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Assessing employee satisfaction with indoor environmental quality (IEQ) in office spaces using post-occupancy evaluation (POE): A case study of administrative offices in Bandar Abbas

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Abstract

Post-occupancy evaluation is a method for assessing building performance and human needs in line with predetermined design objectives. Enhancing indoor environmental quality is one of the primary focuses of this method. This study investigates the satisfaction levels of employees in Bandar Abbas's offices with the IEQ of their workspaces using POE. It is located in the south of Iran. Thus, this study is the first to use POE to assess IEQ in administrative buildings in Iran. This city is The factors evaluated to determine IEQ include lighting, noise, temperature, and ventilation. The research questions addressed are: What is employee satisfaction with the IEQ in the administrative offices of Bandar Abbas? What are the reasons for employee dissatisfaction with the IEQ in these offices? This applied research utilizes a mixed-method approach comprising two stages: quantitative data collection and qualitative data collection. In the quantitative phase, data were collected using standardized Likert-scale questionnaires. Subsequently, semi-structured interviews were conducted to uncover the reasons behind the results obtained from the quantitative data. The results indicate that the highest satisfaction level is associated with the lighting factor, followed by temperature and ventilation, while the lowest pertains to the noise factor. Overall, dissatisfaction with the lighting factor includes the lack of windows, poor maintenance, improper building orientation, excessive room depth, small windows, and inadequate calculation of artificial lighting needs. The reasons for dissatisfaction with the noise factor include disturbing noise from others' conversations, partitioned spaces allowing noise to flow, echoing noise in the lobby, and lack of noise control. Regarding the temperature and ventilation factor, dissatisfaction includes the inability to open windows, unpleasant odors due to proximity to restrooms, lack of openings, and obstructed airflow from air conditioners due to tall partitions, poor maintenance, and inadequate window insulation.

Keywords: Post-Occupancy Evaluation (POE); Indoor Environmental Quality (IEQ); Office, Bandar Abbas; lighting, Noise; Temperature; Ventilation

1. Introduction

Throughout history, one's profession has significantly provided meaning and direction in individuals' lives. On average, people spend one-third of their day and half their waking hours engaged in professional activities. Each profession is conducted within a specific environment that supports the respective activities. Employees operate within buildings assigned to them and are influenced by the architectural environment, highlighting the critical importance of spatial design. Despite the long-standing administrative tradition in Iran, there needs to be more focus on improving these spaces to enhance employee efficiency, satisfaction, and performance. This research seeks to address two key questions: What is the level of satisfaction among employees in Bandar Abbas's administrative offices regarding the quality of the indoor environment? What causes employees' dissatisfaction with the quality of the indoor environment in these offices? These questions form the foundation of this study.

1.1 Post occupancy evaluation

Additionally, thorough evaluations in Iran's post-occupancy evaluation (POE) field suggest that academics should focus more on the administrative sector. Thus, this study is the first to use POE to assess the quality of the interior environment in administrative buildings in Iran. POE focuses on enhancing indoor environmental quality by analyzing human demands and building performance in relation to predefined design goals. These assessments quantify design results, help designers comprehend how spaces affect users, and offer building performance statistics to guide design choices for the next projects (Preiser, 2011). Table 1 lists several definitions of POE as provided by experts in the area. Based on the synthesis of definitions by experts in the field, the Post-Occupation Evaluation (POE) in this study is defined as a systematic process focused on user needs. It involves collecting, analyzing, and comparing current and optimal conditions to assess user satisfaction and contentment after building occupancy.

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The outcomes of this process empower designers, owners, and users throughout the entire building lifecycle.

Table 1
Definitions of Post-Occupancy Evaluation (POE) by Researchers

Year	Definition of Post-Occupancy Evaluation (POE)	Researcher(s)
1978	Classified evaluation focused on user satisfaction and contentment in designed environments, supporting the needs and values for which the environment was designed.	Friedman et al.
1980	An assessment of the effectiveness and satisfaction of users in occupied designed environments.	Zimring, Reizenstein
1988	A systematic process of gathering, analyzing, and comparing existing conditions with optimal conditions and relevant criteria in built environments.	Preiser
1991	A structured study of buildings in use aimed at empowering architects by providing a roadmap based on information from owners, users, and the performance of their designs to achieve better outcomes..	RIBA Institute
1995	POE as a diagnostic tool for buildings post-acquisition and use, offering a new perspective on facility management.	Preiser
2000	POE is an assessment process applicable to any environment or facility of any size.	Sanoff
2001	Focused on the needs of building users from safety, security, usability, psychological, and aesthetic perspectives, as well as physiological comfort.	Preiser
2001	A systematic process evaluates buildings after being used for a time.	U.S. Federal Facilities Council
2001	POE typically focuses on evaluating customer satisfaction and the functional "fit" of a space.	Zimmerman & Martin
2005	Introduced the "Building Performance Evaluation" concept, extending user-centered evaluations to all stakeholders and phases of building use.	Preiser & Schramm
2006	A process measuring the efficiency, performance, and expectations of a building based on users' preferences, experiences, and expectations, including employees, customers, professionals, and supervisors.	Barlex

2. Research Background

Globally, there is an increasing demand for improving indoor environmental quality (IEQ), including thermal, lighting, and acoustic conditions, which can positively influence occupants' health, well-being, satisfaction, and work performance. The technical components of POE address critical survival-related issues such as fire safety, structural integrity, and other durability factors, including noise, ventilation, temperature, lighting, hygiene, and environmental sustainability.This research focuses on IEQ factors such as lighting, ventilation, temperature, and acoustics. Figure.1

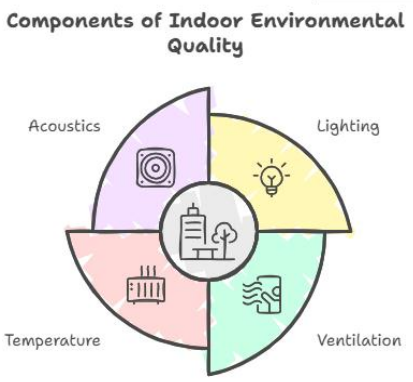

Fig. 1.Component of indoor environmental quality

Studies on POE in Iran have shown that lighting is the most frequently evaluated factor, followed by ventilation, temperature, and noise (Farah et al., 2024). Also, the survey of women's and men's satisfaction with technical factors showed no significant difference based on gender (Farah et al., 2024). Research indicates that building occupants, particularly in work environments, are influenced by building-related factors (Albuainain et al., 2021). Studies on the impact of IEQ suggest that internal factors such as thermal, visual, and acoustic conditions can significantly affect the well-being and satisfaction of occupants (Bourikas, 2021 & Arif, 2016).

