

HOW TO REDUCE TRANSMISSION OF RESPIRATORY INFECTIOUS DISEASE IN INTERIOR SPACES: AN EMPIRICAL STUDY WITH INTERIOR DESIGN PROFESSIONALS

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ABSTRACT

This study was motivated by the need for empirical evidence to inform design guidelines for interior workspaces during the COVID-19 pandemic. This research had two goals: to identify the features of interior spaces and behaviors in Korea where many confirmed cases of COVID-19 were found; and to examine design professionals' opinions on workplace management and operation to reduce transmission of respiratory infectious disease.

A content analysis of newspaper articles on confirmed cases was conducted and a survey was administered to design professionals. The analysis identified common features of the interior spaces with confirmed cases of COVID-19. Based on the analysis of the article contents, a questionnaire was constructed. The questionnaire asked design professionals to suggest interior design considerations that could prevent the spread of the virus in interior spaces.

They emphasized the separation of individual spaces from shared spaces; installing partitions in rooms that could not be divided; ending two-way traffic in narrow hallways; reducing room density and avoiding crowding; adopting touchless technologies and no-touch access to interior spaces; automating interior equipment and facilities; and encouraging office users to work from home if possible. These findings should be factored into interior space planning and management to reduce the risk of exposing future users of these spaces to infectious respiratory diseases.

KEYWORDS

Infectious Disease, COVID-19, Interior Design Professionals, Workplace

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1. INTRODUCTION

1.1 Background and Need

COVID-19 appeared at the end of January 2020 and spread through Korea more rapidly than other respiratory infections like MERS and SARS (Kim & Lee, 2020). Even though Korea had abundant experience with the prevention and treatment of respiratory infections, there was not much medical information about COVID-19 at the time. Principles and methods of treatment and prevention thus were uncertain (Chae, 2020), and there were no established policies and regulations to stop or slow the spread of the virus. In addition, some people who contracted COVID-19 remained asymptomatic but others died (Jeong, 2020), so it was very difficult to predict the course of the disease and its impact on Korean society.

In response to the World Health Organization's (WHO) declaration of the pandemic, many governments started enacting regulations to provide safer workplace environments (Korea Ministry of Employment and Labor, 2020). Countries with no domestic examples of office space regulations consulted the rules and regulations of other countries. A review of literature showed that each country enacted its own regulations on workplace safety to reduce the impact of the pandemic (Xu, Luo, Yu, & Cao, 2020). The most common rules limited office hours, encouraged employees to work from home, enforced a social distance policy in workplaces, and recommended against commuting by public transportation to work (The New York Times, 2020). The WHO (2020) also suggested stopping cross-border movement and minimizing personal contact. All these new rules and regulations deterred large groups of people from gathering and encouraged social distancing (WHO, 2020).

The Central Disease Control Headquarters in Korea (KCDC) replaced K-12 classroom instruction with online classes after several extensions, and recommended telecommuting for industrial workers (Korea Ministry of Education, 2020). However, contrary to initial expectations that the pandemic would end quickly, it dragged on for more than a year. The Korea Ministry of Employment and Labor (2020) presented guidelines for workplace operation and management in 2020. The initial guidelines were not fully applicable because of the lack of empirical evidence. More evidence-based guidelines were thus needed.

In Korea, COVID-19 spread quickly through office spaces at the beginning and then gradually slowed thanks to the established regulations as time went by (Park, 2020). More confirmed cases, however, were found in other types of interior spaces like coffee shops, cafes, and churches (Yang, 2020). Therefore, it is imperative to identify the spatial characteristics and interior space management features in those spaces first and then to examine effective interior design and planning strategies to reduce transmission of the respiratory infectious disease. This approach would propose practical guidelines for reducing the chances of the virus spreading in workplaces where large numbers of people routinely gather.

1.2 Research Purpose and Approach

Considering the need for empirical evidence to suggest more practical guidelines for interior spaces in workplaces, this study has two goals: to identify common interior space features and behaviors in workspaces with confirmed cases of COVID-19; and to examine design professionals' opinions on workplace management and operation to reduce transmission of the respiratory infectious disease.

The research team used both qualitative and quantitative methods. To achieve the first goal, the research team attempted to visit the places with confirmed cases, but pandemic

restrictions made this impossible. Instead, the research team used content analysis to identify the features of interior spaces in which cases of COVID-19 had been confirmed. Newspaper articles documenting those cases were collected. Government regulations on the operation and maintenance of the workplaces were also analyzed. A qualitative approach was employed in this stage.

To accomplish the second goal, an online survey was administered to design professionals in Korea and the United States, asking for their opinions on workplace design and management. From January to July 2021, interior designers and educators were asked to complete the survey. Because COVID-19 was not limited to Korea, design professionals in the United States were also recruited.

1.3 Research Questions

This research was based on the following research questions: 1) What are the common features of interior spaces in Korea where COVID-19 confirmed cases were found? 2) What are common behavioral features in interior spaces where confirmed cases were found? 3) What do interior design professionals recommend to keep office employees safe during a pandemic?

