A Study on the Influencing Factors of Office Environment Design in China

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Abstract
The purpose of the present study was to examine the factors influencing office environment design (OED) in China. A literature review, interview survey, and questionnaire survey were adopted as the research approaches. Satisfaction toward and perceived importance on 21 OED factors were obtained from 489 Chinese office workers (OW). The collected data were then statistically analyzed to highlight the factors with the lowest satisfaction and highest perceived importance. These factors were then presented to 2 interior designers in an expert interview to collect their OED opinions. The findings of the present study can serve as a reference for the future OE planning in China.

Keywords：Office Environment, Office Design, Satisfaction, Importance

1. Introduction

Offices are a second home to office workers (OW). They are environments in which workers make professional contributions and fulfill self-worth. Office-related industries have flourished apace with the advent of globalization and the rapid development of the economy, information technology, and the Internet of Things. This development has led to the emergence of new work patterns that drastically alter office environments (OE).

The authors of the present study have served in the Taiwanese and Chinese office furniture industries for roughly 30 years. They have invested long-term efforts into observing the development of OEs and office furniture and how OWs use them. In addition, the authors have acquired extensive professional knowledge and interpersonal resources in office-related industries over the decades. The authors aspire to utilize their resources to contribute to the future development of OEs in China and provide comfortable, productive, and work-friendly OEs to OWs.

China exhibited little economic development after the founding of the People's Republicin 1949. This stagnation persisted until the Chinese Economic Reform in the 1980s. The development of the Chinese economy gradually accelerated after the mid-1990s, peaking following 2000. In roughly a decade, China escalated to becoming the second largest economy in the world. Amidst China's development, the physical commerce and e-commerce industries have attained extreme success, with companies such as Baidu, Tencent, Alibaba, and Huawei becoming globally famed. The office furniture industry has also exhibited rapid growth following the prosperous economic development and people have placed increasing attention to OEs.

OWs are expressing increased concern over OE issues as economic conditions improve. Thus, investigating the various factors of office environment design (OED) is crucial. Problems, such as OWs' satisfaction toward the functionalization of OEs and their opinions on various OED factors, have not been sufficiently discussed in China. The OED in China is currently in transition. The findings of the present study can serve as a reference for the future planning and designing of OEs in China, thereby providing OWs with comfortable, healthy, safe, efficient, and worker-friendly OEs.

2. Literature Review

According to a complete office design theory proposed by Duffy (1997), previous OE plans can be categorized into four types, specifically, den, hive, cell, and club. Duffy and Willis (1998) later cross-examined work patterns, spaces, and environment systems, classifying work patterns into individual process work, group process, concentrated study, and transactional knowledge work. The Kokuyo Institute of Office Systems published a study in 2000 on office behavior and classified office behaviors into sitter, walker, runner, and traveler, which encompassed all duties and positions of office workers. Hascher, Jeska, and Klauck (2002) classified office work patterns into tasks, logistics and information, projects, and meetings. Steelcase Inc. (2012) examined organization and office behaviors and proposed a space planning theoretical framework based on the office behaviors of I, we, shared, and owned. The researchers of the study combined the four office behaviors to create reasonable office layouts that are adaptable to the increasing demand for digital and multi-functional OEs.

The Buffalo Organization for Social and Technological Innovation (BOSTI) conducted a 7-year survey of 5000 employees from 70 offices and found that the appropriate re-planning of office spaces improved productivity equivalent to 5% to 15% of employees' annual salaries. Brill (1986), who was the CEO of BOSTI at the time, indicated that the four primary OED factors influencing work efficiency were space planning, environment conditions (room temperature, air conditioning, lighting, and noise), human factors (privacy, communication, openness, and personalized space), and furniture design and management. Steelcase (1989) surveyed various OEs and verified that its OE indicator could factually reflect the changing OE demands and preferences of enterprises and white-collar workers. Redman, the project manager of Steelcase Workspace Future Team at the time, published the "China Post 80" survey report in 2010. The report examined the differences in the cultural background and attitudes of the Y Generation in China (known locally as the Post-80 Generation), elucidated how these differences shaped their work behaviors and expectations, and evaluated the types and scope of changes in office spaces.

