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WIDENING THE HORIZON OF ANTHROPOCENTRIC INTERIOR DESIGN TOWARDS MEANINGFUL HUMAN-PLANT INTERACTION

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Abstract. Human-plant interaction is an issue with various dimensions. Humans are inextricably linked to plants and depend on them for their survival. However, they have also developed an anthropocentric and animal-centric attitude and tend to ignore the contribution of plants to their well-being and even to overlook the presence of plants. In recent decades, with the growing body of research on human dependence on nature and positive influence of interaction with nature on human physical and psychological health, a countertrend has emerged: design trends aiming to increase the exposure of urban dwellers to nature and its elements in every step of their daily lives. This study hypothesizes that interiors with integrated indoor plants, designed with appropriate ethical, aesthetic and psychological considerations, can create preconditions and opportunities for more meaningful human-plant interactions and broaden the ethical horizons of interior design towards non-anthropocentric cultural attitudes.

Keywords: *Interior design, indoor plants, human-plant interaction, environmental ethics, human well-being, plant well-being.*

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1. Introduction

The connections of humans with plants are vital in many ways. According to Cho et al. (2015), plants provide and support people with oxygen, food, life resources and living environments as well as influencing their sentiments and bodily functions. Furthermore, plants have provided humans with food, medicine and shelter for millennia and they have considerable cultural and symbolic importance in various nations and cultures (Niazi *et al*., 2023). As DelSesto (2020) figuratively notes, "we wear plants, sit on plants, use plants to get to work, write on the pulverized remains of plants and ingest plants. Plants are a backdrop to ceremonious events. We exchange plants to communicate condolences, congratulations or care". According to DelSesto, being human in itself implies constant contact and communication with plants and we need plants even in the era of high-speed technological transformations. However, in the contemporary world, the impact of urbanization has created a different kind of society where people live in cities, which do not have enough connection with nature and plant environments. Moreover, researchers note that people tend to ignore and undervalue plants and plant environments (Pouteau, 2014; Cho *et al*., 2015; DelSesto, 2020). According to Cho et al. (2015), people tend to treat plants with less care compared to dealing with other life forms, such as animals. Pouteau (2014) notes that plants are like "second animals" in

human perception. DelSesto (2020) refers to this situation as “plant blindness”. It is anthropocentric and animal-centric cultural attitude with which the contributions that plants make to human life remain unnoticed and are easily taken for granted.

However, in recent decades the situation has started to change. The increasing number of studies present positive impacts of nature and plants and plant environments in particular on human health and productivity (Niazi *et al*., 2023). Existing research in this topic demonstrates that people depend on nature not only for their material requirements but also for their psychological, aesthetic, emotional and spiritual needs (Maller *et al*., 2009). Therefore, there is a growing understanding regarding the interaction between humans and the environment. It can be stated that it is an essential aspect of human life since it tends to create a positive impact on both the mental and physical state of people and it increases the quality of life. This experience has led to the design movements aiming to increase the everyday contacts of urban dwellers with nature or nature-like features and environments. Consequently, architecture and design elements with integrated plants, such as biowalls (Andadari, 2024) or vertical green living walls, have started to be implemented more often in urban environments in the last decade; moreover, the factor that such vegetated surfaces help to combat the effects of climate change in cities are taken into account as well. On the other hand, people also have started to spend more time indoors, which migrates the green living wall ideas towards interior design as well. Lee et al. (2015) note that the average contemporary person spends more than 85 percent of daily life indoors; the lives of numerous contemporary people are aggravated by such psychological challenges as technostress. Considering the positive physiological and psychological effects of interacting with plants, plants are more and more often integrated into the interior design of living, working, leisure and entertainment spaces. However, there is not sufficient research regarding the impact of plants on interior design, especially on the visual preferences of different plants. Most of the time, the visual preference studies on the usage of plants in the environment are researched more in landscape architecture and their impact was evaluated in outdoor settings (Huang *et al*., 2022; Kaya *et al*., 2018). Furthermore, even though there is some research on cultural and regional differences in the perception of interior design (Momade, 2022; Wang, 2024), most of the time, it is not related to plants or usage of vegetation, but they are more about the color and pattern preferences (Hidayetoğlu *et al*., 2012; Kamal *et al*., 2022). The studies related to plants are also primarily researched in the context of landscape and urban design (Buijs *et al*., 2009; Tarakci-Eren & Duzenli, 2017; López-Martínez, 2017; Hami & Tarashkar, 2018). It is believed that using plants in interior design consequently means more opportunities for closer human-plant interactions for the urban population as well as implies some challenges related to how humans perceive plants and ethical concerns related to plant treatment and well-being. The research on the maintenance of plants in indoor environments and the recent possibilities of the usage of AI and innovative technologies for plant care, such as smart monitoring, are also areas of research gap in contemporary academia. The research related to the usage of technology in interior design is limited to integrating computer technology and AI as a design tool for aesthetics, as a design tool or their integration into education (Chen *et al*., 2024; Almaz *et al*., 2024; Shao *et al*., 2024).

In that regard, this study raises the hypothesis that it is crucial to research of effective usage of plants in interior design, not only for aesthetics but for sustainable and convenient spaces for people when indoor plants are designed based on appropriate ethical, aesthetical and psychological approaches. The approaches which involve all

these elements can create premises and opportunities for more meaningful human-plant interaction and widen the ethical horizons of interior design towards non-anthropocentric cultural attitudes.

The aim of the study is to highlight the following aspects related to the above-presented hypothesis: 1) interior design trends integrating indoor plants and plant well-being and environmental ethics concerns; 2) psychological effects of plants on humans in interior design; 3) human-plant interaction in interiors and its potential to widen ethical horizons of interior design.

