CONNECTION BETWEEN GREENERY AND WORKPLACES

PhD thesis - Abstract

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The incursion into the paper "Connection between greenery and workplaces" is achieved by evoking a great challenge of the century: the human-nature connection. German philosopher Erich Fromm explains, in the reference work, "*The art of loving*" [6], the human belongingness to nature through the multiple connections translated into the inner attachment to it. Despite the environmental segregation occurred along with the evolution of technology and the built fabric, the connection cultivated throughout the generations remains deeply rooted in the human subconscious, in its moral and aesthetic behaviour and preferences, defined by philosophers and anthropologists as man's intrinsic love for nature and living beings, or "Biophilia" [25].

Remaining within the scope of the primordial requirements, the survival instinct, the procurement of food and the maintenance of the household have always imposed a lifestyle based on the existence of a job in order to ensure the income needed for the family supply. This model, perpetuated over the centuries, becomes for the contemporary man a lifestyle, a way of expressing the beliefs and ideals about the world, as now, in the knowledge society, it comes to occupy a significant percentage of the time.

The topics of nature and of the place of work will be intertwined within the thesis, having as a coagulating factor the human being in his physiological, social and emotional complexity. The topic needs attention both at a local and global level, and for the sake of research coherence, the legislative and applicative study part has been reduced to a precise geographical location, namely the metropolitan area of Paris. Three essential arguments justify the choice:

• Professional considerations of the author, whose design activity in the field of tertiary architectural design has been carried out within the company Consulting, Design & Build (CD&B) Paris, starting with 2014;

• The complexity of the business field, the history and the various architectural typologies encountered in practice, as well as the related legislation;

• The intensified approach in the last decade, regarding the conservation and enrichment of urban green infrastructure through strategies imposed at various intervention scales in the specified area.

The thesis includes two parts, the first one theoretical (chapters 1-5), the second one applicative (chapters 6,7). The succession of the study topics aims at highlighting some aspects relevant to the relationship between the office and the human being with the natural environment. Structured from general to practical, each chapter from the first 5 is dedicated to a distinct topic, the analysis of which follows well-defined objectives, which lead progressively to the applications presented in Chapter 6, respectively the conclusions and future directions of research and practice highlighted in Chapter 7.

The commencement focuses on the topic "*Evolution of the program from a historical and functional point of view*" (Chapter 1) in order to identify the current requirements in terms of work, then moving towards "*The influence of the office building on the outdoor environment*" (Chapter 2), the first known interaction level of the office architecture with the environment,

highlighting the importance of the location and the relationship of the office building with the environment and local identity. The second topic is "*The influence of the office building on the occupants*" (Chapter 3) which aims at defining modern human requirements regarding the workspace and the interaction with nature. The unification of the first two topics is accomplished in the process of identifying "*Biophilic characteristics in the office building*" (Chapter 4). The nature and the plant world are ubiquitous aspects, to which constant reference is made throughout the work, but the detailed analysis is found in the study "*Feasibility of vegetation in constructions*" (Chapter 5), the intention of which is to emphasize the functional contribution of vegetation in the workplace.

The strategies for integrating vegetation into the office architecture represent the main contributing part, being presented in detail by means of the "*Method of integrating vegetation into the typology of the collaborative office. Theoretical applications and case studies*" (Chapter 6). These methods constitute a guide for the implementation of natural elements in various situations, depending on the typology of the office, location and planimetry, outdoor or indoor interventions.

The field of study is addressed to a public made up of professionals in the field of architecture, business (investors, managers, employees/employers) and all the people who work in an office and want to improve the quality of life, by reconnecting to nature and vegetation. The final objective is to establish a set of general functional rules, adaptable to the built context, for the strategic, planned incorporation of the vegetation and of the sources of natural inspiration in the architecture of the administrative buildings.

The main hypotheses of the study are:

• The relationship between the administrative building and the plant environment: Is this a real necessity or a temporary tendency?

• Can plant growing processes be considered models for the spatial organization and operation of the office?

• What criteria determine the qualitative and quantitative implementation of a planting system and how does it influence the indoor and outdoor layout of the office?

1. EVOLUTION OF THE ADMINISTRATIVE PROGRAM AND FUNCTIONAL GENERALITIES

"Architecture failed to keep up with the technological progress pace of the era." (Le Corbusier- "Vers une architecture")

"Modernism (...) failed to accommodate human functions and requirements." (Lewis Mumford)

Evolution of work and of the workspace

The development of the workspace [15] involves topics such as the emergence of new professions, the transformation of the manner of working throughout generations, the needs and preferences of employees and employers in relation to the dynamics of society and time. The history of the office is described with the emphasize of periods and intentions of relating space to the vegetation, thus highlighting how this direction appears punctually, but the need is constantly manifested, in order to be outlined in a standalone style nowadays.