Research question 3 has two sub-questions: What features of interior space should be considered? What behaviors should users of these spaces adopt to keep the interior spaces safe and free from the spread of viruses?

2. REVIEW OF LITERATURE

1) Working from Home

According to Kane et al. (2021), society will not go back to the pre-pandemic practices of workplace operation and management. New ways of running the workplace are thus needed. One new practice is to offer a hybrid work option to employees who want to work from home or go back to the office. Kaushik and Guleria (2020) mentioned working from home to establish and maintain normal routine; social distancing; a good remote work strategy for keeping collaboration; security; a policy framework; and emotional well-being. They also suggested allowing employees to work from home and negotiating with them to provide more stable work options. Kane et al. (2021) and Kaushik and Guleria (2020) emphasized more flexible workplace layout and space planning.

2) Working In-Person

Not every job can be done from home. Some employers prefer to have their employees working on-site. In these cases, they should have regulations to keep office spaces safe during the pandemic. In early 2020 when the pandemic started, Korea had no such guidelines or regulations. People continued to work in their offices without wearing masks, because masking was not required (Park, 2020).

However, the 1,102 square meter Guro Call Center in Seoul had more than 94 confirmed cases of COVID-19 (Yang, 2019). The call center was occupied by 216 people; 5 square meters per person. Common spaces such as hallways and restrooms had even less personal space. The office did not have enough windows to provide natural ventilation. The desks were arranged in long rows, with each desk separated from its neighbors by a 1.5 meter wide partition. As a result, the space was quite crowded (Kim, 2020). Workers spent their time making phone calls, so people were constantly talking. COVID-19 is spread through droplets, so this space was

conducive to the transmission of the virus. This was the first big cluster infection in a workplace in Korea, and it made people fearful of sharing office space (Choi, 2020).

As time passed, more cluster infections were reported in Korea, especially among people working in close proximity in dense spaces with few windows and little natural ventilation. As there was as yet no COVID-19 vaccine, the increasing number of cluster infections was frightening (Jang, 2020). For employers who allowed people to work from home, it was not difficult to implement regulations to reduce workplace density. However, for many employees, working from home was not possible.

3) *Social Distancing Rule in Korea's Workplaces since March 2020*

By March 2020, most Koreans voluntarily wore masks in indoor spaces. A series of newspaper articles described office workers' concerns about the unsafe work environment. The Korea Ministry of Employment and Labor (2020) offered suggestions on how to manage office spaces. In November 2020, it issued strict rules on wearing masks, installing partitions in the workplace, recommending natural ventilation, and enforcing social distancing. Table 1 shows the five levels of social distance required in workplaces in Korea by November 2020 (Korea CDC, 2020).

Table 1 shows the increasingly strict social distancing regulations in Korea. Wearing masks indoors and outdoors was compulsory, with no exceptions. The masking policy was lifted on May 2, 2022 (Korea CDC Headquarters, 2022).

This three-level guideline was modified into the five-level guideline later in 2020 (Korea CDC Headquarters, 2022). Social distancing rules depended on the number of confirmed cases. At the end of November, the Korean government announced "with-Corona" and tried to return to the pre-COVID-19 status quo. However, the omicron variant was then confirmed (Korea Disease Control and Prevention Agency, 2022). Many restrictions were reimposed at the end of November 2021 and concerns about COVID-19 grew once again.

In late April 2022, the Korean government released a new guideline to control the spread of COVID-19 (Korea CDC Headquarters, 2022). There had been a peak in the number of confirmed cases and then the numbers stabilized. COVID-19 was reduced from a level 1 disease to a level 2 (Shin, 2022). The restrictions on the number of people allowed to eat together and restaurants' hours of operation were relaxed in April, 2022, but the masking rules remained in

TABLE 1. Social distance rule in workplace.

Level 1	Level 1.5	Level 2	Level 2.5	Level 3
Preventive phase: Able to control and prevent in daily life	Local spread		Nationwide spread	
Mandatory to wear masks in all spaces	Mandatory masking, hand sanitizing, social distancing among workers, and compliance with all core prevention rules			
Appropriate ratio, recommending work-from-home	Strongly recommending working from home (1/3 of all employees)		Recommending that more than 1/3 of employees work from home	All except essential workers work from home

Source: Ministry of Employment and Labor, 2020

Note: The workplace with high level of unsafety, such as call centers and supply and distribution centers, should be strictly monitored. At level 3, work-from-home should be required except for the essential workers.

place (Shin, 2022). Partitions remained in workplaces and restaurants to prevent transmission of the virus (Kim et al., 2021).

An intensive review of the literature and content analysis revealed five key phrases to reduce the transmission of respiratory diseases such as COVID-19 “putting partitions between work stations,” “social distance,” “natural ventilation or natural air circulation in interior spaces,” “work-from-home,” and “prevention rules such as wearing masks and hand sanitizing in work-place.” The importance of interior considerations was examined in the second phase of this research, when design professionals were surveyed.

