Abstract

Underground commercial complexes have caused confusion and inconvenience to the users, and there has been a problem with activation of them (Hoeven and van Nes, 2013; Dursun, 2007). Actually, many of them have struggled or stopped operation. For the success of the large-scale underground commercial space, a gap may need to be bridged between the design process and architectural design disciplines. In designing large-scale underground spaces, architects have difficulty with perceiving the outcome of a design in terms of spatial configuration and cognition, which strongly affect the success of a commercial space. Currently, in most architectural practice, the zoning and layout plan are formulated by considering the function of each individual facility independently. There is a relative lack of consideration of utilising the advantage of mixed-use facilities to achieve mutual synergy (Kim and Kim, 2007). Several studies have suggested that the spatial configuration of a commercial complex strongly influences the activation of the facilities (Kim et al., 2010; Kong and Kim, 2013).

In this context, this study aims to propose design methods to establish a spatial configuration plan by evaluating design alternatives for activation of a large-scale underground commercial complex, and present design guidelines based on case studies. ‘Central City Shopping Centre’ in Seoul is selected for the case study in which tenants and owners of the shops are constantly changing due to an economic failure over the last 20 years. The research methods are as follows. First, the business models, design process, and spatial configuration of the three cases are analysed utilising space syntax. Second, problems are identified through the analysis of the case with the lowest intelligibility in terms of spatial configuration. Third, the redesign of the case is performed along with analysis of the space syntax for activation of the spatial configuration. Fourth, the results of the improvements are analysed through comparison of the redesign with the current status of the case. Lastly, the design process and guidelines for underground commercial complexes will be proposed, based on the above results for commercial space activation.
The results of this study will provide design methods for analysing the spatial configuration of underground spaces and identifying the spatial behaviour of users, and apply them to the design of an underground commercial complex. In practice, they can be used to evaluate and modify designs to enhance the success of a large-scale underground commercial complex. Furthermore, they can be applied to maximize profits through the activation of a commercial complex.

Keywords
Underground commercial complex, spatial configuration, spatial cognition, design methodologies, design guidelines, commercial space activation.

1. Introduction
1.1 Background and purpose
Population growth and lifestyle changes have led to the emergence of commercial complexes which continue to increase in size. Such commercial complexes affect their local business zones, so their importance is gaining more attention. The spatial configuration of a commercial complex strongly influences the activation of the facilities (Kim et al., 2010; Kong and Kim, 2013). There are many problems with the spatial configuration of existing commercial complexes, which seem directly involved with the vacancy or sales of leased stores. In Seoul, large-scale underground commercial complexes are being built, which are connected to underground subway stations with multiple levels. Thus, the spatial configuration of the complex becomes very complicated, and the underground space increases the level of difficulties in spatial cognition such as way-finding and legibility. Underground commercial complexes have caused confusion and inconvenience to the users, many of which have struggled or failed financially.

Several studies have suggested that the overall shape of the space (i.e. spatial configuration) affects spatial cognition (e.g. Wiseman, 1983; Kim & Penn, 2004) and that spatial cognition is an important factor that affects the activation of a space (e.g. Hillier et al, 1993). There is, however, a gap to be bridged between the design process and architectural design disciplines. In the design of large-scale underground spaces, architects have difficulty with perceiving the outcome of a design in terms of the spatial configuration and cognition, which strongly affect the success of a commercial space.

In the initial design phase of a large-scale commercial complex, the design is generally carried out through a case study of similar facilities and analysis of the building site and merchandising (MD). The design process of a commercial complex consists of MD and theme selection, schematic design, design development, and construction documentation. An architect takes responsibility for not only the architectural design but also the coordination between MD and clients, feasibility study, and mediation among experts of each area. However, the design process may change depending on the business model. For large-scale commercial complexes, therefore, applying an integrated design from the initial phase of planning to consider commercial space activation is difficult in practice. The lack of a systematic plan for the overall spatial configuration or a review/validation method in the existing design process affects commercial space activation.

