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Interiorscaping Trends and Indoor Air Quality Assessment in Interiorscaped Buildings

YOGITA*[1] AND KIRAN SINGH[2]
[1]Research Scholar and [2]Professor & Head
Department of Resource Management and Consumer Science, I.C. College of Community Science
C.C.S. Haryana Agricultural University, Hisar (Haryana) India

*Corresponding Author

ABSTRACT

Indoor air quality (IAQ) has emerged as a critical determinant of occupant health, comfort and productivity, particularly in rapidly urbanizing Indian cities where people spend 80–90 % of their time indoors. Interiorscaping, the deliberate integration of live ornamental plants within built environments, is increasingly promoted as a sustainable, biophilic strategy to complement mechanical ventilation. The present investigation was undertaken in twenty residential and twenty commercial buildings selected purposively from two high–AQI regions (Haryana and the National Capital Territory of Delhi). Data on interiorscaping practices, respondent profiles and communication variables were collected through a structured interview schedule, while indoor concentrations of formaldehyde (HCHO), fine particulate matter ($PM_{2.5}$), total volatile organic compounds (TVOC), carbon dioxide (CO_2), relative humidity, temperature and light intensity were measured using an intelligent air detector, an air-quality monitor, an HTC-2 hygrometer and a digital lux meter. Measurements were recorded from five spatial locations (N, S, E, W and centre) at three intervals per building. Snake plant (45–70 %), money plant/pothos (40–60 %) and areca palm (30–50 %) emerged as the three most popular species. Formaldehyde remained within the WHO limit ($\leq$0.1 mg m^{-3}) in 100 % of the residences, whereas $PM_{2.5}$ exceeded the 15 µg m^{-3} WHO guideline in every sampled building. TVOC compliance was observed in only 30–40 % and CO_2 compliance in 20–50 % of the residences. Chi-square analysis revealed a significant association ($p < 0.05$) between the size of the home and all six IAQ parameters, and between socio-economic status (Kuppuswamy, 2026) and all IAQ parameters. Interiorscaping in the study region is thus widely accepted but requires better plant selection, ventilation planning and maintenance protocols to translate its acknowledged psychological benefits into measurable improvements in air quality.

Keywords: Interiorscaping, Indoor Air Quality, $PM_{2.5}$, TVOC, Carbon Dioxide, Kuppuswamy Scale, Biophilic Design, Haryana, Delhi

INTRODUCTION

Indoor air quality (IAQ) has become a major environmental and public health concern as people spend nearly 90% of their time indoors, where exposure to pollutants such as particulate matter ($PM_{2.5}$), carbon dioxide (CO_2), formaldehyde (HCHO), and total volatile organic compounds (TVOCs) can adversely affect health and well-being (World Health Organization [WHO], 2010; Han and Ruan, 2020). Poor IAQ has been associated with respiratory disorders, allergies, headaches, and reduced occupant comfort, emphasizing the need for sustainable strategies to improve indoor environments (WHO, 2010).

Interiorscaping, the strategic integration of ornamental plants into indoor spaces, has emerged as an effective approach to enhance both aesthetic appeal and indoor environmental quality. Indoor plants not only improve the visual character of interiors but also contribute to phytoremediation by absorbing airborne pollutants through their leaves and root-associated microorganisms (Wolverton *et al.*, 1989). Experimental studies have reported that species such as *Spathiphyllum wallisii*, *Chlorophytum comosum*, *Epipremnum aureum*, and

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Dracaena spp. can reduce concentrations of volatile organic compounds and particulate pollutants under controlled conditions (Dela Cruz *et al.*, 2014; Aydogan and Cerone, 2020). However, field-based evidence on interiorscaping trends and their influence on IAQ in Indian residential and commercial buildings remains limited. Therefore, the present study aimed to document interiorscaping trends and assess indoor air quality in interiorscaped buildings of Haryana and Delhi.

METHODOLOGY

Study area and sampling design

The investigation was conducted in January 2026 in Haryana (Gurugram, Sonipat) and the National Capital Territory of Delhi (Dwarka, Chanakyapuri and Malka Ganj). These locations were selected purposively due to their consistently very-poor to poor winter AQI (275–302). Within Gurugram, four sectors (24, 48, 57 and 102) and within Sonipat, HUDA Sectors 33 and 62 were chosen at random. In Delhi, Dwarka Sectors 13 and 19, Santushti Shopping Complex (Chanakyapuri) and Delhi University (Malka Ganj) were selected. The final sample comprised 40 buildings: 20 residential (10 Haryana + 10 Delhi) and 20 commercial (10 Haryana + 10 Delhi), identified by snowball sampling.

Variables and instruments

Nine independent variables (age, education, occupation, family type, family size, family income, family educational status, size of home and socio-economic status) and seven dependent variables (HCHO, $PM_{2.5}$, TVOC, CO_2, relative humidity, temperature and light intensity) were selected. Socio-economic status was scored using the modified Kuppuswamy Scale (2026). Mass-media exposure was captured through a three-point (daily / often / never) schedule with weights of 3, 2 and 1 respectively. Air-quality data were collected from five points in the same building at three different time intervals per building; means were used for analysis. HCHO, $PM_{2.5}$ and TVOC were measured by an Intelligent Air Detector; CO_2 by an Air Quality Monitor; temperature and relative humidity by an HTC-2 hygrometer and light intensity by a digital lux meter. Recommended standards used for comparison were HCHO ≤ 0.1 mg m^{-3} (WHO), $PM_{2.5}$ ≤ 15 µg m^{-3} (WHO), TVOC < 0.3 mg m^{-3}, CO_2 < 1000 ppm (ASHRAE 62.1), relative humidity 30–60 % and temperature 18–24 °C (ASHRAE 55).

Statistical analysis

Data were coded and analysed using frequency, percentage, mean, weighted mean score (WMS), standard deviation, independent-sample t-test and Chi-square test of independence at the 5 % level of significance.

RESULTS AND DISCUSSION

Personal and demographic profile (residential respondents)

The majority of residential respondents (65.0 %) belonged to the 36–50 y age group, 70 % were graduates or post-graduates, 40 % were homemakers and 40 % in service, 80 % lived in nuclear families, 70 % in small families ($\leq$ 4 members) and 100 % resided in flats. Nearly half (45 %) earned Rs. 82,709–1,65,419 per month and 70 % fell in the upper-middle socio-economic category on the Kuppuswamy scale. Social media (WMS = 2.65) was the most frequently used mass medium, followed by television (2.25), newspapers (1.85) and magazines (1.40) (Table 1, 2 and Fig. 1 and 2).

Source of getting information about indoor plants

Table 3 and Fig. 3 present the major sources through which respondents in Haryana and Delhi were exposed to indoor plants. In Haryana, family members emerged as the most influential source of exposure, securing the first rank (WMS = 1.80), followed by neighbors and self-exposure (WMS = 1.70 each). Friends ranked third (WMS = 1.60), while relatives and personal visits shared the fourth position (WMS = 1.50). Social groups ranked fifth (WMS = 1.40), whereas internet/social media was the least influential source with the lowest WMS (1.20). In Delhi, family members and self-exposure were the leading sources of exposure, both securing the first rank (WMS = 1.80). Friends ranked third (WMS = 1.70), while relatives and neighbours shared the fourth position (WMS = 1.40). Social groups, internet/social media, and personal visits were the least preferred sources, each obtaining a WMS of 1.30 and sharing the sixth rank.

Preferred indoor plant placement areas in residential houses

Table 4 and Fig. 3 presents the potential locations identified by the respondents for placing indoor plants. Since multiple responses were obtained, the total percentage exceeds 100.00 %. The findings revealed that

Table 1 : Personal and demographic variables

Sr. No.	Variables	Category	Frequency (%) (n=10) Haryana	Frequency (%) (n=10) Delhi	Total
1.	Age (in years)	20-35	3 (30.00)	1(10.00)	4 (20.00)
		36-50	5(50.00)	8(80.00)	13 (65.00)
		51-65	2(20.00)	1(10.00)	3 (15.00)
2.	Education of respondent	Matric	1(10.00)	0(0.00)	1 (5.00)
		10+2	4(40.00)	1(10.00)	5 (25.00)
		Graduate	2(20.00)	5(50.00)	7 (35.00)
		Post Graduate	3(30.00)	4(40.00)	7 (35.00)
3.	Occupation of the respondent	Homemaker	3(30.00)	5(50.00)	8 (40.00)
		Service	4(40.00)	4(40.00)	8 (40.00)
		Business	3(30.00)	1(10.00)	4 (20.00)
4.	Family type	Nuclear	9(90.00)	7(70.00)	16 (80.00)
		Joint	1(10.00)	3(30.00)	4 (20.00)
5.	Family size	Up to 4 members (small)	6(60.00)	8(80.00)	14 (70.00)
		5-7 members (medium)	4(40.00)	2(20.00)	6 (30.00)
6.	Family income (monthly)	Rs. 62,032- Rs.82,708	2(20.00)	4(40.00)	6 (30.00)
		Rs. 82,709- Rs.1,65,419	5(50.00)	4(40.00)	9 (45.00)
		≥ Rs. 1,65,420	3(30.00)	2(20.00)	5 (25.00)
7.	Socio-economic status	Upper (26-29)	2(20.00)	4(40.00)	6 (30.00)
		Upper middle (16-25)	8(80.00)	6(60.00)	14(70.00)
8.	Size of the home (sq. m)	Small	3(30.00)	3(30.00)	6(30.00)
		Medium	4(40.00)	3(30.00)	7(35.00)
		Large	3(30.00)	4(40.00)	7(35.00)
9.	Type of houses	Flats	10(100.00)	10(100.00)	20(100.00)

