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# Influence of Office Building Design on Occupant Satisfaction

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**Abstract.** The objective of this study is to examine the influence of building design on office occupants by analysing empirical data on their satisfaction levels and prevalent complaints. A methodology involving literature review, expert interviews, and a field survey with 308 office employees was adopted to acquire the empirical data. The findings reveal that office occupants think Amount of Space as the most important parameter, followed by Layout, and Furniture. On the other hand, occupants are least satisfied by Amount of Space, followed by Interior Design and Layout. Insufficient social areas, insufficient work space, and layout of the work environment, distraction caused by human circulation due to office layout, and ergonomics of the furniture are the most common complaints. The results show that average importance level in each building design parameter is higher than or equal to the average satisfaction level. The largest gap between the perceived importance and satisfaction appears in Amount of Space and Layout. The results are expected to provide insight to designers, facility managers, and renovators of office buildings on how office occupants perceive office building design and frequent complaints encountered in the offices.

## 1. Introduction

The aim of office design is to optimize employee satisfaction with a physical environment that facilitates the organization's workflow as much as possible [1, 2]. The difference between work areas that support or do not support the workflow is to what extent employees can direct their attention and energy to work instead of coping with environmental factors [2, 3]. Since office design determines the layout [4], interaction between employees [5, 6], visual and auditory privacy [7, 8], and distracting factors [9], it is an important indicator of both job performance and employee health and satisfaction [1, 10]. However, empirical studies on the influence of office building design on occupant satisfaction are quite rare [11].

The objective of this study is to examine the influence of building design on office occupants by analysing empirical data on their satisfaction levels and prevalent complaints regarding diverse building design components. For this, a methodology involving literature review, expert interviews and a field survey with office building occupants was adopted in order to acquire the empirical data. The results are expected to provide insight to designers, facility managers and renovators of office buildings on how office occupants perceive office building design and frequent complaints encountered in the offices.

## 2. Methodology

A comprehensive review of the literature and analysis of building performance evaluation systems as well as post-occupancy evaluation (POE) surveys used in the industry were performed in the first step in order to determine the main parameters that can be used to measure building design satisfaction in



office buildings. Frequency analysis and normative refinement techniques were used to analyse and organize the parameters acquired. In the second step, semi-structured interviews were performed with 12 facility managers to verify the parameters needed to measure the influence of building design on the office occupants' satisfaction. Building design related work orders that were created by the facility management team in the facility management and computerized maintenance management software systems were examined to develop a list of occupant complaint types related to the office building design. As a result, a hierarchical structure of the building design parameters and complaint types was established by integrating the literature review and interviews results. In the last step, a survey was undertaken with 308 office occupants to measure their satisfaction levels regarding building design parameters. The offices selected for the study were diverse in terms of the office design (i.e., cellular versus open-plan), purpose of use, facade and floor coverings. All offices had operable windows and automation systems for HVAC control. The level of importance of the building design parameters were also determined using a Five-point Likert Scale and the occupants' complaints related to these parameters were examined. Cronbach's alpha coefficient was used to check the internal consistency to verify the reliability of the survey and Anderson-Darling test was used to check the normality distribution of the data.

### 3. Office Building Design Parameters

Designing alignment between people and the office environment has been the focus of many researchers over the years [12]. Frontczak et al. [13] performed a study by using the Center for the Built Environment (CBE) database and figured out that the most important factor affecting holistic user satisfaction is Amount of space. Since the area per person is calculated as the ratio of the net area of the building or office to the total number of people, users may complain about the lack of space even if the area per person is high. Brennan et al. [4] reported that the satisfaction levels of users who moved from private offices to open offices decreased for all environmental parameters, their stress levels increased and their job performance decreased. In another study, in which 689 users from 11 different companies participated, 20% of users in private offices expressed dissatisfaction with acoustic comfort, while this rate increased to 50% in open offices [14]. Moreover, it was stated that users in open offices complained more about concentration difficulties, stress, and fatigue. In this context, layout and interior design gain great importance.

The comfort, ergonomics, customizability and modularity, color and texture of office furniture are among the factors that affect the holistic satisfaction of the users in their offices. [13, 15]. Office layout and furnishings not only affect individual work performance, but also affect the efficiency of teamwork [16]. In a study conducted by Miles [17], in an office where the existing furniture was replaced with ergonomic tables and chairs and ergonomics training was given to the users; the investment made had a payback period of five months due to the increased employee productivity. Wilson [18] stated that the instinctive bond between humans and nature should also be provided in the working environment. People are happier and feel better when they have access to the outside environment and nature. At the same time, bringing natural elements into offices has a positive effect on user satisfaction and helps reduce stress [19, 20, 21].