Currently, in most architectural practice, the zoning and layout plan are formulated by considering the function of each individual facility independently. There is a relative lack of consideration to utilise the advantage of mixed-use facilities in order to achieve mutual synergy (Kim and Kim, 2007). Also, the user cognition of the internal layout for a commercial complex or connectivity among facilities is insufficiently considered. Therefore, further research is needed to apply the user’s spatial cognition and connectivity among facilities to actual building design.
In this context, this study aims to propose design methods for establishing a spatial configuration plan by evaluating design alternatives for the activation of a large-scale underground commercial complex, and present design guidelines based on case studies.

1.2 Scope and methods

This study examined the case studies of Central City, COEX Mall, and Time Square, which are representative large-scale commercial complexes in Seoul, Korea with large floating populations since their opening in 2000. Among them, Central City Shopping Centre was selected for an in-depth study because the tenants and owners of the shops have been constantly changing owing to financial failure over the last 20 years.

The research process is given below in detail.

First, the business and design processes of the three cases were examined along with their effects on the commercial space activation, and the analysis results of the spatial configuration utilising space syntax were specified.

Second, problems were identified through the analysis of the case with the lowest intelligibility in terms of spatial configuration.

Third, the case was redesigned along with space syntax analysis to activate the spatial configuration.

Fourth, the results of the improvements were analysed through comparison of the redesign with the current status of the case.

Fifth, the design process and guidelines for underground commercial facilities were developed based on the above results for commercial space activation.

The results of this study will provide design methods for analysing the spatial configuration of underground spaces and identifying the spatial behaviour of users. In practice, they can be used to evaluate and modify designs to enhance the success of a large-scale underground commercial complex. Furthermore, they can be applied to maximise profits through the activation of a commercial complex.

2. Literature review

Related previous studies were reviewed with regard to the characteristics of planning and design methods for activating commercial complexes and their spatial configuration.

Four basic principles for activating commercial complexes were proposed to strengthen the integration of the entire facility in terms of the spatial configuration (Kong and Kim, 2010; Lee and Kim, 2012). The four principles are the central axis of activation, central core, circulatory movement system, and MD. This suggests the potential of solving problems with large-scale commercial complexes in terms of theory and practice. In a similar context, Kim and Shim (2011) considered planning aspects related to the modern characteristics of commercial complexes – complexity, attraction factors, and leisure space and proposed to use a configuration method, circulation system, and central space plan as planning elements for activation.

Han et al. (2010) defined an intermediate area as an ‘evolved service space’ that improves the quality of the physical environment within a large-scale mixed-use complex by serving not only as a service space within existing facilities but also as a public space. The arrangement and connection of the intermediate areas such as plazas, and sunken courtyards are essential in determining the spatial configuration of a building interior. Mikunda (2005) argued that four planning elements are needed to form a cognitive map in a commercial complex: a central axis, axial line, zoned areas, and main...
facilities. These are related to the elements for an urban image suggested by Lynch: path, edge, district, node, and landmark.

In order to investigate the space syntax of the environment and user’s cognition in complex commercial area, Kim et al. (2008) focused more on the importance of the spatial configuration of the entire building and argued that quantitative analysis is needed to predict the connectivity between the overall spatial configuration of a mixed-use complex and that of each facility. Also, Kim and Kim (2007) suggested a need to consider the user’s cognition of the internal layout for a commercial complex and the actual building design.

The previous studies on commercial complexes considered the planning characteristics, design method, and inter-functional spatial configuration. Their results are used to identify current problems with complexes and establish new plans. However, most studies have been limited with regard to the objective examination of the overall spatial configuration of a complex. In studies on the architectural planning characteristics, a qualitative approach based on case studies and comparative methodologies has mainly been adopted. To make these studies more applicable to practical design, further research is needed on their meaning in the design process and how they should be reflected in the design guidelines specifically.

In this context, this study aims to propose design guidelines which integrate a qualitative design perspective with quantitative analysis for the activation of large-scale underground commercial complexes, in a way to overcome the limitations of the previous studies.

3. Method

This study analysed the business models, design process, and spatial configuration of the three cases utilising space syntax. This was followed by an in-depth analysis of the case with the lowest intelligibility in terms of the spatial configuration. The case was redesigned, and space syntax analysis was applied to the case to compare its current situation with the resulting improvement from the redesign. Based on the results, the design process and guidelines were proposed for commercial space activation in underground commercial complexes.

3.1 Analysis method

1) Floor plan analysis and field study:

The spatial characteristics of three case studies were analysed based on four design principles as in Table 1 using VGA.