3. RESEARCH METHODS

3.1 Content Analysis of Newspaper Articles

To identify spatial features of the indoor spaces with many confirmed cases and people’s behaviors in those spaces, the researchers collected newspaper articles that reported confirmed cases of COVID-19 in Korea which wrote with a focus on interior spaces and people’s behaviors. The articles were published in Korea’s major daily newspapers from February, 2020 to March, 2021. They included the keywords about interior spaces. The researchers also collected articles on cluster infections of COVID-19.

3.2 Expert Survey with Interior Design Professionals

To collect professionals’ suggestions to improve the workplace environment during the pandemic, an online, intensive survey was conducted with 30 interior designers, architects, building managers, and design educators who had worked in the design field for more than five years. Since there had never been an infectious disease like COVID-19 before, the survey investigated interior designers’ recommendations for office space. According to Groat and Wang (2002), surveys or interviews with experts produce more reliable results. The research team thus tried to collect the opinions of design professionals of design professionals with at least five years of experience in interior design, architecture, or building management.

Thirty interior design professionals recruited for this study were selected using convenience sampling. Most of them were affiliated with interior design organizations in Korea or the United States. Some of the professionals had up to 30 years of experience. Since three of the 30 interior design professionals either did not respond to the survey in time or did not complete it, they were excluded from the analysis.

The questionnaire was based on the content of the literature review. The questions pertain to space planning, interior environmental control, and non-design strategies for space management. It asked respondents to rank the importance of the following items: “separation of space by partitions/screens,” “separation of private from public spaces,” “whether windows can be opened to allow natural ventilation,” “the presence or absence of technology or tools to measure indoor air quality,” “keeping spaces clean and hygienic,” “condition of infectious disease control and prevention before and after work hours,” and “work-from-home policy which could allow office workers to work from the location of their choice.” These questions were expected to provide useful directions for workplace management during the pandemic.

3.3 Limitation of the Study

The first phase of this study utilized content analysis from newspaper articles, which were written in the beginning of the pandemic that reported the confirmed cases in Korea. At the

time, there was no rule or regulations set for the prevention. The articles were selected for the analysis if they reported interior space features of where the confirmed cases were found. The articles were thus intentionally selected for the study. The number of articles for the analysis was less than twenty, therefore. The content was analyzed qualitatively. The frequencies of the keywords regarding interior spaces were thus not counted.

4. RESULTS

4.1 Content Analysis Result

1) Features in Interior Spaces with High Number of Confirmed Cases

From February 2020 through March 2021, most cluster infections were found in call centers for telemarketing, churches, coffee shops, and the dormitories of private schools. Table 1 shows the list of articles showing the features of call centers that could influence the spread of COVID-19. The researchers filtered repeated keywords or phrases in those newspaper articles that explained the features of interior space with confirmed case of COVID 19.

The research showed all of the spaces were crowded. The employees' desks were too close to each other, precluding social distancing. Moreover, employees did not follow the rule of compulsory masking. Lack of natural ventilation due to sealed windows was another problem. When workers were required to gather for assemblies, or when they all had lunch at the same time, the chances of personal contact and virus transmission increased. Most spaces with cluster infections had an inadequate supply of hand sanitizers or partitions that were too low. Tables 2 through 4 show the features of spaces with numerous confirmed cases of COVID-19.

As Table 3 shows, several boarding schools reported confirmed cases of COVID-19. Like the office spaces in Table 2, dormitories had sealed windows and insufficient hand sanitizing products. Having several students sleep in the same room was an additional issue. The air conditioning system and the lack of natural ventilation increased the risk of infection. Having too many desks in close proximity in the classroom was also reported.

At the beginning of 2020, many cases of COVID-19 were confirmed in international boarding schools. As Table 4 shows, room sharing, the lack of partitioning in dining rooms and shared shower facilities were the main problems. There were also no masking requirements.

2) Common Features in Interior Spaces

The main features of interior spaces with many confirmed cases of COVID-19 could be categorized into four parts. First, room density was high and multiple space users shared items in interior spaces. They shared the spaces such as offices or rooms, equipment, and shower facilities. The high density in a small workplace with many confirmed cases could not provide social distance within an office. When spaces are crowded, interior partitions should be installed to create a safer individual work zone. Dining halls and dorm rooms should have partitions, and the wearing of masks should be required.

However, no case reported that the spaces offered proper interior partitions. Especially, no partition within the dining space was found. In cases that involved a shared room with a roommate, it would be desirable to provide the individual living zone with a room partition. The cases reported did not provide any partition in a room even when two or three roommates were sharing a room. Under this sharing situation, the rule to wear a mask was not obeyed properly. Many individuals under this situation were not asked to follow the mask rule firmly, which could bring a result of a sudden increase in confirmed cases.

TABLE 2. Features in office spaces with multiple confirmed cases of COVID-19.