Practicing agriculture represents the first widespread human occupation, implicitly related to the natural environment. The emergence in the Neolithic Era (6000 BC) and the extension over the millennia, shape the relation of human proximity to nature. The Medieval Era draws attention by the appearance of the craftmanship and the formation of the first hierarchical professional communities (the craft guilds), models for organizing work in later eras. The Industrial Revolution, manifested at the same time as the diversification of jobs in the field of services, is remarked by means of the emergence of scientific management and of productivity growth strategies [17]. The "Taylorist management" period is characterized by restricted conditions of ergonomics and comfort in the workplace, while only isolated examples

pointed out in the paper represented exceptions of the time.

The twentieth century presents the first stages of the diversification of the office building, with the rise of the business environment and the requirement to supplement the surfaces of this program. An effect of rapid expansion of the domain, standardization and modularity in constructions is reflected in the "International Style", a trend with a uniform approach, which causes reactions without delay. Thus, the "Landscape Office" uses natural organic models for the first time, in generating the spatial configuration, representing the response to the standardization previously occurred. In a similar way, the "Active Office" designed by Robert Propst [1], continues the intention of making the office dynamic by creating flexible furniture. However, the context of the period cancels the directions towards flexibility on the background of spatial inefficiency, creating the furniture unit, a symbol for the modern office, known as “the cubicle”, massively used during the years 1980-1990.

The “Digital Revolution”, the debut of which is known to have taken place in the 1990s and continues to this day, is characterized by the diversification of configurations and the emergence of arrangements adapted to the company's activity. The campus-like office, conceived in the urban sense, the organizational culture, the shared office or coworking, are models that primarily approach the environmental and spatial quality of the office simultaneously with the wellbeing of the employees.

Functional analysis of the contemporary office

The transition towards new configurations in the arrangement of the office is achieved along with the development of the trades in the field of computer science and creation, occupations that require the appreciation of human capital as essential for the future of the business environment. Human requirements become the engine of operation in the workplace, imposing spatial relationships and Activity-Based Work configurations. At the same time, there is another change, at managerial level, regarding the suppression of thinking and hierarchical organization at team level. Thus, inter-human relations become similar to an *ecosystem*. The functions within the office are diversified within the meaning of introducing common spaces for recreation, sport, socialization and collaboration, which were mainly isolated in previous models [15;22]. Within the context of nature, these common areas are capable of accommodating plant systems, with high potential in the cognitive restoration of users.

2. ECOLOGICAL IMPACT OF THE ADMINISTRATIVE BUILDINGS OVER THE ENVIRONMENT

"To move forward, it is necessary not only to change the workspace, but even the cities." (Francis Duffy)

Effects on the environment: urban and architectural

With the increase of built density and the decrease of ground surface in intra-urban perimeters, the extension of the constructed network became imminent, to the detriment of natural habitats that are thus subject to the fragmentation of green infrastructure. The case of massive urbanization, reflected by the appearance of mega-cities (between 18-90 million inhabitants), has become a worrying factor, determinant in the reassessment of the manner of thinking and building, in the light of more probable speculations of growth of the urban population to 60% in 2030 [9].

Interactions of architecture with the environment imply an understanding of two directions of influence of the facade: from the point of view of the relation with the outdoor, respectively with the indoor. Chapter 2 analyses the first typology, while the second will be presented in Chapter 3.

The relationship of the office building location with the vegetation

In the light of what was stated in the first chapter, work went through several stages throughout generations, and the indoor layout partially reflected these changes. The outside, however, has retained the principles dictated by the International Style for a long time, regarding uniformity in architectural aesthetics.

Poor integration in the context and the unitary treatment of administrative architecture, especially regarding the design of new constructions, caused the moral and visual breakdown of urban landscapes. The effect on users and on the community is transposed in attitudes of alienation from nature and the cultural background, resulting in stress conditions as consequences [8, pp. 29, 133].

The paper proposes a different perspective on the relation of the office building location with vegetation, in the sense of designing the layout and the plant zones, in relation to the constraints imposed by urban conditions. Thus, the position within the constructed network and the planimetry attract certain approaches regarding the insertion of vegetation inside or outside the building.