<table>
<thead>
<tr>
<th>Four elements</th>
<th>Criteria for analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axis</td>
<td>Shape and location of the most integrated corridor</td>
</tr>
<tr>
<td>Core</td>
<td>Location, shape and size of an integration core</td>
</tr>
<tr>
<td>Circulation</td>
<td>Type and pattern of circulatory movement system</td>
</tr>
<tr>
<td>Merchandizing/Tenant Mix</td>
<td>Mix of tenants and merchandizing considering the degree of integration</td>
</tr>
</tbody>
</table>

Table 1: Four design principles of spatial configuration in mixed-use commercial complex (Source: Kong and Kim, 2010; Lee and Kim, 2012)

2) Interview:

Interviews were conducted with a project architect of the TSK office, which participated in the design of Central City, a project architect of JUNGLIM Architecture, which remodelled COEX Mall, and a
project manager of JUNGLIM Architecture, which designed Time Square. Specifically, they were asked about the project backgrounds, operations, and design process. They were also asked about difficulties during the design process, the most important consideration in the design of a large-scale underground commercial complex, and the most influential design characteristics for the projects.

3) Space syntax analysis

The spatial configuration of the three subject areas was analysed using space syntax. The characteristics of the problems with the spatial configuration were analysed using VGA (Visibility Graph Analysis). This analysis will provide a quantitative basis to predict the possibility of activating a shopping space.

The areas subject to spatial analysis were from B1 to 1F. 1F included the nearby walking paths, and the underground area was included only inside the building.

3.2 Method of redesign

Based on the process above, the case with the most serious problems in terms of spatial configuration was redesigned to promote the commercial space activation. Two alternatives were proposed for redesign, and 3D rendering was done for space simulation along with space syntax analysis. Through this process, an optimal alternative was selected, and the degree of commercial space activation was analysed. This process provides a basis for the design of large-scale underground commercial complexes.

The redesign was performed under the following preconditions.

- First, the target floors for redesign were limited to between B1 and 1F.
- Second, the location and shape of the important cores were not changed.
- Third, the redesigned area of the commercial facilities needed to be minimized.
- Fourth, the locations of the key anchors were not changed.

4. Case studies: measuring the degree of activation

4.1 Introduction of three cases

The business models and design processes of Central City, COEX Mall, and Time Square, which are representative large-scale underground commercial complexes in Seoul, Korea, were examined along with the effect of these characteristics on the commercial space activation.

4.1.1 Time Square

Time Square is located in the secondary central business district of Yeongdeungpo in Seoul and was completed in 2009. It is a large-scale commercial complex having five underground floors and 20 ground floors with the site area of 44,000 m² and gross area of 376,000 m². Time Square was developed with an integrated approach and is operated through a rental system. It was designed by RTKL of the USA and JUNGLIM Architecture.

According to an interview with the project manager in charge of this project, JUNGLIM Architecture had difficulty with performing a fast-track construction and design in parallel. It took over the design after the contract with RTKL was cancelled, but the project was successfully completed through communication and collaboration between the client and the architect. Efforts were made to attract a floating population with MD planning to combine medium/low-priced and high-priced items appropriately, a smooth circulation system, and the formation of a central space rotunda for way-
finding. According to depth map analysis, Time Square recorded the highest intelligibility of 0.80, which was taken as an activation indicator of the entire facility.

4.1.2 COEX Mall

COEX Mall opened in 2000 as Asia’s largest underground shopping space. It has six underground floors and 54 ground floors with the site area of 148,784 m2 and gross area of 972,976 m2. COEX Mall was developed through three phases consecutively. The schematic design was carried out by RTKL of the USA, and the construction documentation was done by BAUM Architects respectively. The existing COEX Mall contributed to activation through the appropriate arrangement of anchor facilities such as Hyundai Department Store and Megabox. Depth map analysis showed that COEX Mall registered an intelligibility of 0.60.

4.1.3 Central City

Central City was the first shopping mall complex attempted in Korea, and the construction was completed in April 2000. It is a large-scale commercial complex, which has five underground floors and 33 ground floors with the site area of 62,000m2 and gross floor area of 266,00m2. The overall spatial configuration is composed of a department store, hotel, wedding hall, express bus terminal, shopping mall, and movie theatre.