Article number and month	Name of the Newspaper	Significant Interior Environmental or Management Elements
Article 1. March 2020	Chosun Daily News	Lack of Windows (Ventilatory insufficiency), Mask rules violations, Tight desk layout, Working from home not permitted
Article 2. March 2020	Daegu Daily News	Close desk layout
Article 3 & 4, September 2020	Chosun Edaily Korea	Inadequate surface disinfection, Contaminated air-conditioning intake, Mask rules violations, Hand sanitizing products shortage, Ventilatory insufficiency, Inadequate partitions height, Shared lunchtime
Article 5. June 2020	NToday Korea	Tight desk layout, Mask rules violations, Working from home not permitted Uninstalled partitions, Morning assemblies
Article 6. August 2020	Money Today	Shared lunchtime
Article 7. September 2020	Dong-a Daily News	Tight desk layout, Mask rules violations, Shared lunchtime
Article 8, June 2020	Korean Daily	Mask rules violations
Article 9 & 10, December 2020	Hankook Daily	HVAC types, Unit Heater types
Article 11. December 2020	Chosun Daily News	Tight desk layout (Private institutes) HVAC types, Ventilatory insufficiency (Call Center Offices)
Article 12. November 2020	Joongang Daily News	Tight desk layout, Mask rules violations, HVAC types, Hand sanitizing products shortage, Shared lunchtime

TABLE 3. Features of interior spaces with multiple confirmed cases of COVID-19: Korean private schools.

Article number and month	Name of the Newspaper	Significant Interior Environmental or Management Elements
Article 13. July 2020	Yonhap News Agency	Tight desk layout, Mask rules violations, Lack of Windows (Ventilatory insufficiency), Air conditioning systems, Hand sanitizing product shortage
Article 14. March 2020	Hankyoreh Daily News	Crowdedness in the space
Article 15. December 2020	Chosun Daily News	Lack of Windows (Ventilatory insufficiency), Tight desk layout

TABLE 4. Features in interior spaces with multiple confirmed cases of COVID-19: International boarding schools.

Location of the international school	Name of the Newspaper	Significant Interior Environmental or Management Elements
Daejeon, Korea	Seoul Daily News	Uninstalled partitions in common dining spaces
Hongcheon, Korea	Yonhap News Agency	Dormitory room sharing
Gwangju, Korea	Seoul Economic Daily	Dormitory room sharing, crowedness in the spaces
Daejeon, Korea	Yonhap News Agency	Dormitory room sharing, Shared shower facilities and restrooms, Uninstalled partitions in common dining spaces

The lack of windows that could be opened was another common characteristics of these interior spaces. Some spaces had windows, but they were sealed shut so the lack of natural air circulation increased the chances of virus transmission.

An additional issue was the inability to work from home. This might be a cultural issue, because Korean office workers usually do not take advantage of opportunities to work from home. Most Koreans live in high-rise apartments with no extra room for a workstation or home office. Although there was no clear reason to explain why Korean people do not tend to work from home, many office workers cited the lack of a work-from-home option.

To visualize the relationships among these keywords, a network analysis map as presented in [Figure 1] was drawn using Gephi 0.9.7; a Java-based open-source software enabling network visualization analysis. Significant interior elements from newspaper articles were input to the Excel sheet for preliminary processing. Elements with the same or a similar meaning, before being separated in the tables for detailed explanation, were unified into single keywords. For example, the elements “ventilation insufficiency” and “ventilatory insufficiency” are integrated into “ventilatory insufficiency.” Next, each descriptive element was replaced by a keyword for simpler analysis; “uninstalled partitions in common dining spaces” became “uninstalled partitions” for example. These refined keywords were grouped for each article and organized in an Excel file, which was then used as input data for Gephi.