In order to explore the urban subject in a real context, a description of the situation of the insertion of office buildings in the capital of France, Paris was made. With a specific European urban landscape, regarding height restrictions in the central area, Paris comprises three fundamental urban typologies: the central business district (superimposed on the historical area), the modernist neighbourhood La Défense (suburban) and the recent (suburban) neighbourhoods, designed following the Eco-Neighbourhood certification standards Saint-Denis, Saint-Ouen in the North and Issy-les-Moulineaux in the South. Each requires compliance with European and national legislation, with local variations, different uses of urban vegetation, attracting beneficiaries and companies with different profiles.

Legislation and certification

Ecological certifications in architecture have been limited to reducing energy and resources consumption, using costly technologies, without impact on the quality of indoor environments and therefore on improving users` lives. Sustainability, viewed in the contemporary sense, is a holistic approach at various levels: regional, local, urban and architectural. The certification of the construction is achieved by taking into account the ecological behaviour throughout the lifetime, from construction, to exploitation and re-functionalisation, while aiming at the quality of the indoor space and the impact on the health of the occupants.

The paper highlights manners of intervention applied in Paris, from ecological projects at neighbourhood level, the ecological revitalization of industrial areas, individual and public projects (the Biotope Area Factor), to small interventions practiced by citizens (the Vegetalization Authorization), all aimed towards promoting biodiversity. The Biotope Area Factor is the formula used for efficient sizing of green spaces in design, currently used in western European states. It represents the ratio between the area favourable to the ecological arrangement and the total area of the plot and determines the use of various plant systems in relation to the built environment.

The brief review of international certification systems reveals multiple perspectives in approaching certifications and including their adaptability, and what is important for the present topic is the reference to natural elements associated with human activities: natural light, vegetation, spatial dynamics, air and water quality, aspects that as a whole, create *inner comfort.*

3. THE IMPACT OF THE OFFICE BUILDING ON THE OCCUPANTS

"Sedentarism is the new vice. " [4, p. 18]

The human factor at the centre of the office layout

Treating workplace as secondary in relation to human needs has produced negative effects on employees and productivity in general. Increased comfort in the office has been perceived so far as consuming financial resources, with results that are vaguely noticeable in production. However, research literature and the practice situations show considerable improvements in changing the concept from "staff expense" to "staff investment", and at the physical level, transforming the office from "workspace" into "workplace".

The enquiry in future work, raised by the International Labour Organization, evokes two essential aspects that have determined the transfer of attention from production and management, to the human being and the framework in which he carries out his activity: on the one hand, the occupational evolution and work patterns, which require focus on creativity and quality of work, and on the other hand, the comfort of employees, a problem constantly highlighted in the history of the office. The chapter therefore seeks to identify contemporary human requirements within the workspace, how these can be reflected on the configuration and relationship with the plant world.

Collective thinking shaped within the office is an implicit result of grouped, collaborative or individual activity. The work group and the inter-human interaction existed both in the industrial and in the tertiary environment, not being considered as essential for building a good productive climate, until recently. Belongingness is among the present indispensable requirements [8, p. 105], hierarchically placed immediately after physiological needs and safety. Community feeling, reflected in the organizational culture, is fed by common ideals, field of activity, preferences, the cumulative purpose of which is to channel efforts towards fulfilling the company's tasks.

Challenges such as intergenerational collaboration and the personality of the employees are recurring topics in the configuration of present and future offices, considered as determinants for large companies and suppliers of indoor design products.

Wellbeing is the key word transmitted in most of nowadays design topics from the beneficiaries, administrators of the workspaces, involving a high degree of subjectivity, criteria such as indoor quality, comfort and occupants` health both mental and physical.

Influence of vegetation on indoor comfort

The paper refers to the comfort of the employees in theoretical and applicative manners, as an essential component of the layout, comprising: physiological, functional and psychological comfort [23]. Although the particularity of each situation implies differentiation in terms of the analysis, there are certain basic criteria such as sanitary and hygienic conditions (natural light, ventilation, acoustics, humidity) that can increase or damage the spatial practicability. *Functional comfort* refers to the spatial configuration and the facilitation of carrying out activities in the workplace; involving employees in the design decision-making process brings further benefits in this respect. *Psychological comfort*, the most complex one, implies a close relationship of the user with the place and the community, determined by the sense of belongingness at the individual level and within the collaborative functions. Another implication of psychological comfort is territoriality, or the possibility of local adaptation and personalization of the workplace, where the aesthetic issues become relative, and the individual perception prevails.

