

# Empirical Investigation and Comparative Analysis of Underground Public Pedestrian Facilities in Daegu Metropolitan City

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**Abstract** The study establishes the analytical frame composed of 22 items according to the category of passageway, shop, entrance and amenity for the purpose of executing the empirical investigation of the Underground Public Pedestrian Facilities in Daegu Metropolitan City of Korea. As a result of the research work, the study finds out some problems about the facilities as follows: ① Passageway elements - the skylight was constructed only in one place. In contrast, the standards of passageway and plaza were well-fulfilled except for one or two cases. ② Shop elements - the cases of installing shops where they should not be located were found the most, and a case of over-establishing the shop area was found as well. ③ Entrance elements - the cases not matching roof or canopy standard over entrance facilities were found the most. Overall, the entrances and their connection to the adjacent buildings are appraised as not well-established. ④ Amenity elements - these were appraised as insufficient in all except two cases. Regarding this, not only necessary are the establishment of facilities and the effort of facility managers, but also urgent is the institutional improvement.

*Keywords: Underground Space, Underground Public Pedestrian Facility, Facility Criteria*

## 1. INTRODUCTION

### 1.1 Research Background

Since 1967, Korea has developed public underground space in the urban dimension with the form of underground shopping street, which is prescribed by the Korean law as Underground Public Pedestrian Facility (hereafter UPPF). Now in 2011, Korea has eighty UPPFs built in nineteen cities. The whole sum of their length exceeds 30km, and that of their floor areas amounts to about 700 thousand square meters.

Recently, Korean UPPFs has been facing with a new turning point. In 2005, 'The Regulation on the Determination, Structure, and Installation Standards of Underground Public Pedestrian Facilities'(Ministry of Land, Transport and Maritime Affairs, 2005; hereafter the Rule) was newly enacted so as to improve the legal system, and the society has clearly recognized that the commercially motivated drive of development for the late

forty years or so has resulted in cumulatively burdening the city. Therefore, now is the situation that a so-called paradigm shift occurs, so that it urgently needs to ponder and review this change seriously.

### 1.2 Research Purpose and Method

The physical research subject of this study is the UPPF defined by 'the underground passageways, plazas, shops, and the accompanying entrance facilities, connections, and subsidiary facilities, placed under the streets, plazas, and the like.' This UPPF has surely the public character that is formed in a city.

In this point of view, this study intends to accomplish the following process: first, to establish extensive research items for figuring out the correct condition of UPPFs; second, to utilize the established items in researching the six UPPFs located in Daegu Metropolitan City(hereafter Daegu); third, to synthesize and analyze the current conditions of facilities based on the researched data and the Rule; fourth, to suggest some considerations for the improvement of facility.

## 2. INVESTIGATION OF ACTUAL CONDITIONS OF FACILITIES

### 2.1 Research Overview

#### (1) Overview

In Daegu, the third-largest of Korean cities, there are 7 UPPFs, 8 discount stores, 6 department stores, 9 famous traditional markets, and 2 subway lines running: among them, excluding the small-scale case with much different characteristics, six cases were investigated.

The investigation were conducted ten times in all from October 20 to December 10 in 2010, through field visit, actual measurement, and manager interview.

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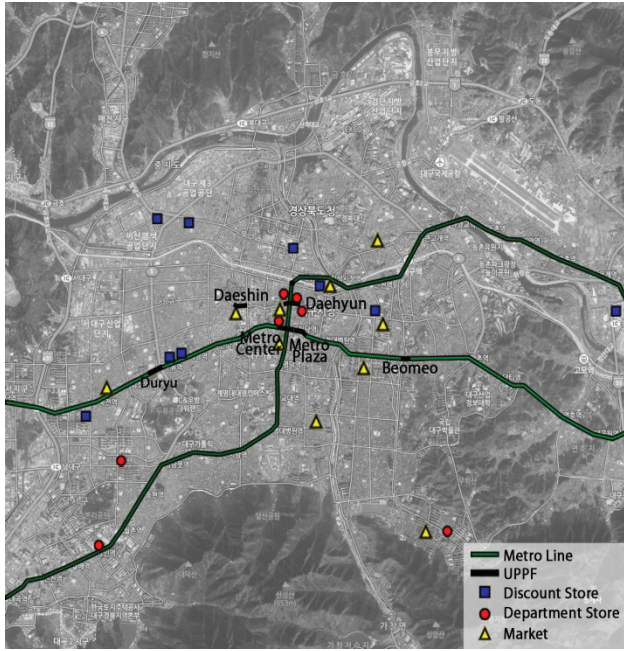