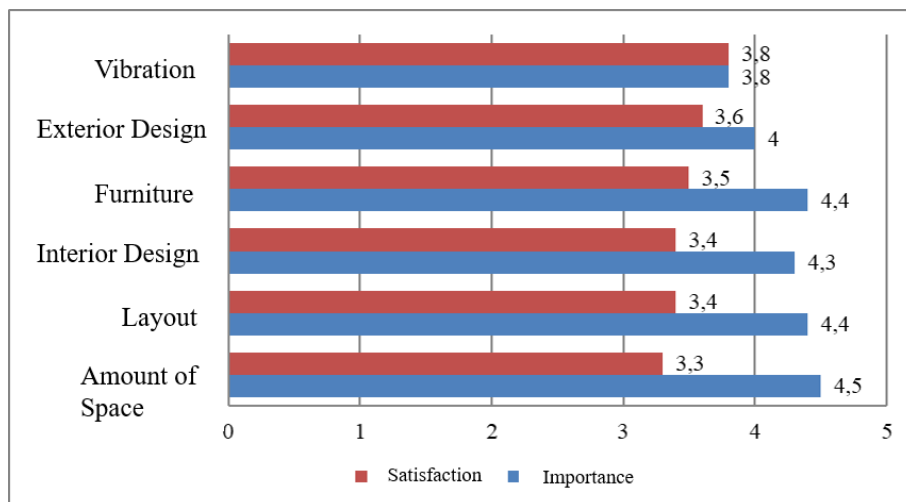
Structural vibrations felt by users can negatively affect the comfort or quality of life of users. While some users indicate discomfort or displeasure, it may cause adverse health effects on others [22]. In addition to the physical discomfort of the vibration to the users; in cases where it is more than the limits determined by the standards, it can cause the particles on the surfaces to move into the air. As such, user health may also be adversely affected due to the increase in particle density in indoor air [23]. As a result of the literature review, frequency analysis and normative refinement processes, office building design parameters that influence occupant comfort and satisfaction are revealed as follows: Amount of space, Layout, Interior Design, Furniture, Exterior Design and Vibration (Table 1):

**Table 1.** Office building design parameters and references.

Office Building Design	Amount of space	(Azar and Menassa [24]; Brown and Gorgolewski [25]; Chen and Ahn [27]; Kato et al. [28]; Langston et al. [29]; Meir et al. [30]; Newsham et al. [31]; Parkin et al. [32]; Paul and Taylor [33]; Preiser and Vischer [34]; Rashid et al. [35]; Schwede et al. [36]; Seshadhri and Topkar [37]; Turpin-Brooks and Viccars [38]; Wilkinson et al. [39])
	Layout	(Ackerly and Brager [40]; Ahn and Pearce [41]; Brown and Gorgolewski [25]; Goins and Moezzi [42]; Healey and Webster-Mannison [43]; Heerwagen and Zagreus [44]; Jailani et al. [45]; Jazizadeh et al. [46]; Kato et al. [28]; Kim and de Dear [5]; Langston et al. [29]; Meir et al. [30]; Driza and Park, [47]; Newsham et al. [31]; Parkin et al. [32]; Paul and Taylor [33]; Preiser and Vischer [34]; Rashid et al. [35]; Riley et al. [48]; Schwede et al. [36]; Turpin-Brooks and Viccars [38]; Voelker et al. [49]; Wang et al. [50])
	Interior Design	(Atkins and Emmanuel [51]; Au-Yong et al. [52]; Azar and Menassa, [24]; Brown and Gorgolewski [25]; Cao et al. [53]; Gultekin et al. [54]; Hauge et al. [55]; Healey and Webster-Mannison [43]; Heerwagen et al. [56]; Jailani et al. [45]; Kato et al. [28]; Laquatra et al. [57]; Leaman and Bordass [58]; Leder et al. [59]; Meir et al. [30]; Menadue et al. [60]; Newsham et al. [31]; Paul and Taylor [33]; Preiser and Vischer [34]; Rashid et al. [35]; Riley et al. [48]; Seshadhri and Topkar [37]; Vos and van der Voordt [61]; Wilkinson et al. [39])
	Furniture	(Ackerly and Brager [40]; Ahn and Pearce [41]; Au-Yong et al. [52]; Brager and Baker [62]; Brown and Gorgolewski, [25]; Brown and Cole, [26]; Goins and Moezzi [42]; Gou et al. [63]; Heerwagen and Zagreus [44]; Kato et al. [28]; Kim and de Dear [5]; Langston et al. [29]; Meir et al. [30]; Driza and Park [47]; Preiser and Vischer [34]; Rashid et al. [35]; Schwede et al. [36]; Singh et al. [64]; Turpin-Brooks and Viccars [38])
	Exterior Design	(Gultekin et al. [54]; Hauge et al. [55]; Heerwagen and Zagreus [44]; Lai [65]; Meir et al. [30]; Menadue et al. [60]; Preiser and Vischer [34]; Seshadhri and Topkar [37]; Stevens [66]; Vos and van der Voordt [61]; Wang et al. [50]; Zagreus et al. [67])
	Vibration	(ISO Standard- 2631-2 [22]; Voelker et al. [49])