The relation to the natural environment is a physiological and psychological aspect as well, coming recently to the attention of the tertiary domain. International research developed by the sustainable commercial carpet company, Interface [9], a work environment deprived of

contact with nature, is accompanied by negative health and wellbeing effects on users: 47% of respondents attest to the limited access to natural light, and 58% declare the absence of vegetation near the working desk or in the field of vision. In contrast, all employees who are welcomed by bright environments enriched with natural elements are more creative and productive, according to the same study.

The ways of creating a human-nature relationship can be resumed by three principles:

• *Directly experienced nature:* use of plant elements and living animals, growing processes, adaptation and relationship patterns;

• *Indirectly experienced nature*: use of natural elements extracted from their habitat and introduced into anthropic environments, such as aquariums, potted plants, fountains, green walls or planted terraces. These represent adapted micro-ecosystems that require consistent maintenance in order to thrive once removed from the original context;

• *Symbolically experienced nature*: a method practiced since Antiquity through metaphorical or stylized expressions, in ornamentation, painting and architecture, of natural inspiration forms.

The importance of Biophilia in administrative architecture

Biophilia, by the definition formulated by American biologist and researcher Edward Owen Wilson, represents "man's instinctive preference towards natural shapes, geometries or features of the environment" [25]. The transposition of the Biophilic Hypothesis into the design practice is achieved by the ecologist and sociologist Stephen Kellert [13] by defining the biophilic attributes, structured in three main categories: *natural analogies, spatial composition and nature in space*, largely associated with the experimentation modalities mentioned above.

Reflected in productivity, biophilic design is approached in multiple situations, as it is not a new topic in tertiary design. The "Hawthorne effect", or the studies of the psychologist Judith Heerwagen [7], highlight the economic importance of green buildings with biophilic arrangements, in parallel with productivity benefits, in terms of the following aspects: air quality and ventilation, thermal comfort, light, configuration, acoustics, biophilia and perspectives, environment and location.

Performance in the office work of the Digital Age is "quantified" through efficiency, optimization and creativity, being activated by an equally complex framework of spatial and environmental characteristics.

4. BIOPHILIC CHARACTERISTICS IN THE OFFICE BUILDING

The need for human reconnection with nature

Various practices of restoring human relation with nature have been applied duringt the last decades, being based on the alienation from nature and progressive living isolated from the outdoor environment. Sedentarism and other chronic illnesses have been associated with a lack of connection with nature and spending extensive time indoors. In the culture of the Far East, where the most frequent deaths caused by labour exhaustion were recorded, "Shinrin-yoku" [24] (known as "forest bathing") is practiced, a therapeutic technique that involves immersion in complex natural landscapes and experiencing them through all senses. The noticeable effects are: reduction of blood pressure, of stress level, improvement of physical and mental state.

Geographically opposite, in the West, psychologist Stephen Kaplan [11] promotes the same principles, researching the Attention Restoration Theory, based on the ability of the natural environment to emit a reduced range of negative stimuli for voluntary attention [21], unlike the workplace where attention is constantly oppressed by technological and human factors. Nature thus provides the framework for concentration and deep thoughts, enhancing introspection and creativity.

Sensory perception and attention

The ability of the human brain to filter information from the environment helps limit the negative stimuli that affect the body, being particularly important for the proper cognitive functioning, creativity and productivity development. Attention is a subject studied primarily in the field of psychology, being equally important in architecture and design, where the balance of stimuli emitted by the spatial and decorative elements causes various cognitive effects.

Active or directed attention requires significant mental effort, being limited in terms of temporal capacity to engage in demanding activities. For long-term operations, rest and recovery periods are required, imposing an alternation between concentration and detachment. Passive attention, on the other hand, is stimulated by environmental factors such as sounds, light, air currents, natural landscapes [24, p. 42], which may influence the psychic positively (relaxation) or negatively (distraction).

Natural elements in the language of spatial perception

Although vegetation was analysed for the physiological and psychological contribution, the introduction of the concept of functional vegetation is particularly important in the context of the paper, continuing the idea formulated by Stephen Kellert "For functional results, nature and its simulations must exceed the decorative stage" [13, p 164]. In this chapter we analyse the potential of vegetation-function correlation, viewed within the meaning of changing spatial perception.

Therefore, from a compositional point of view, the plants inside can be transformed into representative elements for: centres of interest (actions that gravitate towards plant elements), shapes (conducting activities with the integration of plant volumes or surfaces), backgrounds (visually supports and defines the place where multiple activities are carried out). From a perceptual point of view, these can define: simulated vertical or horizontal closures, visual and acoustic separations, delimitation of component planes of the space.