<table>
<thead>
<tr>
<th>Table 2: Comparative analysis of three case studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
</tr>
<tr>
<td>Business model</td>
</tr>
<tr>
<td>Design process</td>
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<tr>
<td>Difficulties in designing</td>
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<tr>
<td>Major considerations in designing</td>
</tr>
<tr>
<td>Design characteristics</td>
</tr>
</tbody>
</table>

For Central City, business was carried out through the selling off of the building site to key anchor facilities. According to the interview with the project architect of TSK, the client produced the overall master plan and floor plan, and TSK was in charge of the exterior design. Also, the client produced the plan with the intention of separating the terminal from commercial facilities such as the department store and hotel. Thus, it was impossible to integrate the design for the whole complex, so there was considerably weak connectivity among the department store, the central plaza, and the hotel. This problem had a negative effect on activation of the space, and Central City recorded the lowest intelligibility of 18% in the depth map analysis.

In summary, the depthmap analysis showed that Central City had the lowest intelligibility of 0.18, while COEX Mall and Time Square had the scores of 0.60 and 0.80 respectively. These three cases show that different business methods affected the spatial configuration. Thus, the business methods of large-scale commercial complexes are closely related with activation, which is directly related to profitability.
### Table 3: Space analysis of three case studies

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Central city</th>
<th>COEX</th>
<th>Time Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>1F</td>
<td><img src="image1" alt="Central city 1F" /></td>
<td><img src="image2" alt="COEX 1F" /></td>
<td><img src="image3" alt="Time Square 1F" /></td>
</tr>
<tr>
<td>B1</td>
<td><img src="image4" alt="Central city B1" /></td>
<td><img src="image5" alt="COEX B1" /></td>
<td><img src="image6" alt="Time Square B1" /></td>
</tr>
</tbody>
</table>

#### Intelligibility (Value)

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Central city</th>
<th>COEX</th>
<th>Time Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.18</td>
<td>0.60</td>
<td>0.80</td>
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</tbody>
</table>

#### Space Analysis

**Central city 1F**
- Activation is concentrated because a strong main axis is formed in the terminal concourse area (A) of 1F. However, the connectivity with B1 is weak.
- The main axis forms a strong diagonal line between the movie theatre (E) and fountain plaza (C) on B1. The degree of activation is high between the fountain plaza and shoe store (B) but low between the movie theatre and space (B).
- The central plaza is the key to the circulation linking B1 with 1F and is connected with the main axis for a high degree of activation.
- Circulation system: The circulation system crucial for shopping is insufficient. Cognition is weak for vertical circulations except for that of the central plaza.
- MD: A targeted circulation is induced by arranging the food court (F) and movie theatre in space, where accessibility and cognition should decrease remarkably on B1.

**COEX 1F**
- A strong main axis is formed on an outer street and inside the convention on 1F. On B1, however, a clear main axis is not formed, and there is a way-finding issue.
- Absence of clear main core: vertical circulations are broken up into two and are close to each other, so the central core (B) does not have clear centrality.
- Circulation system: Because of the absence of a clear main axis and main core, the circulation network is not smooth. For the horizontal circulation system, activation is concentrated on the façade, and accessibility is weak in the back side space. There is insufficient cognition of vertical circulation elements.
- MD: A targeted circulation is induced by placing the hotel and casino in a space on 1F with the lowest accessibility and locating Megabox (C) and the aquarium (D) in a space on B1 where accessibility and cognition are expected to be lowest.

**Time Square 1F**
- Clear main axes are formed (A), (B)
- The main core rotunda (C) is located at the centre of shopping mall. Because it is also interlinked with the main axis, it shows a high degree of activation.
- Circulation system: Overall, there is a smooth circulation network thanks to a clear main axis and main core. Way-finding and spatial cognition are easy for shoppers because of the circulation system.
- MD: On B1, E-mart is placed in a space with low accessibility.
4.2 Analysis of spatial configuration of Central City

Central City was selected for analysis because its spatial configuration had the lowest degree of activation of the three cases. The spatial configuration was analysed through a field survey, floor plan analysis, and space syntax with a focus on B1 and 1F.