#### 4. Empirical Results

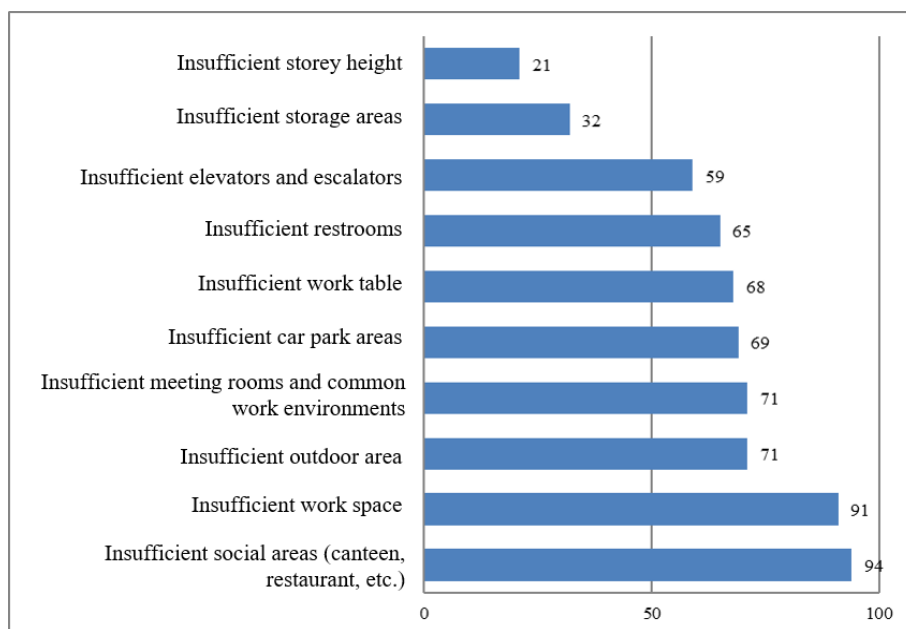
The survey undertaken with 308 office employees reveals the levels of importance and satisfaction in office building design parameters as shown in Figure 1. Office occupants find Amount of Space most important (4.5) followed by Layout (4.4), Furniture (4.4), Interior Design (4.3), Exterior Design (4.0) and Vibration (3.8). Average importance level in all parameters is 4.23. On the other hand, occupants are most satisfied with Vibration (3.8) followed by Exterior Design (3.6), Furniture (3.5), Interior Design (3.4), Layout (3.4) and Amount of Space (3.3). The mean value of the satisfaction levels related to the indicator variables representing the building design, namely, 'space adequacy', 'layout', 'interior design', 'furniture', 'outdoor design' and 'vibration', is 3.5 and the standard deviation value is 0.18. Findings show that average importance level in each building design parameter is higher than or equal to the average satisfaction level.



**Figure 1.** Importance and satisfaction levels in office building design.

#### 4.1. Amount of Space

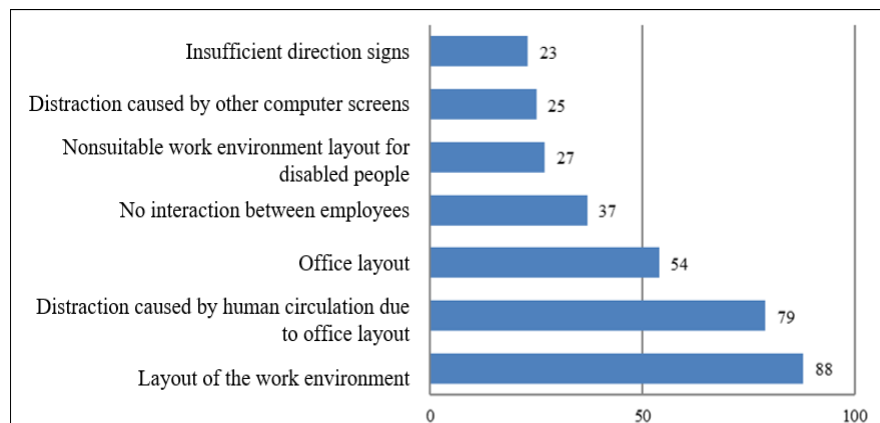
Complaints about Amount of Space category is presented in Figure 2. Most frequent complaint about Amount of Space is ‘Insufficient social areas (canteen, restaurant, etc.)’ (reported by 94 employees who have the said complaint in their current office), followed by ‘Insufficient work space’ (reported by 91 employees), ‘Insufficient outdoor area’ and ‘Insufficient meeting rooms and common work environments’ (reported by 71 employees each).