Although the studies try to explore the characteristics of vegetation, except the aesthetic ones, visual characteristics cannot be neglected, since the presence of vegetation in architecture is visually noticed at first, through morphological and chromatic contrast.

Colour psychology associates human emotions with perception, often referring to the evolutionary theory [16]. Researchers Karen Schloss and Stephen Palmer define chromatic choices in the form of "Theory of the ecological valence of chromatic preferences" [19] by unconscious or conscious chromatic selection, based on past experiences. Therefore, it is assumed that the coloristic preferences arise with the individual’s evolution, through the positive or negative association of object-colour or experience-colour. Preferences differ according to age, culture [9] and are less related to gender differences, despite certain preconceptions [18]. The "Savannah hypothesis" [13], on the other hand, frames chromatic preferences in the spectrum of natural colours, being based on the implicit human-nature connection.

Design examples of biophilic offices

The thesis proposes three examples of tertiary architecture, found in the main study area, Paris, that show good practice strategies from the Biophilic Hypothesis point of view. For accuracy, the applied analytical method followed the model used in the "Terrapin Bright Green" report [5], fundamentally based on Stephen Kellert's research on Biophilia in the indoor space. Thus, the following buildings were selected: "Capital 8", belonging to the Parisian Central Business District, the "Carpe Diem" building from the renowned La Défense area and last but not least, the "La Manufacture Design" building located in the Saint-Ouen Eco-neighbourhood, in the north of Paris.

The examples served for identifying the strategies locally used in the study area, facilitating the implementation of biophilic criteria, in correlation with the local tendencies in the projects described at the end of the thesis. The main observations extracted from this analysis are summarized below:

• Compensation for the absence of urban vegetation by introducing plant systems indoors, associated with common functions;

• The use of faded chromatic ranges in accordance to the general idea of natural inspiration, especially in the work areas;

• Identification of hierarchy in the use of planting material: the vegetation subordinated to space (in the work areas), space subordinated to vegetation or defined by it (in common and relaxation areas);

• The warm-cold, rigid-soft natural materials and textures, simulate alternations and diversity characteristic of the natural environment;

• Organic forms found especially in furniture, but also in defining architectural elements, emphasize the principles of biomimicry [3];

• The spatial configuration outlines the harmony between open and withdrawn areas, providing multiple adaptations to occupants, depending on the activity undertaken;

• The three examples include ecological characteristics that enhance indoor quality, attested by energy and ecological certifications.

5. FEASIBILITY OF VEGETATION IN CONSTRUCTIONS. IDENTIFICATION OF OPTIMAL SYSTEMS FOR OFFICE SPACES

"It is said that the 20th century was the century of physics, the 21st century will therefore be the century of the natural sciences (...). I believe that such a transformation is already visible." (Christopher Alexander," The Nature of Order: An Essay on the Art of Building and the Nature of the Universe, 2003)

Green infrastructure

The objective of the incursion in the topic of vegetation feasibility in the built environment, specifically in office buildings, resides in the orientation towards the application of sustainable design methods, based on the preservation and development of green infrastructure components. In an area with substantial economic potential, it is important that investments are directed to the benefit of the entire community.

Green infrastructure includes interconnected elements at various scales (continental, national, regional, urban, local) of core and linear type. In correlation with the thesis subject, the components were structured according to the potential of their relationship with the building facade: green systems inside and on the interior cover of the building, core-like intermediate green areas, green areas exterior to the building.

The contribution of each system to the coagulation of green infrastructure is highlighted by the ecological index [12]. Although the ecological contribution of vertical plant surfaces is among the lowest, these have great potential in a multitude of constrained urban situations:

• Vegetalization solutions in densely built mineral areas;

• Ecological option, adaptable to both outdoor and indoor spaces;

• Financially adaptable typologies;

• Easy adaptation to site requirements.

The studies carried out within the thesis, revealed that the extensive decorative use of green walls in the office building, leads to losing much of the real benefits of such a system.

Origins and evolution of vertical gardens

The review of the evolution of vertical gardens leads to the functional essence of the system, of support in viticulture and agriculture, respectively of shading system. Vegetation related to the residence was regarded as a privilege in the ancient world and later in the

Renaissance and Baroque, the glory periods of the noble gardens. Botanists like Roberto Burle Marx, Francis Hallé and the naturalist Friedrich Hundertwasser, undertook studies throughout the twentieth century on the incorporation of species into gardens, later reflected in the plant works of the renowned French botanist Patrick Blanc.