1) Analysis of current status

As shown in Figure 1, Central City is a complex with a daily floating population of more than 400,000, and is connected to the subway lines 3, 7, 9 and Gyeongbu Line on B1. There are four main programs for the facilities on 1F: the department store (Shinsegae), bus terminal, hotel (Marriot Hotel), and Famille station.

For the main circulations of 1F, the most active are the one starting from Famille station on the subway line 3/7 to the main axis of the terminal concourse and the one starting from the entrance plaza of the department store at Sinbanpo-ro to the main core via the department store.

The major programs of the underground floor include the department store (Shinsegae), underground shopping mall (Young Street), hotel, movie theatre (Megabox), food court, and bus terminal office. The underground floor can be entered through four entrances via the Gyeongbu Line underground shopping centre. Inside the facility, the main axis is from the fountain plaza to bookstore and the movie theatre; the main circulation is activated along this axis.

With regard to the MD layout, the anchor tenant Shinsegae is located in the northwest corner. A hotel is situated between the central plaza and Famille station, which causes discontinuity. On B1, small shops including clothing stores are located around the main core fountain plaza, while stationery stores and a key tenant bookstore are around the main axis of activation. The anchor tenant Shinsegae is in the northwest corner, and a movie theatre is in the southwest with low accessibility.

Figure 1: Circulation and zoning.
2) Spatial configuration analysis utilising space syntax

The B1 and 1F spatial configurations of Central City were analysed by utilising space syntax.

For the internal circulation of B1, the main axis of activation forms a diagonal line from the fountain plaza to the movie theatre. However, the shoe stores of space “2” and curved footpath mean weak visual connectivity between the two spaces, and the main axis shows low accessibility with a mean global integration (MG) score of 3.14 (Figure 4. #B1-1). The major vertical circulation linking the movie theatre with B1F of Central City has remarkably low cognition with an MG score of 4.58 (Figure 4. #B1-2). In addition, the fountain and amenity facilities are located on the central axis of activation (Figure 5. #B), and the connection path between the department store and the fountain plaza is only 5m in width, and the fountain plaza and the hotel are disconnected.

On 1F, each facility has more entry points compared to B1, so this floor shows a higher MG score (4.35) than B1 (2.95) (Figure 4. #1-all). Depthmap analysis confirmed that the degree of integration is highest (5.49) (Figure 4. #1-1) for the main axis, which is the concourse area of terminal. However, cognition is low because the connection between the main axis and each space is insufficient, and visibility is low especially for the link with the central plaza because of the ticket office and stairway going up to the mezzanine floor. Famille station has an MG score of 4.01 (Figure 4. #1-3); thus, the accessibility and degree of activation are low because of the hotel situated between Famille station and the central plaza. The connections between each facility are significantly passive because the connecting path between the department store and central plaza is only 2.8 m in breadth, and the link between the central plaza and hotel is broken.

The existing Central City has problems such as disconnection of the central axis of activation, poor circulation system, and difficult way-finding. The disconnection of the main axis of activation causes complicated problems, such as inconsistency of the central axes between B1 and 1F, weakening of the axis line due to the curved walkway in the sub-core of B1, and the lack of connectivity between the central axis and Famille station on 1F. In addition, the circulatory movement system within the facility is not smooth enough. The connectivity among Famille station and the fountain plaza of B1 and the bus terminal is also low. There are other problems such as insufficient cognition of the vertical circulation between B1 and the 1F terminal, an inadequate circulatory movement system linking the fountain plaza and movie theatre. These problems have resulted in low intelligibility.

Figure 2: Disconnection of central axis of activation.
5. Redesign

To tackle the problems discussed in the previous section, the existing Central City was redesigned by strengthening the central axis of activation, arranging the main core to be more suitable, and establishing a smooth circulation system. Two alternatives were developed. Through space syntax analysis of the redesign plans, the integration of the important areas and intelligibility were evaluated to compare the improvement with the current status.

The preconditions of the redesign were not to change the main cores and minimize the area reduction of commercial facilities to revive the activation axis. The redesign proceeded under the condition of no changes in the locations of key anchors. Through this, activation was promoted on 1F and B1 of Central City.

5.1 Alternative 1

For alternative 1, the redesign involved raising the degree of integration of Famille station and strengthening the connectivity among each function and the main axis of activation to enhance the intelligibility.

