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The Effect of Houseplant Ratio in Residential Interior on Human Positive Emotions

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ABSTRACT
Urban populations worldwide have reached half of the global population. The increasing dominance of urban human civilization is closely tied to the changing lifestyles of individuals. Present generations spend 90 percent of their time indoors, impacting the intensity of human interaction with the external environment. These lifestyle changes have engendered negative emotional effects on inhabitants, thereby driving the trend of incorporating plants into interior spaces to evoke positive emotions, particularly within residential settings. This research aims to ascertain: 1) the optimal ratio of plants used in residential interiors to evoke the best positive emotional effects for users, and 2) how the selection of plants in residential interiors influences users' positive emotions. A qualitative approach was employed in this study, utilizing questionnaire surveys and interviews to gather preferences, which were subsequently utilized in simulated room experiments. The research findings revealed that the smallest ratio of houseplants in simulated rooms, considering the proportion of space and volume among rooms, furniture, and human circulation, yielded the most significant positive emotional effects. These findings contribute to understanding the proportion of plant additions in residential interiors to maximize positive emotional effects for urban residents at 17-35 age group.
Keywords: indoor plants, stress, positive emotions, indoor generations

INTRODUCTION
Approximately 57% of the global population resides in urban areas (Blachier, n.d.), which significantly influences human lifestyles. According to a survey conducted by YouGov, a market research company, individuals spend 90% of their time indoors (Evans & McCoy, 1998; Han, 2020; Editorial Staff of The Plan, 2018). On average, people spend around 22 hours per day engaged in indoor activities, encompassing their residences, workplaces, and public buildings (Editorial Staff of The Plan, 2018).

This lifestyle trend distances humans further from natural interactions, contributing to increased stress levels and mental health issues (Yin et al., 2020). Additionally, there is a growing concern regarding indoor air quality due to the prolonged indoor stay of individuals (Han & Ruan, 2020). One common solution to address these issues is the incorporation of plants into interior spaces, particularly within residential environments.

Houseplants, as they are commonly referred to indoor plants that commonly occupy in houses, offer numerous benefits to both physical (Chang et al., 2019; Han, 2020) and mental health (Yin et al., 2020). They have been shown to reduce stress among occupants (Kim et al., 2018; Yin et al., 2020). Moreover, houseplants contribute positively to interior environments by enhancing oxygen levels and introducing natural elements, thereby increasing the overall aesthetic appeal of indoor spaces (Kim et al., 2018).

In Indonesia, the urban population accounted for 56.7% in 2020 and is projected to reach 66.6% by 2035 (Rizaty, 2021). The inclusion of houseplants in interior design in Indonesia is becoming increasingly common due to their associated benefits. However, the precise quantity of plants required within residential interiors to derive benefits, particularly in enhancing positive emotions, remains unclear. Therefore, this research aims to determine the optimal

quantity of houseplants necessary for residential interiors to enhance positive emotions and to explore how the selection of plants influences users' positive emotions.

It is important to note that this study does not focus on the placement of plants within residential settings or the specific characteristics of plants themselves, such as color and shape. Instead, the primary focus lies on the quantitative aspect of plant incorporation within residential interiors.

RELATED STUDY

A. The Role of Houseplants in Enhancing Positive Emotions

Houseplants have been extensively studied for their positive effects and benefits on human well-being (Lee et al., 2015). Interacting with indoor plants has been shown to reduce both psychological and physiological stress. Lee and colleagues (2015) demonstrated this by creating the crossover experiments with two tasks: one requiring computer work and the other involving plant transplantation tasks. Subsequent to each experiment, participants from both groups exchanged tasks. Comparative analysis revealed distinct differences in emotional states between the two tasks. Subjects reported feeling more comfortable, calm, and natural after engaging in plant transplantation tasks compared to computer work. Moreover, diastolic blood pressure significantly decreased following plant transplantation tasks (Lee et al., 2015).

Adachi, Rohde, and Kendle (2000) investigated changes in human emotions across three different room conditions: one adorned with flowers, one with foliage, and one devoid of adornments. They found that the presence of flowers had a positive effect on human emotions, such as enhancing compositional elements and self-confidence. However, some evidence of a significant increase in annoyance was also observed in this condition. Foliage display had a slightly negative effect, leading to a slight increase in feelings of anger, yet tended to have a positive effect on mental clarity (Adachi, Rohde, & Kendle, 2000).