**Figure 2.** Complaints about amount of space.

#### 4.2. Layout

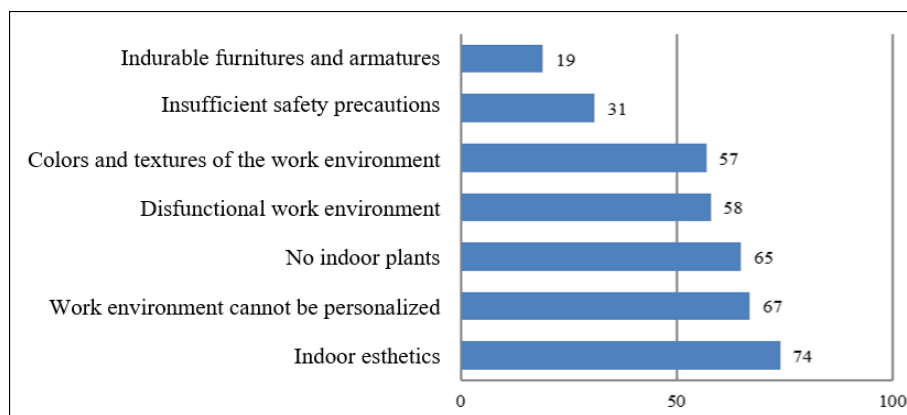
Complaints about Layout category is presented in Figure 3. Most frequent complaint about Layout is ‘Layout of the work environment’ (reported by 88 employees), followed by ‘Distraction caused by human circulation due to office layout’ (reported by 79 employees), and ‘Office layout’ (reported by 54 employees).



**Figure 3.** Complaints about layout.

#### 4.3. Interior Design

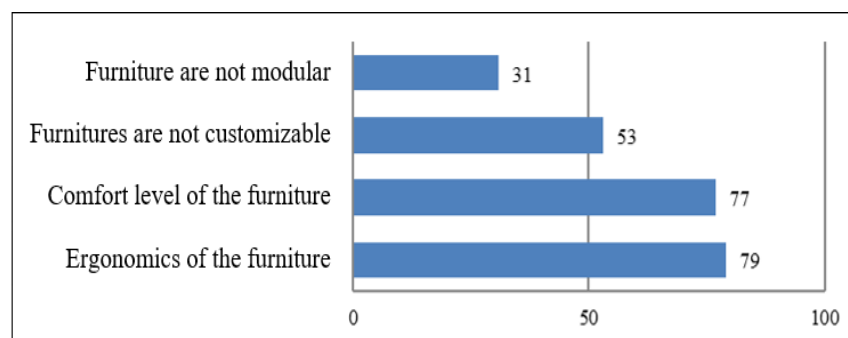
Complaints about Interior Design category is presented in Figure 4. Most frequent complaint about Interior Design is ‘Indoor aesthetics’ (reported by 74 employees), followed by ‘Work environment cannot be personalized’ (reported by 67 employees), and ‘No indoor plants’ (reported by 65 employees).



**Figure 4.** Complaints about interior design.

#### 4.4. Furniture

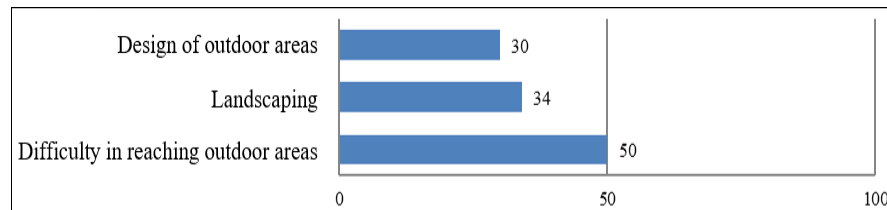
Complaints about Furniture category is presented in Figure 5. Most frequent complaint about Furniture is ‘Ergonomics of the furniture’ (reported by 79 employees), followed by ‘Comfort level of the furniture’ (reported by 77 employees), and ‘Furniture are not customizable’ (reported by 53 employees).



