due to the number of parking spaces and multicollinearity issues. Other building characteristic variables such as appearance were excluded from the variables because they had little relevance to this study. Among the land use characteristics, the permitted use was excluded because it was reflected in the dependent variable, TIR. Among the location characteristics, the distance from the CBD was replaced with the official land price. The number of lanes on nearby roads means the number of lanes on nearby upper roads based on POB. The author judged that subjectivity could be involved in selecting a nearby road and was therefore excluded. The zoning was set as a dummy variable because it was judged that the induction of use

change from a POB located in a residential area to a commercial facility was greater. Dong population and urban population were selected as variables on the assumption that the larger the population, the greater the demand for NPFs in the POBs in the area.

Variables that were selected as variables during study design but were excluded because significant results were not expected during the analysis process are explained. The ratio of the length of the long side to the length of the short side, which represents the shape of the POB site, was also investigated. However, in the case of a POB, it is necessary to secure the size of the parking surface, the turning radius, and the slope, so a certain scale and ratio are required (Usually over 1000 m², average long/short side length = 1.8). Therefore, the ratio of the length of the long side to the length of the short side was excluded from the variable. Most of the urban planning facilities were decided as parking lots, so they were excluded from the variables. Next, the dependent variable is defined. The definition of the dependent variable was basically referring to Equation (1). This is because the official government formula is reliable and the nature of the TIC is closely related to the TIR, the dependent variable of this study. Before defining the TIR, the traffic inducement volume (TIV) is defined. The TIV can be said to be an arbitrary definition that converts the nominal scale of the use change of the POB into a ratio scale. The reason is that there is no legal standard to quantify the degree of use change of POBs, and there are no existing studies. Various NPFs generate additional traffic demand. Therefore, just as the TIC is applied when calculating the traffic inducement charge, the TIC is applied when calculating the amount of traffic caused by NPFs of a POB. According to the Urban Transport Promotion Act, foreign-owned facilities and residential buildings are not subject to traffic inducement charges by applying the TIC. However, the TIV is a numerical value indicating the degree of change in the use of POBs, and the TIC was applied to all NPFs except for parking facilities.

The formula for TIV is as follows:

$$\text{TIV} = \sum(\text{Total Floor Area by NPF} \times \text{TIC}) \quad (3)$$

In order to offset the difference in the total floor area of a POB, the TIV was divided by the total floor area of the POB because it is highly probable that a POB with a large total floor area is larger than a POB with a small total floor area. This value was defined as the TIR and was set as a dependent variable in the analysis of influence factors.

The formula for TIR is as follows:

$$\text{TIR} = \sum(\text{Total Floor Area by NPF} \times \text{TIC}) / \text{Total Floor Area of NPF} \quad (4)$$

Table 5 summarizes the final independent and dependent variables.

4.3. Results

MLRA was performed to analyze the influence factors of NPFs. The results are shown in Table 6. RM was found to be statistically significant ($F = 27.565$, $p < 0.001$), and the explanatory power of the RM was 63.9% (adjusted R-squared was 61.6%) ($R\text{-squared} = 0.639$, $adjR\text{-squared} = 0.616$). On the other hand, the Durbin–Watson ($D\text{-}W$) statistic is 1.999, which is close to 2, so there is no problem in the assumption of independence of the residuals. Variance Inflation Factor (VIF) is also less than 10, so there is no multicollinearity.

Table 6. Analysis results.

Variables		Results					
Independent variable	<i>B</i>	<i>S.E.</i>	β	<i>t</i>	<i>p</i> -Value	<i>VIF</i>	
Constant	(261.759)	641.907		(0.408)	0.684		
Building	SQRT TFA (min 9.1, max 221.8)	0.226	0.091	0.172	2.489 *	0.013	3.724
	LC	4.285	5.365	0.034	0.799	0.425	1.418
	NPS	(0.046)	0.018	(0.155)	(2.558) *	0.011	2.861
	TO	3.240	4.346	(0.035)	0.746	0.457	1.725
	DAU (min 1992, max 2020)	0.145	0.321	0.020	0.450	0.653	1.527
	Owner	77.178	5.936	0.662	13.002 ***	0.001	2.013
	Structure	5.445	3.945	0.057	1.380	0.169	1.346
Land use	Zoning	1.018	4.285	0.011	0.238	0.812	1.665
	DUPA	4.451	5.778	0.037	0.770	0.442	1.831
	SQRT OLP (min 558.4, max 4302.3)	(0.007)	0.005	(0.060)	(1.216)	0.225	1.872
Location	SQRT DPO (min 3.2, max 72.5)	0.047	0.182	0.011	0.257	0.797	1.542
	SQRT DS (min 3.0, max 49.0)	(0.206)	0.320	(0.030)	(0.644)	0.520	1.707
	SQRT DSW (min 5.9, max 144.7)	(0.112)	0.075	(0.067)	(1.496)	0.136	1.554
	SQRT DB (min 3.2, max 25.9)	0.271	0.581	0.018	0.467	0.641	1.150
	SQRT DP (min 3.2, max 45.4)	(0.239)	0.271	(0.035)	(0.882)	0.378	1.199
	ART	(12.457)	4.561	(0.114)	(2.731) **	0.007	1.363
Population	SQRT Dong (min 56.7, max 308.0)	(0.021)	0.038	(0.024)	(0.540)	0.589	1.515
	SQRT City (min 266.9, max 1088.4)	0.006	0.009	0.027	0.684	0.495	1.251