Figure 1. The locations of UPPFs in Daegu

Table 2. General data of Daehyun

Address/Operation	Jung-gu Dongseongno 2-ga 41-8 / Private Sector
Built Year/Remodeling Year	1977.01 / 2001.09
Length and Width	437m × 17.6m
Size/Gross Area	B1 / 9952m <sup>2</sup>
Passageway Area	4,031 m <sup>2</sup>
Shop Area	3,745m <sup>2</sup>
Misc. Area	2,176m <sup>2</sup>
Business Hours	10:30 ~ 22:30
Lighting	2 rows of indirect lighting fluorescent lamp + 2 rows of down lighting
Ceiling Shape	□
Floor Finish	Tile(White)
Ceiling Finish	Plastic(White)

(2) Establishment of Investigation Items

The physical elements constituting UPPFs can be considered in terms of function, structure, safety, and aesthetics(Lee and Sou, 2006). This study established investigation items by the existing research outcomes of facility elements(passageway, shop, and entrance) and amenity(Table 1).

Table 1. Items of Investigation

General	Location and Circumstance, Address/Operation, Built Year/Remodeling Year, Length and Width, Size, Gross Area, Passageway Area, Shop Area, Misc. Area, Business Hours, Monthly Maintenance Fee, Lighting, Ceiling Shape, Floor Finish, Ceiling Finish
Passageway Elements	Width, Ceiling Height, Underground Plaza Area
Shop Elements	No. of Initial Opening Shops, No. of Present Shops, No. of Empty Shops, No. of Monthly Takeover Shops, Area, Standard Width
Entrance Elements	No. of Entrance, Entrance Facility, Width of on-the-ground Walkway, Depth, Maximum Distance between Entrances, No. of Elevator, No. of Escalator
Amenity Elements	Water Space, Green Space, Street Furniture/ Artwork, Others

2.2 Daehyun UPPF

(1) Location and Circumstance

Daehyun is completed in the length of 437m under the two-way four-lane road. It is located in the central commercial sphere of Daegu, linked to the neighboring buildings such as theater, bookstore, and shopping buildings. Opened in 1977, Daehyun underwent the remodeling works finished in the late 2001.

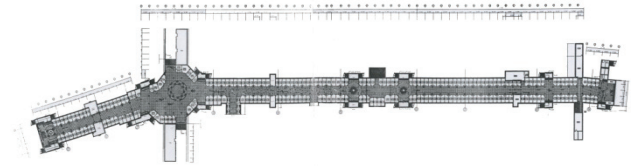


Figure 2. B1 Floor Plan of Daehyun

(2) Passageway Elements

Daehyun has a 17.6m width and a type of ABA, with the A denoting shopping area and the B denoting passage area. The passageway is a 6m-wide row. The ceiling is 2.85m high, and three underground plazas are there with the area of plazas except passageway being 898 square meters. For interior lighting, there are two rows of fluorescent lighting in the center of ceiling; for interior finish, the floor is finished by white tiles, while the ceiling is finished by white plastic materials.

(3) Shop Elements

The minimum area of a shop is 8.25 square meters, while the maximum is 65.2 square meters. The standard width of a shop facing the passageway is 3 meters. 161 shops made in the initial opening has increased by 1.43 times to 231 shops to date, and no shop was found to be empty.

(4) Entrance Elements

There are 24 entrances. It was found that the maximum width of on-the-ground passageway is 18m(that of the entrance-located part is 14.8m) and its minimum width is 5.5m(that of the entrance-located part is 2.6m). The maximum depth from the ground to the first basement floor level is 6.12m; the minimum is 4.59m; and the maximum distance between the entrances in the basement is 110m. Two elevators and eight escalators are installed in the facility.

(5) Amenities

There are one fountain as a water space, street furniture, and two resting places.

### 2.3 Daeshin UPPF

#### (1) Location and Circumstance

Daeshin is completed in 1985, in the length of 302m under the two-way eight-lane road. Adjacent to a traditional market and a park, it needs the smooth passage of pedestrians. In 1980s, it was a central area that makes up the foremost commercial sphere together with Seomun Market, but now it is confronting such problems as the change of commercial sphere, the deterioration of facilities, the organization of shop types, and accessibility.