2. Research methodology

Methodologically this study follows a theoretical conceptual research design, focusing on synthesizing existing knowledge. Such methodology was selected in order to explore human-plant interactions in interior design through several lenses - ethical, aesthetic, psychological - by integrating insights from literature sources across the fields of design, environmental psychology and ethics. In order to convey complex ideas, the research also employed visual conceptual tools - schematic diagrams and mind-maps - to organize relationships between concepts. This conceptual approach, which was successfully utilized in previous research (Daugelaite & Grazulevicute-Vileniske, 2020; Daugelaite, 2023), was chosen because the research question addresses a knowledge gap - the need to broaden the anthropocentric outlook of interior design - which requires cross-disciplinary theorizing beyond the scope of a single empirical study.

A qualitative thematic literature analysis was conducted alongside theoretical conceptualization. Rather than a formal systematic review, a purposive strategy was chosen to capture a wide range of perspectives relevant to integration of plants in interior design. The majority of analyzed sources were peer-reviewed scientific journal articles, the review also included books, relevant essays and other documents that address indoor plants and interior design integrating plants from three angles - human well-being, design aesthetics and environmental ethics. Key inclusion criteria for the reviewed literature sources were: 1) relevance to human-plant interactions in interiors (studies on indoor vegetation effects, biophilic design elements, or plant care in design); 2) representation of ethical, aesthetic or psychological insights (for instance, works on plant ethics or environmental psychology); 3) recency or influence, prioritizing seminal theories and recent findings (e.g. classic works like Ulrich (1984, 1995) healing gardens study and contemporary research on plant well-being and human-plant interactions). The literature search spanned scientific literature databases, such as Web of Science, Scopus, Google Scholar, architecture, design and interdisciplinary sources, ensuring coverage of both design practice examples and scientific findings.

To ground the analysis, the study draws on several ethical, aesthetic and psychological theories related to human-plant interaction. These theories inform the interpretation of findings and the framing of recommendations. Below the key theoretical underpinnings in each domain were outlined.

Ethical theories. This study builds on environmental ethics and post-anthropocentrism, advocating for a shift from human-centered design to a more biocentric approach that recognizes plant life as intrinsically valuable. Concepts like plant well-being and deep ecology (Naess, 2017) highlight the moral responsibility humans have toward plants, treating them as co-inhabitants rather than decor. Legal and philosophical perspectives, such as the recognition of dignity of creatures in the Swiss

Constitution (Pouteau, 2014) and debates on plant rights (Marder, 2013), reinforce the need for ethical considerations in interior design.

Aesthetic theories. Aesthetic theories explain how plants enhance interior spaces by adding moderate visual complexity, balancing order and diversity in design (Ceria, 2022). Evolutionary aesthetics suggests that humans prefer curved, non-threatening plant forms, influencing species selection in interior design (Ellard, 2015; Doğan, 2023). Additionally, color theory highlights how foliage and flower colors impact emotions, with green promoting relaxation and warmer hues enhancing vibrancy (Elsadek *et al.*, 2017). Beyond visual appeal, multisensory qualities, such as fragrance and texture, also contribute to a more engaging and harmonious environment.

Psychological theories. Psychological theories explain the benefits of indoor plants for human well-being. Biophilia hypothesis explains human innate connection to nature (Salingaros, 2019), while stress reduction theory demonstrates how plant-filled spaces lower anxiety and improve recovery. Attention restoration theory suggests that exposure to greenery helps replenish cognitive resources (Zaleskiene & Grazuleviciute-Vileniske, 2014). Additionally, horticultural therapy research supports the role of plant interaction in reducing stress, improving mood and fostering mindfulness, reinforcing the link between psychological well-being and meaningful engagement with plants (Ellings, 2006).

3. Interior design trends integrating indoor plants and plant well-being and environmental ethics concerns

3.1. Integration of plants in interior design

Contemporary ecologically conscious interior design is inseparable from using plants in many cases. When considering interior design trends integrating plants, vertical green structures - biowalls, phytowalls or green walls - first of all come into mind besides the most common and obvious choice of potted plants. Green walls are designed structures which are built with the intention of covering the wall with vegetation that is alive rather than some green elements for decoration. Usually, they contain soil or other types of substrate and integrated hydration delivery systems for establishing a medium for the growth of the plants that can be used both in the interior and exterior design as an arrangement (Medl *et al*., 2017). Even though it might seem as if they only started to be used in architecture in the last few decades, the vertical green walls have a long history. Stanley Hart White, who was a professor at the University of Illinois, first patented his invention in 1938 (Hindle, 2012). According to his drawings and writings, he started to prototype this technology in the backyard of his residence in 1931 as a response to modern gardens (White, 1938). The ecological movement of the 20th century brought more radical ideas of bringing plants into interiors, for example the tree-tenant idea by F. Hunertwasser (Zaraś-Januszkiewicz *et al*., 2015). Overview of contemporary interior design trends, examples and practices has revealed that the options of plant integration in the interior have greatly expanded in the recent decades beyond the green walls and potted plants (Ceria, 2022). It can be metaphorically noted that minimalistic and sterile modern interiors face the entire “invasion” of plants. Plants can be integrated in all four surfaces of the room - walls, floor and ceiling, into various interior elements including furniture and artworks, on columns and staircases which can create aesthetically pleasing indoor-outdoor spaces interaction (Figure 1).