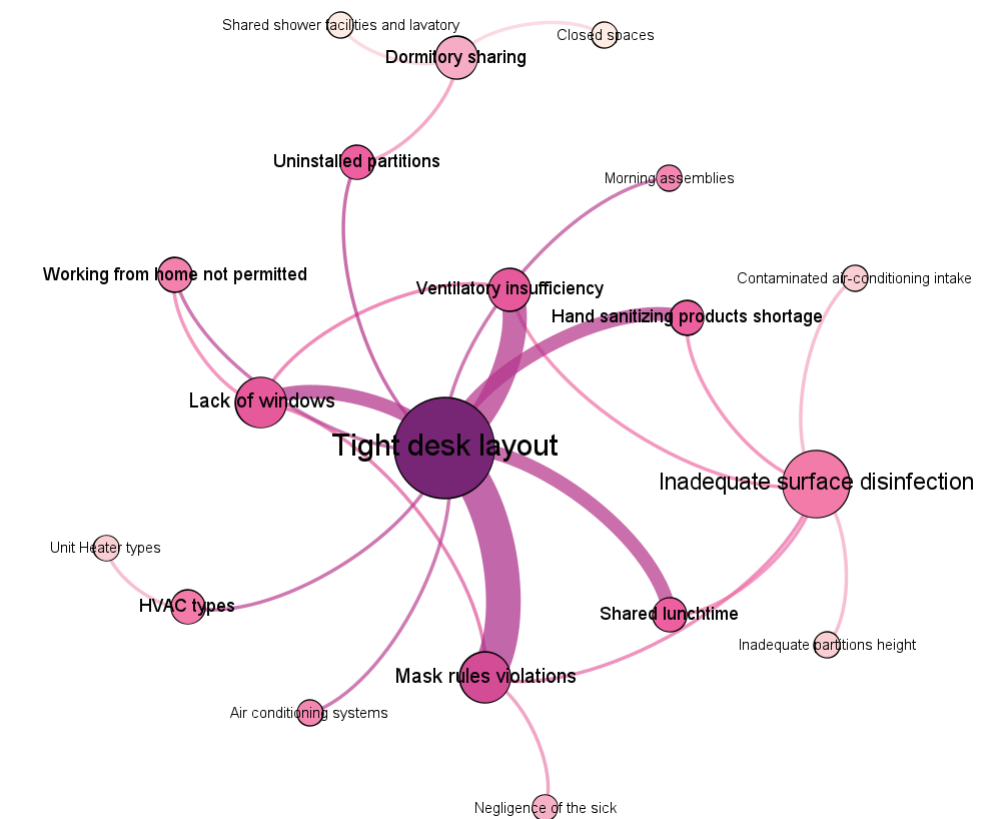
Figure 1 depicts a brief non-directional relationship between each keyword. The bigger the circular node, the greater the frequency of its appearance. Thicker lines represent stronger relationships. The strongest relationship is between “tight desk layout” and “mask rules violations” with the weight of 4.0, followed by the relationship “ventilatory insufficiency” and “tight desk layout” showing the weight of 3.0. As the keyword “tight desk layout” is largest, it also has relationships with “lack of windows,” “shared lunchtime” and “shortage of hand sanitizing products shortage.” Other elements show minimal relationships with each other. This result strongly supported the importance of better spacing between desks so that there is appropriate social distancing and less density in interior spaces.

4.2 Survey Result

1) General Characteristics of the Respondents

To develop more practical strategies for workplace design and management during the pandemic, the results of content analysis became the foundation for the questionnaire survey. It

FIGURE 1. Result of keyword network analysis.



investigated interior design professionals' opinions of the workplace environment. The 27 participants were sufficient for a parametric statistical analysis. The responses showed significant differences between two groups of design experts, however. The normality test was performed before the two groups were compared. It was valid, so the mean difference test was employed.

The 27 experts consisted of 15 interior design educators or practitioners in the United States and 12 in Korea. Table 5 shows their affiliations, age, gender, and their professional experiences in interior design fields. The experts from the United States consisted of 11 interior design practitioners and four interior design educators. Their affiliations included worldwide design firms such as Gensler and AECOM. Some of the experts have been working in small design offices. The experts from Korea consisted of seven interior design practitioners and five design educators. This study included more interior design practitioners than educators in both groups. Their ages ranged from 30s to 60s. One designer from Korea was in her 60s and all the others were in their 30s, 40s, or 50s. Four were male and 23 were female.

2) Quantitative Analysis: Design Experts' Opinions on Ways to Reduce Virus Transmission in Interior Spaces

a. General Features in Interior Design Experts' Opinions

Table 6 presents interior designers' opinions on ways to prevent the spread of infectious diseases in workplace. Six strategies were proposed, based on the review of literature and content analysis: "adding partitions or screen to interior spaces," "separating private from public spaces,"

TABLE 5. Expert survey participants' general information Unit: frequency (%)

Category	Subcategory	US	Korea	Total
Affiliation/Occupation	Interior design practitioner	11 (73.3)	7 (58.3)	18 (66.7)
	Interior design educators	4 (26.7)	5 (41.7)	9 (33.3)
	Total	15 (100.0)	12 (100.0)	27 (100.0)
Age	30s	8 (53.3)	0 (0.0)	8 (29.6)
	40s	1 (6.7)	4 (33.3)	5 (18.5)
	50s	6 (40.0)	8 (66.7)	14 (51.9)
	Total	15 (100.0)	12 (100.0)	27 (100.0)
Gender	Male	2 (13.3)	2 (16.7)	4 (14.8)
	Female	13 (86.7)	10 (83.3)	23 (85.2)
	Total	15 (100.0)	12 (100.0)	27 (100.0)

“whether or not windows can be opened to allow natural ventilation,” “the presence or absence of technology or tools to measure indoor air quality,” “keeping spaces clean and hygienic,” “maintaining control and prevention of infectious disease before and after work hours,” and “work-from-home policy that allows office workers the choice of work location.”

Interior design experts emphasized the importance of “keeping spaces clean and hygienic,” “prevention and control of contagious disease,” and “work-from-home policy.” Their mean values were 4.63, 4.52, and 4.52 out of 5, respectively. They ranked the importance of “installing screens or partitions” and “the use of technology or tools to measure indoor air quality” comparably lower. Their mean values were 3.74 and 3.74, respectively.

b. Opinion Comparisons between Korean and US Interior Design Experts

The opinions of the Korean and American interior designers were markedly different. Some of their opinions were statistically different according to the F-values from mean difference tests.