Bringslimark et al. (2008) concluded from their experimental literature review that indoor plants can reduce stress and enhance pain tolerance. Deng and Deng (2018) further asserted that indoor plants can influence psychological well-being and serve as natural air purifiers.

B. Impact of Houseplant Quantity Ratio in Indoor Spaces

Larsen and colleagues (1998) conducted research on how plant density or the quantity of plants in an office environment affects productivity, attitudes, and perceptions. They created three office conditions: the first with no plants in a 12-square-meter or 31-cubic-meter space, the second with plants accounting for 7.16% of the total cubic meterage, and the third with plants accounting for 17.88% of the total cubic meterage. The research findings indicated that plants influenced the well-being, attractiveness, and comfort of the office. However, it was discovered that increasing the number of plants in the office actually decreased productivity. Larsen and colleagues (1998) advocated for further research in varied settings to understand the effects of plants more comprehensively.

Han (2020) conducted research focused on the green effect of plants based on quantity and distance from individuals, examining perceptions and physical parameters. This study was prompted by the relatively limited exploration of the influence of plant quantity on perceptions and physical parameters compared to findings regarding the impact of plants on these two aspects (Han, 2020). The experiment yielded findings indicating that the visibility of plants had a greater impact than their quantity and green coverage (Han, 2020). Specifically, the number of plants visible in three-dimensional space was more crucial than the actual number of plants placed and their distance from individuals. Furthermore, the distance from plants appeared to have a stronger effect on indoor environmental physical parameters compared to indoor plant coverage (Han, 2020).

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METHODS

A. Initial Data Collection

A qualitative approach was employed for this research. The first stage of the study utilized a questionnaire to assess perceived mental symptoms, preferences for houseplants commonly used in urban areas, and the selection of respondents according to predefined criteria: residing in urban areas and aged between 17 and 35 years. The questionnaire comprised 19 questions and was distributed online over a three-day period (21/01/21-23/01/21), with a total of 36 respondents completing it.

Subsequently, based on the results of the initial questionnaire, three individuals representing respondents who owned houseplants and two individuals representing those who did not own houseplants were selected for interviews. Comparative emotional data between the two groups were then collected.

B. Creation of Simulation Spaces

The third stage involved the creation of simulation rooms. The simulated room chosen was the most frequently utilized space in residential settings, namely the family room. The dimensions of the family room were set at 4 x 3.5 x 3 meters (42 m^3). Two categories of simulation rooms were created, each consisting of three simulation rooms differentiated by distinct variables. Category one comprised simulation rooms with varying sizes of houseplants, while category two involved simulation rooms with differing quantities of plants.

The selection of houseplants to fill the simulation rooms was based on the findings of literature studies on commonly used houseplants, derived from the initial questionnaire regarding preferred houseplants. Four top-ranked houseplants were chosen based on the data obtained: Sansevieria trifasciata, Aloe vera, Lavandula dentata, and Hedera helix. These plants were categorized into the two family room simulation categories, as detailed below.

1. Family Room Simulation Differentiated by Variation in Plant Size

Figure 1. Room Simulation Based on Differences in Plant Size
Source: Author Documentation (2024)

Table 1. Houseplants Size Occupancy Based on Small, Medium, Large Size Classification

Houseplant	Smallest size of the houseplant range (cm)	Medium size of the houseplant range (cm)	The largest size of the houseplant range (cm)
Sansevieria trifasciata	76.2	80	100
Aloe vera	60	80	100
Lavandula dentata	32.2	45	61

Source: Author Documentation (2024)

2. Family Room Simulations Are Differentiated Based on Differences in the Number of Houseplants

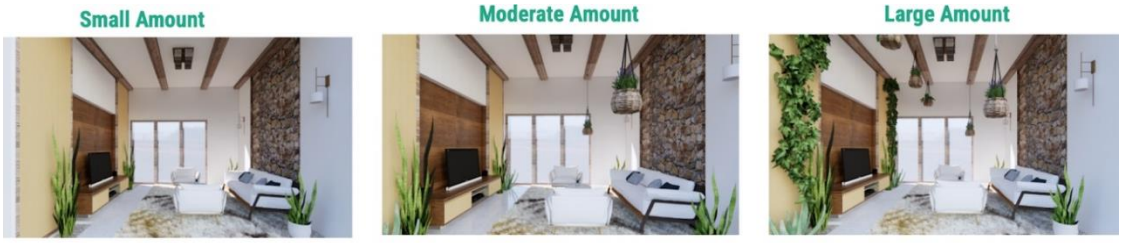

Figure 2. Room Simulation Based on Differences in Number of Plants
Source: Author Documentation (2024)