Figure 3: Concept diagram of Alternative 1.
First, a circulatory movement system was established to provide a connecting path between the main core of 1F and Famille station. Second, the connectivity with the main axis of activation was strengthened by moving the location of the vertical circulation of Famille station. This increased the MG value of Famille station to 4.46 (Figure 4. #1-3). Third, the location of the stairway going up to the mezzanine floor, which was previously located in the centre, was moved to the upper side of the ticket office on the left to strengthen the integration of the main axis of the concourse and the main axis. This increased the MG values of the main axis and the main core to 5.90 and 5.18 (Figure 4. #1-1, #1-2) respectively.

Fourth, considering the existing escalator of the vertical circulation connecting the concourse of B1 and 1F had low cognition, an open space was installed to increase cognition, and the shoe store of B1 was relocated to improve the visibility and accessibility (MG value: 4.92) (Figure 4. #B1-4). Fifth, vertical openness was provided by planning amenities, including a water space in the central plaza and open space near the escalator of the vertical circulation (MG values: 5.18) (Figure 4. #1-2). Sixth, the integration of the main axis was increased through a circulatory movement system connecting

Figure 4: Depthmap analysis of Alternative 1.

<table>
<thead>
<tr>
<th></th>
<th>1F</th>
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<tbody>
<tr>
<td></td>
<td>Present</td>
<td>ALT 1</td>
</tr>
<tr>
<td>1-1</td>
<td>5.49</td>
<td>5.80</td>
</tr>
<tr>
<td>1-2</td>
<td>5.13</td>
<td>5.18</td>
</tr>
<tr>
<td>1-3</td>
<td>4.01</td>
<td>4.46</td>
</tr>
<tr>
<td>1-4</td>
<td>5.76</td>
<td>5.52</td>
</tr>
<tr>
<td>1-5</td>
<td>4.33</td>
<td>4.36</td>
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<tr>
<td>1-all</td>
<td>4.35</td>
<td>4.58</td>
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</tbody>
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<tr>
<th></th>
<th>1F</th>
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</tr>
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<tbody>
<tr>
<td></td>
<td>Present</td>
<td>ALT 1</td>
</tr>
<tr>
<td>B1-1</td>
<td>3.14</td>
<td>3.85</td>
</tr>
<tr>
<td>B1-2</td>
<td>3.18</td>
<td>3.84</td>
</tr>
<tr>
<td>B1-3</td>
<td>-</td>
<td>-</td>
</tr>
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<td>B1-4</td>
<td>4.58</td>
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</tr>
<tr>
<td>B1-5</td>
<td>3.54</td>
<td>3.63</td>
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<tr>
<td>B1-all</td>
<td>2.95</td>
<td>3.35</td>
</tr>
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</table>
the fountain plaza (A) and shoe store (B) (MG value: 3.85) (Figure 4. #B1-1). Finally, the cognition for each entrance of the space was increased, and the spatial integration was strengthened by relocating the amenities and water space which were cutting off the main axis of activation (MG value: (B1): 3.84, (1F): 5.18) (Figure 4. #B1-2, #1-2) (Figure 5).

![Diagram showing present and alternative designs](image)

**Figure 5**: Core redesign – Alternative 1.

![Images showing central cores before and after redesign](image)

**Figure 6**: Core redesign image – Alternative 1.
5.2 Alternative 2

For alternative 2, the design involved increasing the intelligibility more actively by locating the main core, central plaza to be interlinked with the main axis of activation.

The escalator located in the main core of 1F was moved close to the main axis of activation, and the stairway going to the mezzanine floor was moved near the stairway on the right. The accessibility of the terminal concourse and the main core was strengthened by relocating the ticket office in the central plaza to attract more of floating population to B1. This increased the MG values of the main axis and the main core to 6.18 and 4.09 (Figure 8. #1-1, B1-1) respectively.

Figure 7: Concept diagram of Alternative 2.
A circulatory movement system was established by connecting the previously broken-off Famille station and central plaza, and the entrance in the concourse of the main axis was expanded. This increased the MG value of Famille station to 4.58 (Figure 8. #1-3). The main core was redesigned to a hexagonal shape, while its centralised characteristics were maintained. Efforts were made to maintain connectivity with the entrance point and visibility as much as possible. Other elements were the same as for alternative 1.