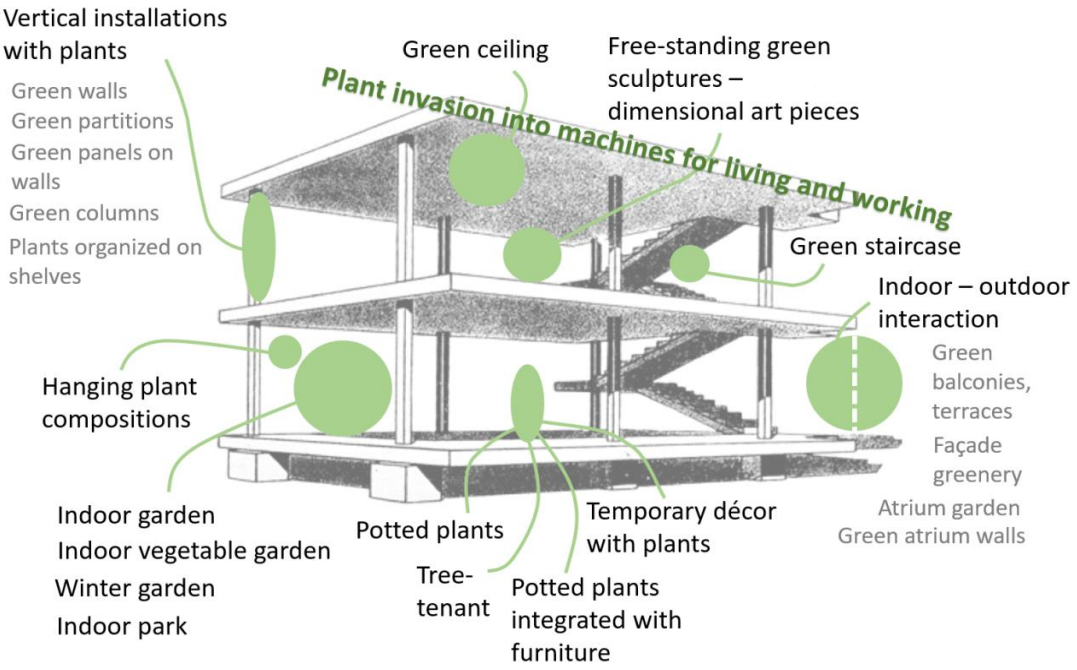

Figure 1. Contemporary possibilities of plant integration in interior design: plant "invasion" into minimalist sterile modern interiors
Source: Prepared by the authors based on Le Corbusier Dom-Ino house structure

Aesthetic effects of interiors with plants. The integration of plant installations in interior design can help bring a sense of nature and the outdoors into indoor spaces and serve as space-shaping elements for achieving various effects. For example, green walls, green partitions and other vertical interior elements with plants or even free-standing dimensional art pieces with plants can be used as a separation between spaces, which do not require an entire partition but a division. Therefore, they can provide a private space which contains translucent borders. Furthermore, according to further research on psychology and ecology, people prefer to see more than be seen in their surroundings due to the developed characteristics from their ancestors who lived in natural environments (Ellard, 2015). In that regard, traits inherited from their semi-transparent setting, which is provided by the interior plants, have the ability to assist in removing the feeling of discomfort caused by being on display, which can directly influence the perception of the space itself. On the other hand, plant installations can be used as a texture and to add a pattern to blank walls, which can have an impact on the perception of the space as well. Plants with attractive foliage, unique shapes, vibrant colors or interesting patterns can catch the eye and enhance the overall aesthetic appeal of a room (Ceria, 2022). They can serve as focal points or add visual interest and texture to an otherwise plain space. When the other visual stimuli in the space have insufficient information, it tends not to catch the attention of the observer and it can change the perception of the aesthetic characteristics of the surrounding.

Human well-being impacts of interior plants. Numerous benefits of plant integration into interior design are reported in literature. For example, plant installations like green walls, have the ability to work as a natural air conditioner. They can absorb air with high CO_2 (Drobchenko & Kurbanova, 2022). Furthermore, they can filter other pollutants and release oxygen, which can improve the quality of the air. However, in some cases, they can have some adverse effects on indoor air quality, especially scented

leaves or flowers, by releasing biogenic volatile organic compounds, which can cause indoor environmental pollution (Suárez-Cáceres, 2021). On the other hand, they can affect the acoustics of the surroundings as well. According to Gunawerdana and Steemers (2019), plants can weaken the noise by absorbing, diffracting and reflecting it. In particular, plants with dense foliage can be used in indoor spaces to control and decrease sound levels, which can be beneficial to the physical health of the people who are surrounded by indoor plants. According to the famous research of Ulrich (1984), which he performed in hospitals, nature and plants have positive effects on the recovery of hospital patients. Furthermore, they can positively affect a variety of health indicators, such as anxiety and blood pressure (Ulrich, 1995; Park & Mattson, 2008). Therefore, the plants in the environment can highly influence not only the hospital patients but also the well-being of human beings in general by reducing stress levels and improving mood (Bringslimark *et al*., 2009). Thus, it is not just the physical health that they can influence. It has been studied by various researchers that plants have the ability to affect mental health in a positive way as well, directly or indirectly (Mangone *et al*., 2017; Martin *et al*., 2020; Rudokas *et al*., 2020).

Plants and biophilic interior design. Not all the interiors with plants can be considered as biophilic, although, according to some researchers (Kavathekar & Bantanur, 2022), indoor plants can be seen as one of the indicators of biophilic design. Biophilia refers to the innate affinity of humans for nature and natural elements, an inborn tendency deeply rooted in human biology. The concept, introduced by E.O. Wilson and expanded by scholars such as S. Kellert and W. Browning has led to various interpretations and dimensions in biophilic design (Kavathekar & Bantanur, 2022) in order to achieve the harmony between human well-being and aesthetics in various designed environments. Notably, Browning et al. (2014) identified 14 key patterns subdivided into three groups - nature in the space, natural analogues and nature of the space - emphasizing essential connections between nature and human well-being within built environments, which are also integrated into standards like the WELL Building Standard rating system (Kavathekar & Bantanur, 2022). Salingaros (2019) distinguished the following components of biophilic index: sunlight, color, gravity, fractals, curves, detail, water, life, representations of nature and organized complexity. It is evident that plants have huge potential in biophilic interior design: their natural forms and fractal patterns create visually stimulating yet calming environments, while their organic curves soften rigid architectural lines. The vibrant colors of foliage and flowers contribute to emotional well-being, complementing natural sunlight to reinforce circadian rhythms. Additionally, plants interact with gravity perception through vertical gardens or hanging planters, introduce complexity and detail in space and symbolize life itself, fostering a deeper connection with nature indoors.