According to a report published by Japan's Ministry of Economy, Trade, and Industry (METI) in 1986, the

workers' top five OE dissatisfactions were insufficient recreational space, narrow space, poor file management, poor layout, and poor air conditioning. Kudo (1990) indicated that ideal office plans should take into account employee psychology, nature of work, procedure, and communication methods. These factors must be satisfied to create a suitable workplace for employees, thereby enhancing office efficiency and productivity and creating mutually beneficial situations. Kudo (1990) proposed numerous factors and trends for space planning, categorizing them into layout method, space ecology, equipment, recreational space, color scheme, furniture selection, office automation (OA) strategy, office culture, and file management. Fawcett (1992) indicated that the OWs' office satisfaction factors include desk space, desk by window, reception, greenery/journey to work, satisfying job, and building fits in. The researcher also mentioned that the factors pending improvement include personal storage, controllable heating, somewhere to relax, easy parking, good pay, and company image.

3. Method

A questionnaire survey was conducted to elucidate OWs' satisfaction and perceived importance concerning various OED factors. The key factors obtained from the survey were then presented to two interior design specialist in an expert interview to collect their suggestions on OE planning. First, factors that influenced OED were collected from a literature review, OW interviews, and the authors' personal opinions. Twenty-one design factors were identified and categorized into four dimensions of space planning, equipment, psychological perception, and work behavior, as tabulated in Table 1. These factors were then used to formulate a questionnaire, which was administered to a group of OW respondents to collect data for a statistical analysis. The questionnaire was a structured, score-based questionnaire. A Liker-type scale was adopted as the scoring system. Although the Likert scale is an ordinal scale, it is often used as an interval scale in data analysis to quantify statistical data. The questionnaire was administered to a group of respondents, who scored the 21 design factors based on their perceived importance and OE satisfaction. Using the analysis results, the OED factors were ordered from lowest to highest satisfaction and again from lowest to highest importance. These findings obtained in the present study can service as a reference for designers.

Table 1.Office environment design factors

Dimension	factor	Definition
Space planning	Space planning	Layout, function, and flow
	Leisure space	Pantry, coffee station, gym
	Conference space	Meeting and discussion spaces
	Personal space	Size of individual work space
	Public space	Corridors and open spaces, reading area
	Reception	Reception counter and visitor area
Equipment	Illumination	Source, color temperature, illumination
	Air condition	Environment ventilation and temperature
	Office furniture	Work table, partition, chair, cabinet
	Office equipment	Computer, Internet, telephone, business machines
	cable management	Storage and concealment of equipment cables

Psychological perception	Decoration	Art and decorations
	Color	Space, building material, furniture color schemes
	Aesthetic	Space design, aesthetics, ambiance
	Natural light	Natural lighting, windows
	Green landscaping	Plants, greenery
	Noise	Volume and frequency
	Safety	Data and personal safety
Work behavior	filing management	Filing method, tools, and effectiveness
	privacy	Private spaces
	Communication	OE communication difficulty

3.1Questionnaire design

The questionnaire comprises three parts.

(1) Respondent demographics questionnaire:

This part comprised gender (male/female), job position (supervisor/general staff), age (20-30/31-40/41 and over), industry (manufacturing/service/design/government/school), and number of employees in the company (100 or less/101 or more).

(2) OE factor satisfaction survey:

This part listed 21 OED factors. Respondents were instructed to score each factor using a five-point scoring system based on their satisfaction. For example, Lighting: □ *Unsatisfactory*, □ *Slightly unsatisfactory*, □ *No comment*, □ *Slightly satisfactory*, and □ *Satisfactory*, which was awarded a score of 1, 2, 3, 4, and 5, respectively.

(3) OE factor perceived importance survey:

This part listed 21 OED factors. Respondents were instructed to score each factor using a five-point scoring system based on their perceived importance (unimportant, slightly unimportant, no comment, slightly important, and important).

Pretest questionnaires were administered to 10 additional respondents to revise any ambiguous semantics or descriptions.

3.2 Respondents

Five hundred OWs were recruited to participate in the present study. The questionnaire was administered physically, via mail, and over the Internet. To achieve homogenized samples, 10-15 businesses were from the each of the four industries, namely, the manufacturing industry, service industry, design industry, and government sector/schools, for the questionnaire survey.