Sr. No.	Size of home (m^2) Haryana	Size of home (m^2) Delhi	Category
1.	< 75	< 60	Small
2.	76-130	61-120	Medium
3.	> 130	> 120	Large

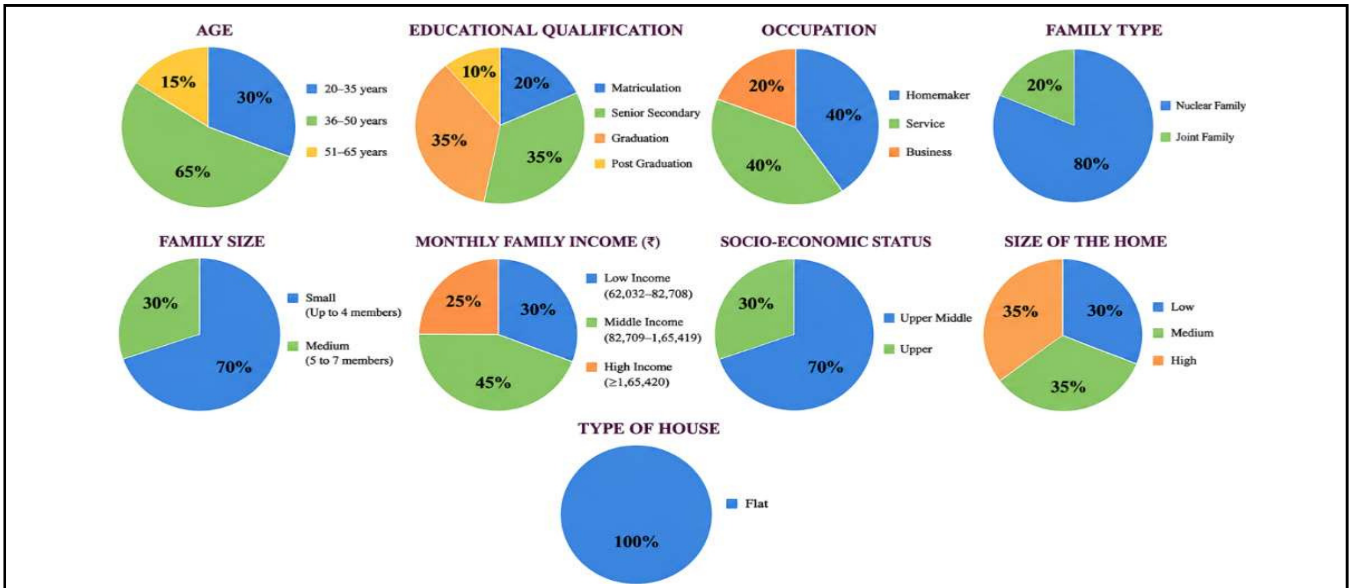

Fig. 1 : Personal and demographic variables

Table 2 : Mass media exposure of respondents'

Sr. No.	Mass media	Frequency of use			WMS	Rank
		Daily	Often	Never		
1.	Social media	14(70.00)	5(25.00)	1(5.00)	2.65	I
2.	Television	8(40.00)	9(45.00)	3(15.00)	2.25	II
3.	Newspaper	5(25.00)	7(35.00)	8(40.00)	1.85	III
4.	Magazine	2(10.00)	4(20.00)	14(70.00)	1.40	IV

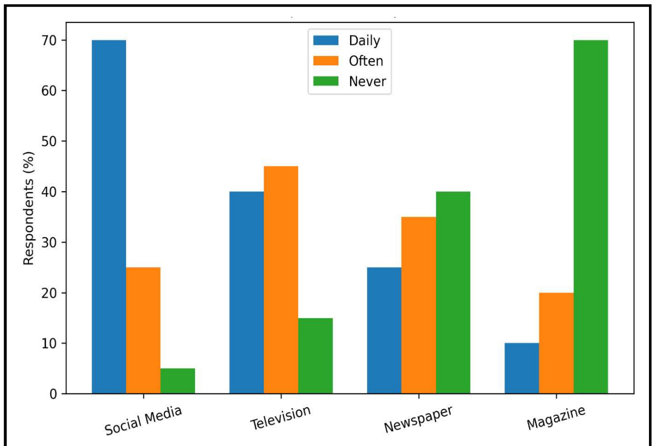

Fig. 2 : Mass media exposure of respondents'

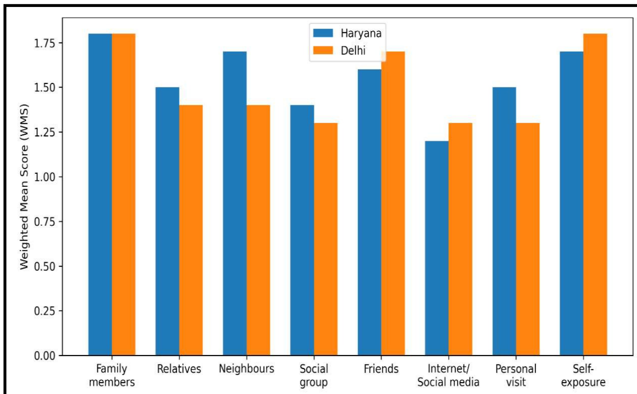

Fig. 3 : Source of getting information about indoor plants

all respondents (100.00%) from both Haryana and Delhi preferred the living room, bedroom, kitchen and entrance as suitable locations for indoor plants. A balcony was also considered an ideal location by 90.00 % of the respondents in Haryana and all respondents (100.00%) in Delhi. The dining area was preferred by 70.00 % of the respondents in Haryana and 80.00 % in Delhi, whereas the study was identified by comparatively fewer respondents (30.00% in Haryana and 50.00% in Delhi).

Table 3 : Source of getting information about indoor plants

Sr. No.	Category	Haryana F (%) (n=10)				Delhi F (%) (n=10)			
		Yes	No	WMS	Rank	Yes	No	WMS	Rank
1.	Family members	8 (80.00)	2 (20.00)	1.80	I	8 (80.00)	2 (20.00)	1.80	I
2.	Relatives	5 (50.00)	5 (50.00)	1.50	IV	4 (40.00)	6 (60.00)	1.40	IV
3.	Neighbors	7 (70.00)	3 (30.00)	1.70	II	4 (40.00)	6 (60.00)	1.40	IV
4.	Social group	4 (40.00)	6 (60.00)	1.40	V	3 (30.00)	7 (70.00)	1.30	VI
5.	Friends	6 (60.00)	4 (40.00)	1.60	III	7 (70.00)	3 (30.00)	1.70	III
6.	Internet/social media	2 (20.00)	8 (80.00)	1.20	VIII	3 (30.00)	7 (70.00)	1.30	VI
7.	Personal visit	5 (50.00)	5 (50.00)	1.50	IV	3 (30.00)	7 (70.00)	1.30	VI
8.	Self-exposure	7(70.00)	3(30.00)	1.70	II	8(80.00)	2(20.00)	1.80	I

Table 4 : Preferred indoor plant placement areas in residential houses

Sr. No.	Potential Plant Location	Haryana F (%) (n=10)	Delhi F (%) (n=10)
1.	Living room	10 (100.00)	10 (100.00)
2.	Bedroom	10 (100.00)	10 (100.00)
3.	Kitchen	10 (100.00)	10 (100.00)
4.	Dining area	7 (70.00)	8 (80.00)
5.	Balcony	9 (90.00)	10 (100.00)
6.	Entrance	10 (100.00)	10 (100.00)
7.	Study	3 (30.00)	5 (50.00)

*Multiple responses

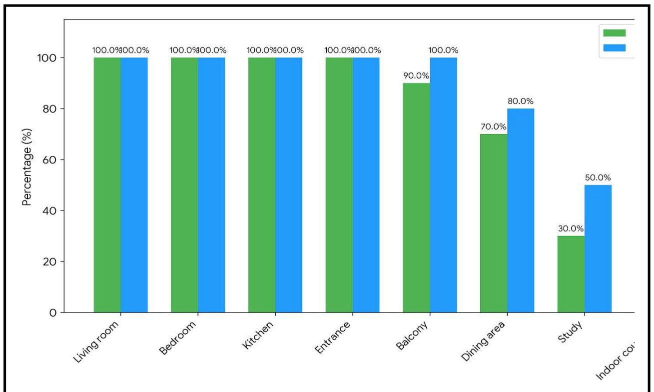

Fig. 4 : Preferred indoor plant placement areas in residential houses

Main sources of natural ventilation in residential areas

Table 5 and Fig. 5 depict the natural ventilation features available in the selected residential households. Since multiple responses were obtained, the total percentage exceeds 100.00%. The results indicated that windows were universally available (100.00%) in both Haryana and Delhi. In Haryana, all the selected households (100.00%) were provided with doors, balcony openings and ventilators. However, in Delhi, doors and balcony openings were available in 90.00% of the households, while ventilators were present in 80.00% of the households. The Open-to-sky courtyard feature was absent in all the selected households of both states.