3.2. Environmental ethics concerns

Well-being of plants in interiors. Besides the above-mentioned mainly positive aspects of plants, several challenges of plant integration into interior design can be mentioned. First and foremost, plants require permanent care and have certain well-being requirements. Cultivation of plants indoors differs from growing plants outdoors. It is not a rare case to see withered plants in green interior walls. It is both economic loss and failure of design solution and clear signal that plants were not treated appropriately. Low-light interiors and low relative humidity will most likely produce a stressful environment for plants (Pennisi, 2009). In order to survive and maintain a healthy look, indoor plants

require appropriate lighting design and other microclimatic features such as temperature and relative humidity, soil or other growing medium, water and properly designed irrigation systems, nutrition, various maintenance, disease and pests' control (Pennisi, 2009). Due to predominant anthropocentric and animal-centric cultural attitudes, interior plant well-being does not attain sufficient researchers' attention and existing analyses are carried out from human perspective. For example, when studying risks and benefits related with indoor plants in healthcare facilities, risks, such as potential microbial infections and allergic issues are analyzed from an anthropocentric perspective (Moslehian *et al.*, 2023). Meanwhile plant care is reflected more as a hobby or technical procedure often involving newest technologies (Pennisi, 2009; Halgamuge *et al*., 2021). Literature and design examples analysis suggests concluding that current biophilic interior design integrating plants is mainly created and evaluated from the anthropocentric perspective: focusing on human benefits and treating man-made interior plant environments as mere settings for human action and well-being. However, term "plant well-being" exists and is used in research and some people taking care of plants identify themselves as "plant-parents", implying the possibility of widening the environmental ethical horizons of interior design towards more plant-centric attitudes (Mazzeo, 2021; Reyes & Navarra, 2022).

Plant ethics. The first widely known case of launching the issue of plant ethics in the public arena was an article in the Swiss Constitution adopted by referendum in 1992, which stipulates that "the dignity of creatures" should be considered in the case of animal, plant and microorganism life (Pouteau, 2014). "The dignity of creatures" may be interpreted in various ways in the context of plants. Some researchers criticize the application of these concepts to plants and call it "substantial personification". Another well-known example is "The Declaration of Tree Rights" that was adopted in 2019 in a meeting room of the French National Assembly in Paris by the non-governmental organization A.R.B.R.E.S during the symposium "Remarkable Trees" organized by a member of the National Assembly and former minister D. Batho, president of French political environmentalist party Génération écologie (Déclaration, 2019). The declaration has no legal status, but it is first of all aimed at changing the way people look at and behave towards trees, to make them aware of the crucial role of trees in everyday life and for the future. The Declaration proclaims that trees occupy two distinct environments, the atmosphere and the soil and perform a fundamental role in the ecological balance of the planet. According to the document, trees must be respected as such, cannot be reduced to a single object and must be entitled to the airspace and underground space, as well as respected for their physical integrity: aerial (branches, trunk, foliage) and underground (root network). The Declaration underlines that the average longevity of trees far exceeds that of the human being and trees must be respected throughout their life, with the right to develop and reproduce freely, from birth to natural death; moreover, trees must be considered as a subject of law. Undoubtedly trees are exceptional plants playing an enormous role in human-wellbeing and shaping of our environments; however, some of the statements of the Declaration can be applied to other plants, including indoor vegetation. Indoor plants are very often reduced to single objects or are organized into living green surfaces as monoculture. However, in natural settings plants make part of diverse ecosystems and are found growing in communities. In some interior design examples plants are even installed up-side-down or in other unnatural manners in order to achieve unusual aesthetic effects. Even if arranging plants as single objects or monoculture or even up-side-down technically does not hinder their growth and aesthetic

appearance, this may be seen as an environmental education challenge as it clearly exemplifies instrumental attitudes towards indoor plants. Buffon and Colagè (2022), meanwhile, argue that the environment has a profound pedagogical impact on human beings and on humanity as a whole and they propose a pedagogical criterion for ecological and sustainable development, which means that any change to the environment should also be seen from a pedagogical perspective. "The consequences it has in the learning processes all human beings constantly undergo all life long, the messages it passes to the people living in it, the effects it will have on the future generations and the contexts it will create for all aspects of human life" must be taken into account (Buffon & Colagè, 2022). Meanwhile the research by Nartova-Bochaver and Muhortova (2020) demonstrates that people who have more positive attitudes to the plant world have stronger general moral attitudes.

4. Psychological effects of plants on humans in interior design

Another research question crucial for the successful plant integration in interior design in order to achieve widely advocated human well-being benefits is the psychological effects of plants on humans. Various questions may be asked in this field: how human psychological reactions are related with shapes, colors of plants, do people react unconsciously to plant defense mechanisms (like thorns and needles or some visual features of poisonous plants), can plants stimulate different emotions in humans, do humans react in a similar way to all plants etc. This section presents a review of existing studies relevant for answering these questions.

In order to answer these questions, first of all general findings of environmental psychology can be applied. For an object to be aesthetically preferred, it should neither be too simple nor too complex, as these characteristics can trigger either boredom or distraction for the observer (Delplanque *et al.*, 2019). When the plants are used as a part of the design, the variation which can be created by the leaf shapes, sizes and surface textures can add depth and complexity to the overall design. As a result, the added palpable characteristics of the plants can contribute to a richer sensory experience, making a space feel more dynamic and engaging, which can have an impact on feelings and emotions as well.

According to Haviland-Jones et al. (2005), people have cultivated flowers in their surroundings for the last 5000 years, even without any benefit from them, rather than the pleasant feelings conveyed by them. In their research, they discovered that when flowers were explicitly presented to people, it could have a positive impact on their mood and at the same time, on their social interactions. On the other hand, the research of Mojet et al. (2016) reveals interesting results regarding the presence of flowers in a room and how they can influence perception even when they are not explicit. According to their research, flowers can positively affect the mood of people and their perception of others. Their performed survey suggests that people are more likely to perceive other people in a positive way when there are flowers in the room, even when there is not any explicit attention drawn to their presence and the emotional effects are measured by a seemingly unrelated test. Furthermore, flowers also had a positive influence on remembering the room itself as well. According to the same research, odorous flowers had a negative impact on the perception and the people in the demonstrated photographs seemed a bit more open, but at the same time, less friendly, more arrogant and more depressed. Therefore, it is essential to note that plants do not only influence judgment or perception

due to the way they look but also due to their characteristics which can affect or trigger other sensations as well. However, the visual appearance of the plants is their most common characteristic, which has been studied by scholars.