Looking at the characteristics of vegetation in the Parisian metropolis, one observes a long tradition in urban agriculture, interrupted during the 19th century, the first major period of expansion. The modernization of the capital, led by the prefect Georges-Eugène Haussmann, implies opening large parks to the public and the planting of alignment trees. The approach continues to the present day, being planned at various intervals of intervention, already leading in 2017 to 2888 ha of urban green spaces.

Vertical vegetation is preserved as a sign of authenticity and local memory, being frequently introduced in public and commercial buildings.

Function of vertical vegetation in constructions

Highlighting the functions of vertical vegetation in the current context of combating climatic phenomena, determines the understanding of the importance of these interventions in architecture:

• The contribution of vertical vegetation to the physiological comfort has been exploited since ancient times in the traditional Nordic architecture, from the point of view of thermal comfort improvement. In the case of workspaces, the practice evokes beneficial situations regarding temperature variations, thermal transfer, the reduction of heat accumulation by up to 75% in the hot season and the loss of heat by 60% during the cold period [14];

• The contribution of vertical vegetation on psychological comfort is also mentioned in this section, in order to highlight systems and connectivity with office activities. Thus, in practice, one can see a tendency to correlate sports activities and of social interaction with indoor plant systems, on the one hand, and the visual connection to outdoor landscapes with concentration activities on the other;

• The contribution of the vertical vegetation on the functional comfort evokes the inefficient use of the vertical systems from the point of view of the occupants' perception, because the logic of locating the living walls is often based only on aesthetic reasons. The perception of indoor vegetation takes place when it is integrated into a coherent compositional ensemble, related to the field of activity, regional, architectural character and spatial concept.

Classification of vertical plant systems

The virtues already stated attract the attention of the business environment, determining a frequent use of green walls. Different green wall implementation strategies are determined, first of all, by their position in the building: systems adapted to external spaces (green facade and the botanical architecture method), respectively indoor (living walls in continuous or modular systems). Choices in substrate types, irrigation technology and plant species depend mainly on the site conditions such as: location, lighting, humidity, ventilation and activities in the vicinity.

The role of vertical vegetation in acoustic attenuation

The sound-absorbing function of the vegetation is intentionally analysed differently within the paper, being regarded as a determinant in the vegetation-workspace relationship. Acoustics is a problem worth considering when designing the office, as the negative impact on employees is strong enough, so that noise represents one of the major complaints about space quality [10] and a real stress issue. Economically efficient, due to the lack of compartmentalization and carpentry, the open-plan office used on a large scale since the 1990s, brings the inconvenience of constant noise.

Plant acoustic solutions for office spaces have been used in the form of sound-absorbing finishes such as carpets, vertical and horizontal separation panels, acoustic furniture, perfected in recent years. Studies that bring botany and acoustics together argue that sound is perceived at a lower intensity if the sound source is visible to the receiver [2]. The implicit correlation of natural landscapes with the feeling of calm and tranquillity is also due to human experience [2; 19], which unconsciously indicates the attenuated perception of noise in relation to vegetation.

The reduction of harmful sound can provide rules for positioning the planted system, of structuring and selecting plant species, through an approach based on measurements and needs analysis, resulting in an optimized system. The density of the foliage layer, the superposition of foliage, and the size of the leaves are essential for meeting the needs of phonic absorption.

6. METHODS OF INTEGRATING THE VEGETATION IN THE TYPOLOGY OF THE COLLABORATIVE OFFICE. THEORETICAL APPLICATIONS AND CASE STUDIES

Chapter 6 describes the theoretical and practical association of some reflections resulting from the incipient part of the thesis. The research and the case studies belong to the professional activity and research of the author, representing possible strategic approaches used to clarify ways of implementing vegetation in office spaces.

Vegetation and Biophilia in European coworking spaces

In the context of current design trends, biophilic office layout seems to be preferred, and investments focused on complex plant installations are a common practice. Personal observations from the professional environment led to questioning these practices in the sense of perception (from the point of view of the occupants), respectively of the economic feasibility (from the managerial point of view). Therefore, the following question seems fair: "Is Biophilia and especially vegetation, perceived as positive by the occupants of the coworking spaces in Europe?".