$n = 302$, $F = 27.565$ ($p < 0.001$), $R^2 = 0.639$, $adjR^2 = 0.616$, $D-W = 1.999$

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. *B* stands for the non-standardized coefficient, *S.E.* stands for the standard error, β stands for the standardization coefficient, *t* stands for the *t*-test statistic (*B/S.E.*), *p*-Value stands for the significance probability, and *VIF* stands for the Variance Inflation Factor.

As a result of testing the significance of the regression coefficient, it was found that the total floor area and the owner had a significant positive (+) effect on the TIR. It was found that the number of parking spaces and the width of the approach road had a significant negative (−) effect. In other words, the TIR is higher when the total floor area is wide, privately owned, the number of parking spaces is small, and the access road type is higher than the middle road. Comparing the size of the standardization coefficient, it was confirmed that the number of owners, the total floor area, the number of parking spaces, and the width of the approach road had a significant effect on the TIR in the order of the size of the standardization coefficient. It was confirmed that the characteristics of the

building and location had an effect on the TIR. As a result, of Hypothesis 1–4, H1 and H3 were verified.

$$\text{TIR} = -261.759 + 0.226\sqrt{\text{TFA}} - 0.046\text{NPS} + 77.178\text{Owner} - 12.457\text{ART} \quad (5)$$

Note: TFA, NPS, and ART represent total floor area, number of parking spaces, and access road type, respectively.

5. Discussion

This study analyzed the status of NPF use of POBs and empirically analyzed the relationship between the variables affecting the TIR. As a result of analyzing the usage status of NPFs, on average, the ratio of NPFs to the total floor area of POBs in Gyeonggi-do was 20.0%. Among non-parking facilities, neighborhood living facilities accounted for the largest share at 77.2%, followed by sales facilities at 8.5%. Since neighborhood living facilities and sales facilities account for 85.5% of NPFs, and the TIC is very high, it can be said that the more private POBs are supplied, the more traffic inducement increases. The parking generation rate of the land-use has a direct influence on parking demand [59]. As a result of analyzing the factors affecting the TIR, it was found that variables related to the building and location characteristics were statistically significant in the TIR. In other words, it was identified that the larger the total floor area of a POB, the higher the private ownership, the smaller the number of parking spaces, and the larger the access road width, a higher TIR. The degree of influence was shown in the order of owner, total floor area, number of parking spaces, and access road type. Building characteristics such as total floor area, owner, and number of parking spaces are the main influencing factors. In terms of location characteristics, the access road type directly related to the POB was found to be an influencing factor rather than the influence of the surrounding facilities of the POB.

First, the private POB had a higher TIR than the public POB. This is consistent with the results of analyzing the status of NPFs described above. It is significant in that it was empirically confirmed through regression analysis. Accordingly, it is advantageous for parking lot management of publicly-own POBs in places with severe parking difficulties. When the public provides a POB, it is possible to improve the convenience for parking lot users and nearby residents by supplying NPFs necessary for the area. In this case, the NPF operator may be entrusted to a private business operator or a local public enterprise under a local government. In addition, the management method can achieve both publicity and profitability by leasing the ownership in the form of a master lease rather than selling the ownership to individuals as equity. When selecting a business, there should be no damage to the property rights of merchants in consideration of surrounding commercial facilities. In addition, when determining the development density, it should be developed within a range that does not infringe on the right to sunlight and the surrounding landscape. In addition, local governments may have difficulties in securing a budget for purchasing a parking lot site, so in the case of an area with severe parking difficulties, a method of selectively purchasing each base may be considered. In addition, public facilities such as public buildings, cultural facilities, and rental housing can be developed together with POBs, and the budget burden can be reduced by matching the public budgets of each department [60]. A shared parking policy will help to provide optimal parking space based on demand. Shared parking avoids over-demand forecasting in the CBD area compared to traditional models [61]. Land uses with complementary demand patterns are often able to share parking facilities so that they need to provide fewer parking spaces in total than the sum of their individual peak demands. These complementary land uses have demand peaks at totally different times, allowing different user groups to “time share” the same parking [62]. In order to reduce the demand for parking, car-sharing can also be an alternative. Providing economic and environmental benefits, car-sharing is prodigious for sustainability [59].