The design experts in Korea ranked “natural ventilation” as the most important way (mean = 4.83) to prevent the spread of viruses in the workplace during the pandemic. They ranked “the maintenance of control and prevention of infectious disease” as second (mean = 4.40), and “keeping the spaces clean and hygienic” (mean = 4.33) as third. The work-from-home policy was not mentioned as frequently. They also ranked “adding partitions or screen to interior spaces” or “having common spaces separated from individual work spaces” lower than the other strategies.

The US design experts ranked “keeping the spaces clean and hygienic” (mean = 4.87) as the most important element to prevent the spread of a virus. Notably, their opinions on “the work from home policy offered by the company” was highly emphasized (mean = 4.80). The third most important strategy was to keep “control and prevention of infectious disease” (mean = 4.60). US experts ranked “natural ventilation” comparably lower. The mean value for this item was 4.20 among the US experts and 4.83 among the Korean experts. Like their Korean counterparts, US design experts ranked “installing partitions” as less important in preventing the spread of viruses in interior spaces.

TABLE 6. Importance ranking of each tactic to prevent the indoor spread of viruses.

Tactics	Korean design experts	US design experts	Total	F-value
Adding partitions or screen to interior spaces	3.92	3.60	3.74	0.548
Separation between common and individual spaces	4.08	3.93	4.00	0.157
Natural ventilation	4.83	4.20	4.48	4.753*
Measuring indoor air quality and keep the air clean	4.00	3.53	3.74	2.047
Keeping the spaces clean and hygienic	4.33	4.87	4.63	5.644*
Maintenance condition of infectious disease prevention and control	4.40	4.60	4.52	0.552
Work-from-home policy offered by the company	4.17	4.80	4.52	3.700

Scale: 1. Not at all important–5. Very important

** $p < .05$

The different opinions between the two groups were confirmed through mean difference tests as Table 6 showed. The importance of “natural ventilation” was supported differently. Korean experts strongly supported this method but US experts did not. This difference was statistically significant according to the F value at $p < 0.05$. The importance of “keeping the spaces clean and hygienic” was more strongly supported by the US design experts than by the Korean design experts. This difference was statistically significant, which showed $F = 5.64$ at $p < 0.05$.

US interior design experts insisted on the importance of the work-from-home policy (mean = 4.80); Korean interior design experts did not (mean = 4.17). The experts in the US noted that they had been working from home since the pandemic was declared. Their opinion was very strong for this strategy. The mean value of the importance of “working from home” to prevent the spread of disease as 4.80 out of 5.00. However, the experts in Korea did not put the highest mean value to the working from home strategy. The mean value for this element was 4.17, much lower than the mean values for the other elements to prevent the spread of a virus in interior spaces.

This result shows that each interior design expert group prioritized different elements to prevent the indoor spread of viruses. Keeping the space clean and hygienic, and the control and prevention of infectious disease were the most important strategies.

3) Qualitative Analysis—Interior Design Experts’ Opinions on The Effective Interior Design Elements in Workplace During COVID-19

The open-ended questions solicited interior design experts’ opinions on which interior design elements should be considered in workplaces during the COVID-19 pandemic and why those

elements were important. Their opinions were analyzed using content analysis. The keywords from the comments were compiled and three ideas were identified: “separation of individual from common spaces,” “having interior partitions,” and “improving natural ventilation.”

a. Interior Partitions

Design experts were asked about the effectiveness of screens or partitions in interior spaces. Many design experts indicated this strategy as one of the easiest ways of preventing the spread of the infectious disease. This is why many recent policies recommended the installation of partitions.

However, interior design experts did not put this tactic as the first one for preventing the spread of viruses. Several design experts stated that partitions would make people feel relieved but their effectiveness had not been scientifically proven. They suggested having partitions when common and individual spaces could not be divided. Some of them stated, “Based on social distancing, partitions must be used to maintain an appropriate distance within workplace, and private and public spaces must be thoroughly separated.”

b. Separation between Common and Individual Spaces

Interior design experts who participated in this study strongly agreed with the effectiveness of separating individual from shared spaces. Many of them stated that separation of private space should be a minimum measure. They also suggested closing common spaces when unoccupied. The common spaces should also be cleaned after people have used them.

When space planning cannot accomplish separation, adding partitions to the space could be the second option. In the words of one designer, “If we can divide spaces with walls, that would be the perfect plan, but some of the spaces cannot be separated from the space planning phase. In that case, placing partitions would be the best option to prevent the spreading of infectious disease.”

c. Natural Ventilation for Improving Indoor Air Flow

Both design expert groups also emphasized “natural ventilation” which will improve the natural air flow. It would not be desirable if the air is circulated within a closed space, however. Several severe confirmed cases in Korea were associated with closed spaces with high density (Park, 2020). Interior spaces should have natural air flows or “natural ventilation.” The windows should open to improve air flow and prevent the spread of viruses.