Most of the literature regarding plants, in the context of the environment and human perception, is focused on the three main areas. These include the relationship between biodiversity levels and human aesthetic preferences (Qiu *et al*., 2013), biodiversity and well-being (Fuller *et al*., 2007; Carrus *et al*., 2015) and aesthetics of green spaces and restorative effects of them (Van der Berg *et al.*, 2003; Pazhouhanfar & Kamal, 2014; Hoyle *et al*., 2019; Suárez, 2022). Perception of visual qualities of plants and their impact on people, in regard to the nuances related to the form, composition, color and character of plants which can be used in interior design, still requires more detailed research. However, research regarding the aesthetic perception of the space and its impact can be implemented for the perception of plants in interior design as well. For example, according to McGee and Park, color can modify the perception of architectural forms and spaces (McGee & Nam-Kyu, 2022). However, it is not only perception of architectural forms; colors can also carry meaning, influence cognition and behavior in achievements, and can affect contexts such as affiliation and attraction (Elliot & Maier, 2014). Furthermore, according to Hidayetoğlu et al. (2012), warm colors can promote memory recall. Therefore, it can be argued that the color of plant foliage and flowers can evoke different emotions and feelings for people who are in the same environment as these objects as well.

According to the research of Heerwagen and Orians (1993), one of the most common feelings that can be evoked by flowers is the feeling of safety. Flowers can indicate the presence of a rich environment that can include edible bulbs or fruits. Therefore, due to characteristics inherited from ancestors, they can provide information regarding survival for human beings. People tend to mainly prefer flowers with vivid and contrasting colors since they require to be visible from a distance (Hůla & Flegr, 2016). As Palmer and Schloss (2010) state, green and blue colors are likely to be preferred most of the time since they signify a rich and safe habitat with lush vegetation, water and clear sky. However, the combinations of some of the colors of the plants or the flowers in the interior design can give different messages to the people and create different atmospheres. According to Elsadek et al. (2017), the usage of green-yellow and bright, green-colored plants can be used in spaces which require comfort and calmness, while red and dark green plants can be used to create energizing emotional atmosphere in places such as offices and areas designed for children. However, green-white plants stimulated mostly negative emotions in their experiment. According to the experiment of Manav (2007), pink and yellow colors had stimulating hue effects and were associated with dynamism, cheerfulness and enjoyment, while green evoked feelings of excitement, relaxation and vividness, confidence and purity. Furthermore, blue was associated with calmness, being peaceful and cold. Thus, plants and especially flowering plants can also alter the perception of the space, which can directly and indirectly affect emotions, feelings and well-being. Even though these evoked emotions can be related to previous knowledge and experience, colors and shapes in one's surroundings can still have various associations, affecting the feelings while the observer is in the place.

In their research regarding the influence of shape and color on the beauty of flowers, Hůla and Flegr (2016) found that shape was more important than color in the overall understanding of beauty of flowers. In particular, radially symmetrical flowers with low complexity were more appealing to their participants, which is also similar regarding the

perception of aesthetics in general. One of the theories in the perception of aesthetics suggests that curved lines can establish the impression that the observed object is not dangerous, whereas spikey lines seem to be perceived as hurtful (Ellard, 2015; Doğan, 2023). However, this might not be the case in the perception of flowers in the surroundings. According to Coss (2003), elements such as thorns and spikes were dangerous for human ancestors and they might arouse strong emotions; however, they might not necessarily be negative in all cases. His experiments demonstrated that his participants (pedestrians and joggers) did not deflect from the provocative dagger-shaped plant when they were passing when it was compared with a rounded-leafed one. However, when the physical structures of the plants, such as cactus with their spiky and thorny leaves, are analyzed, it can be assumed that they would evoke the feeling of danger for the people around them. The experiment of Nates et al. (2010) suggests that the cactus and the other native thorny plant demonstrated to the participants were most disliked compared to other plants. Furthermore, the questionnaire of Sezen et al. (2017) indicates that only seven per cent of the participants stated that they prefer cacti or other thorny plants in their indoor environment. Therefore, thorny plants can be visually striking and might create discomfort, especially in spaces intended to be cozy. On the contrary, due to their evergreen nature, they tend to be easier to look after, which makes them one of the most popular plants used in interior design. Therefore, the choice of plants in the interior design can have various constraints to consider (Figure 2).

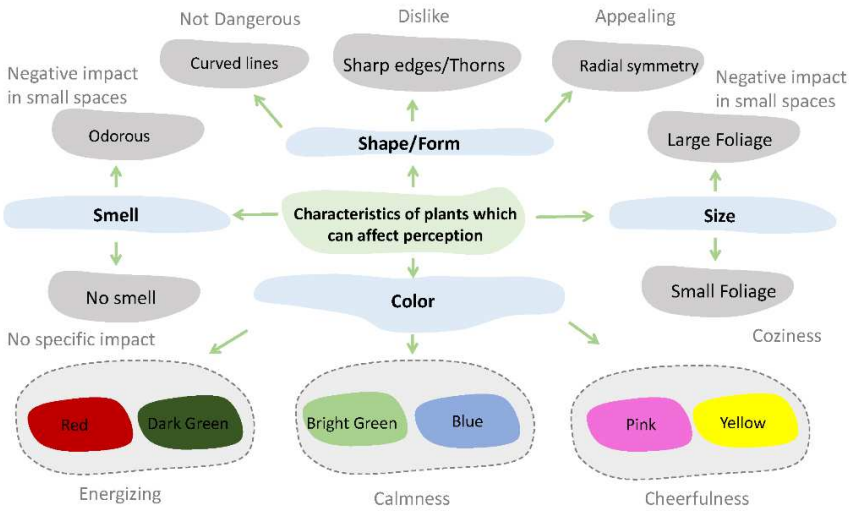

Figure 2. Characteristics of plants on humans and their psychological effects in interior design
Source: Prepared by the authors

On the other hand, it should be noted that the size and the scale of plants can be an essential feature which can affect perception as well. While using tall plants with large foliage can be convenient in spacious or empty spaces, using these kinds of plants in small places can restrict the usage of the space and affect the individual's mental health in a negative way (Sezen *et al*., 2017). Therefore, large plants that are out of scale for the spatial context can create a negative impact rather than a health benefit for people, even though they provide the natural elements in an indoor space. All these positive and negative outcomes of the usage of plants in interior design demonstrate that performing research regarding the impact of plants due to their forms, shapes and colors requires

broader research for establishing a better environment for people. The choice of plant color and shape can contribute to the desired atmosphere and mood in a space and it is important to conduct further analysis regarding these various attributes of plants to understand their perception.