Distribution of houses according to openable window area

Table 6 and Fig. 6 show the distribution of households based on the ratio of openable window area to floor area. The findings revealed that 35.00 % of the households each had an openable window area of 15–17 % and 18–22 % of the floor area, while the remaining 30.00 % fell within the 11–14 % category. In Haryana, an equal proportion of households (40.00% each) belonged to the

Table 5 : Main sources of natural ventilation in residential areas

Sr. No.	Category	Haryana F (%) (n=10)		Delhi F (%) (n=10)	
		Yes	No	Yes	No
1.	Windows	10 (100.00)	0 (0.00)	10 (100.00)	0 (0.00)
2.	Doors	10 (100.00)	0 (0.00)	9 (90.00)	1 (10.00)
3.	Balcony openings	10 (100.00)	0 (0.00)	9 (90.00)	1 (10.00)
4.	Ventilators (wall/roof)	10 (100.00)	0 (0.00)	8 (80.00)	2 (20.00)
5.	Open-to-sky courtyard	0 (0.00)	10 (100.00)	0 (0.00)	10 (100.00)

Table 6 : Distribution of houses according to openable window area

Openable window area to floor area	Haryana F (%) (n=10)	Delhi F (%) (n=10)	Total F (%) (n=20)
11–14%	4 (40.0)	2 (20.0)	6 (30.0)
15–17%	4 (40.0)	3 (30.0)	7 (35.0)
18–22%	2 (20.0)	5 (50.0)	7 (35.0)
Total	10 (100.0)	10 (100.0)	20 (100.0)

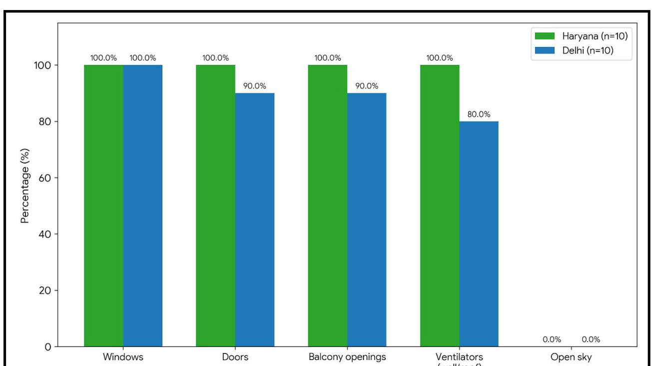

Fig. 5 : Main sources of natural ventilation in residential areas

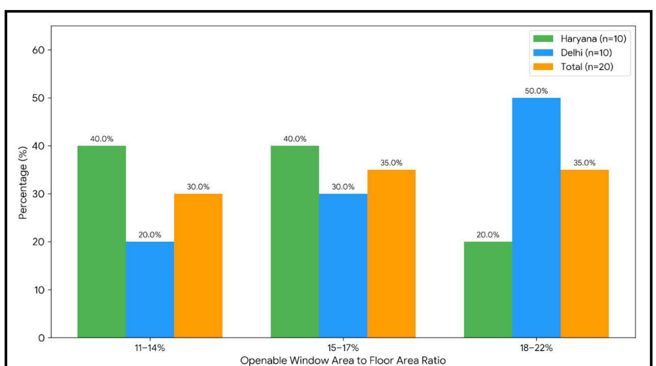

Fig. 6 : Distribution of houses according to openable window area

11–14 % and 15–17 % categories, whereas half of the households (50.00%) in Delhi were in the 18–22 % category.

Awareness of Interiorscaping Practices among respondents

Table 7 and Fig. 7 present the respondents' awareness regarding various aspects of indoor plants. The findings indicated that arranging plants was the most recognized aspect, securing the first rank (WMS = 2.70), with 80.00 % of the respondents responding positively. Plant placement according to available light, creating a calm environment, and reducing stress by using plants jointly secured the second rank (WMS = 2.50). Enhancing aesthetics ranked fifth (WMS = 2.10), while selection of plants and evaluation of ventilation shared the sixth rank (WMS = 2.00). Air improvement (WMS = 1.95) and considering plants as a part of modern life (WMS = 1.90)

Table 7 : Awareness of Interiorscaping Practices among respondents

Sr. No.	Category	Yes	No	Not sure	WMS	Rank
1.	Arranging plants	16(80.00)	2(10.00)	2(10.00)	2.70	I
2.	Air Improvement	9(45.00)	10(50.00)	1(5.00)	1.95	VIII
3.	Selection of plants	10(50.00)	9(45.00)	1(5.00)	2.00	VI
4.	Plant placement acc. To available light	12(60.00)	2(10.00)	6(30.00)	2.50	II
5.	Enhance aesthetics	10(50.00)	8(40.00)	2(10.00)	2.10	V
6.	Part of modern life	6(30.00)	6(30.00)	8(40.00)	1.90	IX
7.	Calm environment	14(70.00)	4(20.00)	2(10.00)	2.50	II
8.	Maintenance activity	7(35.00)	11(55.00)	2(10.00)	1.80	X
9.	Reduce stress by using plants	13(65.00)	3(15.00)	4(20.00)	2.50	II
10.	Evaluation of ventilation	10(50.00)	8(40.00)	2(10.00)	2.00	VI

*Multiple responses

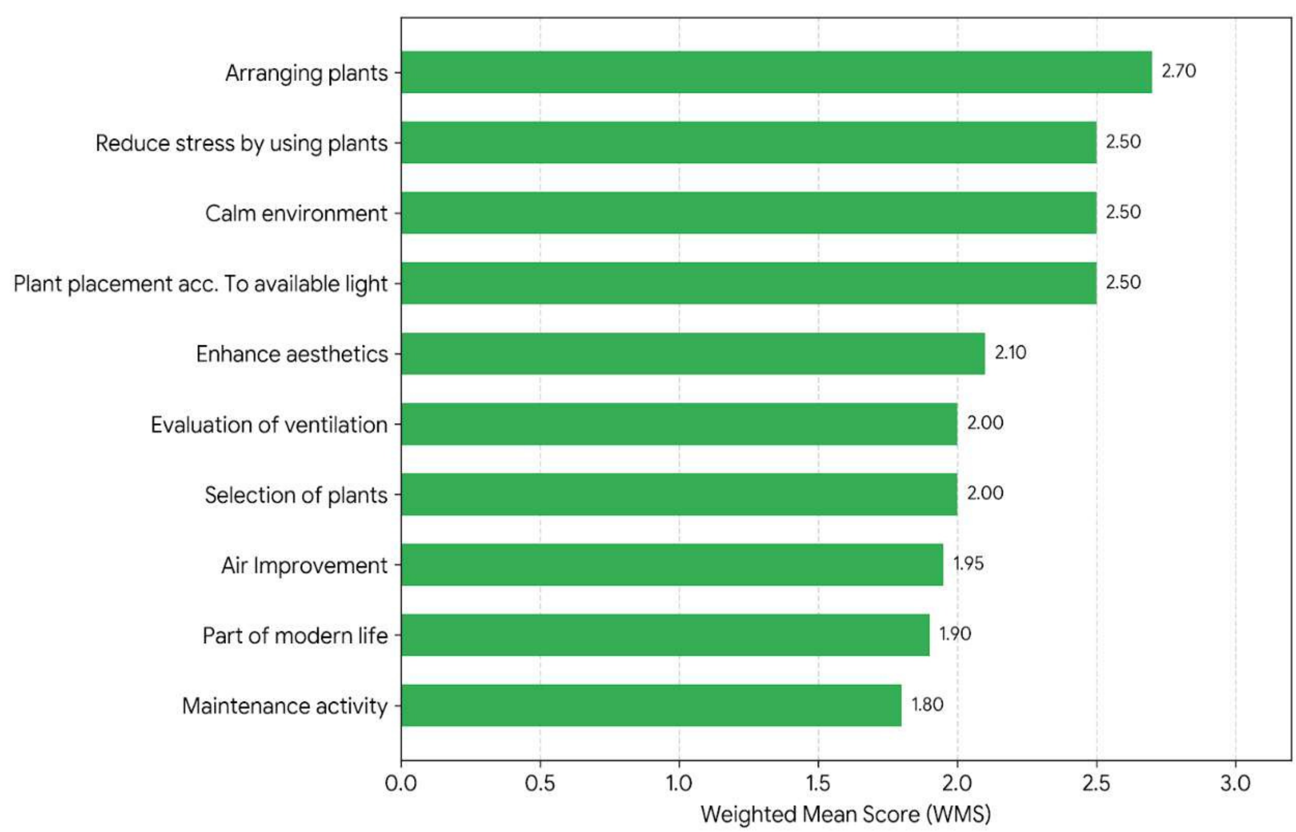

Fig. 7 : Awareness of Interiorscaping Practices among respondents

received comparatively lower awareness. Maintenance activity was the least recognized aspect, securing the tenth rank (WMS = 1.80).