According to research done in the United Kingdom, bad office design costs British firms roughly £135 billion each year. According to the survey, around 79% of participants feel that the indoor atmosphere influences their job happiness and productivity (Wheeler & Almeida, 2005). Furthermore, Arif et al. (2016) discovered that occupant comfort and productivity are impacted by eight IEQ factors: office layout, thermal comfort, indoor air quality, noise, acoustics, lighting, location and amenities, biophilia, and vistas.

Government employees are vital as the bridge between the government and the public. Many authors and researchers have identified significant differences in job satisfaction, productivity, performance, behavior, motivation, and commitment between employees in government offices and private offices (Baarspul, 2011 & Do Monte, 2017). Some authors have highlighted

distinct features of government and private office buildings. For instance, Steel and Warner (2018) argued that poor workplace organization in government offices contributes to employee dissatisfaction. However, researchers are still determining whether studies explicitly assess employee satisfaction with the quality of the indoor environment in government offices. In a study by Li and Barger (2018) on published articles regarding POE in office buildings, it was found that out of 146 projects in 269 articles published between 2010 and 2017, only five projects were related to government buildings. In Iran, a study has yet to be conducted to evaluate the quality of the indoor environment in government offices post-occupancy, making this research the first of its kind. This evaluation focuses on lighting, temperature, ventilation, and noise. Fissore et al. (2023) conducted a comprehensive review on the multidomain effects of IEQ on occupants' overall comfort in office environments. Their study synthesizes findings from various research efforts, highlighting the interconnected nature of IEQ factors and their combined influence on occupant well-being. This review provides a valuable foundation for understanding the importance of a holistic approach to IEQ assessment. Shetaw et al. (2024) performed a bibliometric analysis to evaluate the impact of IEQ on occupant productivity. By examining a vast array of studies published between 2011 and 2023, their research underscores the critical role of IEQ in shaping workplace outcomes. The findings of this analysis emphasize the need for continuous IEQ monitoring and assessment to ensure optimal work environments. The Chartered Institution of Building Services Engineers (CIBSE) released the TM68 Indoor Environmental Quality (2022) technical memorandum, offering practical guidance on monitoring various aspects of IEQ, including thermal comfort, indoor air quality, luminous quality, and acoustic quality. This document serves as a crucial resource for professionals seeking to implement effective IEQ management practices in building design and operation. Taheri (2024) explored a standardized and customizable data-driven process for Post-Occupancy Evaluation (POE), aimed at enhancing design quality by aligning design intent with occupant experience. The research highlights the potential of data-driven approaches to POE in identifying and addressing discrepancies between anticipated and actual building performance, ultimately improving occupant satisfaction. Ege et al. (2024) introduced an innovative approach to POE using ultra-wideband (UWB) technology to gather data on the interactions between people, spaces, and objects in new architectural spaces. Their study demonstrates the effectiveness of UWB technology in capturing detailed information on space utilization and occupant behavior, offering new insights into the post-occupancy performance of buildings. Figure.2

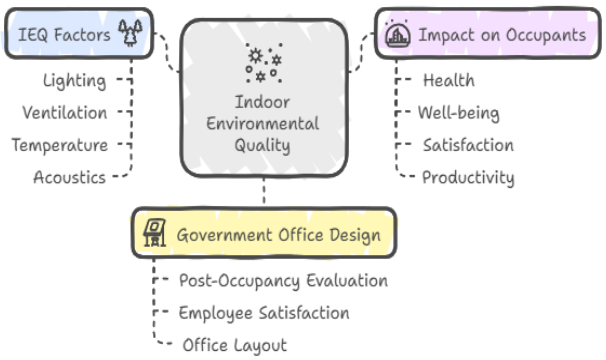

Fig. 2. Conceptual Framework of IEQ Factors and Their Impact on Occupants and Office Design

3. Research Methodology

This study employs an applied research approach, utilizing a mixed-method strategy in a case study to comprehensively understand the satisfaction levels among employees in Bandar Abbas City's administrative offices regarding their office buildings. The study integrates both quantitative and qualitative research methods.

Data were collected using questionnaires in the quantitative phase, while semistructured interviews were employed in the qualitative phase. The statistical population consists of employees from government offices in Bandar Abbas city. Initial inquiries at the Hormozgan governor's office identified 150 agencies as members of the provincial administrative council. Following a review and screening, 50 offices were deemed suitable for evaluation, comprising the statistical population for this study.

With 4,000 employees in these offices, the Morgan table was used to determine a sample size of 351 individuals. Systematic random sampling was employed for data collection. Based on library studies and the obtained evaluation criteria, a closed-ended questionnaire with a six-point Likert scale was prepared and distributed to measure the satisfaction of administrative staff with office buildings. The reason for using a six-point scale was to elicit clear responses from the participants on the subject, avoiding neutral opinions. At this stage, data was collected using standardized international questionnaires that were localized for the context. All mentioned questionnaires were reviewed, and similar and repeated questions in the samples were selected and presented as the questions used in this study. The questionnaires employed include:

- In collaboration with Westminster University, the Post-Occupancy Evaluation Guidebook by the UDE[1] The institute is designed for higher education specialists and staff in the U.K.A

[1]. Association of University Directors of Estates

- Questionnaire under the ASHRAE[2] standard guideline number 2010-55.
- Sample questionnaires provided by the UDE Institute.