**Figure 8:** Depthmap analysis of Alternative 2
5.3 Sub-conclusion

The two alternatives were the same in terms of the specific redesign but differed in the following areas: the modifications to the location and shape of the fountain in the fountain plaza, which is regarded as the most important cognition space in Central City; the connecting paths between the main core and Famille station; and the changes to the location of main core. These redesign efforts improved upon the original intelligibility of 0.18 for Central City: alternative 1 produced an intelligibility of 0.48 for an improvement of 266%, and alternative 2 produced an intelligibility of 0.58 for an improvement of 322%.
## Table 3: Comparative analysis of Redesign and Current plan

<table>
<thead>
<tr>
<th></th>
<th>Present</th>
<th>Alternative 1</th>
<th>Alternative 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1F</strong></td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td><strong>Intelligibility</strong></td>
<td>0.18</td>
<td>0.48</td>
<td>0.58</td>
</tr>
<tr>
<td><strong>Central axis of Activation</strong></td>
<td></td>
<td>• Discordance of main axis of activation between 1F and B1</td>
<td>• B1: relocate the shoe store and strengthen the main axis (MG value: 3.85)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• B1: low visibility and accessibility because of the location of the shoe store (MG value: 3.14)</td>
<td>• 1F: Extend the main axis through Famille station (MG value: 5.80)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 1F: MG value of 5.49 thanks to clear axis and relatively high visibility and openness</td>
<td>• B1: Strengthen the main axis by moving the location of the main core (MG value: 4.09)</td>
</tr>
<tr>
<td><strong>Central Core</strong></td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>• Low cross-sectional openness of central core</td>
<td>• Provide vertical openness by planning amenity facilities including water space as well as open space near vertical circulation (MG value: (B1) 3.45, (1F) 5.18 MG )</td>
<td>• Change the central core to a hexagonal shape while maintaining its centralised characteristics and increase the size of the central plaza</td>
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<td></td>
<td>• MG value: (B1) 3.18, (1F) 5.13</td>
<td>• Maintain the round shape of the main core</td>
<td>• In addition to alt1 redesign, the cognition of each entrance and the spatial integration were enhanced by moving the location of the main core near the central axis and relocating the ticket office in the central plaza. (MG value: (B1) 4.23, (1F) 5.53)</td>
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<td></td>
<td>• On 1F, the visibility of the central core from the central axis of activation was weak because of the existing escalator and the location of the stairway going up to the mezzanine floor.</td>
<td>• The accessibility and visibility were improved by moving the location of the stairway going up to the mezzanine floor and amenities like a water space. A sense of vertical openness was provided by planning a void near the vertical circulation from B1 through 5F. (MG value: (B1) 3.45, (1F) 5.18).</td>
<td>• The accessibility of the terminal concourse and main core was strengthened by locating the ticket office in the central plaza.</td>
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<td></td>
<td>• Because the escalator and pond were located on the central axis of activation on B1, visibility was weakened at the entrance point to Famille station.</td>
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<tr>
<td><strong>Circulatory movement system</strong></td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
<td><img src="image9.png" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>• B1: lack of horizontal circulation system; one-way circulation network of moving in two ways centred around fountain plaza</td>
<td>• B1: add two circulation systems by connecting path within the bookstore to establish a horizontal circulation system and raise the visibility of the circulation connecting department store with the movie theatre</td>
<td>• B1: connect the path to the bookstore to establish a horizontal circulation system and plan an escalator for the vertical circulation in the node</td>
</tr>
<tr>
<td></td>
<td>• 1F: Broken-off accessibility between Famille station and central plaza (MG value of 3.85)</td>
<td></td>
<td>• 1F: With the movement of the central core, the main</td>
</tr>
</tbody>
</table>

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A Study on the design methodologies for activating large-scale underground commercial complexes

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A Study on the design methodologies for activating large-scale underground commercial complexes
6. Conclusion

In this study, space syntax was utilised to analyse the spatial configuration of three large-scale underground commercial complexes in Korea: Central City, COEX Mall, and Time Square. The design processes of these complexes were analysed based on interviews with the design offices in charge of each facility. Central City was found to have the lowest integration, and its layout and circulation were redesigned from the viewpoint of spatial configuration. The degree of commercial space activation was analysed through space syntax. The followings are design guidelines for invigorating large-scale underground commercial complexes.