5. Human-plant interaction in interiors and its potential to widen ethical horizons of interior design

The previous studies highlighted so far demonstrated that people-plant interactions in general and especially in relatively small interiors spaces compared to outdoor plant environments can be very diverse and subtle although are mainly based on anthropocentric approach. However, recent research findings related both to plant physiology and human-environment interconnectedness encourage rethinking such outlook on plants. For example, according to Buffon and Colagè (2022), the latest advances in the life sciences, culminate in the strong principle of complementarity between the organism and the environment. The environment influences organisms as much as organisms change the environment, so the relationship is strong and reciprocal. Meanwhile, Marder (2013) presents plants as beings capable of processing, remembering and sharing information and cites the experiment involving a plant species colloquially known as the common pea conducted by the team of scientists from the Blaustein Institute for Desert Research in Be'er Sheva, Israel. The results of this experiment, published in 2011, showed that a pea plant exposed to drought communicated its abiotic stress to other similar plants with which it shared root volumes. Figuratively speaking, according to Marder, through the roots, it gave its neighbors the biochemical message that a drought had begun, prompting them to react as if they were in a similar situation. Interestingly, plants that were not directly affected by this particular environmental stressor were better able to cope with the adverse conditions when they did occur (Marder, 2013). This means that the recipients of the biochemical signal were able to use their "memory" - information stored at the cellular level - to activate the appropriate protective measures and adaptive reactions when needed. Even if some researchers criticize such personalization of plants as in the above presented figurative account of the experiment as scientifically inaccurate (Pouteau, 2014), Marder (2013) raises the philosophical question: is it ethical to eat plants? In the context of this debate, it is relevant to look at the existing findings on human-plant interaction and how they can be relevant to interior design and approaches to interior plants.

People-plant interaction studies focus on the complex interactions that exist between humans and plants. According to Niazi, this field of research investigates how humans use plants as resources and imbue them with cultural and spiritual values (Niazi *et al*., 2023). Cho et al. (2015) underline the mutual or two-fold nature of human-plant interactions. The ways people may affect plants and plants may affect people were highlighted in previous sections. The research by DelSesto (2020) presents possible people-plant interactions including living plants that can appear in therapeutic gardening but are not limited to it in a structured way: sensory engagement with plant environments, walking, moving or wandering through plant environments, play or other non-plant activities in plant environments, counting, sorting and examining plant materials, table-top gardening and work with potted plants, digging, tilling, plowing or working with soil, making plant-based foods and products, garden planting, weeding, pruning or harvesting. These actions can be further categorized into various degrees of peaceful abiding, tactile

immersion and physical exertion. Reyes and Navarra (2022) use the term "plant engagement" in their study and define it as human connection and experience with plants and distinguish the following human motivations for plant engagement: leisure, stress relief, business, learning, aesthetic, collection, gift, companion, trend. It is evident that part of the reasons for human interaction with plants are based on instrumental and part-on intrinsic value that humans attribute to plants. Researchers also pay attention to specific characteristics of human experiences with plants - intuitive, pre-linguistic or nonverbal lived experience and activities that come before words and purely rational concepts. According to Lee et al. (2015), contact with plants can stimulate four senses in various ways and lead to such experiences as "whirlwind of passion".

DelSesto (2020) has analyzed based on George Herbert Mead's theory of human stages of acting (impulse, perception, manipulation and consummation) how engagement with plant environments can form and transform human self. Figure 3 based on the research by DelSesto (2020) summarizes four stages of acting and how they can occur in plant environments and what human-plant interaction type (peaceful abiding, tactile immersion and physical exertion) they can involve. He concludes that with each act there is the potential to develop a wider perspective on the world, thus Figure 3 further illustrates potential widening ethical horizons and human self-transformation towards the ecological self as described by Naess (2017), in which plants become important and active participants. Moreover, DelSesto (2020) notes that interaction with plants can eventually lead to profound shifts in collective consciousness.

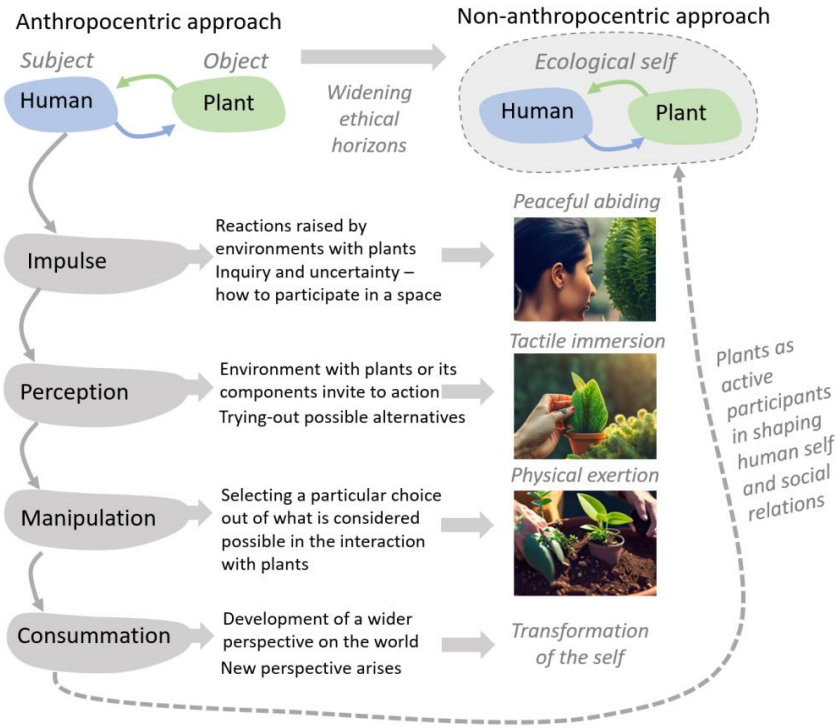

Figure 3. Stages of human perception and ways of human-plant communication
Source: Prepared by the authors based on DelSesto (2020)