Following the collection of surveys, descriptive and inferential statistics were employed to analyze the data. Descriptive statistics were given as charts, frequency distribution tables, and standard deviations. Kolmogorov-Smirnov tests were used to ensure data normality while performing inferential statistics. Once normality was proven, single-sample T-tests were conducted to investigate the influence of physical features on employee satisfaction. Friedman tests were used to prioritize evaluation criteria. Data was analyzed using the statistical program SPSS24. After collecting the questionnaires and conducting statistical analyses on the data, the results that were obtained were examined. A semi-structured interview was conducted to refine further and explore the assessed elements and find reasons for the expressed satisfaction or dissatisfaction with the evaluation criteria. In these interviews, all respondents were asked similar questions but were free to provide their responses in any way they wished. The questions were based on post-occupancy evaluation factors to identify the reasons behind the questionnaire results. At this stage, the snowball sampling method was used, where each person introduced the next interviewee, and the interviews continued until the responses became repetitive and no new information was obtained. The study population was determined to be 4000 individuals, and 351 samples were selected based on the Morgan table. The sample interval was calculated using the snowball sampling formula, dividing the population size by the sample size (Creswell & Creswell, 2017), resulting in a sample interval of 7. This means that for every 7 people on the 4000-person list, one person was interviewed . Figure.3

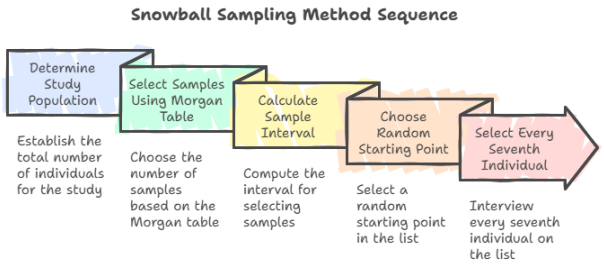

Fig. 3. Method of selecting samples in snowball sampling

A random starting point was chosen, which was the second person on the list. Therefore, with k = 7, the second person surveyed was the 9th person on the list, e.g., 2, 9, 16, 23, and so on.

The interview questions were based on independent variables, which were the post-occupancy evaluation factors and were categorized into 7 titles. Three questions pertained to temperature and ventilation, three questions to light, and one question to sound. After formulating the interview questions based on the research approach and the questionnaire results, interviews were conducted with the study population using snowball sampling until theoretical saturation was reached and no additional data was obtained. Content analysis tools were used for data analysis. Initially, recorded interviews were transcribed. To gain mastery over the subject, the interviews were read multiple times. In the second stage, the unit of analysis was identified. In this approach, specific words, themes, and concepts in the qualitative data were examined. Initially, the unit of analysis and context, which was "word," was identified. Then, it was decided to analyze concepts related to functional elements. In the third stage, it was determined that the presence of a subject was important for analysis. In the next stage, after repeatedly reading the interview texts, coding and categorization were done. Afterward, analysis and inference from the data were performed, and the reports were presented in the form of charts and diagrams, and finally, the results were obtained. In this study, content analysis was used to gain deeper access to the hidden meanings of the interviews and infer and extract meaning from them, focusing on the presence of subjects rather than frequency. Content analysis at this stage was done manually. Figure.4

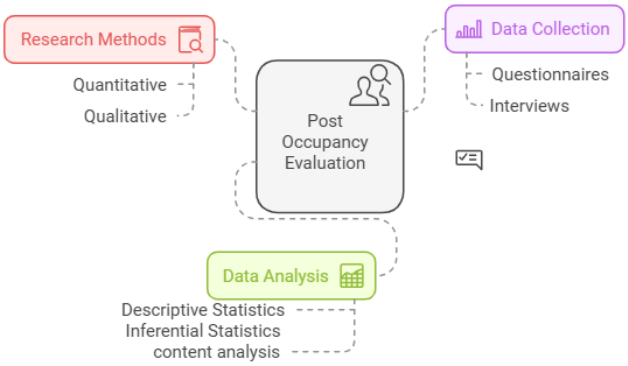

Fig. 4. Research Methods, Data Collection, and Analysis in Post-Occupancy Evaluation

[2]. the American Society of Heating, Refrigerating and Air-Conditioning Engineers

4. Results and Discussion

4.1. Quantitative Results:

The technical elements were assessed using temperature, ventilation, noise, and lighting. Each component is meticulously examined below.

4.1.1.Temperature and Ventilation:

This component was evaluated using seven questions included in the questionnaire. Table 2 provides the frequency distribution of responses to these seven questions.

Table 2
Frequency Distribution/Percentage of Responses to Questions Related to Ventilation and Temperature

Factor	Frequency/ Percentage	Strongly Disagree	Disagree	Somewhat Disagree	Agree	Strongly Agree	Somewhat agree	Mean	Standard Deviation
Suitability of indoor temperature during warm seasons	Frequency	47	45	48	53	75	83	3.89	1.73
	Percentage	13.5	12.78	13.92	15.06	21.31	23.85		
Suitability of indoor temperature during moderate and cold seasons	Frequency	18	29	68	62	85	90	4.24	1.483
	Percentage	5.11	8.24	19.32	17.61	24.15	25.57		
Suitability of indoor air quality	Frequency	46	52	58	65	82	49	3.66	1.616
	Percentage	13.07	14.76	16.48	18.47	23.30	13.92		
Suitability of air circulation in the workplace	Frequency	49	52	91	65	57	38	3.41	1.533
	Percentage	13.92	14.77	25.85	18.47	16.19	10.80		
Comfort level regarding air temperature in the workplace	Frequency	42	39	70	84	64	53	3.70	1.556
	Percentage	11.93	11.08	19.89	23.86	18.18	15.06		
Possibility of manual or mechanical control of heating and cooling	Frequency	26	38	52	49	90	97	4.22	1.600
	Percentage	7.39	10.81	14.77	13.92	25.57	27.56		
Possibility of manual or mechanical control of ventilation	Frequency	84	41	60	44	61	62	3.41	1.822
	Percentage	23.86	11.65	17.05	12.50	17.33	17.61		

Based on the data presented in Table 423 and the column of means, it is evident that among the factors related to the temperature and ventilation component, the highest score was associated with the "adequacy of indoor air temperature in moderate and cold seasons," which had a mean value of 4.24. The factor "possibility of manual or mechanical control of heating and cooling systems" followed closely, with a mean value of 4.22. The "adequacy of indoor air temperature in warm seasons" ranked third, with a mean value of 3.89. The "comfort level in the workplace regarding air temperature" factor was fourth, with a mean value of 3.70. The "adequacy of indoor air quality" ranked fifth, with a mean value of 3.66. The factors "adequacy of air circulation in the workplace" and "possibility of manual or mechanical ventilation control" shared the sixth position, each with a mean value of 3.66.