**Figure 5.** Complaints about furniture.

#### 4.5. Exterior Design

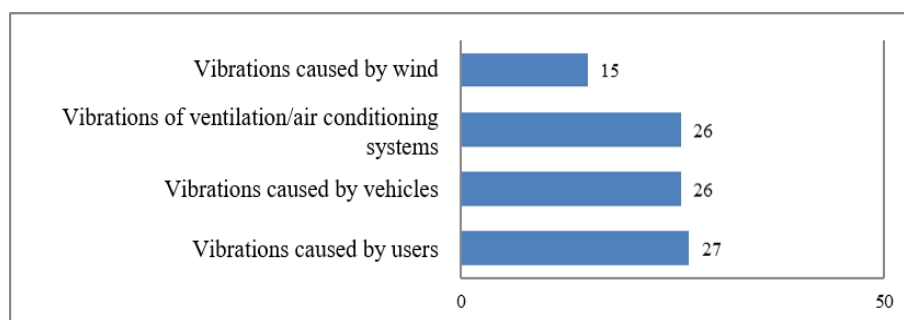
Complaints about Exterior Design category is presented in Figure 6. Most frequent complaint about Exterior Design is ‘Difficulty in reaching outdoor areas’ (reported by 50 employees), followed by ‘Landscaping’ (reported by 34 employees), and ‘Design of outdoor areas’ (reported by 30 employees).



**Figure 6.** Complaints about exterior design.

#### 4.6. Vibration

Complaints about Vibration category is presented in Figure 7. Most frequent complaint about Vibration is ‘Vibrations caused by users’ (reported by 27 employees), followed by ‘Vibrations caused by vehicles’ (reported by 26 employees), and ‘Vibrations of ventilation/air conditioning systems’ (reported by 26 employees).



**Figure 7.** Complaints about vibration.

### 5. Conclusions and Further Research

The survey undertaken with 308 office employees reveals the levels of importance and satisfaction in office building design parameters. Office occupants find Amount of Space most important (4.5) followed by Layout (4.4), Furniture (4.4), Interior Design (4.3), Exterior Design (4.0) and Vibration (3.8). On the other hand, occupants are most satisfied with Vibration (3.8) followed by Exterior Design (3.6), and Furniture (3.5). Occupants are least satisfied by Amount of Space (3.3), followed by Interior Design (3.4) and Layout (3.4). Findings show that average importance level in each building design parameter is higher than or equal to the average satisfaction level. The largest gap between the perceived importance and satisfaction appears in Amount of Space and Layout.

In this study, unlike the surveys commonly used in the industry, the complaints of the users about the design of office buildings were questioned besides the questions of measuring the level of user satisfaction. In the field study conducted with 308 office users, the most commonly referred complaints among 34 complaints were ‘Insufficient social areas (canteen, restaurant, etc.)’ (94 people), ‘Insufficient work space’ (91 people), ‘Layout of the work environment’ (88 people), ‘Distraction caused by human circulation due to office layout’ (79 employees), and ‘Ergonomics of the furniture’ (79 employees). In addition to presenting the level of satisfaction, presenting the reasons for the complaint to the decision makers will reduce the time required to identify the problems and enable development of effective solutions.

The standards define and mandate the necessary parameters to maximize the health and satisfaction of users. However, it is seen that only complying with the standards at the project stage is not sufficient

on its own to ensure user satisfaction. For example, the results of this study show that, although the indicator values for the area needed per person in a building are clearly defined in the standards, the indicator variables have relatively low level of satisfaction. Similar results were also acquired for visual comfort parameters in Tekce et al. [68] and acoustical comfort parameters in Artan et al. [69]. In this context, using occupant feedback in the design phase is of great importance both in the design of new buildings and in renovation works.

Office building design parameters revealed in this study were integrated in a structural equation model of occupant satisfaction for evaluating the performance of office buildings in Tekce et al. [70]. On the other hand, the frequent complaints regarding building design, that were explored empirically in this study, were used in the development of a semantic data model that formalizes occupant feedback information [71]. The proposed semantic data model was later implemented in the Industry Foundation Classes (IFC) schema for the integration of occupant feedback with the Building Information Modeling (BIM). Researchers are currently working on a study that includes the use of artificial intelligence (AI) to analyse the data collected via the occupant satisfaction model developed.

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