3.3 Questionnaire survey

The survey period was one month between 15 March 2016 and 15 April 2016. One hundred and ninety-eight written questionnaires were retrieved. Among which, 13 incomplete questionnaires were discarded. Thus, 185 valid written questionnaires and 304 valid online questionnaires were retrieved, for a combined total of 489 valid questionnaires. The demographics of the respondents are tabulated in Table 2.

3.4 Expert interviews

Two experts were invited to review the OE improvement items highlighted in the analysis results and to discuss their opinions on the improvement of OED. The experts were two design directors serving in interior design companies. They had 23 and 25 years of experience in the field of design and both of them were experienced in OED. During the interviews, the experts were asked to provide their opinions and suggestions concerning the factors that required urgent improvement.

Table 2. Respondents' demographics N=489

Respondent Variables		No. of Samples	Percentage
Gender	Male	274	56%
	Female	215	44%
Position	Supervisor	289	59%
	General Staff	200	41%
Age	20-30	111	23%
	31-40	200	41%
	41 and over	178	36%
Industry	Manufacturing	134	27%
	Service	159	33%
	Design	85	17%
	Government/School	111	23%
Number of Employees in the Company	100 or less	202	41%
	101 or more	287	59%

4. Result and Discussion

4.1Respondents' overall office environment satisfaction

The satisfaction questionnaires were analyzed using a one-sample t-test approach, where the test value= 3 and the confidence interval = 95%. The factors were ordered based on the size of their negative t-values and non-significance values ($p>0.05$). A negative t-value denotes that respondents' satisfaction for the particular factor is less than 3. The analysis results are tabulated in Table 3. The unsatisfactory OE factors included "leisure space," "privacy, aesthetic," "cable management," "filing management," "green landscaping," "decoration," "public space," and "color." The nine unsatisfactory items reflected the respondents' psychological perceptions toward OE and their expectations for soft spaces. Therefore, these factors can be prioritized in OE optimization plans.

Table 3. The office environmentfactors in an ascending order of satisfactionN=489

Factor	Test value= 3					
	t-value	Degreeof freedom	Significance (twin-tailed)	Average difference	95% Confidence interval for variances	
					Lower limit	Upper limit
Leisure space	-7.269	488	.000	-.35787	-.4546	-.2611
privacy	-1.200	488	.231	-.05930	-.1564	.0378
Aesthetic	-1.193	488	.234	-.05521	-.1462	.0358
cable management	-1.183	488	.237	-.05521	-.1469	.0365
filing management	.183	488	.855	.00818	-.0798	.0961
Green landscaping	.288	488	.773	.01431	-.0833	.1119
Decoration	.779	488	.437	.03681	-.0561	.1297
Public space	.845	488	.398	.03885	-.0515	.1292
Color	1.615	488	.107	.07157	-.0155	.1586
Air condition	2.077	488	.038	.10429	.0056	.2030
Reception	2.172	488	.030	.10020	.0095	.1909
Noise	2.313	488	.021	.11043	.0166	.2042
Office equipment	3.238	488	.001	.15337	.0603	.2465
Office furniture	3.748	488	.000	.17996	.0856	.2743
Space planning	3.968	488	.000	.16769	.0846	.2507
Personal space	4.115	488	.000	.18609	.0972	.2750
Conference space	4.132	488	.000	.18609	.0976	.2746
Natural light	4.961	488	.000	.24949	.1507	.3483
Communication	7.756	488	.000	.32924	.2458	.4126
Illumination	10.375	488	.000	.46217	.3746	.5497
Safety	11.967	488	.000	.52761	.4410	.6142

An independent-samples t-test and an analysis of variance (ANOVA) were conducted to examine the differences in respondents' demographics and satisfaction. Results indicated that among the 21 factors, the "gender" demographic achieved significant differences with "space planning" (p=0.007), "office equipment" (p=0.027), and "privacy" (p=0.044), where the satisfaction of female respondents was generally lower than that of male respondents. The "position" demographic achieved significant difference with "reception" (p=0.031) and "green landscaping" (p=0.022), where the satisfaction of the supervisors was generally lower and higher for "reception" and "green landscaping" than that of general staff, respectively. The "age" demographic only achieved significant differences with "air condition" (p=0.001), where the satisfaction of respondents 30 years or younger was lower than that of respondents 31 years or older. The "industry" demographic achieve significant difference with "space planning" (p=0.021), "personal space" (p=0.018), "public space" (=0.034), "office furniture" (p=0.022), "decoration" (p=0.046), and "safety" (p=0.011), where the descending order of satisfaction for the first five factors was service>manufacturing>design>government/school and the descending order of satisfaction for "safety" was government/school>service>design>manufacturing. The "number of employees in the company" demographic achieved significant differences with "leisure space" (p=0.010), "air condition" (p=0.002),