Table 3. General data of Daeshin

Address/Operation	Jung-gu Daeshin 241-1 / Public Sector
Built Year	1985.1
Length and Width	302m × 25m
Size/Gross Area	B1/ 9,036 m <sup>2</sup>
Passageway Area	3,148 m <sup>2</sup>
Shop Area	3,440 m <sup>2</sup>
Misc. Area	2,248 m <sup>2</sup>
Business Hours	9:00 ~ 22:00
Lighting	3 rows of fluorescent lamp
Ceiling Shape	□
Floor Finish	Mock Marble(Light gray)
Ceiling Finish	Metal(White)

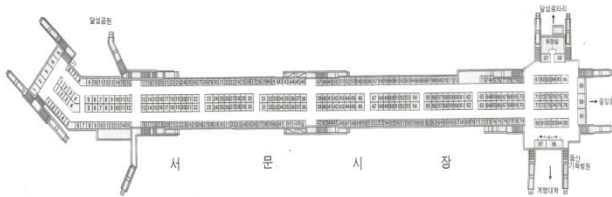


Figure 3. B1 Floor Plan of Daeshin

#### (2) Passageway Elements

Daeshin has a 25m width and a type of ABAABA, with the A denoting shopping area and the B denoting passage area. The passageway consists of two 6m-wide rows, and the ceiling is 2.58m high. For interior lighting, there are three rows of fluorescent lighting in the periphery of ceiling; for interior finish, the floor is finished by gray imitation stones, while the ceiling is finished by white metals.

#### (3) Shop Elements

The minimum area of a shop is 8.25 square meters, while the maximum is 14.85 square meters. The standard width of a shop facing the passageway is 3 meters. 330 shops made in the initial opening has sustained to date, and 40 shops were found to be empty.

#### (4) Entrance Elements

There are 17 entrances. It was found that the maximum width of on-the-ground passageway is 7.7m(that of the entrance-located part is 4.9m) and its minimum width is 4.3m(that of the entrance-located part is 1.5m). The maximum depth from the ground to the first basement floor level is 8.48m; the minimum is 6.72m; and the maximum distance between the entrances in the basement is 110m.

#### (5) Amenities

There are no amenities in the facility.

### 2.4 Duryu UPPF

#### (1) Location and Circumstance

Duryu is completed in 2005, in the length of 432m under the two-way twelve-lane road. It is adjacent to two universities and a cluster of many middle- and high-schools, as well as to such cultural elements as a park, a outdoor music theater, and a culture and arts center, and a large-scale amusement park.

Table 4. General data of Duryu

Address/Operation	Seo-gu Naedang 1290 / Private Sector
Built Year	2005.1
Length and Width	432m × 28m
Size/Gross Area	B1/ 26,096 m <sup>2</sup>
Passageway Area	8,481 m <sup>2</sup>
Shop Area	7,341 m <sup>2</sup>
Misc. Area	10,274 m <sup>2</sup>
Business Hours	9:30 ~ 23:30
Lighting	2 rows of indirect lighting fluorescent lamp
Ceiling Shape	□
Floor Finish	Mock Marble(Light Gray)
Ceiling Finish	Plastic(White)

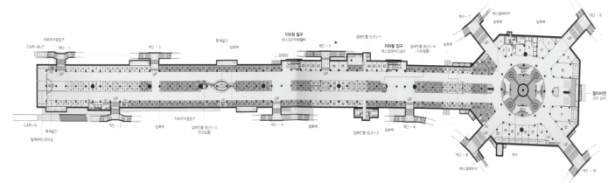


Figure 4. B1 Floor Plan of Duryu

#### (2) Passageway Elements

Duryu has a 28m width and a type of ABAABA, with the A denoting shopping area and the B denoting passage area. The passageway consists of two 6.2m-wide rows, and the ceiling is 3m high. One underground plaza is there with the area being 907.9 square meters. For interior lighting, there are two rows of fluorescent lighting in the periphery of ceiling; for interior finish, the floor is finished by gray-shade imitation stones, while the ceiling is finished by white plastic materials.

#### (3) Shop Elements

The minimum area of a shop is 13.2 square meters, while the maximum is 198 square meters. The standard width of a shop facing the passageway is 3.9 meters. 285 shops made in the initial opening has undergone the integration of more than two shops, so becoming 180 to date. 33 shops were found to be empty.

#### (4) Entrance Elements

There are 20 entrances. It was found that the maximum width of on-the-ground passageway is 18m (that of the entrance-located part is 12.5m) and its minimum width is 5.7m (that of the entrance-located part is 2m). The maximum depth from the ground to the first basement floor level is 9.76m; the minimum is 8.96m; and the maximum distance between the entrances in the basement is 94m. Two elevators and two escalators are installed in the facility.