A one-sample student t-test was employed to evaluate employees' satisfaction with the temperature and ventilation component and its associated factors in Bandar Abbas administrative buildings. The results of this test are detailed in Table 3.

Table 3
Results of One-Sample T student test

Factor	Min	Standard Deviation	t-value	Significance Level	Mean Difference	95% Confidence Interval		Test Result
						Min	max	
Suitability of indoor temperature during warm seasons	**3.89**	**1.73**	**4.213**	**0.001**	**0.389**	**0.207**	**0.571**	**H**
Suitability of indoor temperature during moderate and cold seasons	**4.24**	**1.482**	**9.390**	**0.001**	**0.741**	**0.586**	**0.897**	**H**
Suitability of indoor air quality	**3.66**	**1.616**	**1.847**	**0.066**	**0.159**	**-0.010**	**0.329**	**L**
Suitability of air circulation in the workplace	**3.41**	**1.533**	**-1.147**	**o.525**	**-0.094**	**-0.254**	**0.067**	**L**
Comfort level regarding air temperature in the workplace	**3.70**	**1.556**	**2.467**	**0.014**	**0.205**	**0.041**	**0.368**	**H**
Possibility of manual or mechanical control of heating and cooling	**4.22**	**1.600**	**8.461**	**0.001**	**0.722**	**0.554**	**0.889**	**H**
Possibility of manual or mechanical control of ventilation	**3.41**	**1.822**	**-0.965**	**0.335**	**-0.094**	**-0.285**	**0.097**	**L**
Temperature and ventilation	**4.03**	**1.091**	**4.170**	**0.001**	**0.289**	**0.153**	**0.426**	**H**

According to the data presented in Table 3, the significance level for the factors "adequacy of indoor air temperature in warm seasons," "adequacy of indoor air temperature in moderate and cold seasons," "comfort in

the workplace regarding air temperature," and "possibility of manual or mechanical control of heating and cooling systems" is less than 0.05, with the confidence interval in the positive range. As a result of these elements, employees at Bandar Abbas administrative buildings report high levels of satisfaction. In contrast, the significance threshold for the parameters "adequacy of indoor air quality," "adequacy of air circulation in the workplace," and "possibility of manual or mechanical ventilation control" is more than 0.05, with a confidence interval that spans both negative and positive ranges. Thus, the satisfaction level of employees in Bandar Abbas administrative buildings is low due to these factors.

Furthermore, as indicated in the final row of Table 3, the significance level for the temperature and ventilation component is less than 0.05, with the confidence interval in the positive range. Therefore, the overall satisfaction level of employees in Bandar Abbas administrative buildings with the temperature and ventilation component is high. Figure 5 illustrates the status of factors related to temperature and ventilation.

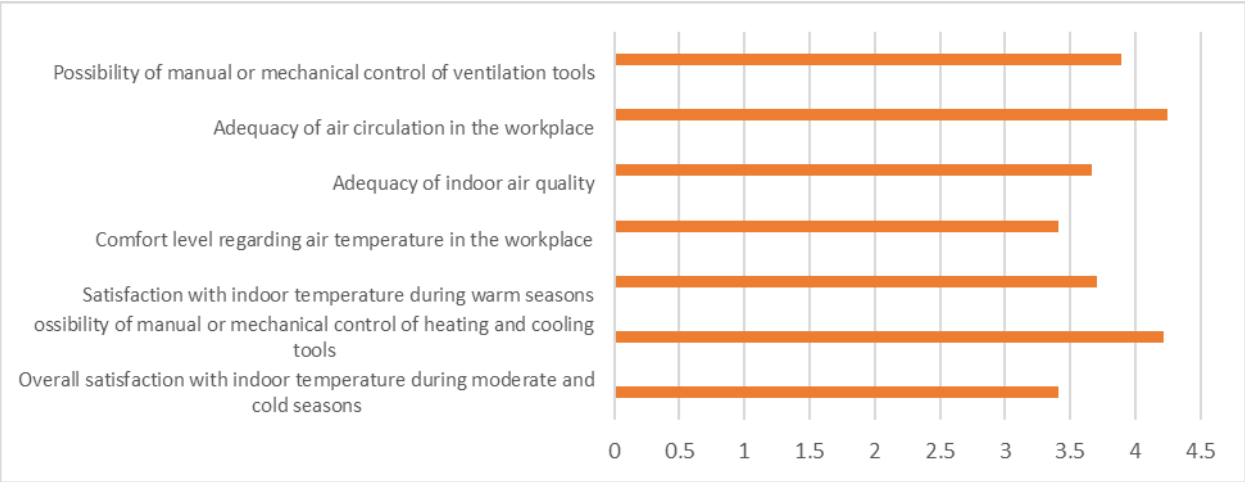

Fig. 5. Status of Factors Related to Temperature and Ventilation Components

4.1.2 Noise

The noise component was evaluated using five questionnaire questions. Table 4 details the frequency distribution of responses to these five questions.

Table 4
Frequency Distribution and Percentage of Responses to Questions Related to Noise

Factor	Frequency/ Percentage	Strongly Disagree	Disagree	Somewhat Disagree	Agree	Strongly Agree	Somewhat agree	Mean	Standard Deviation
The negative impact of others' conversations on concentration	Frequency	**52**	**43**	**67**	**59**	**85**	**46**	**3.63**	**1.625**
	Percentage	**14.77**	**12.22**	**19.03**	**16.76**	**24.15**	**13.07**		
Normalcy of background noise in the workplace	Frequency	**76**	**81**	**82**	**45**	**35**	**33**	**2.95**	**1.571**
	Percentage	**21.59**	**23.01**	**23.30**	**12.78**	**9.94**	**9.38**		
Ability to reduce noise when necessary	Frequency	**45**	**37**	**69**	**67**	**57**	**77**	**3.81**	**1.666**
	Percentage	**12.78**	**10.52**	**19.60**	**19.03**	**16.19**	**21.88**		
Annoyance caused by workplace noise	Frequency	**69**	**61**	**37**	**52**	**70**	**63**	**3.52**	**1.804**
	Percentage	**19.60**	**17.33**	**10.51**	**14.77**	**19.89**	**17.90**		
Possibility of manual or mechanical noise control	Frequency	**112**	**68**	**78**	**43**	**27**	**24**	**2.65**	**1.547**
	Percentage	**31.82**	**19.32**	**22.16**	**12.22**	**7.67**	**6.81**		

Based on the data presented in Table 4 and the mean values, it is evident that among the factors related to the noise component, the highest score is attributed to the factor "the negative impact of others' conversations on concentration," with a mean value of 3.81. The "normalcy of background noise in the workplace" follows with a mean value of 3.63, and the "ability to reduce noise when necessary in the workspace" ranks third with a mean value of 3.52. The factor "annoyance caused by workplace noise" has a mean value of 2.95, placing it fourth, while the factor "possibility of manual or mechanical noise control" ranks fifth with a mean value of 2.65. A one-sample student t-test was employed to evaluate the satisfaction levels of employees in Bandar Abbas administrative buildings regarding the noise component and its factors. The results of this test are presented in Table 5.