Placement of indoor plants in different rooms of the house

Table 8 and Fig. 8 present the distribution of indoor plants across different locations in the households located in Haryana and Delhi. In Haryana, the balcony accommodated the highest number of indoor plants and secured the first rank (WMS = 2.80), followed by the living room and dining area, which shared the fifth rank (WMS = 2.20). The bedroom and study room ranked seventh (WMS = 2.00), while the kitchen ranked eighth (WMS = 1.90). The bathroom was the least preferred location for indoor plants, securing the thirteenth rank (WMS = 1.30).

In Delhi, the dining area emerged as the most preferred location for indoor plants, securing the second rank (WMS = 2.60), followed by the balcony (WMS =

Table 8 : Placement of indoor plants in different rooms of the house

Category	State	No Plants F (%)	1–2 F (%)	3–5 F (%)	>5 F (%)	WMS	Rank
Living Room	Haryana	2 (20.00)	5 (50.00)	2 (20.00)	1 (10.00)	2.20	V
	Delhi	2 (20.00)	6 (60.00)	1 (10.00)	1 (10.00)	2.10	VI
Bedroom(s)	Haryana	2 (20.00)	6 (60.00)	2 (20.00)	0 (0.00)	2.00	VII
	Delhi	3 (30.00)	6 (60.00)	1 (10.00)	0 (0.00)	1.80	IX
Kitchen	Haryana	4 (40.00)	3 (30.00)	3 (30.00)	0 (0.00)	1.90	VIII
	Delhi	4 (40.00)	4 (40.00)	2 (20.00)	0 (0.00)	1.80	IX
Dining Area	Haryana	2 (20.00)	5 (50.00)	2 (20.00)	1 (10.00)	2.20	V
	Delhi	3 (30.00)	2 (20.00)	1 (10.00)	4 (40.00)	2.60	II
Bathroom	Haryana	7 (70.00)	3 (30.00)	0 (0.00)	0 (0.00)	1.30	XIII
	Delhi	7 (70.00)	3 (30.00)	0 (0.00)	0 (0.00)	1.30	XIII
Balcony	Haryana	2 (20.00)	2 (20.00)	2 (20.00)	4 (40.00)	2.80	I
	Delhi	3 (30.00)	3 (30.00)	2 (20.00)	2 (20.00)	2.30	III
Study Room	Haryana	4 (40.00)	3 (30.00)	2 (20.00)	1 (10.00)	2.00	VII
	Delhi	5(50.00)	3(30.00)	1(10.00)	1(10.00)	1.80	IX

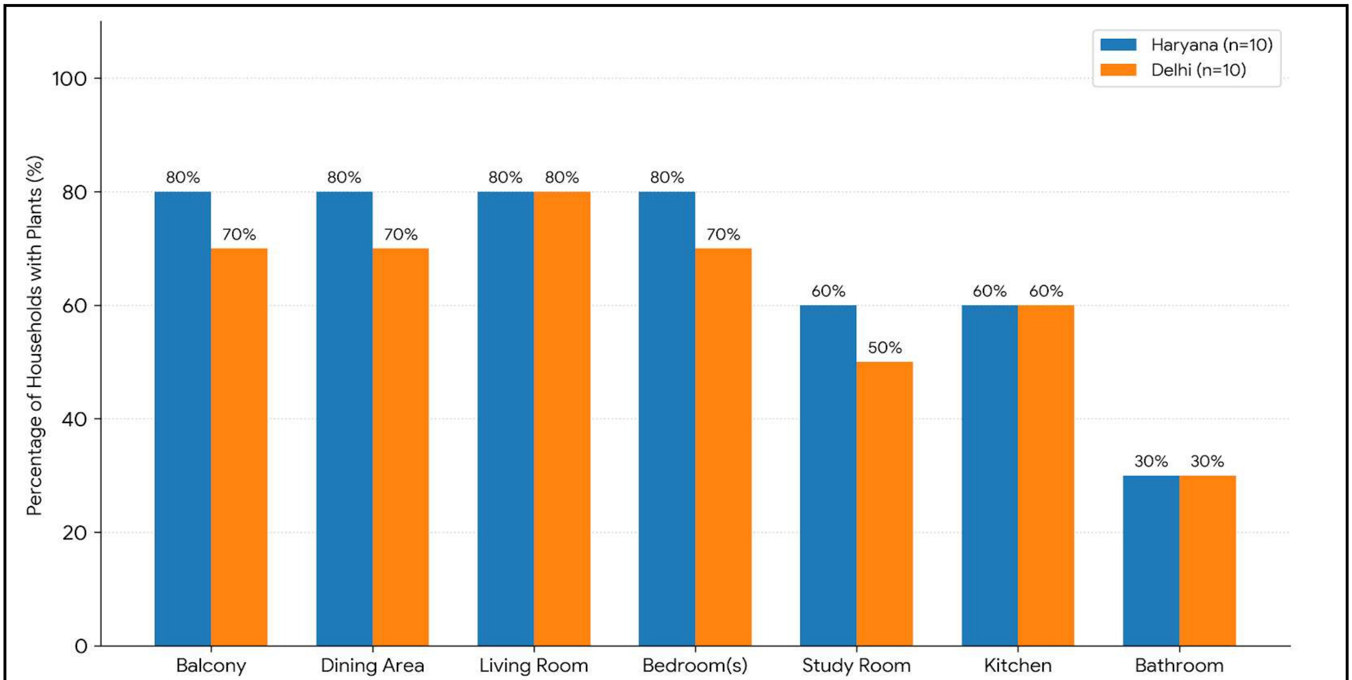

Fig. 8 : Placement of indoor plants in different rooms of the house

2.30). The living room ranked sixth (WMS = 2.10), whereas the bedroom, kitchen, and study room shared the ninth rank (WMS = 1.80). Similar to Haryana, the bathroom was the least preferred location, with the lowest WMS (1.30) and the thirteenth rank.

Different type of pot preferred for planting indoor plant

Table 9 and Fig. 9 present the types of pots used by the respondents for growing indoor plants. The findings revealed that plastic pots were the most commonly used, being reported by 80.00 % of the respondents, followed by ceramic pots (45.00%) and mud pots (35.00%). Cemented pots were used by 20.00 % of the respondents, while glass pots were the least preferred, with only 15.00 % reporting their use.

Table 9 : Different type of pot preferred for planting indoor plant

Type of Pot	Haryana F (%)	Delhi F (%)	Total F (%)
Cemented Pot	2 (20.00)	2 (20.00)	4(20.00)
Mud Pot	4 (40.00)	3 (30.00)	7(35.00)
Plastic Pot	7 (70.00)	9 (90.00)	16(80.00)
Ceramic Pot	5 (50.00)	4 (40.00)	9(45.00)
Glass Pot	1 (10.00)	2 (20.00)	3(15.00)

*Multiple responses

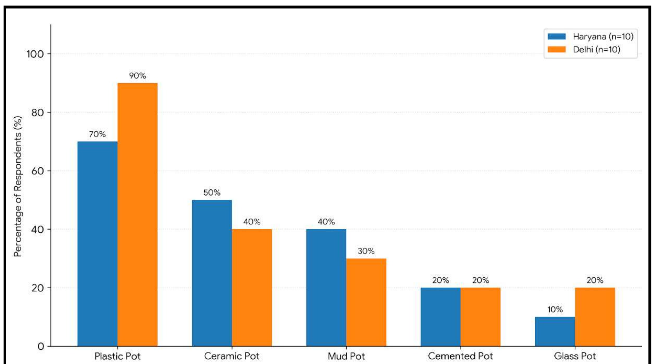

Fig. 9 : Different type of pot preferred for planting indoor plant

Types of indoor plants referred by respondents

Table 10 and Fig. 10 present the types of indoor plants maintained by the respondents. Among the various plant types, the snake plant was the most commonly placed inside the homes, being reported by 45.00 % of the respondents, followed by pothos/money plant (40.00%) and Areca palm (30.00%). Spider plant and succulents were maintained by 25.00 % of the respondents each, while Aloe vera and Dracaena were reported by 20.00 %. Lucky bamboo and croton plant accounted for 15.00 % each, whereas Syngonium was the least commonly grown indoor plant, reported by only 10.00 % of the respondents.