"cable management" (p=0.003), "filing management" (p=0.021), and "privacy" (p=0.023), where the satisfaction of the respondent in large companies was generally higher than that of the respondents in small companies.

4.2 Respondents' overall perceived importance concerning the office environment design factors

The perceived importance questionnaires were analyzed using a one-sample t-test approach, where the test value = 4 and the confidence interval = 95%. The factors were ordered based on the size of their t-values and significance values ($p<0.05$). The analysis results are tabulated in Table 4. OE factors with a perceived importance higher than Test value= 4 included safety, noise, natural light, communication, office equipment, filing management, privacy, personal space, air condition, illumination, conference space, and green landscaping. The twelve factors reflected the respondents' psychological perceptions toward OE and their expectations for equipment and personal space. Therefore, these factors can be prioritized in OE optimization plans. Analysis results also highlight the increased value OWs attach to mental and physical safety, comfort, efficiency, operating modes, and personal space.

Table 4. The office environmentfactors in a descendingorder of importance N=489

Factor	Test value= 4					
	t-value	Degreeof freedom	Significance (twin-tail)	Average difference	95% Confidence interval for variances	
					Lower limit	Upper limit
Safety	14.738	488	.000	.55215	.4904	.6139
Noise	12.183	488	.000	.45808	.3961	.5200
Natural light	7.876	488	.000	.32106	.2539	.3882
Communication	7.609	488	.000	.26994	.2115	.3284
Office equipment	7.471	488	.000	.28425	.2215	.3470
filing management	5.638	488	.000	.22086	.1563	.2854
privacy	5.209	488	.000	.20859	.1426	.2746
Personal space	3.788	488	.000	.15133	.0855	.2172
Air condition	3.739	488	.000	.16360	.0915	.2357
Illumination	2.941	488	.003	.13701	.0602	.2138
Conference space	2.487	488	.013	.09611	.0324	.1598
Green landscaping	2.470	488	.014	.10225	.0340	.1705
cable management	1.611	488	.108	.06748	-.0016	.1365
Reception	1.269	488	.205	.04908	-.0146	.1128
Office furniture	-.746	488	.456	-.02863	-.0919	.0346
Space planning	-.994	488	.320	-.03885	-.1032	.0255
Aesthetic	-1.770	488	.077	-.07566	-.1461	-.0052
Leisure space	-2.867	488	.004	-.11656	-.1836	-.0496
Public space	-3.616	488	.000	-.14519	-.2114	-.0790
Color	-4.567	488	.000	-.20245	-.2755	-.1294
Decoration	-5.127	488	.000	-.22699	-.3000	-.1540

An independent-sample t-test and an ANOVA were conducted to examine the differences in respondents' demographics and perceived importance. Results indicated that the "gender" and "age" demographic failed to achieve significant differences with the 21 factors in terms of perceived importance. The "position" demographic achieved significant differences with "space planning" (p=0.001), "leisure space" (p=0.029), "personal space" (p=0.007), "public space" (p=0.023), "reception" (p=0.038), "office furniture" (p=0.031), "decoration" (p-0.026), "color" (p=0.005), and "aesthetic" (p=0.012), where the perceived importance of supervisors was generally higher than that of general staff. The "industry" demographic achieved significant differences with "decoration" (p=0.015), "color" (p=0.004), "aesthetic" (p=0.002), "cable management" (p=0.023), and "privacy" (p=0.004), where the perceived importance of the respondents in the service industry was generally higher than that of respondents in the design industry, manufacturing industry, government sector, and schools. The "number of employees in the company" demographic only achieved significant differences with "air condition" (p=0.010), where the perceived importance of respondents in large companies was generally higher than that of respondents in small companies.