As it was mentioned above, human-plant interaction is a two-fold process. The studies of how people respond to and interact with plants are widely developed, however still there is less evidence how plants react to external stimuli including interaction with

humans. According to Fromm and Lautner (2007), a weak electric current can be measured in plants and it can change due to external stimuli. For example, when plants were subjected to negative physical stimuli, such as cutting leaves or touching a hot object, amperemeter readings were found to change rapidly (Mousavi *et al*., 2014). Cho et al. (2015) note that plants can respond to external stimuli in a way that we humans hardly recognize.

Cho et al. (2015) conducted an experiment with the aim to test how people would respond to immediate reactions of plants to external stimuli if these reactions, "emotions of plants" as they referred in this research, were directly visible or audible. For this purpose, they used LED emoticon-based device as an emotional proxy for delivering inner states of a plant subjected to external stimuli. This study suggested that people's attitude on plants can be influenced by observing the "emotional expressions" of a plant. Cho et al. (2015) agree that their study had many limitations, nevertheless it concluded that emotional connection to plants - empathetic reactions towards plants - of study participants has increased. This allows making the presumption that closer and more attentive interaction with plants, deeper knowledge about their nature can significantly change attitudes and perspectives towards indoor plants.

6. Discussion and Conclusion

The analysis of literature and existing research has revealed the ambiguous situations in the field of human-plant interaction. From one point of view, humans are inseparably connected with plants and depend on them for survival. From another point of view, humans have developed anthropocentric and animal-centric attitudes, tend to ignore the contribution of plants to their well-being and do not even notice the presence of plants. The indoor lifestyle of contemporary urban populations also contributes to the deepening alienation from nature and the plant environment. However, the rise of biophilic hypothesis and the growing volume of studies revealing human dependence on nature in recent decades caused the emergence of the opposite trend and helped to increase the contact with nature and natural elements in every step of peoples' daily routines.

As it was previously mentioned, contemporary humans tend to spend more and more time indoors, consequently, indoor plants have become an increasingly important well-being factor. Contemporary interior design is not limited to potted plants and green walls but, in some instances, becomes an entire plant "invasion" into previously sterile modernistic environments. In that regard, interior design integrating plants can provide people with more opportunities to interact with plants. Plants as living entities require appropriate conditions in indoor environments in order to avoid stressful states for them. Plant well-being is rarely considered in the interior design context and the users, especially in commercial, public environments, workspaces consider plants more often as a background than active and important participants of the space; however, such emerging trends as "plant-parenting" challenge merely instrumental attitudes to indoor plants and call for more attention towards the well-being of indoor plants as well as for more active and meaningful interaction with them.

While existing studies have examined plant preferences in landscape architecture, there is a lack of research on indoor plant aesthetics and their psychological effects in various cultural contexts. Primarily cultural and regional variations in plant perception, which can develop inclusive and adaptable design strategies, require to be researched

further. Additionally, further investigation is needed into the ethical implications of integrating plants into interior design, moving beyond human-centered frameworks to consider plant well-being. Furthermore, there is a need for a more detailed investigation regarding the potential that the technology can create, such as AI-driven plant monitoring and smart environmental controls, which can improve plant care.

The article demonstrates the importance of plants in interior design through various perspectives, such as ethical, aesthetic and psychological and emphasizes their impact on the environment. **Ethically**, the study critiques the prevailing anthropocentric approach in interior design, which often views plants as passive background elements rather than living beings with intrinsic value. Concepts such as plant dignity and environmental ethics challenge designers to consider plant well-being alongside human benefits and focus on caring for plants. While indoor plants are frequently selected based on human preferences, in fact, their care, the location in which they are placed and maintenance require ethical responsibility. The emerging research suggests that plants can respond to environmental stimuli, raising questions about the moral implications of using them purely for aesthetic or functional purposes. This perspective calls for a shift in design philosophy to one that respects plants as co-inhabitants of interior spaces rather than mere objects for human enjoyment as decorative elements.

On the other hand, **aesthetically**, the research demonstrates that the use of indoor plants can contribute to architectural spatial solutions, such as semi-transparent partitions creating senses of refuge and perspective, creating patterns, textures, the play of light and shadow, creating focal points of compositions and adding visual interests with colors and shapes. When there are plants in interior spaces, the level of visual complexity increases, which makes the space more engaging and harmonious. Furthermore, plants function as natural design elements that soften modern, minimalist interiors, adding depth and vibrancy. However, the selection of the plants is important for achieving the best results. As it was discussed in the article, cascading greenery can create a sense of organic fluidity, while structured plant arrangements can establish order and symmetry. However, aesthetic considerations should not come at the expense of plant health. Ethical concerns arise when plants are used purely for visual effects without proper environmental conditions for their survival. Designers are required to find a balance between aesthetics and ethics, ensuring that plant integration enhances both human experience and ecological responsibility.