Table 10 : Types of indoor plants referred by respondents

Sr. No.	Plant type	Haryana F (%) (n=10)	Delhi F (%) (n=10)	Total F (%) (n=20)
1.	Snake Plant	4(40.00)	5(50.00)	9 (45.00)
2.	Pothos/Money plant	3(30.00)	5(50.00)	8 (40.00)
3.	Areca Palm	4(40.00)	2(20.00)	6 (30.00)
4.	Spider Plant	3(30.00)	2(20.00)	5 (25.00)
5.	Aloe Vera	3(30.00)	1(10.00)	4 (20.00)
6.	Lucky Bamboo	1(10.00)	2(20.00)	3 (15.00)
7.	Succulents	2(20.00)	3(30.00)	5 (25.00)
8.	Croton Plant	2(20.00)	1(10.00)	3 (15.00)
9.	Dracaena	2(20.00)	2(20.00)	4 (20.00)
10.	Syngonium	1(10.00)	1(10.00)	2 (10.00)

*Multiple responses

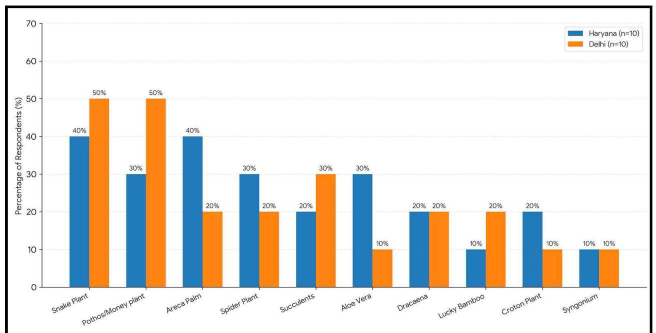

Fig. 10 : Types of indoor plants referred by respondents

Reasons for planting a particular type of plant

Table 11 and Fig. 11 present the reasons for selecting different indoor plant species. The findings indicate that air purification was the most common reason for selecting snake plant (88.89%), pothos/money plant (87.50%), Areca palm (83.33%), spider plant (80.00%), Aloe vera (100.00%), and Dracaena (75.00%). In contrast, beautification and aesthetic appeal were the primary reasons for selecting lucky bamboo, succulents, croton plant, and Syngonium, with all four plants receiving 100.00 % responses for aesthetics. A calming environment was also an important consideration for several plant species, particularly Areca palm (66.67%), lucky bamboo (66.67%), and snake plant (55.56%), indicating that respondents selected indoor plants for both functional and decorative purposes.

Table 11 : Reasons for planting a particular type of plant

Sr. No.	Category	Air purification	For beautification	Create a calming environment	For aesthetics
1.	Snake Plant	8 (88.89)	4 (44.44)	5 (55.56)	6 (66.67)
2.	Pothos/Money Plant	7 (87.50)	4 (50.00)	4 (50.00)	5 (62.50)
3.	Areca Palm	5 (83.33)	3 (50.00)	4 (66.67)	4 (66.67)
4.	Spider Plant	4 (80.00)	2 (40.00)	3 (60.00)	3 (60.00)
5.	Aloe Vera	4 (100.00)	1 (25.00)	2 (50.00)	2 (50.00)
6.	Lucky Bamboo	1 (33.33)	2 (66.67)	2 (66.67)	3 (100.00)
7.	Succulents	2 (40.00)	4 (80.00)	2 (40.00)	5 (100.00)
8.	Croton Plant	1 (33.33)	3 (100.00)	1 (33.33)	3 (100.00)
9.	Dracaena	3 (75.00)	2 (50.00)	2 (50.00)	3 (75.00)
10.	Syngonium	1 (50.00)	1 (50.00)	1 (50.00)	2 (100.00)

*Multiple responses

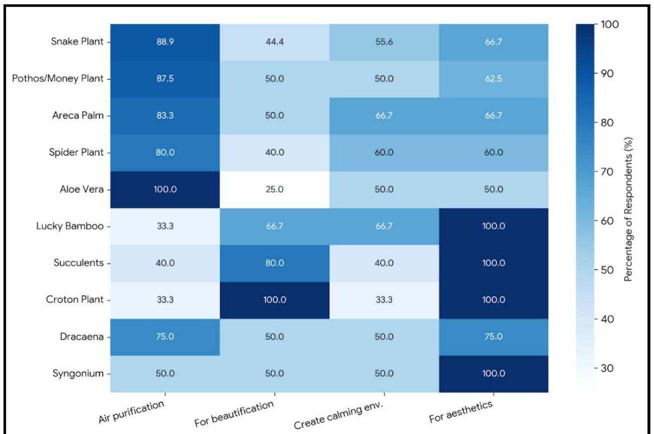

Fig. 11 : Reasons for planting a particular type of plant

Perception of the respondents regarding benefits of indoor plants

Table 12 and Fig. 12 present the respondents' perceptions regarding the benefits of indoor plants in Haryana and Delhi. In Haryana, respondents showed the strongest agreement that indoor plants improve air quality (WMS = 4.50), followed by their role in improving aesthetics (WMS = 3.90) and reducing stress (WMS = 3.80). Comparatively lower agreement was observed for increasing humidity (WMS = 3.00), while refreshing the environment received the lowest level of agreement (WMS = 2.30).

In Delhi, the highest level of agreement was observed for the statement that indoor plants improve air quality (WMS = 5.00). This was followed by refreshing the environment (WMS = 4.70), reducing stress (WMS = 4.50), and improving aesthetics (WMS = 4.20). The statement related to increasing humidity received the

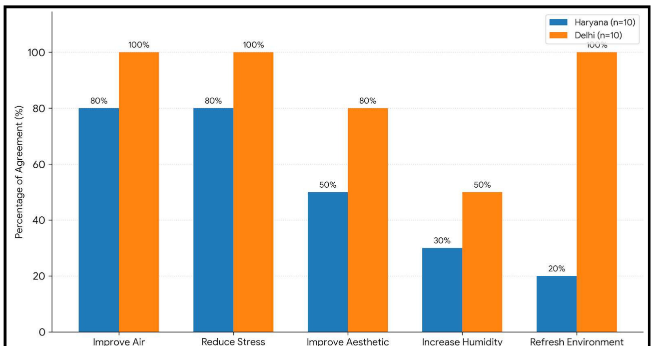

Fig. 12 : Perception of the respondents regarding benefits of indoor plants

Table 12 : Perception of the respondents regarding benefits of indoor plants

Category	State	Strongly Agree F (%)	Agree F (%)	Neutral F (%)	Disagree F (%)	Strongly Disagree F (%)	WMS
Improve Air	Haryana	7(70.00)	1(10.00)	2(20.00)	0 (0.00)	0 (0.00)	4.50
	Delhi	10(100.00)	0(0.00)	0(0.00)	0 (0.00)	0 (0.00)	5.00
Reduce Stress	Haryana	0(0.00)	8(80.00)	2(20.00)	0 (0.00)	0 (0.00)	3.80
	Delhi	5(50.00)	5(50.00)	0(0.00)	0 (0.00)	0 (0.00)	4.50
Improve esthetic	Haryana	4(40.00)	1(10.00)	5(50.00)	0 (0.00)	0 (0.00)	3.90
	Delhi	4(40.00)	4(40.00)	2(20.00)	0 (0.00)	0 (0.00)	4.20
Increase Humidity	Haryana	2(20.00)	1(10.00)	2(20.00)	5(50.00)	0 (0.00)	3.00
	Delhi	3(30.00)	2(20.00)	3(30.00)	2(20.00)	0 (0.00)	3.60
Refresh Environment	Haryana	1(10.00)	1(10.00)	2(20.00)	2(20.00)	4(40.00)	2.30
	Delhi	7(70.00)	3(30.00)	0(0.00)	0(0.00)	0(0.00)	4.70

Table 13 : Compliance of residential buildings with recommended IAQ standards (n = 10 per state)					
Parameter	Within standard		Beyond standard		Standard
	Haryana	Delhi	Haryana	Delhi	
Formaldehyde	10(100.00)	10(100.00)	0(0.00)	0(0.00)	(≤ 0.1 mg/m³) by WHO
PM2.5	0(0.00)	0(0.00)	10(100.00)	10(100.00)	(≤ 15 µg/m³) by WHO
TVOC	4(40.00)	3(30.00)	6(60.00)	7(70.00)	(< 0.3 mg/m³) by IAQ Guidelines
CO_2	5(50.00)	2(20.00)	5(50.00)	8(80.00)	(< 1000 ppm) by ASHRAE Standard
Relative humidity	5(50.00)	8(80.00)	5(50.00)	2(20.00)	(30–60%) by ASHRAE
Temperature	8(80.00)	6(60.00)	2(20.00)	4(40.00)	(18–24°C) by ASHRAE

lowest agreement, with a WMS of 3.60.

Indoor air quality – residential

Compliance with recommended standards is summarized in Table 13. All 20 residences complied with the WHO limit for HCHO, whereas 100 % exceeded the $PM_{2.5}$ guideline. Only 40 % (Haryana) and 30 % (Delhi) of the residences were within the TVOC limit. Compliance with CO_2 was observed in 50 % of Haryana and 20 % of Delhi residences, reflecting weaker ventilation in the metropolis. Temperature compliance was 80 % (Haryana) vs. 60 % (Delhi) and RH compliance was 50 % vs. 80 %. Overall, 50 % of houses recorded low-to-moderate light intensity (50–200 lx) with Haryana registering 60 % in the 50–200 lx band.

Results for commercial buildings

General information and demographic variables

Table 14 presents the general profile of the selected commercial buildings. The findings revealed that hotels/ restaurants constituted the largest proportion of the selected buildings (40.00%), followed by offices (35.00%). Educational institutes and the other category each accounted for 10.00 %, while hospitals/clinics and salons/ spas represented 5.00 % each. With respect to locality, the majority of the commercial buildings (95.00%) were located in urban areas, whereas only 5.00 % were situated in semi-urban areas, indicating that the study was predominantly conducted in urban settings.