#### (5) Amenities

There are one fountain as a water space, street furniture, and an event stage.

**2.5 Metro Center UPPF**

(1) Location and Circumstance

Metro Center is completed in 2005, in the length of 480m under the two-way twelve-lane road. It is an important spot of transportation as a subway transfer station, adjacent to the various contexts such as financial offices, cramming school street, culture street, department store, traditional market, telecommunication street, and oriental medicine market.

Table 5. General data of Metro Center

Address/Operation	Jung-gu Deoksan 88 / Private Sector
Built Year	2005.3
Length and Width	480m × 34.4m
Size/Gross Area	B2 / 60,165m <sup>2</sup>
Passageway Area	13,457m <sup>2</sup>
Shop Area	13,086m <sup>2</sup>
Misc. Area	33,622m <sup>2</sup>
Business Hours	10:00 ~ 22:00
Lighting	2 rows of indirect lighting fluorescent lamp
Ceiling Shape	□
Floor Finish	Tile(White)
Ceiling Finish	Plastic(White)



Figure 5. B1 Floor Plan of Metro Center

(2) Passageway Elements

Metro Center has a 34.4m width and a type of ABAABA, with the A denoting shopping area and the B denoting passage area. The passageway consists of two 7.2m-wide rows, and the ceiling is 3.2m high, except for the upward-open plaza, whose ceiling is 6.5m high. Three underground plazas are there with the area being 1,436 square meters. For interior lighting, there are two rows of fluorescent lighting in the periphery of ceiling; for interior finish, the floor is finished by white tiles, while the ceiling is finished by white plastic materials.

(3) Shop Elements

The minimum area of a shop is 5.87 square meters, while the maximum is 169.69 square meters. The standard width of a shop facing the passageway is 4 meters. 403 shops made in the initial opening has sustained to date, and 14 shops were found to be empty.

(4) Entrance Elements

There are 17 entrances. It was found that the maximum width of on-the-ground passageway is 10.3m (that of the entrance-located part is 6.6m) and its minimum width is 5.5m (that of the entrance-located part is 1.9m). The maximum depth from the ground to the first basement floor level is 11.22m; the minimum is 10.2m; and the maximum distance between the entrances in the basement is 96m. Three elevators and twelve escalators are installed in the facility.

(5) Amenities

There are a fountain, green space, street furniture, an event stage, internet searching stands, and artworks.

**2.6 Metro Plaza UPPF**

(1) Location and Circumstance

Metro Plaza is completed in 2005, in the length of 366m under the two-way twelve-lane road, linked to Metro Center. It is located in an area where population concentration is expected, adjacent to financial offices, cramming school street, culture street, telecommunication street, and furniture street.

Table 6. General data of Metro Plaza

Address/Operation	Jung-gu Deoksan 127-1 / Private Sector
Built Year	2005.6
Length and Width	366m × 26.4m
Size/Gross Area	B1 / 12,434m <sup>2</sup>
Passageway Area	5,208m <sup>2</sup>
Shop Area	4,321m <sup>2</sup>
Misc. Area	2,905m <sup>2</sup>
Business Hours	10:00 ~ 22:00
Lighting	2 rows of indirect lighting fluorescent lamp
Ceiling Shape	~
Floor Finish	Mock Mable(Light Gray)
Ceiling Finish	Plastic(White)

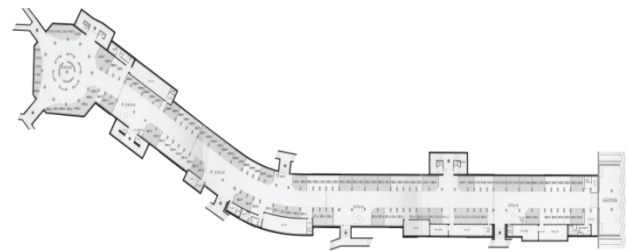


Figure 6. B1 Floor Plan of Metro Plaza

(2) Passageway Elements

Metro Plaza has a 26.4m width and a type of ABA, with the A denoting shopping area and the B denoting passage area. The passageway is a 7.2m-wide row, and the arch-type ceiling is 3m high. One underground plaza is there with the area being 776.95 square meters. For interior lighting, there are fluorescent lighting and point lighting; for interior finish, the floor is finished by gray imitation stones, while the ceiling is finished by white plastic materials.