Psychologically, the study emphasizes the profound impact of plants on human well-being. Numerous findings indicate that plants contribute to stress reduction, improved mood and cognitive restoration. The biophilia hypothesis supports the idea that humans have an innate connection to nature, making interior plants a crucial element in fostering comfort and relaxation Different plant characteristics, such as color and form, evoke distinct emotional responses. Green foliage and bright green or blue colored flowers are associated with calmness and focus, which makes them ideal for workspaces. On the other hand, red and dark-green colored flowers can create an energising atmosphere in social or creative environments. Moreover, human-plant interactions extend beyond passive observation; activities such as caring for plants or engaging with green installations can promote mindfulness and psychological resilience. Furthermore, indoor plants can become important human well-being enhancers by functioning as natural air conditioners, improving air quality and room acoustics, absorbing noise and contributing to physical, psychological health, improving mood and productivity of users of interior spaces. However, the study also raises questions about subconscious reactions

to certain plant forms, such as thorny or asymmetrical species, which may trigger discomfort or unease. Existing studies reveal that people react emotionally and psychologically to size, scale, shapes, colors, defensive mechanisms (thorns, needle), conditions (blooming) and other characteristics of plants and these characteristics can influence preferences towards interior environments with indoor plants. It is believed that further research is needed so that it would be possible to explore how plant characteristics, such as shape, color and scent, impact human perception and emotional well-being, particularly in enclosed indoor spaces.

In order to take benefits of these design and well-being opportunities, several aspects, that should be considered, were distinguished and discussed in this research: well-being of indoor plants used in interior design, miscellaneous psychological effects of plants on humans that should be taken into account when designing interiors where close human-plant interaction occurs and human-plant interaction question in general, calling for better understanding of plants, meaningful activities involving interior plants and potential widening environmental ethical attitudes as a consequence of these interactions. Figure 4 briefly summarizes subtopics and questions distinguished as a guideline for further research.

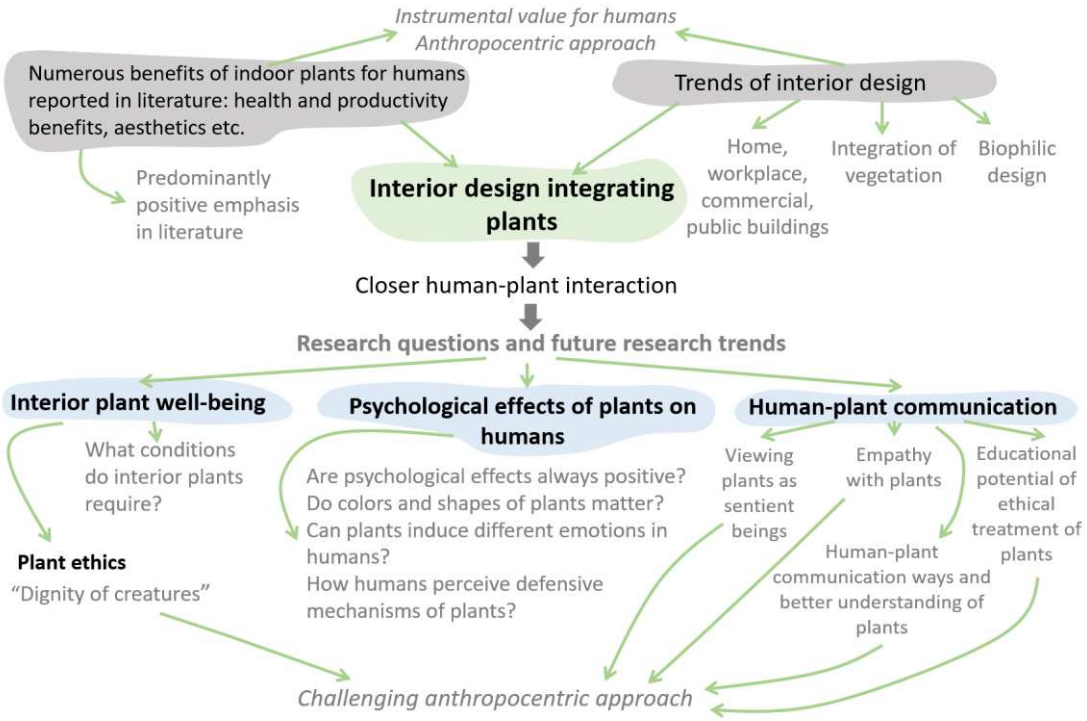

Figure 4. Generalization of research findings and future research directions
Source: Prepared by the authors

Human-plant interaction studies underline that people can be involved in the interaction with plants in various degrees of peaceful abiding, tactile immersion and physical exertion. The knowledge from the fields of therapeutic horticulture and horticultural therapy demonstrate that such interactions can contribute to psychological stability and even healing of traumas for humans (Ellings, 2006). Moreover, according to DelSesto (2020), by communicating with plants and directing "attention outside of

immediate calculative self-interest" people may experience self-transformation and widening of ethical horizons. After analysis of horticultural therapy literature, it is possible to propose human-plant communication forms as components of interior design, for example observation and contemplation of plants and life in general, learning about the nature and well-being of plants, routinely taking care of plants by the users of the space not only by hired professionals or even indoor gardening.

According to results of this research, it is found crucial for interior designers and architects to adopt an integrated approach that considers ethical responsibility, aesthetic enhancement and psychological benefits when incorporating plants into interiors. In that regard, it is believed that the findings of this study can establish relevant theoretical and practical implications. Theoretically, the study challenges the dominant human-centered perspective in interior design and proposes a more holistic, ethical approach that considers plant well-being integral to sustainable design. By incorporating environmental ethics, the study broadens the scope of interior design beyond aesthetics and functionality to include moral responsibility toward living organisms. The research situates interior design within broader disciplinary dialogues, indicating that thoughtfully designed human-plant interactions can foster greater empathy toward nature and also enrich theoretical discourse in both ethics and psychology. Practically, these insights can inform architects and interior designers in creating spaces supporting human and plant well-being. As a result, several key recommendations emerge from this study. First of all, strategic plant placement should be prioritised to maximize both functional and aesthetic benefits. Secondly, ethical design practices should guide plant selection and maintenance. Designers should avoid purely decorative plant arrangements and instead consider the environmental conditions necessary for plant health, including light, humidity and irrigation systems. Thirdly, the psychological impact of plants should be carefully considered. By embracing these principles, designers and architects can create spaces that not only enhance human well-being but also promote a more ethical and sustainable relationship with nature.

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