1) Design process

First of all, there is a need for an integrated design process which takes into account the diversity of business models.

From the three case studies, it is found that not only the architectural plan but also the business model affected the formation of the spatial configuration. Time Square showed the highest degree of activation; it was developed by the client in an integrated manner and is being operated by leasing. COEX Mall was developed over three consecutive phases. Central City showed the lowest degree of activation and pursued business by selling off key anchor facilities. Therefore, the integrated design covering the whole complex was impossible, so connectivity among facilities was insufficiently considered. Thus, the business model of a large-scale commercial complex appears to be closely related to its activation, which is directly related to the profitability. The more diverse stakeholders are and the more integrated a variety of facilities are, the more necessary it is to design the spatial configuration of the entire complex and have areas which coordinate a variety of opinions.

Therefore, an integrated design system is needed to control the entire design from the beginning while considering diverse business models.

2) Site plan

In the site plan, facility positioning is important. First, facilities need to be positioned through site analysis and commercial analysis. The target customers need to be selected by income and age, and facilities need to be positioned by considering the current surroundings and accessibility and by understanding the context. Second, the design should consider connectivity and openness based on the flow of people. The connectivity among facilities should be strengthened by designing open spaces among facilities with a high flow of floating population. Such a site plan will not only improve the cognition of the entire complex but also help to increase the profitability of each facility.
3) Circulation plan
In a large-scale underground shopping space, a circulation system should be formed from the user perspective to improve way-finding. First, diverse types of open space need to be designed, such as an atrium or sunken plaza, which connect underground and ground spaces to resolve the way-finding issue, which is more pronounced in underground spaces. Second, both horizontal and vertical circulation systems are important for vitalizing a shopping mall. The internal space should be zoned to allow for continuous circulation without dead-end spaces.

As proposed by this study, spatial interconnectivity considering the flow of shoppers (i.e. spatial configuration planning) is an important element for circulation plan.

4) Spatial configuration plan
To activate a large-scale shopping space, a main axis of activation is required. It is also important to form a main core to concentrate the flow of floating population.

First, the central axis of activation should be firmly established at the centre of the shopping mall to influence each space. If the axis is located along the same line on each floor, this increases the integration of the entire space and is advantageous in activating the commercial area.

Second, the central core, which is a landmark recognized as a central space by shoppers, should be at the centre of the spatial configuration and near the central axis of activation. When there is smooth visibility and accessibility with the secondary core, it helps customers with way-finding.

Third, it is important for the design to provide cross-sectional visual openness and promote visual connectivity between the outside and inside through an atrium and openings between floors. These are also major tools for attracting natural lighting and outdoor air into an internal space, giving visual continuity and decreasing the sense of being closed in an underground space. These help to display the activated shopping mall dynamically through people travelling in diverse directions.

5) MD plan
MD should be arranged by the degree of activation and accessibility. That is, a targeted circulation is induced by placing anchor facilities such as hotel, department store, and movie theatre in a space with low degrees of activation and accessibility.

Existing MD plans are mainly dependent on qualitative or empirical judgment. In contrast, spatial structure analysis makes it possible to quantitatively predict the space accessibility and consequently the degree of activation. Objective ground rules for MD plan which comprehensively consider the degree of activation of each space, brand awareness, and consumer behaviours such as planned and impulse purchases need to be developed based on the quantitative analysis method suggested by this study.

Because large-scale commercial complexes contain diverse functions and facilities and have the spatial disadvantage of being underground, it is difficult to invigorate an entire space without an integrated plan from the initial design phase. As demonstrated by the interviews with architects, there is an absence of basic design guidelines to activate an entire facility in practice. In this context, this study intended to overcome the limitations of preceding studies that examined planning methods for mixed-use complexes mainly through a simple qualitative approach.

The purpose of this study was to propose design guidelines through the integration of a qualitative design and quantitative analysis for the activation of a large-scale underground commercial complex. Therefore, the activation of a commercial complex needs to be verified systematically from the planning and design phase based on the design guidelines developed through this study. An
integrated design process is required to increase the integration of the entire facility in terms of the spatial structure. This will help to maximize the profit of the commercial facilities.

References