(3) Shop Elements

The minimum area of a shop is 21.77 square meters, while the maximum is 370.57 square meters. The standard width of a shop facing the passageway is 4 meters. 138 shops made in the initial opening has sustained to date, and 45 shops were found to be empty.

(4) Entrance Elements

There are 18 entrances. It was found that the maximum width of on-the-ground passageway is 9.8m (that of the entrance-located part is 6.1m) and its minimum width is 5.0m (that of the entrance-located part is 2.3m). The maximum depth from the ground to the first basement floor level is 9.52m; the minimum is 8.67m; and the

maximum distance between the entrances in the basement is 60m. Two elevators are installed in the facility.

(5) Amenities

There is street furniture.

## 2.7 Beomeo UPPF

(1) Location and Circumstance

Table 7. General data of Beomeo

Address/Operation	Susung-gu Beomeo 935 / Public Sector
Built Year	2010
Length and Width	371m × (19 ~ 24)m
Size/Gross Area	B1 / 8,833m <sup>2</sup>
Passageway Area	4,862m <sup>2</sup>
Shop Area	2,256m <sup>2</sup>
Misc. Area	1,715m <sup>2</sup>
Business Hours	Not yet open
Lighting	2 rows of direct lighting fluorescent lamp
Ceiling Shape	□
Floor Finish	Mock Mable(Light Brown, Dark Gray)
Ceiling Finish	Plastic(White)

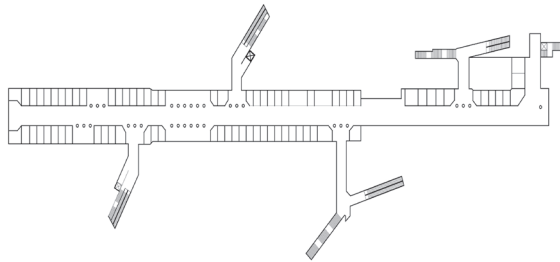


Figure 7. B1 Floor Plan of Beomeo

Beomeo is completed in 2010, in the length of 371m under the two-way twelve-lane road, located crossroad enabling good accessibility. It is located in an area where population concentration is expected, adjacent to financial offices, cramming schools, and clinics.

(2) Passageway Elements

Beomeo has a 19m width and a type of ABA(partially AB), with the A denoting shopping area and the B denoting passage area. The passageway is a 7m-wide row, and the flat-type ceiling is 3m high. One underground plaza is there with the area being 416 square meters. For interior lighting, there are fluorescent lighting; for interior finish, the floor is finished by brown and gray imitation stones, while the ceiling is finished by white plastic materials.

(3) Shop Elements

The standard shop unit is 3m by 3.47m, 10.42 square meters. In the facility, 72 shops were installed, but yet not run.

(4) Entrance Elements

There are 11 entrances. It was found that the maximum width of on-the-ground passageway is 14.4m(that of the entrance-located part is 11.7m) and its minimum width is 5.4m (that of the entrance-located part is 2.6m). The maximum depth from the ground to the first basement floor level is 9.76m; the minimum is 7.82m; and the maximum distance between the entrances in the basement is 95m.

(5) Amenities

There are some benches in the facility.

## 3. ANALYSIS AND APPRAISAL

### 3.1 Synthetic Analysis of Facility Elements

From a synthetic analysis of the data researched above, the following result can be extracted(Table 8):