Table 5
Results of One-Sample Student's T-test for Evaluating Employee Satisfaction with the Noise Component and its Factors

Factor	Min	Standard Deviation	t-value	Significance Level	Mean Difference	95% Confidence Interval		Test Result
						Min	max	
The negative impact of others' conversations on concentration	**3.63**	**1.625**	**1.443**	**0.150**	**0.125**	**-0.045**	**0.295**	**L**
Normalcy of background noise in the workplace	**2.95**	**1.571**	**-6.617**	**0.001**	**-0.554**	**-0.719**	**-0.389**	**L**
Ability to reduce noise when necessary	**3.81**	**1.666**	**3.478**	**0.001**	**0.310**	**0.135**	**0.484**	**H**
Annoyance caused by workplace noise	**3.52**	**1.804**	**0.177**	**0.859**	**0.017**	**-0.172**	**0.206**	**L**
Possibility of manual or mechanical noise control	**2.65**	**1.547**	**-10.302**	**0.001**	**-0.849**	**-1.012**	**-0.687**	**L**
Noise	**3.30**	**0.840**	**-4.249**	**0.001**	**-0.190**	**-0.278**	**-0.102**	**L**

As indicated by the data in Table 5, the significance level for the factors "annoyance caused by workplace noise," "negative impact of others' conversations on concentration," and "possibility of manual or mechanical noise control" is less than 0.05, with the confidence interval for "negative impact of others' conversations on concentration" lying within the positive range, while the intervals for "annoyance caused by workplace noise" and "possibility of manual or mechanical noise control" lie within the negative range. Consequently, the satisfaction level of employees in Bandar Abbas administrative buildings regarding the "negative impact of others' conversations on concentration" factor is high. In contrast, their satisfaction regarding "annoyance caused by workplace noise" and "possibility of manual or mechanical noise control" is low.

The significance level for "normalcy of background noise in the workplace" and "ability to reduce noise when necessary in the workspace" is more significant than 0.05, with confidence intervals spanning both positive and negative ranges. Therefore, employees' satisfaction with these factors could be higher.

Additionally, as indicated in the final row of Table 5, the significance level for the noise component as a whole is less than 0.05, with the confidence interval falling within the negative range. Thus, the overall satisfaction level of employees in Bandar Abbas administrative buildings with the noise component could be higher. Figure 6 illustrates the status of factors related to noise.

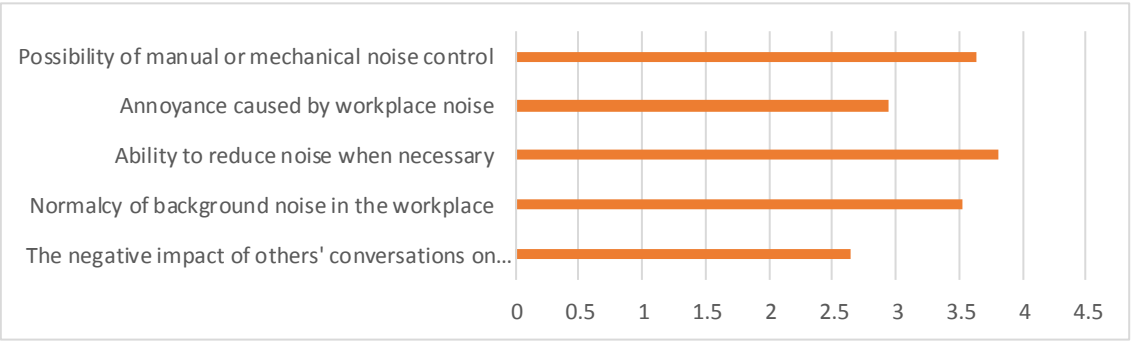

Fig. 6. Status of Factors Related to Noise Components

4.1.3 Lighting

The lighting component was evaluated through eight questions in the questionnaire. Table 6 presents the frequency distribution of responses to these eight questions

Table 6
Frequency Distribution/Percentage of Responses to Questions Related to lighting

factor	Frequency/ Percentage	Strongly Disagree	Disagree	Somewhat Disagree	Agree	Strongly Agree	Somewhat agree	Mean	Standard Deviation
Satisfaction with workplace lighting conditions	Frequency	**25**	**34**	**60**	**80**	**76**	**77**	**4.08**	**1.512**
	Percentage	**7.10**	**9.65**	**17.05**	**22.73**	**21.59**	**21.88**		
Satisfaction with the amount of light and its impact on computer work	Frequency	**31**	**33**	**55**	**75**	**82**	**76**	**4.06**	**1.557**
	Percentage	**8.81**	**9.39**	**15.63**	**21.30**	**23.3**	**21.59**		
Adequacy of light reflection from computer screens	Frequency	**30**	**35**	**53**	**80**	**88**	**66**	**4.02**	**1.524**
	Percentage	**8.52**	**9.94**	**15.06**	**22.73**	**25**	**18.75**		
Adequacy of artificial lighting in the workspace	Frequency	**26**	**30**	**75**	**79**	**78**	**64**	**3.98**	**1.474**
	Percentage	**7.39**	**8.52**	**21.31**	**22.44**	**22.16**	**18.18**		
Adequacy of natural light in the workspace	Frequency	**44**	**32**	**65**	**65**	**74**	**72**	**3.88**	**1.641**
	Percentage	**1.502**	**9.09**	**18.47**	**18.47**	**21.02**	**20.45**		
Overall satisfaction with the quality of workplace lighting	Frequency	**19**	**29**	**52**	**90**	**84**	**78**	**4.21**	**1.432**
	Percentage	**5.40**	**8.24**	**14.77**	**25.57**	**23.84**	**22.16**		
Possibility of manual or mechanical control of daylight	Frequency	**65**	**35**	**66**	**57**	**75**	**63**	**3.71**	**1.694**
	Percentage	**1.915**	**9.94**	**18.75**	**16.19**	**21.31**	**17.90**		
Possibility of manual or mechanical control of artificial light	Frequency	**35**	**36**	**59**	**64**	**85**	**71**	**3.97**	**1.594**
	Percentage	**9.94**	**1.23**	**16.76**	**18.18**	**24.15**	**20.17**		