Personal profile of the respondents

Fig. 13 shows the profile of respondents showed that 45.00 % belonged to the 20–40 years age group, followed by 35.00 % in the 41–60 years category and 20.00 % were 61 years and above. Regarding education, 50.00 % were graduates, while 25.00 % had completed 12th standard and 25.00 % were postgraduates. In terms of work experience, 40.00 % had 2–5 years of experience, 35.00 % had 6–9 years, and 25.00 % had 10–12 years of experience. With respect to monthly income, 40.00 % earned ¹ 51,000–¹ 1,00,000, whereas 30.00 % each earned less than ¹ 50,000 and more than ¹ 1,00,000 per month. Overall, the respondents were

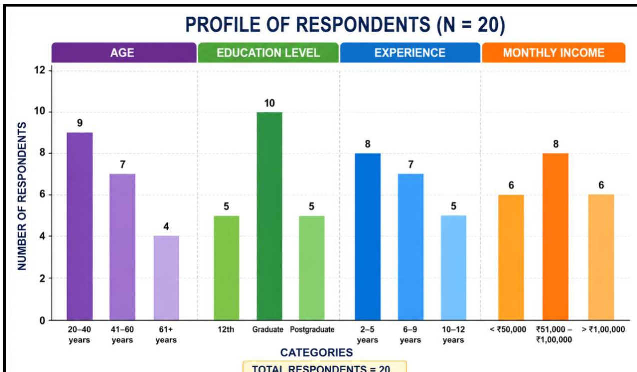

Fig. 13 : Personal profile of the respondents

Table 14 : General information and demographic variables					
Sr. No.	Variables	Category	Haryana F (%) (n=10)	Delhi F (%) (n=10)	Total F (%) (n=20)
1.	Type of commercial building	Office	4(40.00)	3(30.00)	7(35.00)
		Educational institute	1(10.00)	1(10.00)	2(10.00)
		Hospital/Clinic	0(0.00)	1(10.00)	1(5.00)
		Salon/Spa	0(0.00)	1(10.00)	1(5.00)
		Hotel/Restaurant	5(50.00)	3(30.00)	8(40.00)
		Other	1(10.00)	1(10.00)	2(10.00)
2.	Locality	Urban	9(90.00)	10(100.00)	19(95.00)
		Semi Urban	1(10.00)	0(0.00)	1(5.00)

Table 15 : Allocated spaces in commercial buildings

Sr. No.	Types of space present	Haryana (n=10)		Delhi (n=10)	
		Yes	No	Yes	No
1.	Reception area	10(100.00)	0(0.00)	10(100.00)	0(0.00)
2.	Workstations	2(20.00)	8(80.00)	6(60.00)	4(40.00)
3.	Cabins/offices	3(30.00)	7(70.00)	6(60.00)	4(40.00)
4.	Conference room	3(30.00)	7(70.00)	2(20.00)	8(80.00)
5.	Cafeteria	1(10.00)	9(90.00)	1(10.00)	9(90.00)
6.	Meeting hall	2(20.00)	8(80.00)	1(10.00)	9(90.00)
7.	Dining areas	6(60.00)	4(40.00)	3(30.00)	7(70.00)
8.	Lecture rooms	1(10.00)	9(90.00)	1(10.00)	9(90.00)
9.	Entrance	10(100.00)	0(0.00)	10(100.00)	0(0.00)
10.	Washroom(s)	10(100.00)	0(0.00)	10(100.00)	0(0.00)

predominantly young, graduate-educated individuals with moderate work experience and middle-income levels.

Allocated spaces in commercial buildings

Table 15 and Fig. 14 present the allocated spaces available in the selected commercial buildings. As multiple responses were recorded, the total percentage exceeds 100.00 %. The findings revealed that reception areas, entrances, and washrooms were present in all commercial buildings (100.00%) in both Haryana and Delhi. Workstations and cabins/offices were more commonly observed in Delhi (60.00% each) than in Haryana (20.00% and 30.00%, respectively). Dining areas were reported in 60.00 % of the buildings in Haryana compared to 30.00 % in Delhi. Conference rooms, meeting halls, cafeterias, and lecture rooms were available in relatively fewer buildings in both states.

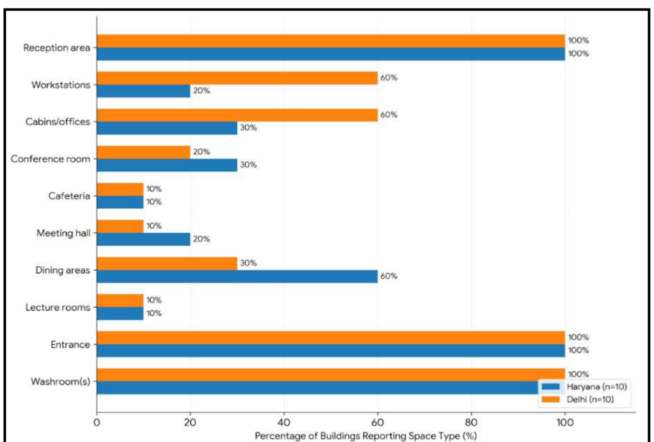

Fig. 14 : Allocated spaces in commercial buildings

Main source of natural ventilation

Table 16 and Fig. 15 present the main sources of ventilation in the selected commercial buildings. As multiple responses were obtained, the total percentage exceeds 100.00 %. The findings revealed that doors were the most common source of ventilation, being present in all buildings (100.00%) in both Haryana and Delhi. Windows and ceiling fans were more frequently reported in Haryana (80.00% each), whereas exhaust fans, HVAC systems, and mixed ventilation were more prevalent in Delhi (80.00% each). Air Handling Units (AHUs) were

Table 16 : Main source of natural ventilation

Sr. No.	Main Source of Ventilation	Haryana F (%)	Delhi F (%)
1.	Windows	16 (80.00)	14 (70.00)
2.	Doors	20 (100.00)	20 (100.00)
3.	Ventilators	8 (40.00)	6 (30.00)
4.	Exhaust Fans	14 (70.00)	16 (80.00)
5.	HVAC System	8 (40.00)	16 (80.00)
6.	Air Handling Unit (AHU)	6 (30.00)	12 (60.00)
7.	Ceiling Fans	16 (80.00)	12 (60.00)
8.	Split Air Conditioner	14 (70.00)	14 (70.00)
9.	Cross Ventilation	10 (50.00)	6 (30.00)
10.	Mixed Ventilation (Natural + Mechanical)	10 (50.00)	16 (80.00)

*Multiple responses

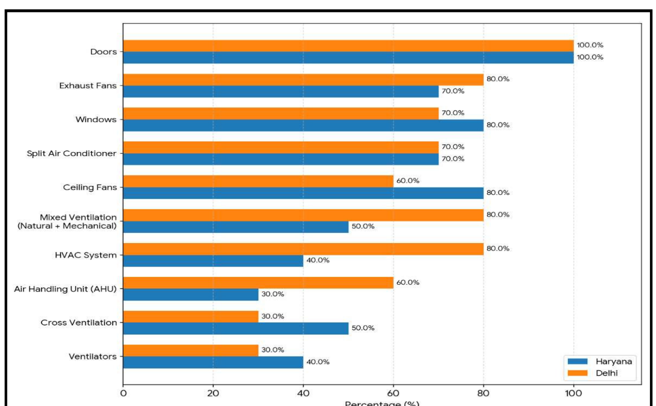

Fig. 15 : Main source of natural ventilation

Table 17 : Source of knowledge about interiorscaping			
Sr. No.	Sources of Knowledge	Haryana F (%)	Delhi F (%)
1.	Internet / Websites	15 (75.00)	18 (90.00)
2.	Social Media	13 (65.00)	17 (85.00)
3.	Nursery / Plant Sellers	11 (55.00)	10 (50.00)
4.	Interior Designers / Architects	7 (35.00)	13 (65.00)
5.	Office Management / Employer	9 (45.00)	14 (70.00)
6.	Environmental Awareness Programmes	5 (25.00)	9 (45.00)
7.	Newspapers / Magazines	6 (30.00)	8 (40.00)
8.	Television	8 (40.00)	7 (35.00)
9.	Professional Training / Seminars	4 (20.00)	8 (40.00)

*Multiple responses

available in 60.00 % of the buildings in Delhi compared to 30.00 % in Haryana. Cross ventilation was reported in 50.00 % of the buildings in Haryana and 30.00 % in Delhi, indicating variations in ventilation strategies between the two states.

Source of knowledge about interiorscaping

Table 17 and Fig. 16 present the sources through which respondents acquired knowledge about interiorscaping. The findings revealed that internet/ websites were the most common source of information, reported by 75.00% of the respondents in Haryana and 90.00% in Delhi, followed by social media (65.00% and 85.00%, respectively). Nurseries/plant sellers were reported by 55.00% of the respondents in Haryana and 50.00% in Delhi. Knowledge gained through interior designers/architects, office management/employers, and environmental awareness programmes was comparatively higher in Delhi (65.00%, 70.00%, and 45.00%, respectively) than in Haryana (35.00%, 45.00%, and 25.00%, respectively). Television (40.00% in Haryana and 35.00% in Delhi), newspapers/magazines (30.00% and 40.00%), and professional training/seminars (20.00% and 40.00%) were the least frequently reported sources of knowledge.