Table 8. Facility Elements Analysis of UPPFs in Daegu

	Daehyun	Daeshin	Duryu	Metro Center	Metro Plaza	Beomeo	Total(Average)
Built Year/Remodeling Year	1977/2001	1985	2005	2005	2005	2010	
Length×Width(m)	437×17.6	302×25	431×28	480×34.4	366×26.4	371× (19 ~ 24)	
Size/Ceiling Height(m)	B1/2.8	B1/2.6	B1/3.0	B2/3.2	B1/3.0	B1/3.0	(2.93)
Gross Area(m <sup>2</sup> ) A	9,952	9,036	26,096	60,165	12,434	8,833	126,516(21,086)
Misc. Area(m <sup>2</sup> )	2,176	2,448	10,274	33,622	2,905	1,715	53,140(8,857)
※ Net Gross Area(m <sup>2</sup> ) B	7,776	6,588	15,822	26,543	9,529	7,118	73,376(12,229)
Passageway Area(m <sup>2</sup> ) C	4,031	3,148	8,481	13,457	5,208	4,862	39,187(6,531)
Shop Area(m <sup>2</sup> ) S	3,745	3,440	7,341	13,086	4,321	2,256	34,189(5,698)
No. of Shop	231	330	180	403	138	72	1,354(226)
Average Shop Area(m <sup>2</sup> )	16.2	10.4	40.8	32.5	31.3	31.3	(25)
Total Passageway Ratio (C/A, %)	40.5	34.8	32.5	22.4	41.9	55.0	(31)
Total Shop Ratio(S/A, %)	37.6	38.1	28.1	21.8	34.8	25.5	(27)
Passageway Ratio(C/B, %)	51.8	47.8	53.6	50.7	54.7	68.3	(53.4)
Shop Ratio(S/B, %)	48.2	52.2	46.4	49.3	45.3	31.7	(46.6)
Underground Plaza Area(m <sup>2</sup> )	898	-	908	1,436	777	416	4,435(887)
Area Ratio of Plaza/Shop(%)	24	-	12.4	11	18	18.4	(13)
Plaza Ceiling Height(m)	3.2	-	3.9	6.5	3.0	3.0	(3.92)
Passageway Width(m)	6	4	6.2	7.2	7.2	7	(6.27)
No. of Entrance	24	17	20	17	18	11	107(17.8)
Net Gross Area per Entrance(m <sup>2</sup> )	414.7	531.5	791.1	1561.4	529.3	647.1	(686)
Parking	305	-	135	680	34	28	1,182
Net Gross Area per Parking(m <sup>2</sup> )	25.5	-	117.2	39	280.3	254.2	(56.5)
Skylight(m <sup>2</sup> )	-	-	-	250.6	-	-	
Depth(m)	4.59 ~ 6.12	6.72 ~ 8.48	8.96 ~ 9.76	10.2 ~ 11.22	8.67 ~ 9.52	7.82 ~ 9.76	(7.83 ~ 9.14)
Maximum Floating Population(pp/h)	5,736	1,206	2,340	6,768	804	2,142	18,996

※ Net Gross Area(B) = Gross Area(A) - Misc. Area = Passageway Area(C) + Shop Area(S)

- ① The length of UPPFs is 2,387m, so the average length is 397.8m.
- ② The average gross area of all UPPFs is 21,086 square meters; the average passageway area is 6,531 square meters; and the average shopping area is 5,698 square meters.
- ③ There are underground plazas in 5 UPPFs, with the average ceiling height being 3.92m, the average area being 887 square meters. The plaza area to shopping area ratio ranges from the minimum 11% to the maximum 24%.
- ④ For passageways, the average ceiling height is 2.93m and the average width is 6.27m. It can be inferred that the whole UPPFs are used by over 100 thousand people a day.
- ⑤ For the entrances installed in a UPPF, the average number is 17.8 and the net gross area of an entrance is 686 square meters.
- ⑥ The maximum depth of 6 UPPFs is 11.22m and the minimum is 4.59m.
- ⑦ The average passageway area to the average gross area ratio is 31%, and the average shopping area to the average gross area ratio is 27%. In terms of the net gross area, the passageway to shopping ratio is 53.4% to 46.6%, which means the passageway area is larger.

**3.2 Comparative Appraisal of the Present Construction and the Rule**

**(1) Underground Passageway**

The standards of underground passageway construction by the Rule are summarized in Table 9, and the appraisal of facilities by each item as follows:

Table 9. The Standard of Underground Passageway Installation

Content	Standard
Width	(Maximum number of pedestrians per hour / 1,600) + Tolerance (if underground shops exist, 2m; or else, 1m) $\geq 6m$ *pertinent to all underground passageways constructed in the facility
Ceiling Height	3m min.
Figure of Floor	No stairs, Slope: 1/18 max. *in case of difficulty by the landform, adjustable up to 1/12

① Width - the widths of passageways are calculated as follows: in Daehyun,  $6m > (5,736/1,600) + 2 = 5.6$ ; in Daeshin,  $6m > (1,206/1,600) + 2 = 2.8$ ; in Duryu,  $6m > (2,340/1,600) + 2 = 3.5$ ; in Metro Center,  $6.3m = (6,768/1,600) + 2$ ; in Metro Plaza,  $6m > (804/1,600) + 2 = 2.5$ ; and in Beomeo,  $6m > (2,142/1,600) + 2 = 3.34$ . Only the case of Daeshin did not fulfill the standard.

② Ceiling Height - the standard of 3m ceiling height was fulfilled in four places, except for the cases of Daehyun and Daeshin.