The method involved analysing and structuring freely-expressed reviews of coworking spaces users, retrieved from the public database of the www.coworker.com online platform, regarding the spaces chosen for carrying out collaborative activities. The initial premises, favourable to the perception of vegetation, were diverted following the study to new perspectives, unexpected, but beneficial to the overall vision:

• Decorative vegetation is rarely perceived as a beneficial element in space, and as a result, users do not reason with this kind of approach;

• Natural landscapes located in the vicinity determine positive reactions, in association with sports and recreational activities. The correlation of the vegetal frames with common functions is perceived positively, turning vegetation into a background for conducting various activities;

• The harmonious use of remote and shared workspaces is more important than the allocation of an extended area to a unique configuration;

• The geographical location was essential in the perception of indoor vegetation, since the only positive reactions came from the areas of cold climate states.

Indoor vegetation: perception of green colour in the office

The study on green chromatics in the office involved the imagistic analysis of four spatial categories (common area, front desk area, conference area, work area) belonging to ten Parisian office locations, arranged with the integration of Biophilia, including indoor vegetation. The online application used for the chromatic decomposition of images is https://labs.tineye.com/color/, which allows the percentage chromatic identification.

The exclusive use of vegetation in relation to common functions (front desk, saloon, cafe) is noted. For workspaces, the association of natural representations simulated by chromatics and materiality is practiced, avoiding the visual overload that can occur from the use of plants; outdoor vegetation, visually accessible during the performance of daily tasks, on the other hand, offers opportunities for cognitive and visual rest, beneficial in the work process.

Analytical method of the green characteristics of office buildings

The theoretical reference to the real estate field within the thesis, reveals the economic potential of the sustainable criteria for evaluation, especially regarding the comparative (empirical) method and the financial theory (it aims at estimating the dynamics of the property in the future) [20]. In this regard, the proposal of a "green index" that summarizes criteria such as: energy certification, proximity to the urban nature and the presence of vegetation associated to the construction, is useful for highlighting all the "green" characteristics of the building.

The Parisian metropolitan area represented the study area, regarding the urban context of 100 buildings selected from the main business areas: The Central Business District, La Défense and sub-urban neighbourhoods. The attractiveness and different character of the built fund determines different economic categories, and the comparison of the buildings can be made only by the comparative method and zoning structure.

The correlation of these indices with the lease cost shows that the relationship with nature brings economic benefits, regardless of the location in the constructed network. The result is an additional argument for the feasibility of real estate investments aimed at sustainable development.

The influence of planimetry and location in the arrangement of offices

Following the previous research, the recurrence of planimetric typologies specific to each urban area was observed. Therefore, the classification into three main categories was associated with the construction site, indicating a different approach to the ways of introducing the natural elements:

• *Compact planimetry* - large business centres: flexible furnishing configurations, introduction of vegetation in common areas and correlation of function with outdoor landscapes;

• *Patio planimetry* - historical areas: organization of furnishing in compartmentalized spaces, exploitation of generous surfaces and heights from the first floors, introduction of vertical plant systems in the inner courtyard;

• *Inhomogeneous planimetry* - suburban areas: flexible configurations, strong indoor-outdoor relationship, landscaping treatment of the outdoor.

This structure serves to identify potential intervention methods in different urban contexts, regarding efficient correlation of the indoor plant systems with existing green spaces, planimetry and interior partitioning, methods that will be further applied in the case studies of the next subchapter.

Flexible-biophilic spatial configurations - the association of the natural model with the operation of the contemporary office

The three case studies presented in the last subchapter are defined by applying the conclusions drawn from previous research, adapted to the requirements and characteristics of the given situation and client demands. The projects described are: a conceptual planning of a coworking space in the Parisian Central Business District, the conceptual planning of a contest-project in the former industrial area of Lyon and the design of the headquarters of a company in an extra-urban context in Lyon. The projects were accomplished in collaboration with the design department of Consulting, Design and Build, Paris, and represent adaptations made by

the author to the initial concepts in harmony with the topic of the research, except for the last project (gave into use in 2018), which is presented faithfully, as it summarizes a number of principles relevant to the paper.

Next, we will briefly mention the main observations for highlighting the specific character of each project:

• *Coworking in the historical centre:*

The challenges of the project: adapting new models of dynamic layout to a rigid planimetry and obtaining the ecological coefficient.

Suggested solutions:

- use of unused built vertical surfaces for supporting vertical gardens, in a context presenting a lack of ecological horizontal surface;
- relationship between the inner courtyard/atrium defined by planted walls and common functions of leisure, collaboration and sports;
- hierarchy of accessibility: public access, common functions at the lower levels, restrictive access, functions for members on the upper floors;
- the absence of urban nature is compensated by the two green areas specific to the building and the general applied Biophilic concept.