Next, the larger the total floor area of the POB, the greater the TIR. This is because the larger the total floor area of the POB, the greater the total floor area of the NPF. The majority

of NPFs are neighborhood living facilities, sales facilities, and cultural and congregational facilities with a large TIC. Paradoxically, since these facilities require a large space, a POB with a large total floor area is preferred. In this regard, as the total floor area of POBs increases, it is necessary to consider a plan to gradually lower the ratio limit of NPFs. This is the same as the purpose of introducing POBs in the Enforcement Decree of the Parking Lot Act of 1992. At that time, based on POBs that were not urban planning facilities, the percentage of NPFs was allowed up to 20% if the total floor area of the POB was 1000 m² or more. However, if the total floor area of the POB is less than 1000 m², the ratio of NPFs is allowed up to 30%. In the early stage, NPFs with a small TIC were allowed, such as neighborhood living facilities (average 2.25), automobile-related facilities (average 1.19), and neighborhood public facilities (average 1.20). After that, NPFs with a large TIC such as cultural and congregational facilities (average 3.75) and sales facilities (average 2.98) were gradually allowed (TIC based on cities with a population of 1 million or more). Through this, it can be seen that the public nature of the POB is weakening. Accordingly, sales facilities such as department stores, shopping centers, and large stores, as well as cultural and congregational facilities such as movie theaters, exhibition halls, and wedding halls, should make it mandatory to install an attached parking lot in a POB. According to the current Parking Lot Act, when department stores, shopping centers, large stores, movie theaters, exhibition halls, wedding halls, etc. are installed in a POB, the installation of an attached parking lot is optional. Rather, it is necessary to actively allow residential facilities with a low TIC, such as officetels and small apartments, in POBs with excellent accessibility to the city center and public transportation, thereby enhancing the housing satisfaction of single or two-person households such as newlyweds, college students, and young people. Achieving well-functioning POBs markets would require efforts both to actively foster such markets and to regulate to ensure their health. One-sided deregulation would not be enough [63].

Lastly, it was found that the TIR was high when the width of the road in contact with the POB was more than the middle road. This is because, as the width of the access road increases, large-scale and high-density development of POBs is possible, which increases the total floor area and the proportion of NPFs increases. In this regard, from the time of planning the parking lot, a site suitable for the width of the access road should be selected as the parking lot by considering the allowable ratio of NPFs, etc. When planning the district unit plan, a thorough investigation of the current status of surrounding use, securing of parking lot, and the width of the access road is conducted to determine the permitted use and ratio of NPFs, and to select a reasonable parking lot location. If only a parking lot facing a narrow road is provided to lower the TIR, it will be difficult to introduce neighborhood living facilities, sales facilities, and cultural and congregational facilities preferred by private POBs. This will have a negative impact on the supply of parking facilities through the private sector. Therefore, when establishing a parking lot supply plan, it is necessary to secure a parking lot site of an appropriate size according to the width of the access road by reflecting the urban center system and the demand for NPFs.

6. Conclusions

This study is valuable as the first study to investigate the use of POBs and analyze the factors affecting POBs. It can be said that it is not deeply related to this study in that previous studies targeted two-dimensional outdoor parking lots. However, independent variables were set through previous studies of off-street parking lots and POBs. It is also meaningful to define TIR operatively and quantify the change of use due to NPFs.

This study has certain implications not only for Korea but also for other countries. The increasing complexity of urban planning can be illustrated by the trend to develop land uses that serve a number of purposes [64]. Additionally, the need for three-dimensional POBs will increase to supply insufficient parking spaces in the city center. This study will be meaningful data if you want to supply a POB that satisfies all of the suppliers, consumers, and users. Researchers in each country can use the methodology of this paper.

It is important to note that the TIC used to define the TIR is different for each country and city.

Based on this study, the scope of the study can be expanded. First, it is a fundamental question about whether it is appropriate to allow NPFs in a POB. This is determined by the relevant laws and regulations by policy makers, but it is up to future researchers to provide the basis for their judgment. Second, if NPFs are allowed in a POB, what level is appropriate? Under the current law, ordinances are required to be set according to the circumstances of each local government, but additional research is needed to present a specific ratio. Third, it is a critical reflection on the current system that does not require an attached parking lot for NPFs. This is an attractive factor for POB operators. However, users of parking facilities may lack a parking lot, and general commercial building operators who need to install an attached parking lot may raise equity issues. Fourth, additional research is needed on factors affecting user satisfaction with NPFs. In particular, it is urgent to study the satisfaction of residents of residential facilities such as officetels and apartments. If several improvement methods are sought through research, a POB can be an alternative for urban housing supply. This is because the parking lot is located in the central area of the city, close to work and school, and it is located in a convenient place to use public transportation such as subways and buses. It is also because it is supplied in a small dedicated area suitable for one or two-person households. Earlier research on parking showed that the parking problem arises mainly due to people wanting to park exactly in front of the door of their destination [60,65].

The limitation of this study is that there is a possibility of some omissions because there is no official statistical data from the government on POBs, and a request for information disclosure was made to the city government of Gyeonggi-do. In addition, in the case of private POBs, it is difficult to secure personal information such as operating performance, so there is a limit to the selection of variables for research expansion. In order to solve this limitation, it is necessary to establish official statistical data at the government level on POBs. Even for private POBs, it is necessary to disclose information on the publicly available parts of the operating performance in consideration of the nature of the parking lot that performs public functions.

This study will enable government officials who decide and implement policies related to POBs and researchers from research institutes that support them to recognize the need for full-scale research and system improvement on this topic.

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