③ Figure of Floor - the Rule disallows multi-level floors according to the 'Act on Guaranteeing Convenience Promotion for the Disabled, the Old, and Pregnant Women,' and this standard was fulfilled in all cases.

**(2) Underground Plaza**

The Rule prescribes the standard of underground plaza installation as follows:

Table 10. The Standard of Underground Plaza Installation

Content	Standard
Area	10% min. of the underground shops area
Ceiling Height	3.3m min.
Location	one place min. constructed in contact with underground passageway

① Area - underground plaza areas are calculated as follows: in Daehyun,  $3,745 \times 0.1 = 374.5 m^2$ ; in Daeshin,  $3,440 \times 0.1 = 344 m^2$ ; in Duryu,  $7,341 \times 0.1 = 734.1 m^2$ ; in Metro Center,  $13,086 \times 0.1 = 1308.6 m^2$ ; in Metro Plaza,  $4,321 \times 0.1 = 432.1 m^2$ ; and in Beomeo,  $2,256 \times 0.1 = 225.6 m^2$ . All five places except Daeshin fulfilled the standard.

② Ceiling Height - only the cases of Duryu and Metro Center fulfilled the 3.3m standard.

**(3) Skylight**

The Rule prescribes the standard of skylight installation as follows:

Table 11. The Standard of Skylight Installation

Content	Standard
Area	2% min. of the underground shops area *in case of difficulty in installation, use another way of daylight window construction.

The required skylight area was calculated as follows: in Daehyun,  $3,745 \times 0.02 = 75 m^2$ ; in Daeshin,  $3,340 \times 0.02 = 67 m^2$ ; in Duryu,  $7,341 \times 0.02 = 147 m^2$ ; in Metro Center,  $13,086 \times 0.02 = 262 m^2$ ; in Metro Plaza,  $4,321 \times 0.02 = 87 m^2$ ; and in Beomeo,  $2,256 \times 0.02 = 46 m^2$ . Except for Metro Center, however, any other place has no skylight, and even Metro Center does not fulfill the standard slightly.

**(4) Underground Shop**

The Rule prescribes the standard of underground shops installation as follows:

Table 12. The Standard of Underground Shop Installation

Content	Standard
Total Shops Area	$\leq$ Underground Passageway Area + Underground Plaza Area
The Limit of Shop Installation	Shop installation is prohibited within 3m from the every exit. The shops located at corners can be installed only within the line connecting two points, each of which withdraws from the corner intersection by 2m in each direction.
Size Limit	One side of a shop shall be in contact with underground passageway by more than 3m.
Prohibited Use	Shops of treating gas, dangerous articles, liquor or chemicals; Trades of making noise, vibration, dust or stench; Performance hall and theater

① Total Shops Area - the Rule prescribes the minimum ratio of pedestrian area(underground passageway area + underground plaza area) to shops area as 50 to 50. That is, the shops area shall be less than the pedestrian area. Except for the case of Daeshin, all other cases fulfilled this standard.

② Installation Limit - the standards of proscribing the shop installation within 3m from exits and of proscribing the corner out-off at road intersection were fulfilled in the cases of Metro Center,

Metro Plaza, and Beomeo.

③ Size - the standard of prescribing the least 3m contact between one side of a shop and underground passageway was fulfilled in all six places.

④ Prohibited Use - the provision of prohibited use was fulfilled in all cases.

#### (5) Entrance Facility

The Rule prescribes the standard of underground entrance facility installation as follows:

Table 13. The Standard of Underground Entrance Facility Installation

Content	Standard
Width of Entrance	2m min. ※ in case of one entrance, at least the width of underground passageway or more.
Width of Surface Walkway	≥ 3m, excluding the width of entrances ※ in case that no obstruction in surface walk is ensured, adjustable to 2m.
Interval between Underground Entrance Facilities	within 100m of inner interval ※ in case of inevitability, within 120m.
Constructed Facility	In the entrance facility which directly connects to underground plaza, one or more upward and downward escalators shall be installed. Over the entrance, a roof or a canopy shall be constructed.
Connection to Underground Floor	Construct if it can improve publicity such as convenience and escapability of users. The width of connection to underground floor is the same as that of underground passageway(except for the case of constructing them in different directions). In the connection to underground floor, construct at least 2m wide entrance stairs connected to the surface.

① Width of Entrance - the widths of entrances range from 2m (in Daeshin) to 6m (in Beomeo), all cases fulfilling the 2m minimum standard.

② Width of Surface Walkway - the required width of surface walkway except for entrances is more than 3m(in case of inevitability, 2m). Except for the case of Daeshin(1.5m~4.9m), all other cases fulfilled the standard.