4.3 Cross-analysis between respondents' unsatisfaction and perceived importance

An analysis of means (ANOM) was performed to analyze questionnaires. The unsatisfaction scores (6-x, x=satisfaction scores) were multiplied by the perceived importance scores to obtain the score weight of each OED factor. The score weights were then ordered in a descending order, as tabulated in Table 5. An important level of 4 and a unsatisfaction level of 3 was adopted as the reference points. The urgency of improvement increases concurrently with the weight score.

Table 5. Overall score weight order of the office environment

designfactors N=489

Factor	Perceived importance score score	Unsatisfaction score	Score weight
Leisure space	3.88	3.36	13.04
Noise	4.46	2.89	12.89
privacy	4.21	3.06	12.88
filing management	4.22	2.99	12.62
cable management	4.07	3.06	12.45
Green landscaping	4.11	2.99	12.29
Office equipment	4.28	2.85	12.20
Air condition	4.16	2.9	12.06
Aesthetic	3.92	3.06	12.00
Natural light	4.32	2.75	11.88
Reception	4.05	2.9	11.75
Personal space	4.15	2.81	11.66
Conference space	4.1	2.81	11.52
Communication	4.27	2.67	11.40
Public space	3.85	2.96	11.40
Safety	4.55	2.47	11.24
Space planning	3.96	2.83	11.21
Office furniture	3.97	2.82	11.20
Decoration	3.77	2.96	11.16
Color	3.8	2.93	11.13
Illumination	4.14	2.54	10.52

4.4 Design suggestions based on the key office environment factors

Based on the 9 OED factors highlighted by the respondents and results of the expert interviews, the following design suggestions were proposed:

(1) Leisure space: In response to the increased demand for communication, office rest areas can be expanded into office communal areas that provide comfortable chairs and tables, a coffee bar, or a fitness zone for staff members to interact and socialize.

(2) Noise: The primary sources of noise in an office originate from communication, machinery, air conditioners, telephones, and outside noise. Sound-absorbing building materials and soundproof screens/elevated partitions can be used to reduce noise. In addition, office machines can be placed in a centralized location and office windows can be fitted with airtight windows.

(3) Privacy: Based on different operating characteristics, OWs may require space to engage in independent thinking. Office spaces can be partitioned to create several independent and isolated space, which OWs can use to engage in creative thinking undisturbed.

(4) Filing management: File management can be categorized into physical and digital file management. The top priorities for file management are security and maintenance. Thus, filing procedures and filing tools should be standardized. Effectively file categorization sand labeling reduces query times and improves efficiency. In addition, designers should also take into account the security management and digital password protection of filing cabinets, digital backups, and cloud storage.

(5) Cable management: Offices contain various equipment and interconnecting cables. Ceilings, walls, and raised floors can be utilized to resolve cable exposure problems. Office furniture with cable concealment functionality can also be used to conceal surrounding cables, thereby creating a tidy OE.

(6) Green landscaping: One of the major expectations of OWs is good visibility and natural lighting. Visually pleasing areas of the office should be assigned to OWs that stay in the office for extended periods of time. Designs should control the layout of the office space to maximize the natural light entering the office. Partitions and screens should not obstruct the direction of light.

(7) Office equipment: Office equipment relates to work efficiency, convenience, and management. In addition to computer equipment, server room design should also consider concealment, fire prevention, temperature control, security, sound insulation, prevention of static electricity, and cable management.

(8) Air condition: OWs have different air conditioning requirements, and current air conditioning systems have yet to perfect uniform coverage. Therefore, designers should endeavor to enhance the natural convection in the OE. CO_2 detectors can also be installed and plants can be placed in the OE to regulate indoor CO_2 concentrations. In future, the development of smart air conditioning systems and the popularization of green buildings may improve current air conditioning problems.

(9) Aesthetic: OE can be designed based on the style of the business, combining spatial functionality, aesthetics, building material and furniture selection, color schemes, and decoration and layout to create a spacious and comfortable OE.

5. Conclusion

OWs' OE satisfaction affects their physiological and psychological health and work performance. In the present study, Chinese OWs were surveyed to elucidate their satisfaction and perceived importance toward

various OE factors. The survey results were then collated to determine key OED trends. The findings of the present study can serve as a reference for business owners, workers, office furniture vendors, and interior designers engaging in OED.

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