• *Refunctionalization in an industrial area*

The challenges of the project: dividing a single volume to accommodate various types of activities, relationship with the outdoors, creating comfort in an industrial aesthetic.

Suggested solutions:

- the spatial division through the treading plan, the provision of areas with lowered ceiling for concentration and refuge activities;
- exploiting the generous height of the space by introducing the multi-role vegetation: visual, spatial fragmentation, sound attenuation;
- common-individual functional harmonization using specialized furniture;
- preserving the industrial character and the local memory by inserting the water feature as a visual and physical delimitation between the public area of the building and the one destined for the resident companies.

• *Nature in corporate culture:*

- the location defined by the criteria of the EverEst Eco-neighbourhood in the suburban area of Lyon is also reflected in the choice of location for the headquarters of Bonduelle Fresh;
- conceptual correlation of the nature and culture of the company through chromatics, materiality, functional structure, symbolic references to plant elements and living plant systems;
- complex project where all three biophilic categories are implemented;
- the vegetal systems are associated with the common areas: atrium-tree, front desk-vertical garden, cafe - planted separating system, terrace-green terrace;
- the optimal balance between vegetal relation with the outdoor, respectively the indoor systems, consists in the quality offered by the perception thereof, not in the quantity of the planted material.

7. PERSONAL CONTRIBUTIONS AND CONCLUSIONS

Personal contributions

The present research aimed at deepening a topic of general interest, being addressed to the actors involved in the interaction with office spaces, either as occupants, administrators or professionals in the field. Beyond the simplicity of the advanced idea of "vegetation-setting",

the topic has become very complex, and the multidisciplinary approach imperiously necessary. Of the possible directions opened after the deepening of the vegetation field, the most relevant was selected, the one considered perfect for the relationship of human with nature. Biophilia became, thus, the related specialty between the administrative function and the plant connection, having the human factor constantly interposed. The main contributions are briefly listed below:

• Structuring the research topic and selecting the main directions of study is a first contribution to clarifying the role of the plant world in architecture;

• The progressive reduction of the analysis field to a geographical area and a specific architecture program, was part of the decision-making process of the research;

• The professional experience in the segment of tertiary design constituted the main reasoning for choosing the administrative architecture program;

• Strategies for integrating vegetation into the office architecture are the main contributing part. Overall, these represent a guide for the implementation of natural elements in various contextual situations;

• Introducing the principle of vegetation hierarchy in relation to space and function is a contribution aimed at rationalizing the implementation;

• The introduction of the "Green" Index makes the connection between real estate evaluation process and the set of sustainable office building criteria. The importance of the concept is given by the research that evokes the contribution of vegetation to real estate value;

• Functional vegetation is one of the essential concepts addressed in the thesis, in order to highlight the multiple contributions of the plant environment to the proper functioning of the workplace;

• Highlighting the acoustic criterion for the configuration of vertical plant systems introduced in the open plan office.

Future directions in research, practice and education

The thesis is structured as a research model with extrapolation potential for any geographical area, despite the reduction of the present study to the urban areas belonging to the French built fabric.

Future intentions, explained in the final chapter of the paper, refer to the application in research, profession and educational projects, based on the conclusions drawn from the present study. By taking over the models of good practice identified in the studied geographical region, actions will be started mainly in the Romanian context, where the field of administrative architecture is in an incipient stage compared to other areas.

General conclusions

The sequence of information within the thesis was fundamental for the correlation of various concepts and the natural conduct of the research. The architectural creation is regarded as a means of dialogue between indoor and outdoor space, between building and occupant, and the role of nature, particularly of plants, becomes a guiding topic for the research.

The professional activity in the field of interior office design, carried out concurrently with the completion of the thesis, facilitated the engagement of the research in practice. The research represents the theoretical supplementing and specialization of the author in the direction of biophilia, an increasingly frequent requirement from companies and employees. Discrepancies between environmental trends, "commercial" design and the real challenges, raise problems of financial nature that favour the association of natural interventions with non-feasible investments.

Considering the foregoing, the feasibility of vegetation in architecture becomes a long-term strategy. Moving the attention from aesthetics, towards the role of nature as an integral

part of the general functional scheme, one observes a paradigm shift of the concept "plants in architecture" towards the possibility of multilateral analysis. The integration of vegetation as a unique, decorative element in the office space, is unlikely to determine a coherent environment with substantial impact over the occupant.

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