Table 2. The Number of Plants Used in The Family Room Simulation is Differentiated Based on The Classification of Small, Medium and Large Numbers

Houseplant	Room with a small number of houseplants occupancy (per pot)	Room with a moderate number of houseplants occupancy (per pot)	Rooms with a large number of houseplants occupancy (per pot)
Sansevieria trifasciata	4	4	4
Aloe vera	1	3	3
Lavandula dentata	-	2	4
Hedera helix	-	-	2

Source: Author Documentation (2024)

C. Collection of Family Room Simulation Feedback

The two categories of family room simulations previously created were distributed via an online questionnaire to gather feedback over a period of three days (01/04/21-03/04/21), with a total of 53 respondents participating.

Respondents were provided with options to indicate their perceived emotions by selecting checkboxes provided within the questionnaire. They were permitted to choose more than one emotion. Furthermore, respondents had the option to express emotions not included in the provided choices by directly typing them.

Each perceived emotion concerning all options in the two simulation categories was then categorized into three emotion categories: positive, neutral, and negative. Words with similar emotional meanings were grouped together and counted as a single word.

RESULT

A. Interview Result

The outcomes of interviews conducted with two distinct respondent groups are as follows. The first group comprised three respondents who possessed houseplants in their residences, while the second group consisted of two respondents who did not have any plants in their homes. Both respondent groups reported experiencing similar daily emotional states, specifically negative emotions. However, the disparity lies in the variety of negative emotions experienced daily, with respondents from both groups expressing negative emotions differently. For instance, the three respondents who owned houseplants only delineated two negative emotions experienced daily, such as anxiety and stress. Conversely, the two respondents without plants in their homes reported experiencing a broader spectrum of negative emotions, including fatigue, restlessness, pressure, discomfort, lack of enthusiasm, boredom, and unease.

One of the most frequently cited factors contributing to these negative emotions, as mentioned by nearly all respondents from both groups, was work-related stress. Some

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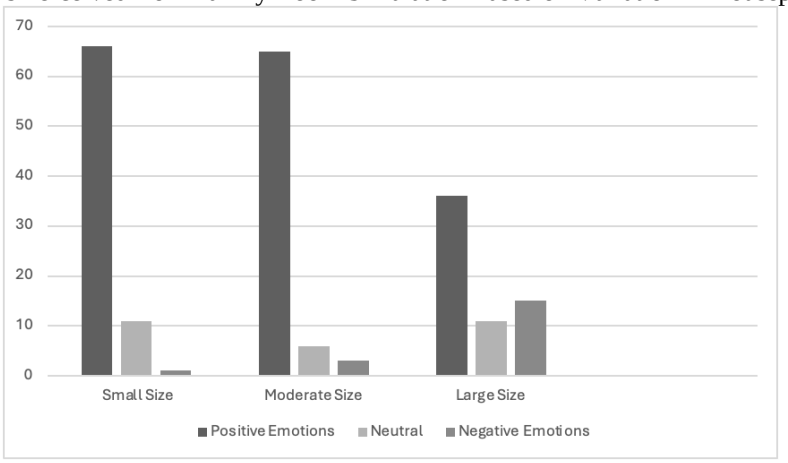
respondents also added that home environment conditions, personal circumstances, and various dynamic factors were contributing factors.

Regarding the feelings experienced by both respondent groups towards the rooms in their homes, differences in perceived emotions were observed between respondents with plants in their rooms compared to those without plants. The three respondents who had plants in one of their home rooms reported experiencing positive emotional changes when in rooms containing plants. They felt more relaxed, rejuvenated, and less constrained. Conversely, the two respondents without plants in their homes, one felt indifferent, while the other occasionally felt bored and stressed at home.