③ Interval between Underground Entrance Facilities - this study measured the interval between underground entrance facilities as the distance between the stair centers of two entrance facilities. Accordingly, the intervals were found to be 110m in Daehyun and Daeshin; 94m in Duryu; 96m in Metro Center; 60m in Metro Plaza; and 95m in Beomeo. All cases fulfilled the standard.

④ Constructed Facility - only in the case of Daeshin, canopies were constructed over all entrances; the canopy standard was not fulfilled in all other cases. Except for the case of Daeshin and Metro Plaza, escalator standard was fulfilled in all other cases.

⑤ Connection to Underground Floor - the Rule prescribes for underground connection to construct at least 2m wide entrance stair connected to the surface. This standard was fulfilled in the cases of Daehyun, Metro Center, and Beomeo.

#### (6) Amenity

Amenity elements are the most lacking part in domestic UPPFs, and this study appraised them in terms of four items: water space, green space, street furniture/artwork, and others. Water space was made up in Daehyun, Duryu, and Metro Center; green space was made up only in Daehyun and Metro Center; street furniture and

artwork is installed in four places except for the cases of Daeshin and Beomeo; and others included exhibition space and internet searching stands, which are installed only in Metro Center.

As above, the contents applied to all facility cases can be summarized in comparison with the installation standards of the Rule like the following Table 14. In this table, the average of standard fulfillment value of all facility cases is calculated as 0.665. The cases of Metro Center, Duryu, Daehyun, and Beomeo have the higher fulfillment value than the average value, while the cases of Metro Plaza and Daeshin have the lower value.

Table 14. Comparison with the Actual Conditions and the Installation Standards

	Dae hyun	Dae shin	Du ryu	Metro Center	Metro Plaza	Beomeo
Passageway Width	○	×	○	○	○	○
Passageway Ceiling Height	×	×	○	○	○	○
Figure of Floor	○	○	○	○	○	○
Plaza Location	○	×	○	○	○	○
Plaza Area	○	×	○	○	○	○
Plaza Ceiling Height	×	×	○	○	×	×
Skylight Area	×	×	×	×	×	×
Total Shops Area	○	×	○	○	○	○
The Limit of Shop Installation	×	×	×	○	○	○
Size Limit	○	○	○	○	○	○
Prohibited Use	○	○	○	○	○	○
Width of Entrance	○	○	○	○	○	○
Width of Surface Walkway	○	×	○	○	○	○
Interval between Underground Entrance Facilities	○	○	○	○	○	○
Escalator	○	×	○	○	×	○
Canopy	×	○	×	×	×	×
Connection to Underground Floor	○	-	-	○	-	○
Water Space	○	×	○	○	×	×
Green Space	○	×	×	○	×	×
Street furniture/ Artwork	○	×	○	○	○	○
Others	×	×	×	○	×	×
Fulfillment Index	0.71	0.3	0.75	0.9	0.62	0.71

○: Fulfillment ×: No Fulfillment -: N.A.

## 4. CONCLUSION

Conducting empirical research on six UPPFs constructed in Daegu, Korea, this study could draw its conclusions as follows:

First, it established the analytical framework for researching physical condition of UPPFs via the review of precedent studies and the contents of the Rule.

Second, the drawn analytical framework was utilized in researching the UPPFs of Daehyun, Daeshin, Duryu, Metro Center, Metro Plaza, and Beomeo, so as to construct the physical basic data of those facilities.

Third, comparing between the researched facility conditions and the installation standard prescribed by the Rule, it was able to draw the following appraisals on the facilities:

① Passageway elements - the skylight, which can be called the most important of underground environmental elements in a facility, was constructed only in one place. In contrast, the standards of passageway and plaza were well-fulfilled except for one or two cases.

② Shop elements - the cases of installing shops where they should not be located were found the most, and a case of over-establishing the shop area was found as well. As for the over-density condition of shops, the minimum area of a shop amounts to 5.87 m<sup>2</sup>, and the average number of shops located in a meter was 0.57. This is appraised as a serious situation.

③ Entrance elements - the cases not matching the roof or canopy standard over entrance facilities were found the most. Overall, the entrances of UPPFs and their connection to the adjacent buildings are appraised as not well-established.

④ Amenity elements - this specially established element in this study was appraised as insufficient in all other UPPFs except two cases. Regarding this, not only necessary are the establishment of facilities and the effort of facility managers, but also urgent is the institutional improvement.

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