Based on the data presented in Table 6 and the column of means, it is clear that among the factors related to the lighting component, the highest score was assigned to "overall satisfaction with the quality of workplace lighting," which had a mean value of 4.21. This was followed by "satisfaction with workplace lighting conditions," with a mean value of 4.08, and "satisfaction with the amount of light and its impact on computer work," which held a mean value of 4.06. The "adequacy of light reflection from the computer screen" factor came in fourth, with a mean value of 4.02. The "adequacy of artificial light in the workspace" ranked fifth, with a mean value of 3.98. Sixth was the "possibility of manual or mechanical control of artificial light," with a mean value of 3.97. This was followed by "adequacy of natural light in the workspace," with a mean value of 3.88, and "possibility of manual or mechanical control of daylight," with a mean value of 3.71.

A one-sample Student's t-test was employed to further evaluate the satisfaction levels of employees in Bandar Abbas administrative buildings regarding the lighting component and its factors. The results of this analysis are detailed in Table 7.

Table 7
Results of One-Sample Student's T-test for Evaluating Employee Satisfaction with Lighting and Environmental Factors

Factor	Min	Standard Deviation	t-value	Significance Level	Mean Difference	95% Confidence Interval		Test Result
						Min	max	
Satisfaction with workplace lighting conditions	**4.08**	**1.512**	**7.154**	**0.001**	**0.577**	**0.418**	**0.735**	**H**
Satisfaction with the amount of light and its impact on computer work	۴/۰۶	۱/۵۵۷	۶/۷۱۰	**0.001**	**0.577**	**0.394**	**0.720**	**H**
Adequacy of light reflection from computer screens	۴/۰۲	۱/۵۲۴	۶/۴۰۲	**0.001**	**0.520**	**0.360**	**0.680**	**H**
Adequacy of artificial lighting in the workspace	۳/۹۸	۱/۴۷۴	۶/۱۱۰	**0.001**	**0.480**	**0.326**	**0.635**	**H**
Adequacy of natural light in the workspace	۳/۸۸	۱/۶۴۱	۴/۳۱۹	**0.001**	**0.378**	**0.206**	**0.550**	**H**
Overall satisfaction with the quality of workplace lighting	۴/۲۱	۱/۴۳۲	۹/۲۶۷	**0.001**	**0.707**	**0.557**	**0.858**	**H**
Possibility of manual or mechanical control of daylight	۳/۷۱	۱/۶۹۴	۲/۲۹۷	۰/۰۲۲	**0.207**	**0.030**	**0.385**	**H**
Possibility of manual or mechanical control of artificial light	۳/۹۷	۱/۵۹۴	۵/۵۶۶	**0.001**	**0.474**	**0.307**	**0.642**	**H**
lighting	۳/۵۶	۰/۸۴۶	۷/۳۰۴	**0.001**	**0.487**	**0.356**	**0.618**	**H**

As the data in Table 7 indicates, the significance level for all factors related to the lighting component is less than 0.05, with the confidence interval within the positive range. Consequently, the satisfaction level of employees in Bandar Abbas administrative buildings with all factors related to the lighting component could be higher. Additionally, according to the final row of Table 7, the significance level for the overall lighting component is also less than 0.05, with the confidence interval in the positive range. Therefore, the overall satisfaction level of employees in Bandar Abbas administrative buildings with the lighting component could be higher. Figure 7 illustrates the status of factors related to lighting.

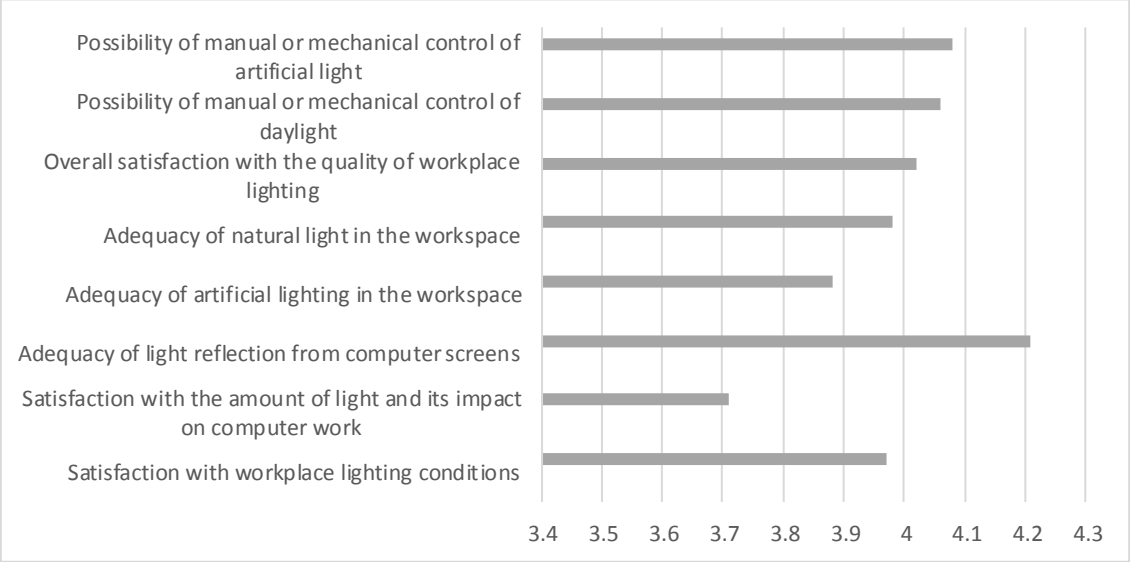

Fig. 7. Status of Factors Related to lighting

4.2 Qualitative Data:

After collecting quantitative data from the questionnaires and completing statistical analyses, a semistructured interview was conducted to identify the underlying reasons for employee dissatisfaction with the environmental quality factors assessed. Table 8 details the interview questions and the responses obtained, categorized by factors related to lighting, temperature and ventilation, and noise.