4) Interior Design Experts’ Additional Opinions on Effective Interior Elements

The two groups suggested different ways to provide interior elements that were effective in reducing the spread of viruses. The Korean designers placed more emphasis on interior partitions, space separation considering social distance, and natural ventilation. Interior design experts in the United States proposed more designer-driven solutions, such as “controlling the circulation and making wider hallways,” “providing a variety of seating areas and options to encourage social distancing,” and “providing interior corners for hygiene products.”

a. Controlled Circulation and Wide Hallways in Interior Spaces

Design experts in this study suggested controlling the traffic in interior spaces to keep people from gathering in or passing through the same spots simultaneously. They were especially concerned about crowding during lunch hours and the arrival or departure time of the day.

Having wider hallways to keep the social distance was suggested for new buildings. For existing spaces with narrow hallways, design experts suggested one-way traffic to prevent

face-to-face contact with people with viruses. They suggested, “Designing the layout, floor patterns, and signage to promote a one-way flow when entering and exiting the office.”

b. Other Interior Design Elements to be Considered

Several interior design experts suggested providing a variety of small group seating areas and places for employees to take breaks and eat lunch. This is another way to maintain social distance in workplaces. Other experts mentioned “reducing density planning.” Adding small desks or stations for hand sanitizers was also suggested. The spots for hand wipes or hand sanitizers should be in plain view and easy to access.

5) Non-Design Strategies Suggested by Design Experts

The US designers in this study offered several non-design strategies. They indicated the need for “no touch technologies” in the workplace. Touching door handles or water taps could be another source of infection. They also emphasized an automatic sanitizing system and an automatic ventilation system. Touchless technologies and the systems would be activated by sensors or motion detectors. Many designers addressed in their survey that it is important to develop various no-touch technologies for interior items. To implement the ideas from interior designers, technology experts and design experts need to collaborate more closely.

a. No-Touch Technology

To prevent the spread of viruses in interior spaces, many design experts urged the adoption of “no-touch technologies.” Having sensors would be a reasonable option. Several designers suggested touchless technologies for doors and windows, electronic appliances, water taps, or lighting. According to one expert, “reduce the contact in office space, add touch-free access and self-sanitizing materials,” “add touchless access (e.g. lighting, doors, faucets).”

b. Automatic Systems in Interior Spaces

A system that can automatically turn natural ventilation off and on or that can open and close windows would be useful. This suggestion is related to touchless technology. For instance, indoor air quality measurement seems to be necessary in offices where workers spend most of the day. A system that can measure air quality, thermal comfort, lighting and give an alarm will be useful. Due to the cost of all three systems, linking them should be considered.

c. Additional Considerations

Both interior design expert groups emphasized “strict sanitation procedures,” “organizing lunch time to avoid eating in a big group,” “installing hand sanitizer stations in communal areas, especially the kitchen.” They also highlighted “work from home” with virtual connections for working collaboratively. An element of remote work was thus emphasized.

5. DISCUSSION

This study applied two research methods. One was a content analysis of interior features in confirmed COVID-19 cases through a review of newspaper articles. The other was the administration of an expert survey.

The result from the content analysis of newspaper articles regarding confirmed COVID-19 cases presented important features in interior spaces to reduce the chances of virus transmission. A high room density, not wearing masks, lack of windows, and lack of opportunities to

work from home, were selected. These items were applied in constructing the survey questions for design experts.

The survey participants were divided between design experts in Korea and in the United States. Their responses to the importance of elements to prevent the spread of viruses were different. The Korean design experts emphasized “natural ventilation” and “maintenance condition of infectious disease prevention and control.” United States design experts prioritized “keeping spaces clean and hygienic” and “work from home policy” for office users. The two groups did not give a high rank to “adding partitions in interior spaces” to prevent the spread of viruses. Their opinions on “separating individuals from common spaces” were more positive than adding partitions to prevent virus transmission. Installing partitions was not strongly supported. They saw this strategy to be efficient when room separation was not possible.