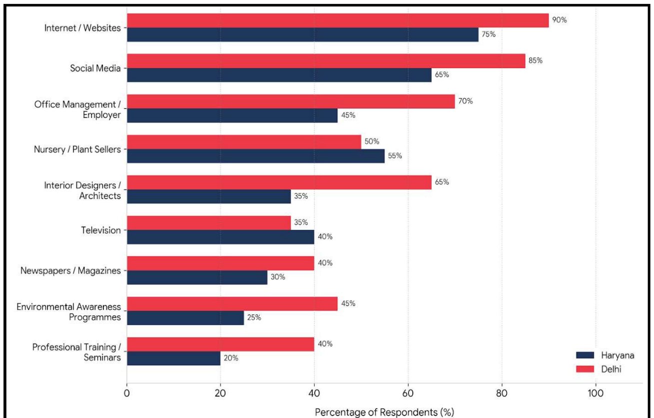

Fig. 16 : Source of knowledge about interiorscaping

Types of plants used across different areas of commercial buildings

Table 18 and Fig. 17 present the types of indoor plants used across different areas of the selected

Table 18 : Types of plants used across different areas of commercial buildings				
Sr. No.	Plants	Haryana F (%) (n=10)	Delhi F (%) (n=10)	Total (n=20)
1.	Snake Plant	7 (70.00)	7 (70.00)	14(70.00)
2.	Money Plant / Pothos	6 (60.00)	6 (60.00)	12(60.00)
3.	Areca Palm	5 (50.00)	5 (50.00)	10(50.00)
4.	Spider Plant	4 (40.00)	3 (30.00)	7(35.00)
5.	Rubber Plant	2 (20.00)	3 (30.00)	5(25.00)
6.	Bamboo Palm	2 (20.00)	2 (20.00)	4(20.00)
7.	Dracaena	4 (40.00)	4 (40.00)	8(40.00)
8.	Succulents	3 (30.00)	3 (30.00)	6(30.00)
9.	ZZ Plant	2 (20.00)	3 (30.00)	5(25.00)
10.	Syngonium	2 (20.00)	2 (20.00)	4(20.00)
11.	Croton Plant	1 (10.00)	2 (20.00)	3(15.00)

*Multiple responses

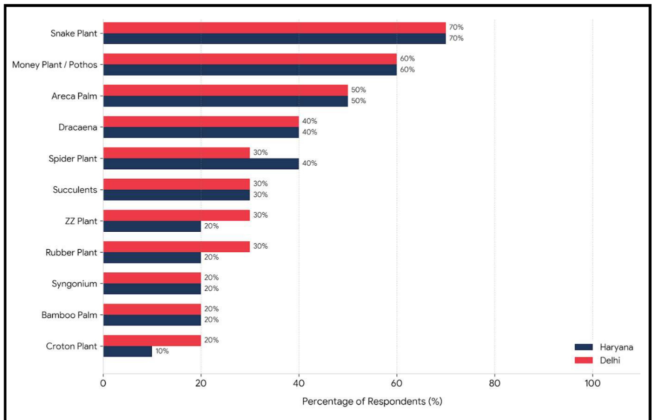

Fig. 17 : Types of plants used across different areas of commercial buildings

commercial buildings. As multiple responses were recorded, the total percentage exceeds 100.00 %. The findings revealed that the snake plant was the most commonly used species (70.00%), followed by money plant/pothos (60.00%) and Areca palm (50.00%). Dracaena was found in 40.00 % of the buildings, while spider plant and succulents accounted for 35.00 % and 30.00 %, respectively. Rubber plant and ZZ plant were each reported by 25.00 % of the buildings, hereas bamboo palm and Syngonium were used by 20.00 %. Croton plant was the least commonly reported species, accounting for 15.00 % of the responses.

Presence of plants in different areas of commercial buildings

Table 19 and Fig. 18 present the presence of indoor plants in different areas of the selected commercial buildings. As multiple responses were recorded, the total percentage exceeds 100.00 %. The findings revealed that entrances were the most common location for indoor plants, with plants present in 100.00 % of the buildings in Haryana and 90.00 % in Delhi. Reception areas and cabins/offices also showed a high presence of indoor plants in both states. In contrast, cafeterias, meeting halls, lecture rooms, and washrooms had comparatively fewer indoor plants, particularly in Delhi. Overall, indoor plants were more frequently observed across different functional spaces in the commercial buildings of Haryana than those in Delhi.

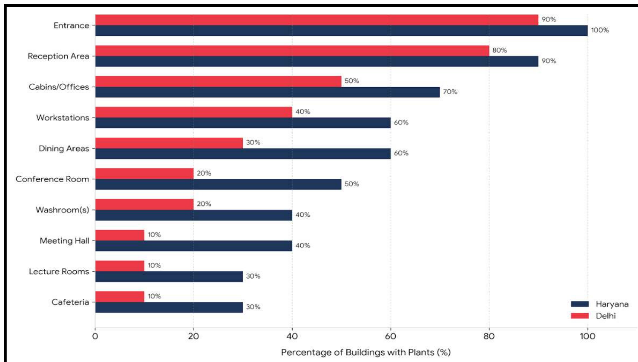

Fig. 18 : Presence of plants in different areas of commercial buildings

Approximate number of plants present in the spaces present

Table 20 and Fig. 19 present the approximate number of indoor plants present in different spaces of the selected commercial buildings. The findings indicated that entrance areas had the highest number of plants in both Haryana and Delhi, with the highest WMS of 2.40 and 2.00, respectively. Reception areas and cabins/offices also showed comparatively higher plant availability in both regions. In contrast, spaces such as cafeterias, lecture rooms, and washrooms recorded lower WMS values, indicating fewer plants in these areas. Overall, commercial buildings in Haryana exhibited a comparatively greater number of indoor plants across different spaces than those

Table 19 : Presence of plants in different areas of commercial buildings

Sr. No.	Space	Haryana		Delhi	
		Yes	No	Yes	No
1.	Reception Area	9 (90.00)	1 (10.00)	8 (80.00)	2 (20.00)
2.	Workstations	6 (60.00)	4 (40.00)	4 (40.00)	6 (60.00)
3.	Cabins/Offices	7 (70.00)	3 (30.00)	5 (50.00)	5 (50.00)
4.	Conference Room	5 (50.00)	5 (50.00)	2 (20.00)	8 (80.00)
5.	Cafeteria	3 (30.00)	7 (70.00)	1 (10.00)	9 (90.00)
6.	Meeting Hall	4 (40.00)	6 (60.00)	1 (10.00)	9 (90.00)
7.	Dining Areas	6 (60.00)	4 (40.00)	3 (30.00)	7 (70.00)
8.	Lecture Rooms	3 (30.00)	7 (70.00)	1 (10.00)	9 (90.00)
9.	Entrance	10 (100.00)	0 (0.00)	9 (90.00)	1 (10.00)
10.	Washroom(s)	4 (40.00)	6 (60.00)	2 (20.00)	8 (80.00)

Table 20 : Approximate number of plants present in the spaces present

Sr. No.	Space	Haryana					Delhi				
		Upto 4 plants	5-10 plants	> 10 plants	WMS	Rank	Upto 4 plants	5-10 plants	> 10 plants	WMS	Rank
1.	Reception Area	2 (20.00)	5 (50.00)	3 (30.00)	2.10	II	4 (40.00)	4 (40.00)	2 (20.00)	1.80	III
2.	Workstations	3 (30.00)	4 (40.00)	3 (30.00)	2.00	III	5 (50.00)	3 (30.00)	2 (20.00)	1.70	IV
3.	Cabins/Offices	2 (20.00)	5 (50.00)	3 (30.00)	2.10	II	4 (40.00)	4 (40.00)	2 (20.00)	1.80	III
4.	Conference Room	4 (40.00)	4 (40.00)	2 (20.00)	1.80	V	6 (60.00)	3 (30.00)	1 (10.00)	1.50	VI
5.	Cafeteria	5 (50.00)	3 (30.00)	2 (20.00)	1.70	VII	7 (70.00)	2 (20.00)	1 (10.00)	1.40	VIII
6.	Meeting Hall	4 (40.00)	4 (40.00)	2 (20.00)	1.80	V	7 (70.00)	2 (20.00)	1 (10.00)	1.40	VIII
7.	Dining Areas	3 (30.00)	5 (50.00)	2 (20.00)	1.90	IV	5 (50.00)	4 (40.00)	1 (10.00)	1.60	V
8.	Lecture Rooms	5 (50.00)	3 (30.00)	2 (20.00)	1.70	VII	7 (70.00)	2 (20.00)	1 (10.00)	1.40	VIII
9.	Entrance	1 (10.00)	4 (40.00)	5 (50.00)	2.40	I	3 (30.00)	4 (40.00)	3 (30.00)	2.00	I
10.	Washroom(s)	5 (50.00)	3 (30.00)	2 (20.00)	1.70	VII	7 (70.00)	2 (20.00)	1 (10.00)	1.40	VIII

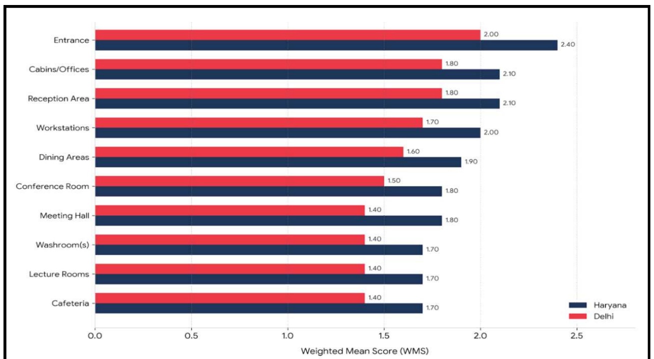

Fig. 19 : Approximate number of plants present in the spaces present

Purpose of interiorscaping in commercial buildings

Table 21 and Fig. 20 present the purpose of interiorscaping in the selected commercial buildings. The findings revealed that aesthetic appeal was the primary purpose of interiorscaping, reported by 100.00 % of buildings in Haryana and 90.00 % in Delhi. Enhancing brand image was another important purpose in Haryana in Delhi.