Table 8
Interview questions and reasons for dissatisfaction with evaluation factors

IEQ	questions	responses
Temperature And Ventilation	What is your opinion on the air quality in your workplace? Please explain.	The windows cannot be opened. The office is located near the restroom, resulting in an unpleasant odor in the workspace. Spaces separated by tall partitions do not have access to windows.
	What is your opinion on the ventilation in your workplace? Please explain.	The height of the partitions prevents cool air from circulating into the rooms. Air conditioners are serviced infrequently.
	What is your opinion on the workplace temperature during the warm and cold seasons? Please explain.	Warm air enters through the windows. Spaces separated by tall partitions do not have access to windows. Everyone relies on the central skylight for lighting, resulting in insufficient light reaching all areas.
Lighting	What is your opinion on the overall lighting in the building? Please explain.	Spaces separated by tall partitions lack access to windows. The reliance on the central skylight results in insufficient light distribution, preventing adequate illumination in all areas. When bulbs burn out, there is a significant delay in their replacement.
	What is your opinion on the natural lighting in the building? Please explain.	The orientation of the windows does not allow sufficient light to enter. The depth of the rooms prevents light from reaching the entire space. Spaces separated by tall partitions lack access to windows. The reliance on the central skylight results in insufficient light distribution, as adequate light does not reach all areas.
	What is your opinion on the artificial lighting in the building? Please explain.	When bulbs burn out, it takes a long time to replace them. Bulbs with sufficient voltage are not installed.
Noise	What is your opinion on the amount of outside noise entering the building and the noise level inside the building? Please explain.	The noise from others' conversations is disturbing. Partitioned spaces cause everyone to hear each other. The noise echoes in the lobby. There is no control over adjusting the noise levels.

In the section on temperature and ventilation, three questions were posed, revealing the following reasons for dissatisfaction:

1- The inability to open windows
2- Office proximity to bathrooms results in unpleasant odors
3- Spaces separated by tall partitions lacking access to windows for ventilation
4- Tall partitions obstructing the flow of cool air
5- Delayed servicing of air conditioning units
6- Warm external air enters, and cool internal air escapes through window gaps.

Three questions related to lighting were asked, and the reasons for dissatisfaction with natural and artificial light were identified as follows:

1- Spaces separated by tall partitions lacking access to windows and natural light.
2- Insufficient light distribution due to reliance on a central skylight
3- Long delays in replacing burnt-out bulbs
4- Inadequate orientation preventing sufficient light entry
5- Insufficient light reaching deep rooms
6- Long delays in replacing burnt-out bulbs
7- Use of bulbs with insufficient voltage

One question regarding acoustic conditions was posed, and the reasons for dissatisfaction were:

1- Disturbing noise from other people's conversations
2- Partitioned spaces cause everyone to hear each other
3- Echoing noise in the lobby
4- Lack of control over noise levels

5. Conclusion:

This study was conducted in the domain of post-occupancy evaluation, addressing the questions, "What is the level of employee satisfaction with the quality of the indoor environment in Bandar Abbas administrative offices?" and "What are the reasons for employee dissatisfaction with the quality of the indoor environment in these offices?" A mixed-method approach was employed to answer these questions. Initially, quantitative data were obtained through a questionnaire and semistructured interviews with employees to identify the causes of the recorded dissatisfaction. The findings are presented below. The one-sample Student's t-test was used to evaluate the satisfaction levels of employees in Bandar Abbas administrative buildings regarding technical elements (lighting, noise, temperature, and ventilation). The test results are presented in Table 9.

Table 9
Results of Student's t-test for Evaluating Employee Satisfaction with Technical Elements

Factor	Min	Standard Deviation	t-value	Significance Level	Mean Difference	95% Confidence Interval		Test Result
						Min	max	
technical elements	**3.69**	**0.940**	**3.901**	**0.001**	**0.195**	**0.097**	**0.294**	**H**

The findings in Table 9 show that the significance level for the technical aspects is less than 0.05, with a confidence interval in the positive range. As a result, staff at Bandar Abbas administrative buildings are quite satisfied with the technological aspects. Subsequently, the Friedman test was used to prioritize employee satisfaction in these buildings in terms of post-occupancy evaluation components. The results of this test are shown in Table 9.

Table 10
Results of the Friedman Test for Prioritizing Employee Satisfaction with Post-Occupancy Evaluation Components

Component	Mean Rank	Test Statistic	Degrees of Freedom	Significance Level	Priority Ranking
Temperature and Ventilation	5.23	0.001	7	412.902	2
Noise	4.19				3
Lighting	5.93				1

As indicated by the data in Table 10, the significance level of the Friedman test is more significant than 0.05. Consequently, the hypothesis of equal satisfaction among employees in Bandar Abbas administrative buildings regarding the post-occupancy evaluation components is rejected. The mean rank column reveals that the "lighting" component occupies the first position, with a mean rank of 5.93. The "temperature and ventilation" component, with a mean rank of 5.23, holds the second position, while the "noise" component, with a mean rank of 4.19, ranks third.

Mixed Analysis:

Regarding the temperature and ventilation factor, employees generally express satisfaction with the temperature and ventilation of their work environment. Dissatisfaction primarily stems from areas needing more windows or having windows that cannot be opened, resulting in lower satisfaction with airflow. This issue is particularly significant when temperature and ventilation rely on openable windows in colder seasons. In environments with tall partitions, air circulation is diminished. Additionally, the proximity of some spaces to restrooms or pantries leads to unpleasant odors. Table 11 presents the results obtained from the questionnaire alongside the reasons identified through the interviews.