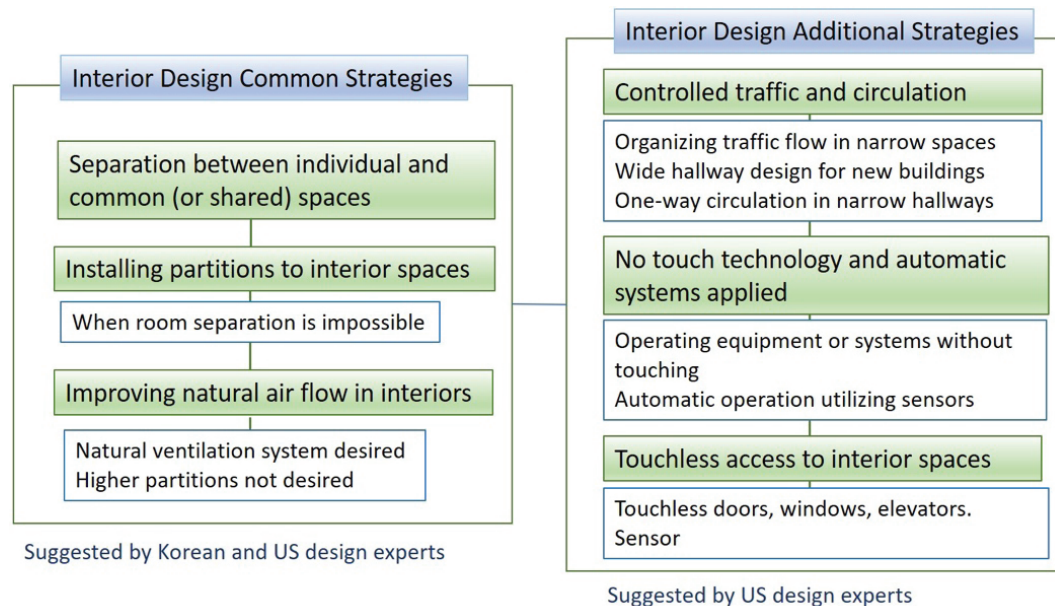
The designers were asked about other strategies to prevent the spread of infection and keep interior spaces clean and sanitary. The experts from the US and Korea proposed the three strategies presented in Figure 2. The most effective strategy was separation of individuals from common spaces. Adding partitions was suggested if separation was impossible. They also suggested natural ventilation.

They suggested automatic systems in interior spaces, having touchless technologies such as buttonless heating, cooling, lighting control, and no touch access to spaces. Examples of no touch access to spaces would be automatic doors with sensors. A hybrid or work-from-home policy was also recommended.

6. CONCLUSION AND SUGGESTIONS

This study was a response to the need to modify interior spaces during the pandemic. The first goal of this study was to identify common interior space features and behaviors in the places in Korea where confirmed cases were found. The second goal was to examine design experts’

FIGURE 2. Interior design strategies for preventing the spread of viruses.



recommendations for workplace planning and management to provide practical guidelines for protecting office users' health and safety during the pandemic.

To accomplish these two research goals, the researchers relied on both qualitative and quantitative methods. A content analysis was based on newspaper articles and a standardized survey questionnaire was administered to professionals in interior design. Because the COVID-19 pandemic was a global issue, interior design professionals in Korea and the United States were recruited.

The findings answered the three research questions. In response to the first research question, the study found a lack of policies and regulations in managing social distance, personal mask wearing, and hand washing and cleaning. Most confirmed cases were found in the interior spaces with high density, no partitions, no windows, or windows that could not be opened. Several cluster infections happened in call centers where many people shared a large basement office with no windows and no partitions. These spaces were crowded and poorly ventilated.

For the second research question, the study found that many people did not wear masks while they were sharing interior spaces. They also ate lunch together. In the boarding schools, students shared bedrooms and bathrooms.

After analyzing the issues from these confirmed cases, the Korean government established policies and regulations to slow the spread of the virus through social distancing, masking and the management of interior spaces.

To answer the third research question, a survey questionnaire was administered to Korean and American experts in interior design. Their opinions on interior design considerations for preventing virus transmission during the pandemic were compiled and analyzed. The main suggestions were the separation of individuals from shared or common spaces, the installation of partitions, and using natural ventilation to improve air flow. In addition, they suggested controlling interior traffic and circulation, widening the hallways in new buildings, enforcing one-way circulation for narrow hallways in existing buildings, and staggering lunch or meeting hours to avoid crowding. They also suggested touchless technologies for equipment and systems and access to interior spaces. Touchless heating cooling, lighting, and ventilation systems are examples, as well as automatic doors, windows, and touchless water taps in bathrooms. These ideas require collaboration between system engineers and interior designers.

In addition, it is important for space users to comply with rules and regulations despite the discomfort and inconvenience. They should wear masks, keep social distances, and pay attention to policies about cleanliness. Without users' cooperation, interior spaces cannot be safe and sanitary. By following regulations and policies, their workplace would be safer and healthier. Lastly, the designers recommended encouraging employees to work from home to limit the density of offices. Employers should offer this flexibility for office users.

In addition to the policies and regulations for preventing transmission of COVID-19 (e.g. focusing on social distancing, wearing masks, or adding partitions), this study suggested additional strategies to improve interior workplace safety during the pandemic. The design experts participating in this study made several useful suggestions. Just adding partitions to existing office spaces was not strongly supported. Interior designers supported more holistic approaches for improving indoor air circulation, maintenance of clean office spaces, avoiding high density in office spaces, and reducing traffic flow in hallways and workplaces. They also suggested more integrated approaches that utilize touchless technologies. Despite the end of the pandemic, their concerns about future infectious diseases strongly suggests a new perspective for designing and

managing workplace environments. Designing a workplace with “less crowded space planning and touchless or no-touch technologies” is an important strategy to pursue. These suggestions need to be considered and implemented in the future interior design for office spaces, which would reduce infections and space users’ exposure to respiratory infections.

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