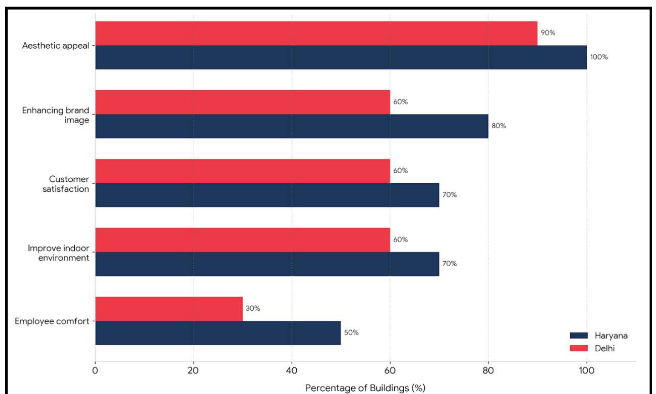

Fig. 20 : Purpose of interiorscaping in commercial buildings

Table 21 : Purpose of interiorscaping in commercial buildings

Sr. No.	Category	Haryana		Delhi	
		Yes	No	Yes	No
1.	Aesthetic appeal	10(10.00)	0(0.00)	9(90.00)	1(10.00)
2.	Improve indoor environment	7(70.00)	3(30.00)	6(60.00)	4(40.00)
3.	Enhancing brand image	8(80.00)	2(20.00)	6(60.00)	4(40.00)
4.	Employee comfort	5(50.00)	5(50.00)	3(30.00)	7(70.00)
5.	Customer satisfaction	7(70.00)	3(30.00)	6(60.00)	4(40.00)

Table 22 : Frequency Distribution of buildings within standard and beyond standard

Parameter	Within standard		Beyond standard		Standard
	Haryana	Delhi	Haryana	Delhi	
Formaldehyde	10(100.00)	10(100.00)	0(0.00)	0(0.00)	($\leq$ 0.1 mg/m³) by WHO
$PM_{2.5}$	0(0.00)	0(0.00)	10(100.00)	10(100.00)	($\leq$ 15 µg/m³) by WHO
TVOC	4(40.00)	3(30.00)	6(60.00)	7(70.00)	(< 0.3 mg/m³) by IAQ Guidelines
CO_2	2(20.00)	0(0.00)	8(80.00)	10(100.00)	(< 1000 ppm) by ASHRAE Standard
Relative humidity	7(70.00)	6(60.00)	3(30.00)	4(40.00)	(30–60%) by ASHRAE
Temperature	3(30.00)	1(10.00)	7(70.00)	9(90.00)	(18–24°C) by ASHRAE

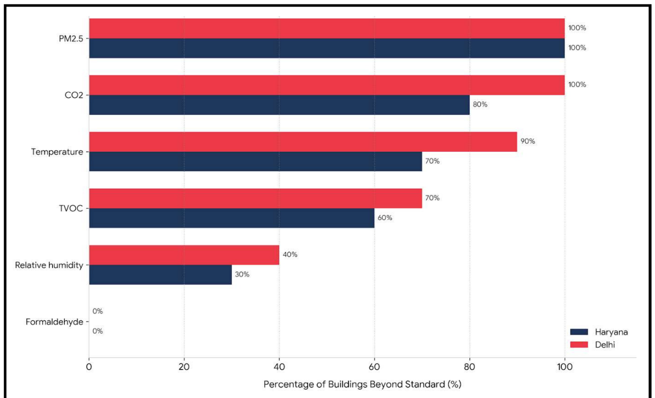

Fig. 21 : Frequency Distribution of buildings beyond standard

(80.00%), whereas improving indoor environment and customer satisfaction were also commonly reported in both regions. Employee comfort was comparatively less considered, particularly in Delhi (30.00%). Overall, interiorscaping was mainly adopted to enhance visual appeal and create a better indoor environment, with Haryana buildings showing a wider range of purposes compared to Delhi.

Indoor air quality — commercial

For commercial buildings, HCHO compliance was universal (100 %), but $PM_{2.5}$ again exceeded the WHO limit in every building. TVOC exceeded standards in 60 % (Haryana) and 70 % (Delhi) of the buildings, and CO, was beyond the ASHRAE limit in the majority of commercial spaces, particularly in Delhi (100 %). Temperature compliance was reported in only 30 % of Haryana and 10 % of Delhi commercial buildings, while relative humidity remained within the recommended range in 70 % and 60 %, respectively. Nearly half of the buildings (45 %) recorded moderate light intensity of 301–500 lx (Table 22 and Fig. 21).

Association between household characteristics and IAQ

Chi-square analysis revealed a highly significant association ($p < 0.05$) between size of home and every IAQ parameter – HCHO (χ^2 = 35.000), $PM_{2.5}$ (χ^2 = 35.000), TVOC (χ^2 = 20.000), CO, (χ^2 = 29.796), RH (χ^2 = 31.111) and temperature (χ^2 = 30.053). Similarly, Kuppuswamy socio-economic status was significantly associated with HCHO (χ^2 = 11.865), $PM_{2.5}$ (χ^2 = 11.865), TVOC (χ^2 = 12.857), CO, (χ^2 = 15.918), RH (χ^2 = 11.799) and temperature (χ^2 = 15.767), indicating that both structural volume and material affordability strongly influence the indoor pollutant load of urban Indian dwellings (Table 23).

Table 23 : Association Between Size of Home and SES with Indoor Air Quality and Emotional Psychological Impact

Parameters	Size of home	SES
Formaldehyde	35.000*	11.8651*
$PM_{2.5}$	35.000*	11.8651*
TVOC	20.000*	12.8571*
CO_2	29.796*	15.9184*
Relative Humidity	31.111*	11.7989*
Temperature	30.053*	15.7672*

*Significant at 5 % level of significance
*Highly significant at 1 % level of significance

The consistent placement of ornamental plants in living rooms, entrances and balconies observed in the present study indicates a preference for incorporating greenery into highly visible and frequently occupied indoor spaces, reflecting the increasing popularity of interiorscaping for both functional and aesthetic purposes (Bringslimark *et al.*, 2009; Dela Cruz *et al.,* 2014). The predominance of snake plant (*Dracaena trifasciata*), pothos (*Epipremnum aureum*) and areca palm (*Dypsis lutescens*) is consistent with previous studies that identified these species as suitable indoor plants because of their adaptability, low maintenance requirements and potential to improve indoor environmental quality (Wolverton *et al.*, 1989; Dela Cruz *et al.*, 2014). The universal exceedance of the WHO guideline for $PM_{2.5}$ across the studied buildings supports the findings of Morawska *et al.* (2017), who reported that indoor particulate matter is strongly influenced by outdoor air pollution and building ventilation characteristics. This suggests that while indoor plants may contribute to pollutant removal, they should be regarded as a complementary strategy rather than a substitute for adequate ventilation and other air-quality management measures (Aydogan and Cerone, 2020). Furthermore, the comparatively lower compliance with recommended CO_2 concentrations in Delhi aligns with the observations of Persily and de Jonge (2017), who highlighted the influence of occupancy density and ventilation effectiveness on indoor CO_2 accumulation. The significant association between home size and indoor air quality parameters also supports the ventilation-volume relationship proposed by Sundell (2004), whereas the observed socio-economic differences are comparable to the findings of Adamkiewicz *et al.* (2011), emphasizing the influence of housing characteristics and household resources on indoor environmental quality.

Conclusion

Interiorscaping is now a mainstream feature of both residential and commercial buildings in Haryana and Delhi, driven primarily by aesthetic and psychological motivations and secondarily by the perceived air-purifying properties of ornamental foliage. While formaldehyde and thermal comfort parameters largely remained within recommended limits, $PM_{2.5}$, TVOC and CO_2 frequently exceeded international guidelines, particularly in the highly-occupied commercial buildings of Delhi. Both the volume of the dwelling and the socio-economic status of its occupants significantly influenced the indoor pollutant load, whereas the psychological benefits of interiorscaping remained largely independent of these variables. The findings underline the necessity of coupling deliberate plant selection with efficient ventilation design and evidence-based maintenance protocols to translate the aesthetic appeal of interiorscaping into measurable improvements in indoor environmental quality.

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