Table 11
Integration of Quantitative and Qualitative Data on the Temperature and Ventilation Factor

	Questionnaire		**Interview**
Row	Statements on Temperature and Ventilation	Dominant Satisfaction Level	Interview Results
1	Satisfaction with temperature during warm seasons	Strongly Agree	Due to the absence of windows in some spaces, or the presence of non-operable windows in others, the level of satisfaction with air circulation is low. This issue is particularly pronounced during the colder seasons when temperature and ventilation rely on openable windows. In environments with tall partitions, the ability for air to circulate within the space is reduced. Additionally, the proximity of spaces to restrooms or pantries results in unpleasant odors in the environment.
2	Satisfaction with temperature during cold seasons	Strongly Agree	
3	Satisfaction with air quality	Agree	
4	Satisfaction with air circulation	Somewhat Disagree	
5	Satisfaction with thermal comfort	Somewhat Agree	
6	Satisfaction with temperature control	Strongly Agree	
7	Satisfaction with air control	Strongly Disagree	

(Source: Authors, 2024)

Concerning the noise factor, employees generally express dissatisfaction with the noise levels in their work environment. No sound control exists in areas partitioned by tall partitions, resulting in noise flow between spaces. This lack of noise control has caused dissatisfaction among some employees, as it eliminates the ability to regulate and minimize noise levels. Table 12 presents the results obtained from the questionnaire alongside the reasons identified through the interviews.

Table 12
Integration of Quantitative and Qualitative Data on the noise Factor

	Questionnaire		*Interview*
Row	Statements on Noise	Dominant Satisfaction Level	Interview Results
1	Satisfaction with Background Noise Levels.	Agree	There is no effective sound control in environments with partitioned spaces, allowing noise to propagate freely between areas. This lack of sound control has resulted in dissatisfaction among some individuals. Furthermore, this issue eliminates the possibility of regulating and adjusting the environmental noise levels.
2	Annoyance Caused by Environmental Noise.	Disagree	
3	Satisfaction with Others' Conversations.	Agree	
4	Ability to Reduce Noise.	Strongly Disagree/agree	
5	Satisfaction with Noise Control.	Strongly Disagree	

Regarding the lighting factor, employees generally express satisfaction with the lighting levels in their work environment. Despite many office areas lacking natural light, a degree of satisfaction exists across all lighting-related aspects. This satisfaction is mainly due to sufficient lighting through artificial sources. Table 13 presents the results obtained from the questionnaire alongside the reasons identified through the interviews.

Table 13
Integration of Quantitative and Qualitative Data on the lighting Factor

	Questionnaire		**Interview**
Row	Statements on Lighting	Dominant Satisfaction Level	Interview Results
1	Satisfaction with Workplace Lighting Levels	Somewhat Agree	Despite the lack of natural light in many office spaces, there is a significant level of satisfaction across all lighting-related aspects. This satisfaction is primarily attributed to the provision of adequate artificial lighting.
2	Satisfaction with Light Reflection on Monitors	Agree	
3	Satisfaction with Light Emission from Monitors	Somewhat Agree	
4	Satisfaction with Artificial Lighting	Somewhat Agree	
5	Satisfaction with Natural Lighting	Agree	
6	Satisfaction with Daylight Control	Agree	
7	Satisfaction with Artificial Light Control	Agree	

Overall, dissatisfaction with the lighting factor includes lack of windows, poor maintenance, improper building orientation, excessive room depth, small windows, and inadequate calculation of artificial lighting needs. For the noise factor, the reasons for dissatisfaction include annoying noise from others' conversations, partitioned spaces causing everyone to hear each other, echoing noise in the lobby, and the inability to control noise levels. Regarding the temperature and ventilation factor, the reasons for dissatisfaction include the inability to open windows, unpleasant odors due to proximity to bathrooms, lack of openings, obstructed airflow from air conditioners due to tall partitions, poor maintenance, and inadequate window insulation.

This study outlines a proposed model aimed at enhancing the quality of the indoor environment in office spaces, grounded in the findings from the Post-Occupancy Evaluation (POE) and subsequent analyses. The model focuses on four key factors: lighting, temperature and ventilation, noise, and air quality. Below, each factor is discussed in detail.

1. **Lighting**

Enhancement of Natural Light: Utilize larger windows and open-plan designs to maximize the availability of natural light. This approach not only reduces energy consumption but also positively impacts employee morale and productivity.

Efficient Artificial Lighting: Install automated and adjustable lighting systems to provide adequate illumination in all working conditions. These systems should be designed to meet the diverse needs of employees and various activities, ensuring sufficient and appropriate lighting.

2. **Temperature and Ventilation**

Advanced HVAC Systems: Implement HVAC systems capable of automatic and manual temperature and humidity control. These systems should optimize airflow and temperature to ensure thermal comfort for all employees.

Natural Ventilation: Ensure that windows can be opened and create airflow paths within office spaces to promote natural ventilation and reduce reliance on mechanical systems.

3. **Noise Control**

Acoustic Insulation: Install soundproofing materials and noise reduction systems to prevent sound transmission between different office areas. This measure is particularly important in spaces with high partitions and busy environments.

Quiet Zones: Designate specific areas for quiet work, helping to reduce noise and increase concentration. These zones can include meeting rooms, rest areas, and quiet workspaces.

4. **Air Quality**

Air Purification: Use air filters and purification systems to enhance indoor air quality and reduce environmental pollutants. These systems should be regularly maintained and replaced to ensure their effectiveness.

Odor Control: Create separate spaces for kitchens and restrooms with adequate ventilation to prevent unpleasant odors from spreading in the work environment.

The proposed model emphasizes the importance of addressing these four key factors to improve the environmental quality of office spaces. By understanding the specific reasons for dissatisfaction, targeted improvements can be made to create more comfortable and productive workspaces. This model provides valuable insights for architects, designers, and facility managers aiming to optimize indoor environmental quality in office buildings.

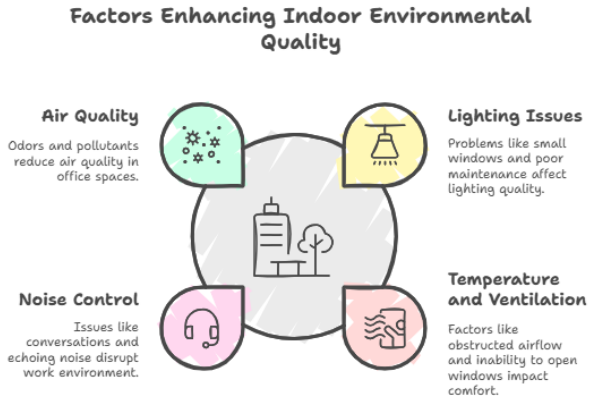

Fig. 8. Factors Enhancing IEQ

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