B. Simulation Feedbacks Results

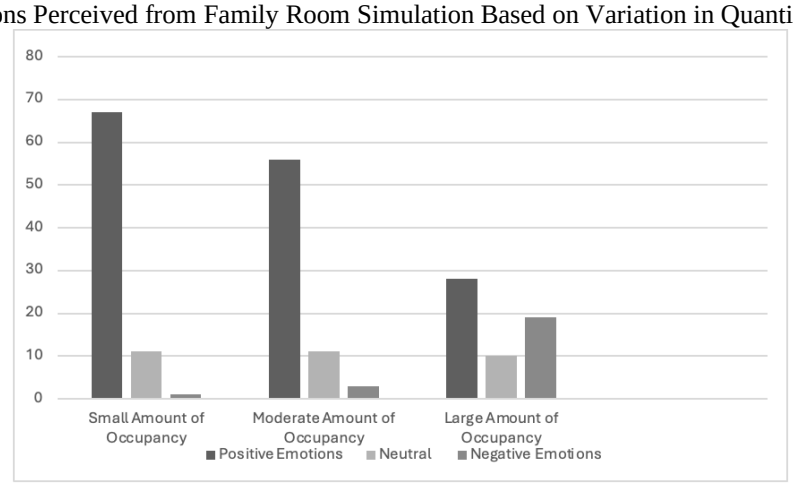
Graphic 1. Emotions Perceived from Family Room Simulation Based on Variation in Houseplant Size



Source: Feedback on Room Simulation (2024)

The most frequently expressed positive emotions were "comfortable" (N=32) and "calm" (N=24), whereas the commonly expressed negative emotion was "excessive" (N=2).

Graphic 2. Emotions Perceived from Family Room Simulation Based on Variation in Quantity of Houseplants



Source: Feedback on Room Simulation (2024)

The most frequently expressed positive emotions were "comfortable" (N=33) and "calm" (N=29), while the commonly expressed negative emotion was "too crowded" (N=2).

DISCUSSION

Houseplants in residential settings immediately evoke positive emotions among occupants. Visually, houseplants greatly assist inhabitants in feeling refreshed and less constrained when observing plants. This aligns with the findings of experiments conducted by Larsen and colleagues (1998), which stated that plants have a positive effect on well-being and enhance the attractiveness of the room. Although the study by Larsen and colleagues (1998) was conducted in office settings, its relevance extends to residential settings as well.

Based on the results of distributing feedback questionnaires on family room simulation, the category of simulation rooms differentiated by the size of the plant fillers showed that the room with the smallest plant size ratio of 84:16:1, in terms of room volume (RV) : furniture and human circulation volume (FHV) : plant volume (PV), provided the most positive emotional effects compared to the other two simulation rooms with different plant sizes (medium and large). Similarly, in the simulation rooms differentiated by the quantity of plant fillers, the family room with fewer plants with a ratio of 420:80:7 (RV:FHV:PV) provided the most positive emotional effects compared to rooms with medium and large quantities of plants.

These findings support Larsen and colleagues' (1998) discovery that an increasing number of plants actually reduces work productivity in the office. This contradicts the frequently hypothesized notion that more plants positively affect productivity. Larsen and colleagues (1998) explain this opposing finding by suggesting that an excessive number of plants may cause distractions while people are working, a phenomenon also observed in this study.

Another interesting finding is that an increasing number and size of plants actually create a sense of dread for some respondents. This demonstrates that more plants do not always enhance comfort for everyone.

The familiarity of the plants in the simulated rooms created becomes a significant factor in how positively individuals perceive the rooms they observe. Plants that are excessively large and numerous may appear unfamiliar to individuals, leading many respondents to feel uncomfortable with simulations containing an increasing number and size of plants.

CONCLUSION

The smallest plant size ratio of 84:16:1 (RV:FHV:PV) and also the fewest number of plants with a ratio of 420:80:7 in terms of RV:FHV:PV from the family room simulation results elicited the highest degree of positive emotional responses compared to the magnitude of plant size and quantity in the room. Houseplants can induce a greater sense of well-being and attractiveness, thus visually evoking positive emotions. However, this effect can only be achieved if the ratio of houseplants present in the room is proportional.

Due to the limitations imposed by the pandemic, the method of creating simulation rooms for this study was restricted, resulting in limited respondent experiences. Further development of this research could involve exploring aspects of room simulation using virtual reality (VR) or even conducting experiments in real rooms to enhance the sense of spatial experience.

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